



Government of the People's Republic of Bangladesh  
Ministry of Water Resources  
Bangladesh Water Development Board  
Water Resources Planning Organization

# COMPARTMENTALIZATION PILOT PROJECT TANGAIL

28



## FINAL REPORT

Annex D-Institutional Development  
Annex E-Agriculture  
Annex F-Fisheries

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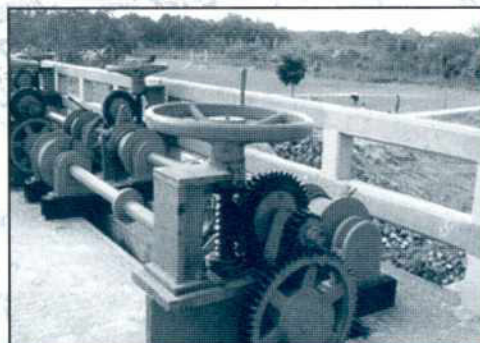
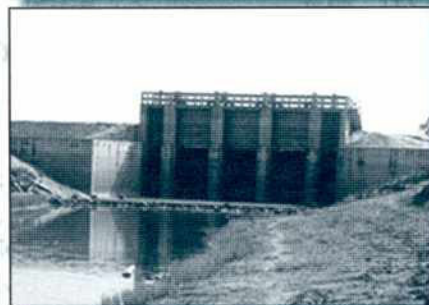
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# COMPARTMENTALIZATION PILOT PROJECT TANGAIL



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## Acronyms and Abbreviations

AA	-	Adjacent Area
AARC	-	Adjacent Area Represent Committee
ADAB	-	Association of Development Agencies in Bangladesh
ADB	-	Asian Development Bank
ADP	-	Annual Development Plan
AEP	-	Agriculture Extension Program
AEZ	-	Agro- Ecological Zone
AIT	-	Asian Institute of Technology
ARC/INFO	-	GIS Software program
ASSP	-	Agricultural Support Services Project
ATAP	-	Annual Technical Assistance Program
BADC	-	Bangladesh Agricultural Development Corporation
BAE	-	Bilateral Associate Expert (GoN)
BAFRU	-	Bangladesh Aquaculture and Fisheries Resources Unit
BARI	-	Bangladesh Agricultural Research Institute
BARD	-	Bangladesh Academy for Rural Development
BBS	-	Bangladesh Bureau of Statistics
BCAS	-	Bangladesh Center for Advanced Studies
B/C ratio	-	Benefit/Cost ratio
BELA	-	Bangladesh Environmental Lawyers Association
BFRSS	-	Bangladesh Fisheries Resources Survey System
BKB	-	Bangladesh Krishi Bank
BLE	-	Bangladesh Left Embankment
BM	-	Bench Mark
BMD	-	Bangladesh Meteorological Department
BMDC	-	Bangladesh Management Development Centre
BPIS	-	Buried Pipe Irrigation System
BR	-	Bangladesh Rice
BRAC	-	Bangladesh Rural Advancement Committee
BRDB	-	Bangladesh Rural Development Board
BRE	-	Bangladesh Right Embankment
BS	-	Block Supervisor
BSS	-	Bittahin Samabay Samity (Landless Cooperative Society)
BURO	-	Bangladesh Unemployment Rehabilitation Organization
BUET	-	Bangladesh University of Engineering & Technology
BWDB	-	Bangladesh Water Development Board
BWFMS	-	Bangladesh Water and Flood Management Strategy
CA	-	Command Area
CARE	-	Co-operative for American Relief Everywhere
CC	-	Chawk Committee
CDS	-	Controlled Drainage Structure
CE	-	Chief Engineer
CFD	-	Controlled Flooding & Drainage
ChWMC	-	Chawk Water Management Committee
CMG	-	Canal Maintenance Group



CPP	-	Compartmentalization Pilot Project
CPPSC	-	Compartmentalization Pilot Project Steering Committee
CPT	-	Core Planning Team
CT	-	Consultants Team
CWMC	-	Compartment Water Management Committee
CWM forum	-	Compartment Forum
DAE	-	Department of Agricultural Extension
DC	-	Deputy Commissioner
DEM	-	Digital Elevation Model
DFO	-	District Fishery Officer
DGIS	-	Directoraat Generaal Internationale Samenwerking
DFL	-	Dutch Guilders
DHI	-	Danish Hydraulic Institute
DLAC	-	District Land Acquisition Committee
DoF	-	Department of Fisheries
DPHE	-	Department of Public Health Engineering
DS (WL)	-	Downstream Water Level
DSS	-	Departmental Social Services
DTC	-	District Technical Committee (Agriculture)
DTW	-	Deep Tube Well
DWA	-	Deep Water Aman
DWTA	-	Deep Water Transplanted Aman
EAD	-	Expected Annual Damage
EC	-	Executive Committee
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
EMG	-	Embankment Maintenance Group
EMP	-	Environmental Management Planning
EPT	-	Extended Project Team (CPP)
FA	-	Financial Assistance
FAP	-	Flood Action Plan
FAP 19	-	Geographic Information System FAP
FAP 20	-	Compartmentalization Pilot Project FAP
FAP 25	-	Flood Modeling and Management FAP
FAO	-	Food and Agricultural Organization
FCD	-	Flood Control and Drainage
FCD/I	-	Flood Control, Drainage and Irrigation
FDAM	-	Flood Damage Assessment Modeling
FFW	-	Food for Works
FMM	-	Flood Management Model
FPCO	-	Flood Plan Co-ordination Organization (merged with WARPO)
FRG	-	Federal Republic of Germany
FRI	-	Fisheries Research Institute
FTG	-	Farmers Testing Group
FWMM	-	Flood and Water Management Model



FY	-	Financial year
GB	-	Grameen Bank
GDI	-	Gender related Development Index
GIS	-	Geographical Information System
GHK	-	Consultants Group
GoB	-	Government of Bangladesh
GoN	-	Government of Netherlands
GPA	-	Guidelines for Project Assessment (FPCO 1992)
GPC	-	Gated Pipe Culvert
GPI	-	Gated Pipe Inlet
GPS	-	Global Positioning System
GPV	-	Gross Product Value
GO	-	Government Organization
ha	-	Hectares
HD model	-	Hydrodynamic Model
HDI	-	Human Development Index
hh	-	Household
HTW	-	Hand Tube well
HYV	-	High Yielding Variety
ICDDR'B	-	International Center for Diarrhoeal Disease Research, Bangladesh
ICID	-	International Commission on Irrigation and Drainage
ICWMC	-	Initial Compartmental Water Management Committee
ID	-	Institutional Development
IDC	-	Information Dissemination Center
IDP	-	Institutional Development. Promoter
IOV	-	Inspectie Onderzoek Ter Velde (DGIS- M&E unit)/ Operations Review Unit (Ministry of Foreign Affairs GoN)
IPM	-	Integrated Pest Management
ISPAN	-	Irrigation Support Project for Asia and the Near East
IWRM	-	Integrated Water Resources Management
JrE	-	Junior Engineer
JMBA	-	Jamuna Multipurpose Bridge Authority
JWME	-	Junior Water Management Engineer
KfW	-	Kreditanstalt für Wiederaufbau
KJDRP	-	Khulna Jessore Drainage Rehabilitation Project
KSS	-	Krishak Samabaya Samity
LCS	-	Landless Contracting Society
LGED	-	Local Government Engineering Department
LFP	-	Lohajang Flood Plain
LLP	-	Low Lift Pump
Lps	-	Liters per second
LUS	-	Land Use Survey
LV	-	Local Variety
MAEP	-	Mymensingh Aquaculture Agriculture Extension Programme (GoB)
MARC	-	Multi - Action Research Center
MBSS	-	Mohila Bittahin Samabay Samity (Women's Landless Cooperative Society)





ME	-	Mechanical Engineering Department, BWDB
M&E	-	Monitoring & Evaluation
MDF	-	Management Development Foundation, Netherlands
MDSCS	-	Multi- disciplinary Sub- compartmental Survey (CPP)
meq	-	Milliequivalent
MIKE II	-	Name of Modeling Program
MIWDFC	-	Ministry of Irrigation, Water Development and Flood Control
MoU	-	Memorandum of Understanding
MOT	-	Manually Operated Tubewell
MP	-	Muriate of Potash
MPO	-	Master Plan Organization (now WARPO)
m+ PWD	-	Meter plus Public Works Department
MT	-	Metric Tons
MV	-	Modern Variety
MoWR	-	Ministry of Water Resources (formerly MIWDFGC)
NAA	-	Northern Adjacent Area
NACOM	-	NGO
NAM	-	Rainfall -runoff module of MIKE II
NAS	-	Needs Assessment Survey
NAI	-	Needs Assessment Intervention
NCA	-	Net Cultivable Area
NCRS	-	North Central Regional Study
NGO	-	Non-Government Organization
NPV	-	Net Present Value
NWMP	-	National Water Management Plan
NWP	-	National Water Policy
NWRS	-	North West Regional Study
ODA	-	Overseas Development Agency
O&M	-	Operation and Maintenance
OFR	-	On- Farm Research
OFRD	-	On-Farm Research and Demonstration
OFTD	-	On-Farm, Testing and Demonstration
OFTR	-	On- Farm Testing and Research
OM	-	Organic Matter
P	-	Phosphorus
PAP	-	Project Affected Person
PC	-	Project Council
PD	-	Project Director
pH	-	Hydrogen-ion concentration
PoE	-	Panel of Experts (FPCO)
PPG	-	Peoples Participation Guidelines
PPM	-	Parts per Million
pm	-	Person month
PRA	-	Participatory Rural Appraisal
PSA	-	Production System Analysis



PT	-	Project Team
PWD	-	Public Works Department
RASDO	-	Rural Agricultural Social Development Organization
R&H	-	Roads and Highways
RF	-	Resident Facilitator
RNE	-	Royal Netherlands Embassy
RRA	-	Rapid Rural Appraisal
SATU	-	Social Advancement through Unity
SC	-	Sub-Compartment
SCF	-	Standard Conversion Factor
SCWMC	-	Sub-Compartment Water Management Committee
SDE	-	Sub-Divisional Engineer
SFS	-	Social Forestry System
SIDO	-	Sr. Institutional Development Officer
SIR	-	Sirajganj Interim Report
SIRDp	-	Sirajganj Integrated Rural Development Project
SMG	-	Structure Maintenance Group (CPP/PAP)
SO	-	Section Officer
SRDI	-	Soil Resources Development Institute
SSS	-	Senior Scientific Officer/ Society for Social Services
SRP	-	Systems Rehabilitation Project
SUS	-	Samaj Unnayan Sangstha
STW	-	Shallow Tube Well
SWMC	-	Surface Water Modeling Center
TAPP	-	Technical Assistance Project Proforma
TA	-	Technical Assistance
T- Aman	-	Transplanted Aman
TARD	-	Technical Assistance for Rural Development (NGO)
TC	-	Technical Committee (MWR, GoB)
TCM	-	Tangail Compartmental Model
TIR	-	Tangail Interim Report
Tk	-	Taka
TL	-	Team Leader
TN	-	Technical Note
TNO	-	Thana Nirbahi Officer
ToR	-	Terms of Reference
TSP	-	Triple Super Phosphate
UNDP	-	United Nations Development Program
UNICEF	-	United Nations International Children's Emergency Fund
UP	-	Union Parishad
UPOMA	-	NGO
UST	-	Unnayan Shahajogi Team
WARPO	-	Water Resources Planning Organization
WB	-	World Bank
WCS	-	Water Control Structure



WFP	-	World Food Program
WID	-	Women in Development
WME	-	Water Management Engineer
WMC	-	Water Management Committee
WP	-	Working Paper
WUG	-	Water Users Group
XEN	-	Executive Engineer (CPP)
XO	-	Extension Overseer
Zn	-	Zinc



# Glossary

<i>Aman</i>	A group of photoperiod-sensitive rice planted in May-August and harvested in November-December.
<i>Aus</i>	Photoperiod-insensitive paddy varieties grown with irrigation from December -February
<i>Baor</i>	Oxbow lake, natural depression usually formed by the change of course of rivers
<i>Bazar</i>	Market place
<i>Beel</i>	Small lake, low-lying depression, a permanent body of water in a floodplain or a body of water created by rains or floods.
<i>Bidi</i>	Local Cigarette
<i>Bigha</i>	Unit of land (1/3 of an Acre)
<i>Boro</i>	A group of photoperiod-insensitive and fairly cold tolerant rice varieties transplanted in December-February and harvested in April-May.
<i>Borrowpit</i>	Excavated small and seasonal water bodies present mainly along the public roads.
<i>Catch Assessment</i>	Determining the daily catch of the fishermen
<i>Catch per unit</i>	Quantity of fish caught by the fishermen in unit time and effort (Fishing equipment)
<i>Chamara</i>	Important deep water <i>Aman</i> variety
<i>Chari in the Bari</i>	A ditch on the homestead
<i>Chawk</i>	A readily recognizable manageable field unit bounded by village roads and settlement areas. These are physical entities and are easily recognized by village people. Each chawk has water inlet or outlet through bridges, culverts, road breaches etc.
<i>Chula</i>	Home made furnace
<i>Cluster</i>	A group of sub-compartments, which are merged together for management reasons. Their hydrological features resemble an independent status.
<i>Compartment</i>	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.
<i>Crore</i>	100 lakh
<i>Cusec</i>	Discharge unit: 1 cusec equals 28 liters per second
<i>Decimal</i>	Unit of area measurement, 40 m <sup>2</sup>
<i>Deshi Jute</i>	White jute ( <i>Corchorus capsularis</i> ) varieties, tolerant to standing water.
<i>Dhaincha</i>	An erect leguminous species ( <i>Sesbania sesban</i> ), used for green manure and fencing
<i>Doon</i>	Traditional water lifting device
<i>Dopa</i>	Lowest land type according to farmers' classification
<i>DW Aman</i>	Deep water <i>Aman</i> , a rice variety
<i>Frame Survey</i>	A survey for estimating the number of fishermen or gears.
<i>Hat</i>	Weekly market
<i>Hijoldigha</i>	Important deep water <i>Aman</i> variety
<i>IPM</i>	Integrated Pest Management, a balanced combination of pest control measures, including biological, mechanical and chemical methods, based on observations of population levels of pests and predators, economic thresholds and scoring.



<i>Jalmahal</i>	A leased water body or river stretch.
<i>Khal</i>	A natural channels.
<i>Kharif</i>	Crop season from March-October (Kharif-I: March-June, Kharif-II: July-October)
<i>Khash land</i>	Land owned by the government
<i>Kutchra</i>	Unlined earthen channel
<i>Lakh</i>	100.000
<i>Madrasha</i>	Islamic School
<i>Mastan</i>	Muscle man/thug
<i>Mohalla</i>	Urban village
<i>Multi-criteria analysis</i>	An analysis and display of the impacts of proposed structural and non-structural works in which a wide range of criteria is 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.
<i>Pagar</i>	Small water body
<i>Palam</i>	Homestead land
<i>Patchot</i>	Intermediate land type according to farmers' classification
<i>PA-Matrix</i>	A relational matrix, depicting links between participants and activities in a certain process.
<i>Parishad</i>	Council
<i>Perching</i>	Placement of branched sticks (perches) in crop land as resting place for insect-eating birds.
<i>Pourshava</i>	Town council
<i>Pucca</i>	Lined earthen channel
<i>Rabi</i>	Crop season (November-February)
<i>Rapid Rural Appraisal</i>	A systematic, but semi-structured activity carried out in the field by a multi-disciplinary team and designed to quickly acquire information. Bacterial processes of separating jute fiber in standing or slows running water.
<i>Retting</i>	Bacterial processes of separating jute fiber in standing or slows running water.
<i>Salish</i>	Traditional informal village court which mitigate the disputes of the vilagers. The traditional village Matabbars (Chieftains) are the judges.
<i>Sub-Compartment</i>	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 and provided with (semi) cotrolled structures.
<i>T. Aman</i>	Transplanted Aman, a rice variety.
<i>Tan</i>	Highest land type according to farmers' classification.
<i>Thana (previously Upazila)</i>	Local administrative unit. Each Thana is composed of 10-15 Unions.
<i>Tossa Jute</i>	Jute ( <i>Corchorus olitorius</i> ) varities, grown in the highest land types, not tolerant to standing water.
<i>Union</i>	Smallest electoral unit of areas outside municipalities comprising several mouzas (or villages), and generally divided into three wards. It has a Union Parishad (Council). Local administrative unit. Each Thana is composed of 10-15 Unions.



02

**Annex D**  
**Institutional Development**



# Table of Contents

<b>Introduction</b>	1
<b>Commencement of the Project</b>	2
CPP Initiation	2
Institutional Development Experiences Elsewhere	2
National Policies on Institutional Development	3
Institutional Development During Project Identification, 1989	3
Institutional Development in the Terms of Reference, 1990	4
General	4
The Project Concept	4
Consultants' Technical Proposal, 1991	5
<b>People and Institutions</b>	6
Existing Interest Groups	6
High Land and Low Land	7
Upstream and Downstream	8
Inside the Compartment and Outside	8
Rural Elite, Small Farmers and Landless	8
Boatmen	9
Professional Fishermen	10
Commercial and Industrial Sector and Tangail Town Dwellers	11
Women	11
Existing Institutions in the Area	11
Flood Control and Water Management Organizations	12
Other Stakeholder Organizations	12
Elected Local Government	13
Non-Governmental Organizations	13
Government/Semi-Government Agencies	13
Bangladesh Water Development Board/Ministry of Water Resources	13
Other Government Agencies	14
<b>The Activities as Implemented</b>	15
CPP Set-up and Resources	15
Summary of Starting Conditions	16
Concept Development, 1990-1993	17
Need Assessment Among Stakeholders, Spring 1992	20
Preparation of Stakeholder Consultation, Mid 1992	20
Development of Options	20
Intervention by the FPCO	22
The Abridged Consultation Process	23
Consultation of Stakeholders, 1992-1994	23



<i>Project Design, 1993</i> .....	25
<i>Construction of Infrastructure, 1991-1999</i> .....	26
<i>The System Management Requirements</i> .....	27
Formation of Lower-Level Water Management Institutions, 1994-1998.....	29
<i>Phase I Chawk and Sub-Compartment Committees</i> .....	29
<i>Phase II Chawk and Sub-Compartment Committees</i> .....	32
Formation of Compartment-level Institutions, 1996, 1999.....	36
System Operation, 1995-1999 .....	37
<i>Operation 1995-1997</i> .....	37
<i>Operation 1998</i> .....	37
<i>Operation 1999</i> .....	38
<i>Fisheries-Related Issues</i> .....	39
Strengthening Chawk & Sub-Compartment WMC's, 1996-2000.....	39
<i>Committee Training</i> .....	39
<i>Developing of Procedures, By-laws, O&amp;M Plans</i> .....	40
<i>Legalization</i> .....	41
<i>Information Dissemination</i> .....	42
Preparation for Operation by BWDB O&M and Compartment WMC, 2000 -.....	42
Maintenance.....	42
Institutional End Results.....	46
<i>Government Agencies</i> .....	46
<i>Water Management Committees</i> .....	46
<i>Institutional Arrangements</i> .....	47
<b>Lessons Learnt</b> .....	48
Involvement and Consultation of Stakeholders, GO's and NGO's .....	48
<i>Stakeholders</i> .....	49
<i>Bangladesh Water Development Board</i> .....	49
<i>Other Government Agencies and Institutes</i> .....	50
<i>NGO's</i> .....	50
Infrastructure Design, Planning and Implementation .....	50
Water Management Institutions.....	51
<i>General Composition</i> .....	51
<i>Women and Landless</i> .....	51
<i>Fisherfolk</i> .....	52
<i>Union Parishad Officials</i> .....	52
<i>Tangail Town and Adjacent Areas</i> .....	53
<i>Compartment Water Management Committee</i> .....	53
<i>Timing of Committee Formation</i> .....	53
Strengthening Water Management Institutions.....	54



<b>Conclusions and Recommendations</b> .....	56
Overall Results.....	56
Prospects under the Most Likely Scenario .....	56
Requirements to Enhance the Project Output .....	57
Conclusions .....	58
How CPP-like Projects Should Be Done a Next Time .....	59
<i>A Pilot Project</i> .....	59
<i>A Compartmentalization Project</i> .....	59
<i>A Water Management Project</i> .....	59

#### List of Tables

Table 1: Farmer Categories by Land Type, Rural Area CPP.....	7
Table 2: Data on Farmers and Landless, Rural Area Tangail .....	8
Table 3: Data on Fishermen, Rural Area Tangail .....	10
Table 4: Staffing for Institutional Development, CPP .....	15
Table 5: People's Suggestions During CPP Needs Assessment .....	20
Table 6: Type of Requests per Interest Group .....	25
Table 7: Comparison between People's Proposals and CPP Implementation .....	27
Table 8: Structure Planning and Performance .....	28
Table 9: Chawk Water Management Committees Phase I and II .....	33
Table 10: Sub Compartment Water Management Committees Phase I and II .....	35
Table 11: Compartment Water Management Committee, Phase I and II .....	36
Table 12: SCWMC Training and Subjects .....	40
Table 13: Delineation of Maintenance Responsibilities .....	43
Table 14: Maintenance Cost per household per Sub Compartment .....	45
Table 15: WMC Performance and Maintenance Prospects .....	47
Table 16: Stage of Involvement Per Type of Institution, Achievements.....	48
Table 17: Stage of Involvement Per Type of Institution, Recommendation .....	60
Table 18: Beneficiary Committee Structure, Recommendation .....	62

#### List of Figures

Figure 1 The Drainage Systems with <i>Khals</i> and Structures .....	18
Figure 2 Clusters, Sub Compartments and <i>Chawks</i> .....	19
Figure 3 Need Assessment Survey .....	21
Figure 4 Command Areas Inlet Structures 1998.....	30
Figure 5 Catchment Areas Outlet Structures 1998.....	31
Figure 6 Unions and Sub Compartments .....	34
Figure 7 Greater Mymensingh O&M Circle BWDB .....	44

## List of Appendices

Appendix 1 .....	65
List of Documents Consulted.....	67
Appendix 2 .....	71
Government and Non-Government Organizations in Tangail.....	73
Appendix 3 .....	75
CPP Institutional Development History Bar Chart.....	77
Appendix 4 .....	79
Structure Functionality vs. Participation in Planning.....	81
Appendix 5 .....	85
Election Procedure for Chawk Water Management .....	87
Election of Sub-compartment Committee and Executive Committee.....	88
Appendix 6 .....	89
A. Composition of Sub-Compartment Committees.....	91
B. SCWMC Composition in Relation to Population (Households) .....	91
Appendix 7 .....	93
Draft Guidelines CPP, July 1998.....	95
Appendix 8 .....	109
Structure Management and Operation Frequency.....	111
Appendix 9 .....	113
Roles in Compartment Operation & Maintenance.....	115
Appendix 10 .....	117
Union Chairmen and SWMC-Leadership.....	119



## Introduction

This report is an annex to the final report of the Compartmentalization Pilot Project in Tangail, which ran from 1991 to 2000. It describes the implemented activities, achievements and learnt lessons and relates those to the project's origins and Terms of Reference.

The report will try first to describe the conditions under which the project was conceived and started in 1991. The description of the pre-project phase and early project period might seem irrelevant at this end stage. However, it has to be described in order to understand the implemented activities and achievements; and to realize that the problems with which the project has been struggling with, originate from the conception and the decisions taken during inception of CPP. The report will show that these could not be undone in either the first or the second phase.

In the third chapter, the report records all the relevant activities as they took place. It provides the thinking behind it, where possible, and analyses the results.

The fourth chapter then lists the achievements and failures of CPP in terms of institutional development.

The fifth chapter will give the prospects for the post CPP period.

The final chapter gives conclusions and, on basis of lessons learnt, attempts to give recommendations for future projects that bear similarities with CPP, such as water management projects and participatory development pilot projects.

That it is difficult to be accurate and fair on particularly the things that happened many years ago will be obvious. In the report, use has been made of nearly all important documents produced during the project period and especially the reports made in 1998 by two of the three former Institutional Development Specialists. With comments on the annex by the present team and by some that have worked in CPP in the past, it is hoped that a reasonable degree of accuracy and of fairness has been achieved.



# Commencement of the Project

## CPP Initiation

The Compartmentalization Pilot Project (CPP) was started as a core component of the Flood Action Plan (FAP), a US \$120 million dollar multi-donor combination of 26 studies and planning exercises. The Flood Action Plan was developed in reaction to the floods of 1987 and 1988. FAP consisted of planning studies (e.g. five regions, Dhaka protection, Meghna River bank), numerous technical support studies (e.g. agriculture, maintenance, flood response, fisheries) and few experiments. CPP, an experiment in compartmentalization, started as FAP 20.

At that time it was realized that more of the traditional flood control projects would not solve flood problems. This was because they kept floods out, while people wanted to allow beneficial floods in and keep them on their fields. Another realization was that projects tended to fail if people were not involved in planning and system management. Completed systems until then had been very inefficiently managed and maintained, caused environmental damage and unintentionally affected and antagonized many people.

The answer to this was controlled flooding and people's participation in system management. This was most prominently raised in the Flood Policy Study of the UNDP (May 1989). As controlled flooding was a new concept, a pilot project was needed. The Flood Policy Study suggested that the Tangail and Sirajganj<sup>1</sup> areas, which were already considered for implementation by other projects, would be possible locations. The study stressed the importance of water management and people's participation.

## Institutional Development Experiences Elsewhere

At the time of CPP's initiation, people's participation in planning or Operation and Maintenance (O&M) was not practiced in BWDB projects, although in most policy documents of that time the need for involvement of beneficiaries in O&M was mentioned. Some projects sought people's participation only in organizing groups to capitalize on the newly improved environment (co-operatives) or on employment opportunities in the implementation phase (Labor Contracting Societies/LCS). Projects in which beneficiaries were involved in project design or system management did not exist.

Even today, only a handful of projects in Bangladesh has achieved a level of practical experience in people's participation in water management projects. These are, in order of starting sequence, System Rehabilitation Project (SRP), CPP, Char

<sup>1</sup> Sirajganj has been dropped as project area during the first project years and is therefore not relevant for institutional development. Sirajganj will further not be referred to anymore, except in one case.



24

Development & Settlement Project (CDSP), Command Area Development Project (CADP), Small Scale Water Resources Development Project (SSWRDP) and Khulna Jessore DRP (KJDRP). When CPP started in 1991, SRP had not started activities in the field and the rest of the projects had not started at all.

### **National Policies on Institutional Development**

At the time of initiation of CPP, no national policy existed on people's participation or institutional development. In 1994, the then Ministry of Irrigation, Water Development and Flood Control (MIWDFC, the present Ministry of Water Resources/MoWR)) issued the Draft Guidelines for People's Participation, in which elements of both System Rehabilitation Project (SRP)'s and CPP's early policies were incorporated. They became final and formal in 1995. Efforts under System Rehabilitation Project in 1997 led to seminars in which new guidelines were outlined, which were then elaborated by System Rehabilitation Project (SRP) in 1998. Since then several parties have commented on these, this led to a new round of policy and guideline drafting. In the meanwhile, the National Water Policy, a basis for any water management related guideline, was drafted and accepted by Parliament in autumn 1998. The second basis for guidelines would be the newly formed local elected government structure at the level of Upazila/Thana and District. Water management organizations were supposed to be integrated with these. It was a complicating factor in establishing water management organizations that repeatedly delayed the determination of a structure for people's participation in water management.

The Participatory Water Management Guidelines are now being prepared under a new multi-agency Task Force under the Secretary, MoWR.

### **Institutional Development During Project Identification, 1989**

The same year as the UNDP Flood Policy, Study an identification mission for the Compartmentalization Project was fielded. It stated in December 1989:

*"Unless there is local participation from the outset, it is doubtful whether compartmentalization will ever be practical and viable".*

Yet, in their planning proposal, the identification mission provided only a first phase of three months in which "consulting local officials, NGO's and residents" was just one among a long list of tasks. After these three months, the project had to come up with a complete plan and design. Construction would start later the same year. Just one "Agro Sociologist" was provided in the manning schedule. A set up was envisaged with a compartment board mainly with government officials and separate sub compartment committees with beneficiaries.



## Institutional Development in the Terms of Reference, 1990

### *General*

The next step was the writing of Terms of Reference by the Flood Plan Co-ordination Organization (FPCO) in preparation of the project start. Before the compartmentalization experiment was designed, no feasibility study was carried out nor a proper needs assessment among potential beneficiaries. Probably, this omission occurred because of the pressure from the other FAP components to come with results. Most of the five regional planning components of FAP (FAP 2 to FAP 6) started around the same time as CPP FAP20. They were, however, dependent on the outcome of the compartmentalization experiment, the results of which they were supposed to incorporate in their feasibility studies. This pressure to come with results has been the main reason for the hurry in which CPP was conceived, prepared and started.

The Terms of Reference (June 1990) was written in much the same vein as the identification mission report. It assumed a four and half year project with design, baseline survey and first structure completion in the first year and then four years of operation of increasing amounts of infrastructure. All essential parts of the complete system should be in place before the third monsoon. The most concrete description of institutional development tasks at hand stated:

*"Prepare and try out alternative proposals for establishing local Boards of Management and setting up arrangements for consultations with NGO's, local government, beneficiaries and those who may be affected adversely, with special attention to disadvantaged groups, in particular women".*

Institutional development would fall under the Sociologist (one person year), whose main job, however, was to conduct socio economic studies:

*"Professional Requirements: he/she should have [...] at least 10 years' experience in rural development or in carrying out socio-economic surveys".*

### *The Project Concept*

CPP was a pilot project, not only in the technical sense, but also in the sense of people's participation and O&M Institutional arrangements. These were being not practiced in Bangladesh in any systematic way.

The objectives of the project were according the Terms of Reference (page 4):

*"...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 the Action Plan"*

And specifically this will entail the

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

The Phase II objectives were the same, the difference probably being that it asked for sustainability and:

*"[...] integrated water resource management options for different sections of the rural population [...]"*

This would be achieved by creating a compartment with sub-compartments each of which can be isolated by embankments and structures. The existing periphery embankment would be improved and inflow structures would be added while *khals* would be (re) excavated. Management would be given to compartment level board and sub compartment committees. Mitigation would be sought for negative effects on navigation, fisheries, land possession, and bio-diversity, flood risks.

Through compartmentalization, the project would aim at reducing drainage congestion, stabilizing monsoon season flood levels and protection from harmful floods. The project would apply phased implementation, maintaining principles of people's participation and institutional development.

#### *Consultants' Technical Proposal, 1991*

The consultants' technical proposal was to experiment institutionally by having a board in one compartment (either Tangail or Sirajganj) consisting of officials (including NGO's, Union Parishads) and in the other, a board of directly elected beneficiaries. They further added a Bangladeshi sociologist and created room for staff for socio-economic surveys. They followed the Terms of Reference concept of consultation leading to infrastructure and committees formed only later for O&M.



# People and Institutions

## Existing Interest Groups

The project area consists of a highly varied landscape, with a large floodplain and numerous small individual pockets, which were inter-related in not yet understood ways. By introducing the compartment, an area of 13,200 ha and a population of 48,000 households were all brought under one system, necessitating co-operation where there had never been much co-operation. Whether each of the many different interest groups and institutions would be involved or not, they would determine the success of the project.

The stakeholders, who should play a role in either planning, decision making, water management or institutional arrangements can be divided in various categories of beneficiaries and project-affected people. Which people and institutions should be involved in the various stages of the project and system Operation & Maintenance (O&M) depends on the objectives. The reasons and objectives of participation by local people are manifold.

- Firstly, the people will ultimately determine the possible level of sophistication in management.
- Secondly, they will always be there.
- Thirdly, they are most knowledgeable about the details of the area and most committed to the success of the system. This commitment and ownership feeling will increase with their involvement. This counts also for the intended O&M related government and non-government institutions, although much less so.
- Fourthly, involvement of people and institutions is important for information dissemination.

The criteria for involvement of stakeholders are the stake they have in a system, the mandate, the expertise, the home location and the possible commitment. The stakeholders can be split over various interest groups in various ways:

- a) Location: highland and lowland, upstream and downstream, inside and outside;
- b) Land use: farming (the type of crop and variety grown), fishing, industry, town;
- c) Land status: rural elite, small and marginal farmers, landless and sharecroppers; and
- d) Gender: men and women



Interest patterns can be very complex because of the many factors involved, but generally, location and land use define interests more than land status.

#### *High Land and Low Land*

In water management, there are in principle, interest differences between highland and lowland. Lowland owners will benefit from better flood control and drainage and will favor early closure of inlets and early opening of water control structures and outlets. Highlanders will benefit from better water inlet in dry periods and subsequent retention of water and therefore favor the opposite from the lowlanders. Table 1 indicates that 35% belongs to categories F0 and F1 and 65% to the deeper flooded areas F2 and F3.

In an assessment whether bigger farmers have relatively more low or high land than smaller farmers, the same table also shows that the various land user groups do not occupy distinct different pockets. The area owned by large farmers tends to be a little more in the deeper flooded areas where only Local Aman and Deep Water Aman can be grown. The data do not show how many farm households own both highland and lowland.

Farmers Category	% of HH	% of Land Owned	% of Land Operated	% of Land Operated per Flood Criteria Land Type			
				F0 <30cm	F1 30-90cm	F2 90-180cm	F3 >180cm
Share-cropper	5%	1%	2%		36%	59%	6%
Marginal Farmer (0.2-0.4ha)	24%	12%	10%	2%	35%	41%	23%
Small (0.4-1.0ha)	52%	41%	45%	3%	33%	48%	17%
Medium (1.0-2ha)	15%	26%	26%	9%	38%	40%	13%
Large (>2ha)	5%	21%	17%	4%	10%	69%	17%
Total HH Farmer Only	100%	100%	100%	4%	31%	49%	16%

Table 1: Farmer Categories by Land Type, Rural Area CPP

Source: 1992 Household Survey

Stakeholders from different corners of the *Chawks* should all be separately involved in planning and implementation and in water management institutions.



### *Upstream and Downstream*

For upstream and downstream interests in general a similar story can be told as for high land and low land, but the scale is bigger, i.e. at the level of Sub-Compartments. Interests will be sufficiently taken care of by those who represent Sub-Compartment Committees at Compartment level.

### *Inside the Compartment and Outside*

Contrary to the insiders, the people outside of the Compartment will oppose the periphery embankment and closure of inlets during harmful floods, because it might increase flooding in their area. Therefore, stakeholders from the adjacent areas should all be separately involved in planning and implementation and in water management institutions.

### *Rural Elite, Small Farmers and Landless*

The size of each group depends much on definition and on the data source. Table 2 shows the data from the 1992 household survey (HHS), a sample survey, and the data from the 1997-98 so called Stakeholder List (SL).

Category	Criterion HS*, 1992	% of Total HH HS*, 1992	Total No. of HH HS*, 1992	Criterion SL*, 1997	% of Total HH SL*, 1997	Total No. of HH SL*, 1997	Remarks
Farmer	>0.2ha	31%	8,600 hh	>0.12ha	68%	22,234 hh	
Landless	<0.2ha	69%	20,100 hh	<0.12ha	32%	10,594 hh	Incl Fishermen and sharecroppers
<b>Total</b>		<b>100%</b>	<b>28,700 hh</b>		<b>100%</b>	<b>32,828 hh</b>	

Table 2: Data on Farmers and Landless, Rural Area Tangail

\*Source : Household Survey 1992 (HHS) and Stakeholder List 1997-98 (SL)

As the Stakeholder List formed the basis for interest group representation and other institutional development activities in the project, these data will be used mostly in this Annex.

Interests among these groups overlap, but the scale of benefit varies greatly.





Table 1 shows that within the farmer category, 5% can be considered as large farmers. These form the rural elite, who often have, beside land, more equipment and access to credit and government resources. Through these resources, they are able to dominate village life. This group benefits from the project through improved water management and through a new asset, i.e. structures, that they can manipulate to their advantage. These they can manipulate for both agriculture and beel aquaculture purpose. Agriculture related water management interests would, however, vary within this group as some have low land and some highland, while some are active in fishery and others are not.

Rural elite will need inclusion in any form of water management institution or decision making process, as they are normally the ones who can and do make decisions. It can be expected that they will not need extra attention from a project, to be well represented. They will bring in leadership, expertise and their influence.

Small farmers will benefit from improved water management. However, the benefit is relatively less than that of larger farmers, because they have fewer resources to capitalize on improved water management and because their control of the structures is less.

Landless can be sharecroppers, land laborers or non-farm laborers and artisans. Sharecroppers will benefit in similar ways as small farmers, but to a lesser extent. Non-farming landless will be interested in protection only. Land laborers will benefit if agricultural intensification leads to increased labor demand. Among these groups is also a large portion of subsistence fishermen, which might see their fish catch being reduced under certain conditions.

Small farmers and farming landless, because of their obvious stakes and relatively disadvantaged position, will need inclusion in any form of water management institution or decision making process. They will, however, need extra attention from a project, in order to be well represented.

#### *Boatmen*

The report "*Boatmen In and Around the Project, May 1996*" found that about 0.5 percent of all rural households had members who were boatmen, although very few (12) had it as primary occupation. They were concentrated in some 11 villages inside the compartment. Boatmen were estimated to have numbered 144 in total. Through implementation of CPP, they would lose their boating routes and their trade inside the



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area. The public would see an increase in the cost of transportation of bulk goods and breakable items and a decrease in monsoon mobility areas. Most of the villagers, however, will be compensated by increased access to motorable roads.

Boatmen should be involved in decision making, but mostly their customers will decide for them. They would not need inclusion in committees if the project results in making their services redundant.

#### *Professional Fishermen*

The same household survey and stakeholder list provides data on fishing households.

Category	% of Total HH HHS*, 1992	Total No. of HH HHS*, 1992	% of Total HH SL*, 1997	Total No. of HH SL*, 1997	Remarks
Professional Fishermen	1%	325 hh	1.4%	445 hh	
Occasional Fishermen	3%	935 hh			Mostly Landless
Subsistence Fishermen	65%	19,000 hh			Mostly Landless

Tebale 3: Data on Fishermen, Rural Area Tangail

\*Source : Household Survey 1992 (HHS) and Stakeholder List 1997-98 (SL)

Note: Professional Fishermen are practicing open water fisheries for more than 4 months per year

At the beginning of the project, it was thought that the fishermen would be seriously affected by the project. The compartment infrastructure was assumed to block the inflow of fish by structures and to reduce of water bodies by improved drainage. Structures create the possibilities for letting in and retaining fish rich water or for letting out fish rich water through a net placed in the structure. However, the benefit of this would not accrue to traditional fishermen. These created fishery opportunities would be more to the benefit of surrounding farmers and more powerful elite, as they would be in charge of the structures. In that sense, fishermen might lose access to open water fishery resources.

This group because of the involved risks and opportunities has obvious stakes, and will need inclusion in any form of decision making process. Inclusion in water management institutions. Fishermen will need extra attention from a project, to be well represented.



### *Commercial and Industrial Sector and Tangail Town Dwellers*

Bazar Dwellers, shopkeepers, traders, transport businessmen, brick factories, service holders, educational institutes and students will all favor flood control and drainage of excess rainwater. This will keep transport going and shops plus facilities accessible.

### *Women*

Statistically women make up slightly less than half of the population of the area. In reality, and especially during the labor migration season, women exceed men in number. In that season not only widow headed and divorcee headed households are headed by women, but also those households where men have gone on migratory labor, resulting in up to an estimated 25% seasonally female headed households.

As found during consultations, the interests of women in water management run parallel to those of their male partners. Floods or droughts have, however, more impact on their daily lives (drinking water collection, household management, harassment) than on those of men. Women in their look at water management will further pay more attention to aspects like drinking water (family and livestock), sanitation, security and flood protection.

Determining whether the stakes, insights and expertise of women in water management projects are different from those of men is difficult. In CPP these are probably not sufficiently different to alone justify inclusion in O&M committees. It is, however, important that they are involved in planning and implementation, to determine whether these aspects are different as well as to keep informed that half of the population, that normally is not kept well informed. In case experience points out that women have clearly different water management interests or expertise, and the system has taken care of those, the project should make extra effort to guarantee their continued place in the O&M institutions, too. In case the project has a specific objective to raise (or not lower) the status of women and wants to achieve this through quota, the concerned quota for women should be applied to representation in water management institutions, too.

### **Existing Institutions in the Area**

The relevant existing institutions in the area are the stakeholder groups, Thana offices for many government agencies, Union Parishads and many NGO's. Appendix 2 lists Government Organizations (GO's) and NGO's of the area, as well as those who co operated with CPP.



### *Flood Control and Water Management Organizations*

Before CPP, there was a peripheral embankment but with several openings. Floods were controlled only slightly by this embankment. The embankment had many openings, and culverts. In the Western embankment were four inlet structures with stoplogs, serving small areas. These embankment parts had been built mostly by Union Parishads under Food for Work, some 30 years ago. The inlets were built by the BWDB. The inlet systems were not inter-linked.

The inlets functioned sub-optimally, because of maintenance problems, stealing of stoplogs and the stoplogs not being able to effectively closing the orifice. No committees existed. In times of flood or conflict, people would look towards Union Parishad (UP) officials and sometimes other elite for initiatives and leadership.

### *Other Stakeholder Organizations*

Beneficiary organizations existed as functional groups and as groups organized by third parties such as Bangladesh Rural Development Board (BRDB) and NGO's.

The functional groups are mostly tubewell irrigation groups and the area's five fishermen associations, which have one umbrella organization. e.g. BRDB supported 198 farmers' co operative societies in 1992. The 1992 Household Survey found that 54% of fishing households, 11% of farmer households, 5% of non-farm households and 4% of urban households had members in any type of co-operative. In the adjacent area, these figures were much lower.

In addition, according the CPP's institutional survey in 1992, more than two thousand groups have been organized and supported by NGO's in the whole of Tangail District. This concerns mostly landless and women groups. None of these groups was related to water management or O&M issues.

For CPP, it was important to know whether there were groups that manage assets jointly and were able to mobilize resources for maintenance. The main examples are probably tubewell irrigation groups and mosque committees, although tubewell irrigation group consists often of one owner and a number of users. Experiences from elsewhere in Bangladesh (System Rehabilitation Project findings) show that in flood control and drainage, there do exist local organizations with resource mobilization capacity although this is not widespread. They often depend on a few rich individuals who invest a bigger share and claim a bigger share of benefits.



### *Elected Local Government*

During the project period in Tangail, only Union Parishads with their Chairmen were in place. The Unions and particularly the Chairmen play a central role in the local power structure, in decision-making processes, in conflict resolution, and in resource allocation. This has been recognized in national policies developed during the nineties. System Rehabilitation Project (SRP) studies on local water management initiatives also found that in non-project situations, Unions played the crucial role in construction, structure operation and maintenance. U.P. members' interests in projects like CPP are, however, often not the same as those of the beneficiary population, as their own political and financial interests tend to dominate development interests.

### *Non-Governmental Organizations*

The 1992 Household Survey found that NGO coverage was generally confined to a small geographic area and limited to non-farm and urban households. A full inventory of all NGO's was carried out in 1996, although no report was published. Appendix 2 shows all relevant non-government agencies of the area and their involvement in CPP. Some 25 NGO's were locally active in the area in 1996, of which 15 started after the project (1991). Ten NGO's have offices in the compartment, of which five had more than one office. In 1992, only three NGO has had an office in the area.

No NGO was involved with water management for flood control and drainage. The most important group of water management beneficiaries is farmers and these fall outside the traditional target groups of NGO's who generally concentrate on the landless, assetless and women. The interest of NGO groups in CPP could be expected to be in labor opportunities created through construction works and agricultural intensification.

### *Government/Semi-Government Agencies*

Government agencies are listed on page 2 of Appendix 2.

### *Bangladesh Water Development Board/Ministry of Water Resources*

In any institutional O&M arrangement to be proposed by CPP, the **Bangladesh Water Development Board** (BWDB) would play a central role. BWDB affairs in Tangail District fall under the O&M Sub Division Tangail (Sub Divisional Engineer, SDE), which lies in O&M Division Tangail (Executive Engineer, XEN), which in its place falls under O&M Circle Greater Mymensingh. This falls again under Chief Engineer North Central Region.



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BWDB has a poor record of operating and maintaining water management systems. The emphasis in the organization is on construction, while operating and maintaining systems has only received some attention in irrigation projects.

The average BWDB official has no training or experience in operation or maintenance. Built-up knowledge about systems is often lost due to frequent staff transfers. Records are not kept systematically or are not accessible. In most cases, the systems are only maintained with donor funds, e.g. rehabilitation projects and Food for Work (World Food Program). Preventive maintenance is not practiced and the response to emergencies is often inadequate due to lack of budget or communication. Repairs of a damaged structure gate hardly ever take place in the same monsoon as the damage occurs.

#### *Other Government Agencies*

Many other government agencies had activities and mandates in the area. They can be distinguished as:

- Those who might play a role in O&M, such as Department of Roads & Highways, Jamuna Bridge Authority, Local Government Engineering Department (LGED) and Tangail Pourashava. The performance of LGED and Tangail Pourashava in maintenance is comparable to that of the BWDB.
- Those whose co-operation will facilitate CPP implementation, such as: Deputy Commissioner's office/Ministry of Land (land acquisition); Local Government.
- Engineering Department (LGED); Tangail Pourashava and Unions (road/culvert/bridge O&M); Department of Roads & Highways; and Jamuna Bridge Authority (infrastructure affecting CPP); and Thana Nirbahi Officer (local government involvement in O&M).
- Those whose sector will be influenced by CPP and (might) need co-ordination, such as Department of Agricultural Extension, Department of Fisheries, LGED and Tangail Pourashava.
- Those whose co operation forms an opportunity to enhance project output, such as Department of Agricultural Extension, Department of Fisheries, Bangladesh Rural Development Board (BRDB), Department of Roads & Highways, LGED, Tangail Pourashava, national or international resource and research institutes.



# The Activities as Implemented

## CPP Set-up and Resources

The achievements of a component depend on the project institutional set up and allocated resources, which, therefore, have to be mentioned here.

Due to its experimental character, CPP was implemented by a separate BWDB office and a large number of consultants. The MoWR's Flood Plan Co-ordination Office (FPCO) was co-ordination and monitoring CPP during Phase I. This role has been taken over by WARPO in a later phase. A project director was assigned for day to day management and an Executive Engineer (XEN) was assigned to implement construction works. Both had a team of BWDB staff to implement activities. After the project, the CPP Sub-Division would be merged with the O&M Division Tangail and the separate offices of the Project Director CPP and XEN CPP would be discontinued.

Other District and Thana level Agencies have been involved in varying degrees with CPP. CPP has also co-operated with seven locally based NGO's during the consultation stage, of which five withdrew afterwards. Many other NGO's have been involved in various project activities, notably studies, training, mobilization of Labor Contracting Societies. They have all been listed in Appendix 2.

Staff responsible for people's participation was all consultant staff, as the BWDB lacks specialized staff. During the project period both the Project Director and Executive Engineer have played important roles.

The following consultant staff was available for institutional development activities. See also Appendix 3.:

Staff	91	92		93		94		95		96		97		98		99	
	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Expatriate Sociologist/ Institutional Specialist	1	1	1	½	1	1	1	1	1	1	½	½	½	½	½	½	½
National Institutional & Training Specialist		½	1	1	1	1	1	1	1	1	½	1	1	½		½	
National Mid-Level Sociologists	1	2	2	2	2	1	1	1	1	1	1	1	2	2	2	1½	1
Field Professionals				1½	2	3	3	3	3	3	1	1	4	10	8	6	5½
Table 4: Staffing for Institutional Development, CPP																	

Source: Data for Phase I are extracted from the Completion Report 1996



Phase I started with one Expatriate Sociologist (original allocation: 12 month). Staff was increased in stages during the first two years up to five people. In the Phase II less expert staff was available, but more field staff, especially during the reformation process. In the last project years, this was again gradually reduced.

Institutional Development related exercises such as need assessment, consultations and committee formation were big enterprises and received insufficient attention. However, during the end of Phase I and during the final Phase, more and more non-core components, such as agriculture, fisheries and Labor Contracting Societies/Embankment Maintenance Group, were increased in size. This did not so much decrease the size of Institutional Development staff or facilities, but decreased the available attention from management side. A core component like institutional development needs continuous high level attention in order not to lose either focus or momentum.

#### *Summary of Starting Conditions*

The project started with an untested and complex technical concept in which many aspects were still extremely vague. No hydrological computer model for a simplified compartment had been tried out either. Further, the project had no examples of how people's participation and system management for even simple water management projects might be done in Bangladesh. Nor had a systematic pre-project study been done on the water management priorities and attitudes of local people, or on their general management capabilities.

Neither the stakeholders nor the BWDB, the probable key players in institutional arrangements, had any experience or proven skills in either operation or maintenance or other aspects of organized flood water management.

The project had been allotted too little time and too few staff to do a meaningful exercise in people's participation and institutional development.

Although it is relatively easy to conclude these things in hindsight, it should be noted that many of these constraints were also observed during the starting period by people within the project and others involved in the water sector.

Although the starting conditions were such that the probability of ultimate success had been reduced considerably, the project has undertaken many activities to redress the starting problems and make the most of the possibilities. It has in the process developed and tried out concepts of people's participation and institutional development, which were new and useful to Bangladesh.



### *Concept Development, 1990-1993*

The project team in Phase I started to elaborate the few words of the Terms of Reference into a voluminous consultation process, although the allotted time and staff was too limited. They further made the concept and project formulation dependent on participatory decision making. They stated that for an experiment as this to succeed, the people should feel as much ownership as possible. In addition, they stressed, in line with the Terms of Reference, the need for a flexible approach and (construction) program, linked to non-structural activities.

The following documents and activities illustrate the development of the concept :

#### **1992 Inception Report, Interim Report, Strategy Paper**

The area of 13,200 ha was given a preliminary division in 4 clusters, 16 sub-compartments and the Lohajang Floodplain. See Figure 1 Drainage System with Water Control Structures, and Figure 2 Clusters, Sub-compartments and *Chawks*. Methodology was developed with need assessment, consultation, development and selection of options and formation of committees.

FPCO decision: "People cannot select between options. The project is a test of controlled flooding with gated structures and a periphery embankment".

#### **1993 Institutional Development Strategy and Integral Planning Document**

Revised planning of institutional development program

#### **1994 Approach adjusted and applied in Cluster IV**

Contrary to Clusters IB, II and III, committees in Cluster IV had to endorse total plan before construction. Total of 143 *chawks* delineated.

#### **1995 Operation Manual**

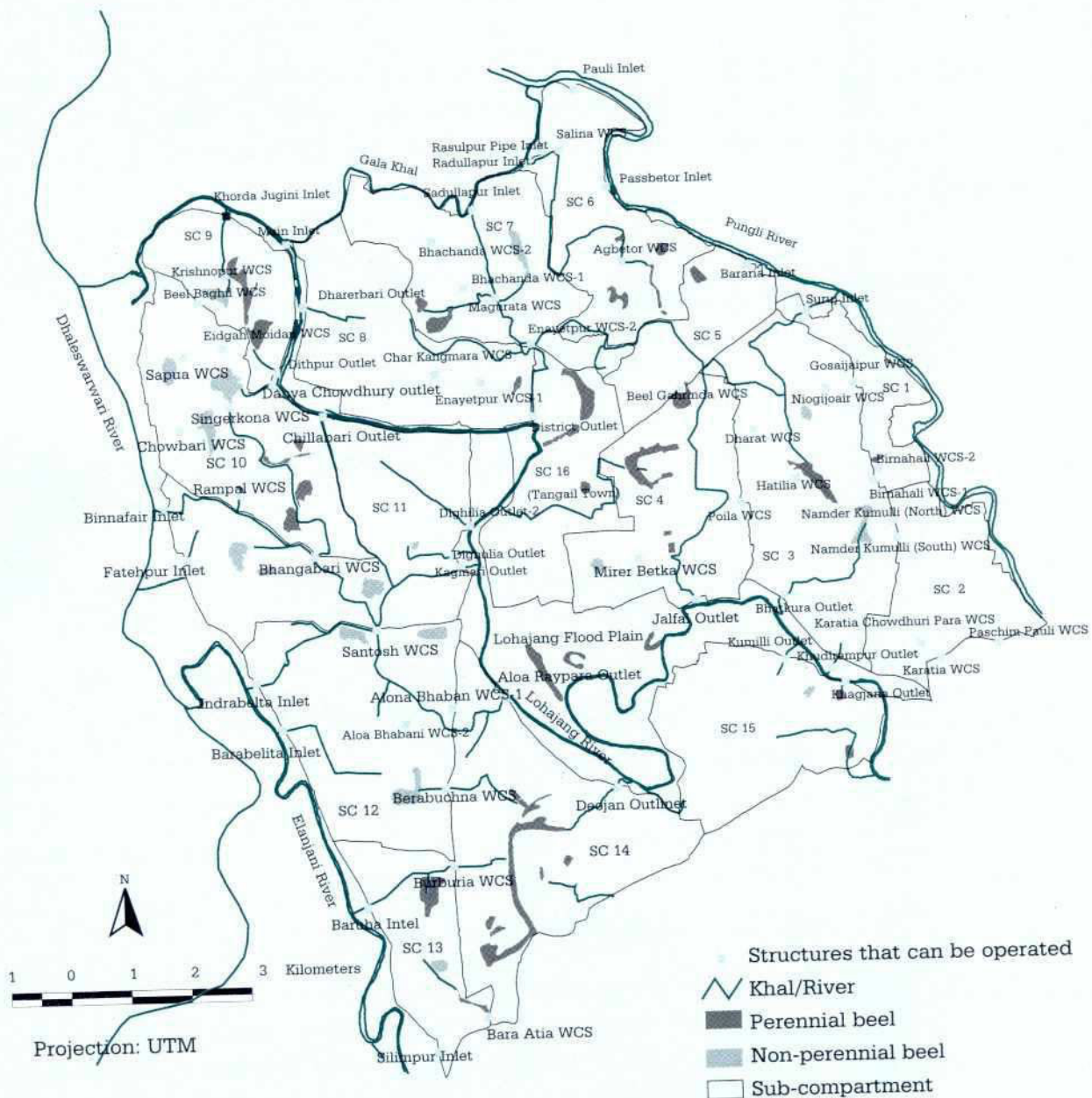
#### **1996 Terms of Reference for Phase II :**

The institutional base should be replicable and sustainable without project and/or financial assistance. Attention given to aspects of equity, legality, national policy.

#### **1997 Inception Report, institutional development methodology revised.**

A Review resulted in changes in approach and committee composition.





Figur 1 : Drainage System With Water Control Structures



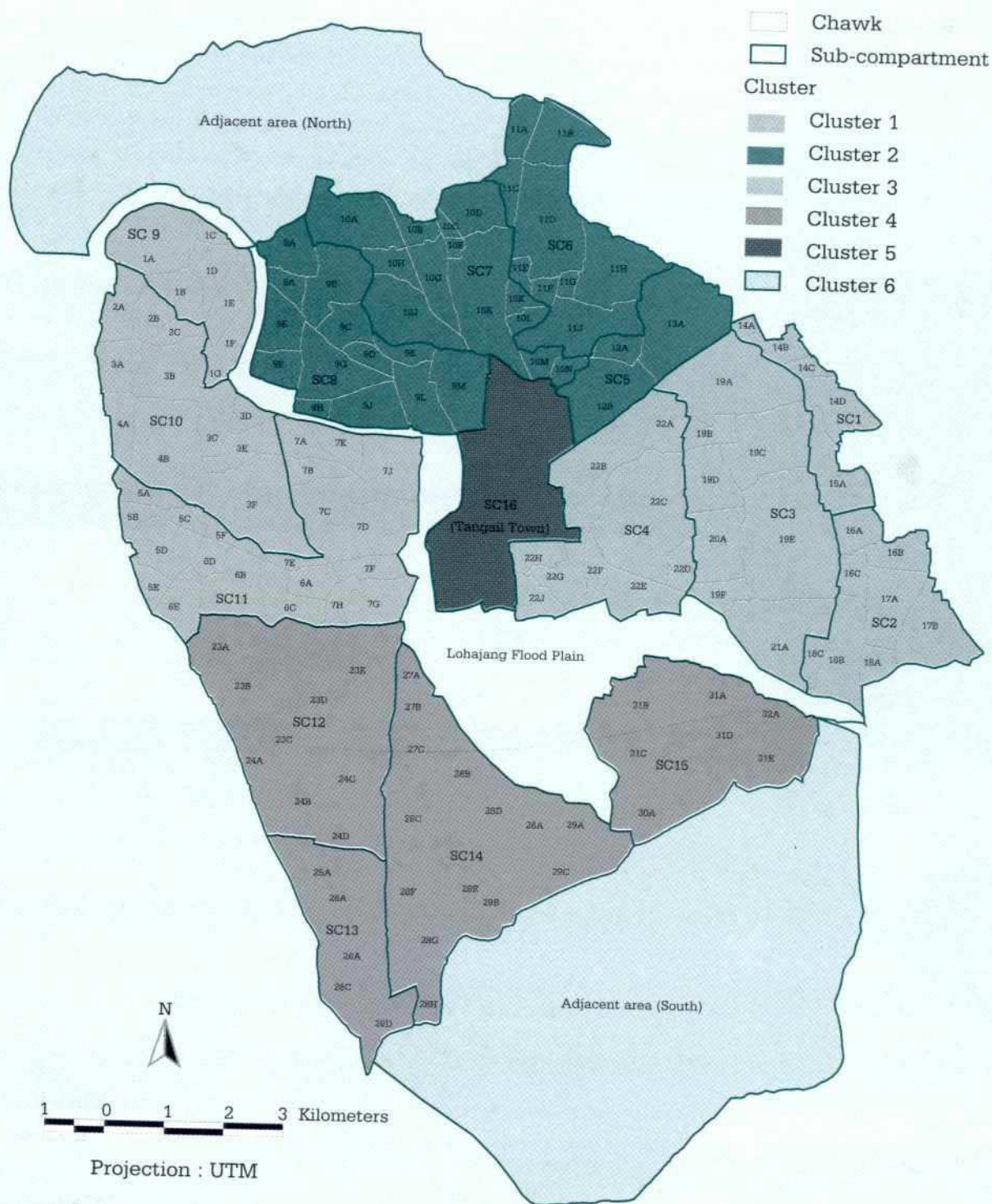


Figure 2: Clusters, Sub-compartment and Chawks



### Need Assessment Among Stakeholders, Spring 1992

A first step in inventorying local needs and ideas was a multi-disciplinary baseline survey in which 96 of the existing 218 villages of the area in and around the proposed compartment were covered. (See Figure 3-Need Assessment Survey). This was a large exercise with a team consisting of a male and female sociologist, drainage engineer, agronomist, and fishery specialist. All were national experts, backed by an expatriate sociologist. The survey was done on an adapted version of Rapid Rural Appraisal (PRA), taking 2 days to criss-cross a sub-compartment.

Methodology and all data are presented in the Interim Report (CPP, 1992). The table below gives an indication of what people suggested to CPP teams. Some 40 khals were suggested for re-excavation or new excavation, although about few there was disagreement.

Sub-Compartment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	LFP	E
Khals	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Culvert/bridge	x	x	x	x			x									x		
Road							x											
Embankment							x									x		x
Control Structure					x								x					

Table 5: People's Suggestions During CPP Needs Assessment

Source: Interim Report Annex 1 Multi disciplinary Sub Compartment Survey, 1992

Notes: LFP= Lohajang Floodplain, E=Adjacent Area. Requested regulators were Salina, Pauli, and Baruha.

The result was a good insight in to the local physical situation and in what people's priorities were.

### Preparation of Stakeholder Consultation, Mid 1992<sup>2</sup>

#### Development of Options

On The basis of the need assessment, which shows drainage as the highest if not only local priority, four options were developed to be discussed with the stakeholders.

Option "A" was Improved Drainage, which provides for excavation of *khals* to improve linkage of the floodplain to the rivers. This would benefit winter cropping and fisheries. It would have to be accompanied by embankment protection of specific localities like Tangail Town.

<sup>2</sup> This is based on the Interim report (CPP 1992)





Figure 3 : Need Assessment Survey



Option "B" was Option "A" with ungated periphery structures, which would throttle the inflow of river water and reduce floods, while avoiding operation conflicts and reducing maintenance costs.

Option "C" provided for gated structures plus improved horseshoe embankment, in order to control extreme floods and regulate flood levels for cultivation of High Yielding Variety crops. Disadvantages: more land acquisition needed, reduced fish and navigation.

Option "D" provided for total flood control by placing regulators in the main rivers, particularly the Lohajang and by closing the Southern boundary.

#### *Intervention by the FPCO*

The Interim Report states: that just before the consultation was due to start (May 28, 1992) objections were raised by FPCO<sup>3</sup> against this procedure. Options A, B and C were said to be not relevant, as they did not provide for the envisaged level of flood protection.

Accordingly, the Project Director requested the FPCO to arrange a high level meeting to decide on the issue.

On 29 June 1992, a meeting was held at FPCO to discuss this matter. In that meeting, the FPCO<sup>3</sup> confirmed the opinion that options without the flood protection provided by gated inlet structures, could not be considered. A decision about a gated outlet in the river Lohajang would be left until next year. As far as internal water management is concerned, all options were left open" (Interim Report 1992, P. 90).

In order to be able to test the compartmentalization concept (option D), the project team was forced to change. The consultation process moved from "discussing options" to "selling the compartmentalization concept/option" to the public, whose support and participation would be sought for constructing and maintaining these facilities.

The result of this ruling was that finally a decision was forced with regard to the Terms of Reference contradiction between being a compartmentalization experiment and a people's participation experiment. Real participation in system design had stopped.

<sup>3</sup> Flood Plan Co ordination Organization, including the Panel of Experts (expatriates, national)



### *The Abridged Consultation Process*

During July 1992, details of the FPCO decision were worked out in a number of follow up meetings. This resulted in additional design work and redesigning the consultation process.

Due to the discussions about flood protection mentioned above and the resulting change in approach, the consultation process was delayed by 8 weeks. Both FPCO and the donors, however, expressed the need to maintain the original date for submitting the Tangail CPP Interim Report - October 1. To accomplish this, the consultation process was reduced from 3 months to 3 weeks. The Northern sub-compartments, both inside and outside the Tangail CPP area, and which would be most affected by the flood protection works, were covered. In addition, in three sub-compartments the consultations regarding the internal water management options were held. In total 26 meetings were held with the different interest groups between mid-August and early-September 1992.

The result of this strongly limited consultation exercise was that the stage was set for compartmentalization interventions. Due to the received feed back, the project increased emphasis on navigation, mitigation measures and employment opportunities.

People would follow the proposed concept, although they had only wanted improved drainage, thereby showing they were not yet ready for compartmentalization. People's acceptance of whatever project comes to their area results from the expected influx of resources, and the belief that the project knows what is best for the people. Consultation was to continue after the Interim Report submission, in order to further fine-tune the system design.

### **Consultation of Stakeholders, 1992-1994**

The fine tuning consultation rounds have been much more systematic and extensive than the original ones. They were implemented cluster wise, the last one (Cluster IV) being done in 1993/94. See History Bar Chart in Appendix 3.

The beneficiary population was divided in interest groups of farmers, landless, women and fishermen, of which existing organized groups (associations, NGO groups) were consulted as separate groups. Women groups, however, were mainly landless women groups. Attempts to mobilize farmer women groups mostly failed.



33

This was followed up by combined meetings. The meetings were asked to come with proposals for water management, while the project from its side proposed to the group an infrastructure set, mainly consisting of regulators.

The project's proposals were based on the need for compartment experimentation, the engineering analysis and the need assessment. All these proposals remained within the context of a compartment with an already decided periphery embankment and main inlet. However, as can be seen in Appendix 4 Participation in Planning of Structures, 40% of all structures were never discussed in the consultation meetings. Local people proposed, as they had during the need assessment, works that would facilitate drainage: culverts, bridges and *khals*. Some groups objected to certain proposed regulators or demanded navigation locks, but in general the ideas of the project were accepted.

Consultation in Cluster IV took place only by the end of 1994, but with an improved approach. The difference was that all proposals were discussed with the groups, that then SCWMC's were formed, and that then these new committees endorsed the set of infrastructure as per the discussion. Meetings were also more streamlined and well attended.

The details of these meetings are given in People's Involvement in Planning of Water Management Interventions (Technical Note 96/18, dd. September 1996) and the cluster wise reports on Consultations (Clusters II & III, IV, Adjacent Area).

The results of the consultation were a fine-tuning of the proposed system with addition of bridges and culverts. It also led, of course, to greater acceptance of the pilot project and made first steps to development of beneficiary institutions. Another result was increased insight in the relevance of involving the different interest groups.

The following table indicates the interests of the various interest groups, judging by the type of requests they made:

Farmers were most interested in water management infrastructure (structures, *khals*). Landless showed relatively less interest in structures and more in bridges and roads.

Women (landless, poor mostly, sometimes fisherfolk) did not make a single request for new water management infrastructure. Typically, they requested to fill unused



Group	Requests	Khal	Structure	Road/Bridge	Procedure	Unique Proposals	Accepted Proposals
Farmers	61	30%	20%	33%	17%	85%	25%
Landless	18	30%	5%	45%	10%	33%	20%
Women	18	0%	0%	70%	30%	60%	11%
Fishermen	5	20%	0%	20%	60%	67%	22%
Table 6: Type of Request per interest Group							

Source : Proceedings of Consultation Meetings in Cluster IV, February 1996

*khal* holding stagnant and polluted waters; to provide navigation facility in DeoJan regulator; and not to obstruct inlet of water by infrastructure. In addition, they requested, besides a number of culverts, to look after fishing communities; to create income-generating activities; and to avoid involving local politicians in implementation. All these requests have been put under the "procedure" category.

Typically fishermen have not requested structures, as these might impede fish migration, but they requested procedures to reduce negative impacts (provide navigation locks) and for excavation of *khals* that increase water flows in the area. Their only granted request was an agreement to keep the gates always open until 15 July.

Inclusion of these groups was valuable, but that might also be said of inclusion of other groups who were not consulted. In concluding whether any of these groups can be safely missed in a consultation process, the landless group comes closest. The column "unique proposals" shows that 67% of their requests has also been made by others, i.e. farmers or women groups.

The degree of acceptance (11 25%) of proposals does not significantly differ among the groups, from which might be concluded that the project did not favor particular groups above others.

#### *Project Design, 1993*

For the first three clusters the project team compiled, by the end of 1993 construction plans and design (Integral Planning and Detailed Construction Cost Estimate, December 1993). The design was based upon the outcome of consultations. As regulators were the core item in the project, a table in Appendix 4 is given which



80  
shows for each structure:

- The first moment it was proposed
- Who proposed it
- Whether beneficiaries were consulted or not
- When it was completed, and
- Whether it has been functioning.

The annexed table shows that nearly all structures were proposed by the project and before consultations.

The only structures for which the idea seems to have come up during the discussions with local people are Bhangabari, Rampal, Baruha, Salina, Pauli, Bararia and Aloa Bhabani 2. Other structures were a result of the interpretation of the consultants of needs assessed in the field. Twenty-six structures (40%) were never discussed with the beneficiaries during consultation, mostly in Cluster III.

Proposals by the beneficiaries were for about 50% not accepted due to a range of reasons: not needed, not feasible, no budget (lower priority Cluster IV culverts), etc.

#### *Construction of Infrastructure, 1991-1999*

Prior to the integral planning and design exercise (December 1993), many structural designs were already finished and few construction activities started already in Fiscal Year 1992/93. It concerned *khals* and structures mostly in Cluster 1B, where consultation ended in spring 1993. The first structure (Khorda Jugini) was completed in December 1993.

Appendix 4 Participation in Planning of Structures shows that most structures were completed for Cluster 1B in 1994-1995, for Cluster II in 1995, for Cluster III in 1995-96 and for Cluster IV in 1995-98. The Main Inlet was completed in January 1996.

Progress in re-excavation of *khals*, embankments, culverts and bridges has been more or less in line with that of structures, be it that some *khals* suffered delays or cancellation due to land acquisition problems.

The result of the construction program will be discussed in other Final Report annexes. From the People's Participation point of view, it is important to assess the extent to which involvement of people in planning makes a difference. The samples



Intervention Type	Total Beneficiary Proposals *	Accepted Beneficiary Proposals	Accepted Project Team Proposals*	Total Accepted 1993	Integral Plan December 1993	Implemented 1999 (excl. minor works)
Modify Old Inlet	4	4	0	4	4	4
Regulators/WCS	5	5	51	56	72	61
Irrigation Inlet					33	1
Khals (km)	NA	NA	NA		84 km	75km
Khals (no.)	70	43	3	46	51	33
Bridge/Culvert	105	21	10	31	61	24
Embankment	8	7	3	10	17	

Table 7: Comparison between People's Proposals and CPP Implementation

**Source :** People's Involvement in Planning of Water Management Interventions, 1996 Interim Report 1992, Integral Plan 1993 and Progress Reports 1992 1998

**Note :** Data on implemented infrastructure relate to infrastructure planned in Integral Plan 1993 Some proposals for structures made during need assessment have been in other reports ascribed to the consulted people, but study of documents (Interim Report mainly) shows that these were actually consultants' interpretation of needs (See also 0)

for CPP structures being built with and without consulting people seem sufficiently big to make an assessment possible. Appendix 4 shows per structure the original proposers and an evaluation of their present performance. The following table categorizes the results.

The assessment per structure will probably change and is in few cases open for discussion, but the table is meant to give the general picture, i.e. the clear relation between involving people in planning and the success of infrastructure. The most problematic<sup>4</sup> structures appear to have been project initiatives on which the people were not consulted. Structures that emerged first from need assessment and consultation meetings have the highest chance of success.

#### *The System Management Requirements*

By 1996, the system started to get sufficient shape to make conclusions about its possibilities. The review at the start of the second phase concluded that sub-compartments actually did not exist because of their often porous boundaries. It also concluded that *chawks* (144) nor sub-compartments (15) are separable hydrological units for inlet, drainage or control of water. Also the systems consisting of several *chawks* had the same problem. The Figures 4 and 5 show the outlet catchment areas and the inlet command areas. A Figure with internal Water control Structure dependent areas has not been shown, as it is too complex a picture. With the

<sup>4</sup> Many of the problematic structures are less or not functional because prospective beneficiaries allowed obstructions in the drainage path, which indicates lack of ownership or confidence in the benefits. In other cases the obstructions could not be removed, the insight in which the project could have obtained by consulting the people.



Original Proposal	Not Functional	Less Functional	Moderately Functional	Functioning Well	Total
During Need Assessment + Consultation				4	4
During Consultation Process		1	1	3	5
By Project Team after Need Assessment, but people not consulted			1	3	4
By Identification Mission/Project Team, and people duly consulted		9	4	11	24
By Identification Mission/Project Team, but people not consulted	8	4		11	23
<b>Total</b>	<b>8</b>	<b>14</b>	<b>6</b>	<b>32</b>	<b>60</b>
Table 8: Structure Planing and performance					

Source : Interpretation of Appendix 4. Included are structures covered for which data were available

exception of Sub-Compartment 9, none of the sub-compartments forms a catchment or command area for one inlet or outlet, let alone overlapping Catchment and command areas. In the Western part, the inter-linked areas are smaller, up to 12 *Chawks*. In the eastern part, one North to South system exists, linking the Sadullahpur, Rasulpur and Suruj inlets to the Jalfai and Bhatkura outlets, involving seven sub-compartments.

More detailed drainage study revealed also that drainage patterns were not always those assumed in the earlier years. Only in 1998/99 did the modeling exercises result in conclusions about what were the optimal operation modes of the various parts of the system. This changed the picture of which *Chawk* or sub-compartments needed to co-operate and consult with each other.

In 1996/97, the choice was made to improve the setting by taking the different drainage units as redefined in 1996 as water management units. However, at the time of the reformation process, the project team decided as yet not to change the boundaries, as sub-compartment committees and beneficiaries had started to get used to being a unit, and had started to develop some cohesion. The effort that any revision would take could not be justified by the possible benefits. Operating structures and maintaining infrastructure would not become much easier for committees anyhow. The same applied for *chawks*, which were also left as they were. They were found, moreover, suitable units for mobilization at the lowest level,



although they would have to be integrated better with the sub-compartment organizational set-up. In hindsight, this refraining from a reshuffle was good, as in 1999, again the insights on how to arrange the units had changed.

It should be realized that a system is never finalized. It will continue to alter each year as minor changes are made by local people, sometimes aided by third parties. Mainly culverts will be added in unit area boundaries making them increasingly porous, and *khals*, culverts and control structures will be obstructed by construction of crossdams or ponds.

The complex hydrological situation made the organization of unit wise institutions difficult. Sub-compartments were used as units. The complexity and the continuous changing of both the situation and the insights give reason to use a more vague and flexible delineation of unit areas until after construction.

### **Formation of Lower-Level Water Management Institutions, 1994-1998**

#### *Phase I Chawk and Sub-Compartment Committees*

The original model provided for formation of new farmers *Chawk* committees (Water User Groups/WUG's) and involvement of existing groups of women, landless and fishermen. These groupings were thought to have the various interests sufficiently represented. These *Chawk* level groups would each choose three representatives to the SCWMC, in which also were present six Government/NGO officials and three Union *Parishad* officials. Some 99 *Chawk* Committees were formed in Phase I with 891 members (no women, landless, fishermen) and 15 Sub-Compartment Committees with 269 members (11% women, 11% fishermen, 11% landless). See Table 9 and 10 below.

Farmer *Chawk* Committees were formed for Cluster 1B in 1994, for Cluster II and III in 1995 and 1996, for Cluster IV in 1994. The Sub-Compartment Committees were formed for Cluster 1B in 1994, for Cluster II and III in 1996 and for Cluster IV in early 1995. The process was not completed in Clusters II and III, where some 11 *Chawk* Committees could not be formed due to resistance to CPP. This was partly because the concerned people objected to the excavation of *khals* on fresh land, and partly because anti FAP NGO's (UST, Nijera Kori, Food For All) had much influence in the area. The process is described in detail in *"People's Participation and Institutionalization in CPP Phase I"*, by Jean Louis Leterme, 1998)

The results of the committee formation can be best shown by giving the Phase II institutional review conclusions carried out among committees and beneficiaries:

- The water management objectives and WMC work were not well known, especially among non-farmers. This was hardly surprising, as there was still less system to manage.







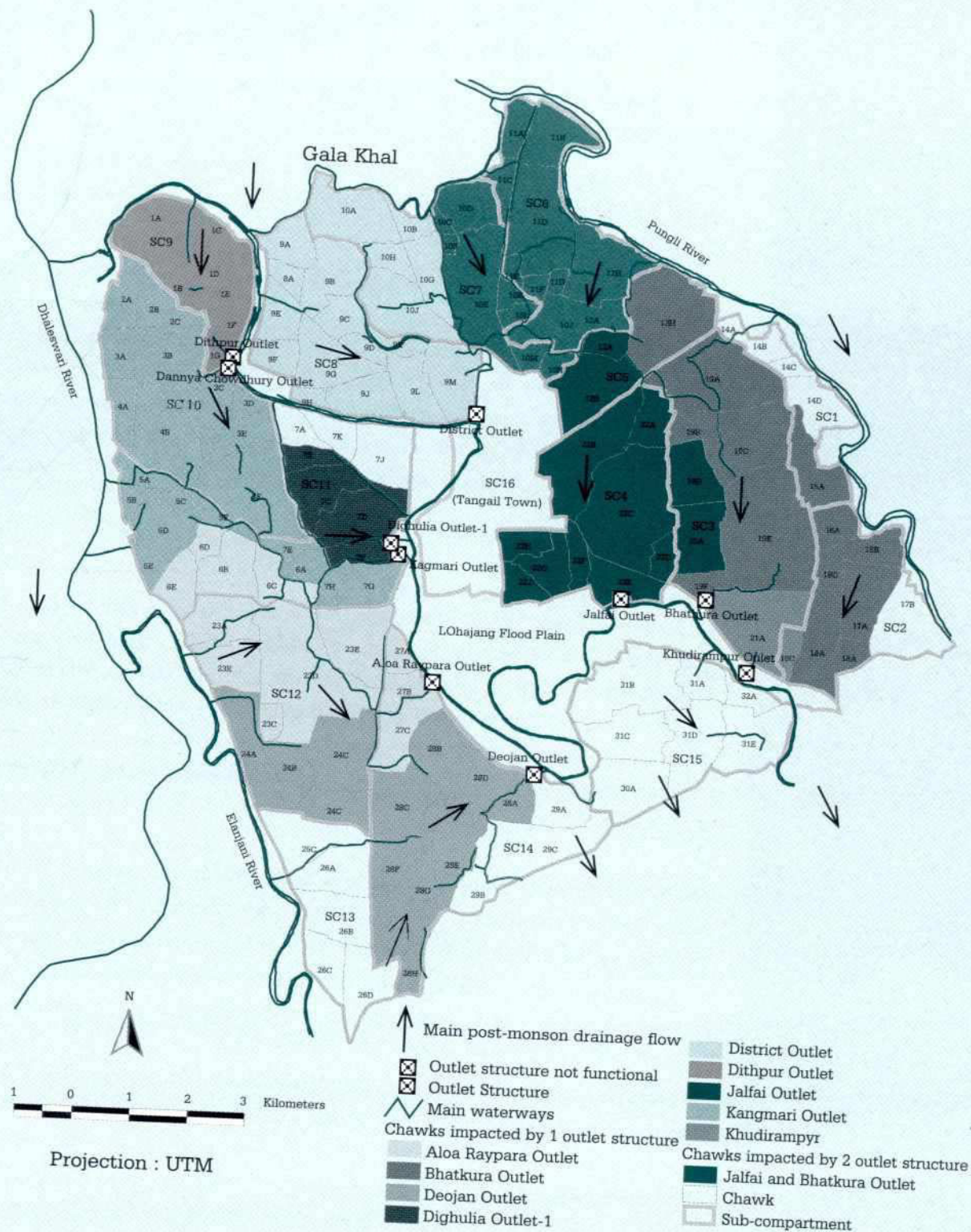


Figure 5: Catchment Areas Outlet Structures



- Beneficiaries, except fishermen, were positive about the system.
- Operation was still flawed: not democratic, not equitable, less role for ChWMC's
- As O&M should be done by beneficiaries, the committees should also consist of pure beneficiaries. GO/NGO officials should not have a vote and serve only as possible resource persons.
- Composition was flawed. Landless and Women do not have different water management interests from farmers and/or fishermen. Different interest groups needed representation at *Chawk* level, while *Chawk* committees needed direct relationship with the Sub-Compartment level. Functioning of UP Chairmen as Committee Presidents was not satisfactory due to diverging interests, occasional absence and chairmanship of more committees at the same time. See Figure 6 indicating which Chairman chairs which SCWMC.

#### *Phase II Chawk and Sub-Compartment Committees*

Based on the review, the committees were reformed. Updates of population were obtained from a new *Chawk* stakeholder list. Some of the summary data per sub-compartment are shown in Appendix 6. *Chawk* WMC's were to consist of representatives of farmers from highland, medium land and lowland plus fishermen and landless. Fisherman would only be member in *Chawks* where they lived. Women would make up one third of these group representatives. All the GO/NGO officials were removed and fishermen, women and landless represented *Chawk* committees not NGO/BRDB groups.

Although interests of women and landless might overlap with those of their male family members respectively with farmers, they were included. At the one hand, this is to be sure that any different view would be heard. At the other hand, it is because committees were also, tools for information dissemination and their inclusion would improve information flows to generally uninformed sections of the population.

The reformation program was a long and cumbersome exercise, completed within the first half of 1998. In each area to be covered, a stakeholder survey was conducted by locally hired enumerators, who visited each corner of the *Chawk*. All the listed households were then invited to the meetings. Many meetings took place: 199 meetings (lasting 1 to 6 hours) nominating about 3000 candidates and 110 meetings electing 1240 ChWMC members. One to three nomination meetings were enough to cover each *Chawk*. Of the total 32,000 invited households, 21,000 people attended a meeting. More than 30% of all the households was represented by at least one



member. At average 107 people (44% women) participated per meeting. The whole process is described in detail in "People's Participation in Water Management, Experiences from CPP 1996 1998", by Piet Jan Zijlstra, 1998). The election and (re) formation process is shown in Appendix 5 - Election Procedure for WMC.

Committee Composition	Phase I		Phase II		Remarks
	Total	Women	Total	Women	
Per <i>Chawk</i> Committee Farmers (high, medium, low)	9		9	33%	3 high, 3 medium, 3 low.
Women Representative Landless/Sharecropper Representative			2	33%	
Fishermen Representative			0 to 2	43%	Phase II: only if living in <i>Chawk</i> , Total 30(13 women)
Total Member	9		11 to 14	37%	
Total No. of ChWMC's Formed	99	NA	110	NA	
Total ChWMC Members	891		1240	37%	
Total Office Bearers (Presid. Treas., etc.)	396		441	25%	Women: 100 Treasurer, 9 Vice Pres., 1 Secretary
Table 9: <i>Chawk</i> Water Management Committees Phase I and II					

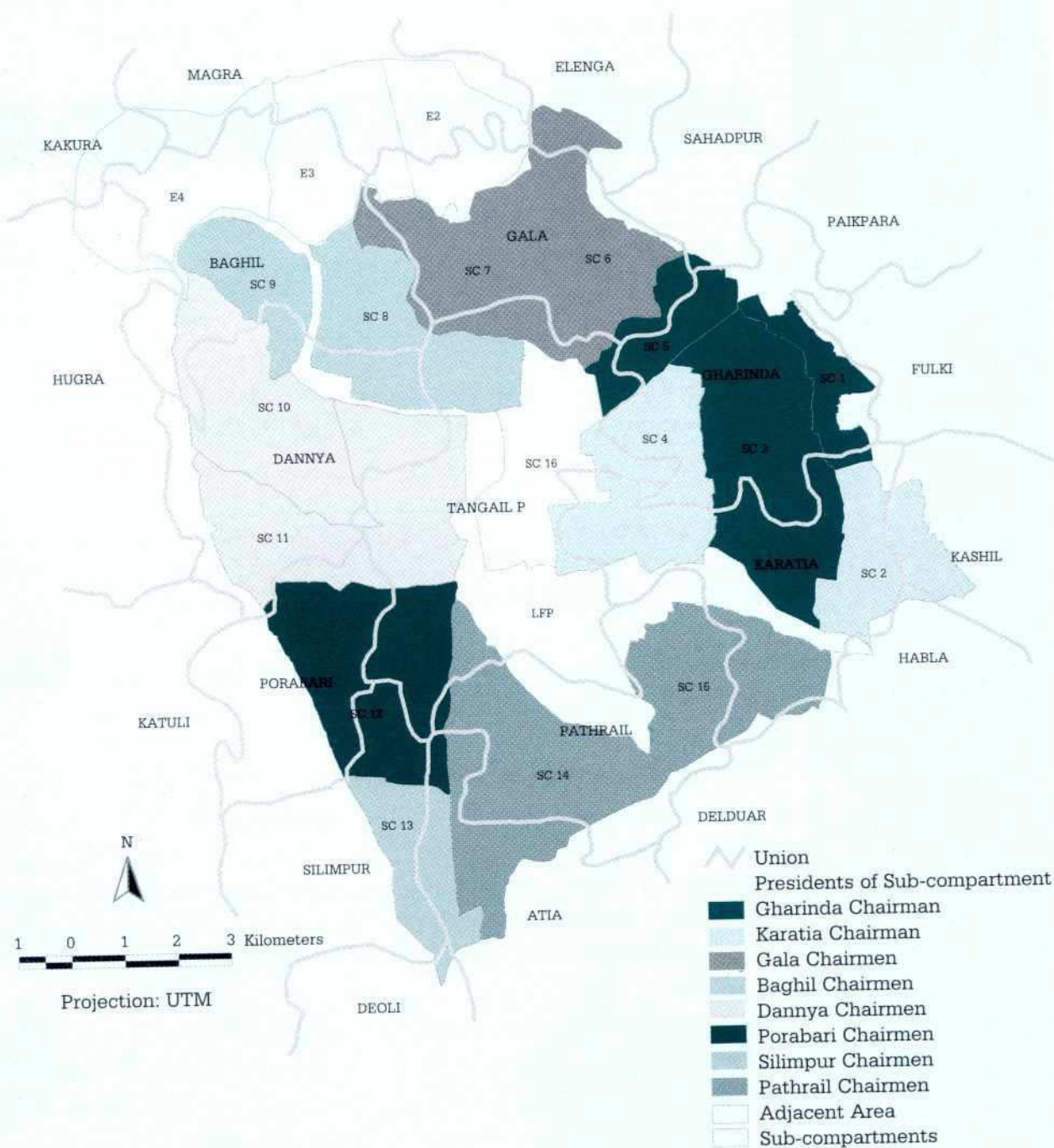
The 110 *Chawk* Committees had a total of 1240 members (459 women, 220 landless,)

Table 10 compares the composition of the *Chawk* and the Sub-Compartment Committees of the first and second phase.

The 15 Sub-Compartment Committees had in total of 403 members, of which 110 women, 13 fishermen, 33 landless and 45 UP members, with 81 households per SCWMC member. No committee was formed for Tangail Town Sub-Compartment. While in Phase I there was only one woman among 456 office bearers (<1%), in Phase II there were 125 from among 501 office bearers (25%). Table 10 compares the composition of the Sub-Compartment Committees of the first and second phase.

The Sub-Compartment WMC's consisted of 11 to 48 members, with three farmers/landless (one female) and zero to two fishermen per *Chawk* plus four UP officials (one woman). They had Executive Committees of six to 11 members. One third of members was female. Appendix 6 shows per SCWMC the composition in Phase II, also in relation to interest group populations. These figures have not changed much between formation and today.





Figur 6: Unions and Sub-compartments



The Institutional Development Section intended to limit the Chairmen of the Union Parishads to presiding only one SCWMC, while in Phase I they had presided over all SCWMC's that fell largely in their Union. Chairmen's performance as President had not been ideal. Change, however, proved too difficult. A compromise was sought in giving day to day management to the Vice President. When problems occurred again

SCWMC Composition	Phase I		Phase II		Remarks
	Total	Women	Total	Women	
Per SCWMC					
ChWMC Representative	3	100%	3	33%	Phase I: only presidents
NGO/BRDB Women Representative	3				
NGO/BRDB Landless Representative	3				
Fisherman Representative	3		02	15%	Phase II: only if living in SC
NGO Representative	1				
BRDB Representative	1				
DAE + DOF Representative	2				
CPP Extension Overseer and Agri Staff	2				
UP Chairman	1		1		
UP Members	2		3	33%	
Executive Committee Members			6	11	27%
Total Member	16	18	11	48	32%
For all SCWMC's					
Total No. of SCWMC Formed	15		15		
Total SCWMC Members	269	11%	403	32%	
Total Office Bearers (Pres., Treas., etc.)	60	2%	60	25%	Women are all Treasurers

Table 10: Sub-Compartment Water Management Committees-Phase I and II

in April 1999, the situation was again reviewed. See Appendix 10 Union Chairmen and SCWMC Leadership for a full assessment.

It is believed that in the 110 *Chawk* committees and 15 Sub-Compartment Committees the relevant interest groups are now better represented; that committees do not contain non stakeholder officials; that the composition is more balanced; and that the representation of women, landless, and fishermen, has improved. In addition, the role of the UP Chairman has been slightly reduced. *Chawks* are now well represented to SCWMC, and relevant ChWMC's have now a bigger role in system management. Information flows have improved. Although all this certainly improves the chances of better system management, the real impact in terms of water management efficiency and equity can not be told without detailed study.



Further, the project has not been able to further involve most ChWMC's in a more meaningful way. A quantity of 110 ChWMC's was simply too many.

### Formation of Compartment-level Institutions, 1996, 1999

With regard to compartment level institutions, CPP followed the official MoWR guidelines in the first phase. These prescribed a huge Project Council with beneficiaries and officials chaired by the Deputy Commissioner (DC). It is not clear, whether this Council was supposed to be the Compartment O&M institution too. The formula used in CPP resulted in a Council of 79 members. After a second meeting in autumn 1996, it never convened again. The council, being an unwieldy concept, was discontinued. As experiences elsewhere in the country also showed problems with the Project Councils, the concept is under scrutiny at national level.

In Phase II, it was decided, in line with the revision of the Sub-compartment Committees, to make a Compartment WMC also mainly consisting of Sub-compartment representatives. A new concept has not been finalized, as CPP decided to wait for the new MoWR Guidelines, which have not been completed. After the reformation of SCWMC's, the Project Director formed a temporary Compartment Forum with Presidents and Vice-Presidents of SCWMC's. Tangail Town, the Adjacent Areas and third agencies were not represented. Only few parts of upstream adjacent areas fall under unions, whose Chairmen already represent SCWMC's in the Forum (See Figure 6). The Forum has met a number of times and has discussed minor works and maintenance principles.

Compartment WMC	Phase I		Phase II		ChWMC		Remarks
	Total	Women	Total	Women	Executive	Full	
SCWMC Presidents	8		8		8	8	15 SC's under 8 Unions
SCWMC Vice Presidents			15		15	15	
Other SCWMC Representatives	47	5	0 15			15	Secretaries
Adjacent Area Representatives	3					?	UP Chairmen
Pourashava Representatives	1				2	2 3	Chairman, engineer
GO & NGO Representatives	11					?	LGED, TNO, DAE, observers
CPP Specialist	1						Phase II: observers
SDE/Member Secretary	1		1		1	1	
Deputy Commissioner/Chairman	1						
XEN O&M Division					1	1	Chairperson
Project Director CPP			1				Chairperson during Phase II.
							Other CPP officials present
Total Number of Members	79	5	25		27	43 50	

Table 11: Compartment Water Management Committees-Phase I and II



As management of the compartment is jointly done with BWDB, which will retain O&M of the Main Inlet and periphery, XEN O&M will be ultimately chairing the committee. The committee should have official link with LGED, Department of Roads; the Deputy Commissioner's Office, Agricultural Extension, and any future elected Upazila Council and NGO's. It is not advisable to make all those parties official members of the ChWMC. Government fisheries; roads and agricultural specialists might be called as resource persons when needed.

## **System Operation, 1995-1999**

### *Operation 1995-1997*

How the system, or better the set of individual structures, was operated by the WMC's until 1998, was not monitored in detail. Gate operation was recorded and general exchanges were held with users on monsoon experiences. The frequency of gate operation per year is shown in Appendix 8.

### *Operation 1998*

The new committees were formed and trained on operation in 1998 so the monsoon of 1998 was the first where it could be ascertained whether WMC has kept to made agreements. Operation was monitored and interviews held for each structure with beneficiaries and operators on both operational and institutional issues.

The monsoon of 1998, however, saw extreme flooding. This resulted in CPP led flood fighting, which dominated the WMC activities until September. CPP involved WMC's in paid for flood fighting. Unfortunately, this was followed by a process to get WMC's involvement in the selection and execution of minor works. Therefore, the subjects dealt within the indeed numerous meetings of SCWMC's and ChWMC's during July December 1998 were mostly flood fighting and minor works. This was mainly because people were interested and experienced more in discussing money issues than discussing joint management. Moreover, there were not many operation problems. Later, the SCWMC's were asked to deliberate on by-laws and system operation. Meetings where CPP staff was present were well attended and reasonably democratic in character. Some SCWMC's meet more with their Executive Committee than with the full meeting. Records were kept well. Solutions in 1998, however, mostly consisted of requests by the committee to CPP, as they were used until 1998 to turn to CPP also for small ways of support.

Actually, many committees do not have to meet that often and can remain inactive for most of the year. This, however, poses a risk, as reviving them at the time of need will be difficult. At such times, minor conflicts among leaders will easily derail the



committee. In addition, without a strong and committed third party, such as the project, the committee might be reduced to a few active members, who do not meet formally anymore.

The monitoring exercise found that committees have been operating the completed structures reasonably well, and that conflicts and complaints were rare. The most often noted conflicts relate to obstructions built in *khals* and before structures and the manipulation of structures for the benefit of either powerful beel aquaculturists or *khal* fishery by neighboring farmers. Another observation is that especially in Cluster 3 people saw the water influx from Cluster 2 (breaches and opened gates) as something which could not be reduced or increased by their own initiative. The Sadullahpur and Rasulpur structures and their operators had never seen as they were too far away. Unfortunately, no specific operation modes were defined in 1998, so that not could be monitored whether committees kept to their agreements. However, responsibilities for structure operation were well outlined and generally kept to in practice. See Appendix 8 for structure operation responsibilities and frequency from 1995 to 1998.

Therefore, it might be said that operation of structures has gone well, in spite of the fact that the WMC's were not yet strong institutions.

#### *Operation 1999*

For the monsoon 1999, a well thought out monitoring system was developed in which the water management and institutional data collection were integrated. Monitoring could also be more meaningful because the project had agreed with both BWDB and WMC's on operation practices and target levels. Both consultants and BWDB staff were to be involved.

The 1999 monsoon, however, was very dry and flood levels rose, for example, at the Main Inlet only twice above the target level. Occurrences for monitoring were scarce. BWDB staff hardly participated in the monitoring. In addition, communication channels between SCWMC's and XEN CPP, the agreed upon communication chain, did not work.

People did not keep to the target levels, as they wanted to let in maximum water quantities to be on the safe side in what they saw as a drought year. No notable conflicts occurred. Conflicts about distribution of (beneficial and harmful) floods are probably avoided by keeping the internal structures open. More common are conflicts between farmers and powerful *beel* aquaculturists or between farmers and people who obstructed drainage paths by, for example, crossdams. The former conflict shows the need for providing regulator locks to the WMC's.



### *Fisheries-Related Issues*

Fisheries have not been effected in the ways anticipated. Assessment of the past monsoons shows that the operation of the infrastructure has not led to a substantial reduction of the flooded area and the period of flooding. Firstly, on request from fishermen, it was agreed to keep the inlets open until half July, so that the pre-monsoon situation will not differ much from the pre-CPP period. Secondly, the late and post monsoon situations do not differ much from before. Most areas try anyhow to drain (half October) as quick as possible to allow Aman harvesting and sowing early *Rabi* crops. Thirdly, improving drainage was only possible to a limited extent, due to a number of factors such as downstream conditions and obstructed drains.

The main change has been a reduction in access to open water fishery resources. The control of structures by non-fishermen has contributed to this, but much more this access is reduced by the increase of fishermen and the privatization of *beels*. Both of these are Bangladesh wide phenomena. Solutions to both are beyond the institutional arrangements of CPP.

### **Strengthening Chawk & Sub-Compartment WMC's, 1996-2000**

Committees were strengthened by proposing roles and procedures for them, holding discussions with them, and giving training on committee functioning and system operation, and by giving operator training.

#### *Committee Training*

The old SCWMC's (14, 313 participants) were trained end 1994 (Cluster 1B) and 1996 (Clusters II, III, IV) mostly on CPP matters, committee functioning and a little bit on system operation. Then, immediately upon the reformation, 15 new SCWMC's were trained on the same subjects, with more on system operation. During the training, signed agreements were made on committee procedures, and on which would be the structure operation committees (*Chawk* or Sub-Compartment) and daily supervisors. In addition, the subject of gender was raised, first during the July'98 training, then for 147 SCWMC women alone in November, 1998 and again with Executive Committees in April May, 1999.



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Subject	1994+1996	1996	July'98	Nov'98	April'99	Autumn'99
	12 SC's (232 men) 7 days	3 SC's (81 men) 2 days	15 SC (399mixed) 2 days	15 SC (147 women) 2 days	15SC+ (157 mixed)* 1 day	15 SC (269 mixed) half day
CPP	6 hr	3 hr	1 hr	2 hr	0.5 hr	
Committees	8 hr	1 hr	6.5 hr	1.5 hr	2 hr	
Operation	6 hr	3 hr	2.5 hr	1.5 hr	3 hr	
Maintenance	0.5 hr					3.5hr
Field Visit	5 hr	2 hr				
Agric./Fishery	3 hr	1 hr				
Gender	1 hr		1 hr	4.5 hr	1 hr	
Table 12: SCWMC Training and Subject						

Note : The July'98 training was for full committees. The November'99 training added gate operators. The April'99 training was only for executive committees plus other key responsible persons.

During WMC meetings in 1998/99, CPP staff was present to discuss operation and committee affairs. The emphasis of these instructive discussions changed during 1999/2000 to maintenance affairs.

In 1995 and 1996, 50 operators were selected by SCWMC's for completed structures and trained by CPP. Operators were paid by CPP as gatekeepers until 1998. From 1999, operation was done by WMC's themselves, employing in some cases an operator.

The focus of the project and committee support has not always been on the main issues of operation and maintenance, but the end result comes probably close to what is possible in training and supporting so many committees. CPP had not finalized its operation and maintenance policies before mid 1999. More training for the committees before spring 1999 would, therefore, not have been useful.

#### *Developing of Procedures, By-laws, O&M Plans*

In 1998, Draft Guidelines for Water Management Committees were developed in English and imparted to the SCWMC's during the July '98 training. See Appendix 7 Guidelines for WMC's. These were the basis for draft by-laws developed early 1999 in Bangla, which were proposed to SCWMC's during the April '99 training as a basis for by-laws to be developed by themselves. There has been discussion about by-laws for *Chawk* Committees, which was, however, found unnecessary. *Chawk* related procedures were incorporated in SCWMC by-laws.



59

84

In 1996, an Operation Manual was developed, still under Phase I. The manual was never used, as at the beginning of the final Phase II both the committees and the water management situation were reviewed and insights changed.

In 1999, another operation plan was developed as well as a maintenance plan. Operation instructions per SCWMC were developed in simple Bangla in late 1999. Maintenance agreements to be signed by BWDB, WMC, and, where necessary the Union *Parishad* and LGED, were developed late 1999. They use the maintenance plan as a basis. During the July '98 training, agreements have been made about which committee was in charge of which structure and which person was in charge of daily supervision. See Appendix 8 Structure Management Responsibility and Operation Frequency.

The plans and arrangements will need to be reviewed and updated by the BWDB after a few more years of experience.

#### *Legalization*

The importance for legalization of water management organizations is often overestimated. Legalization is said to be needed for committees to collect money, to be a legal party in conflicts, and to deal officially with government agencies. However, in rural Bangladesh many community efforts do not fall under any law. For example, the mosque committee does not have a legal status but they mobilize resources, are legal parties in conflicts, and deal with any government agency. During the project, the recognition by BWDB is more than enough for WMC's to perform their function. For the post project period, WMC's should only be registered under a law that will in no way limit their efficacy as a committee. At present, committees can only register under the Societies Act or the Co-operatives Act. These are very unsuitable, as other projects and committees have found out.

All water sector projects in Bangladesh are now awaiting the new local government structure and proper legal arrangements for registering water management committees. The new laws and guidelines should enable institutions to escape from the limitations of the present alternatives. The project thinks it has achieved optimal legal status under the circumstances by linking committees to Union *Parishads* and by having them officially recognized by the BWDB. These linkages should be maintained as they are, as too much interweaving of U.P's and WMC's will lead to decreased efficiency.



### *Information Dissemination*

The project has always made efforts in dissemination of project information. This was partly born out of the wish to counter the constant criticism from outsiders. This criticism was sometimes justified, but often based on misinformation or wrong intent. One step was the establishment of an Information Dissemination Center, which has taken care of dissemination of project policies towards villagers and WMC members. The venue was also used by WMC's for meetings.

### **Preparation for Operation by BWDB O&M and Compartment WMC, 2000 -**

From June 2000 the O&M of CPP (now under XEN CPP) will fall under the BWDB XEN Division O&M Tangail, with whom the CPP Sub-Division will be merged. It is not yet decided whether the Sub-Division Tangail will be reshaped after the merger, but this might be necessary as the Sub-Division CPP is situated in the middle of Sub-Division Tangail and as such will create an institutional anomaly. See Figure 7, showing the BWDB Greater Mymensingh O&M Circle, Divisions and Sub-Divisions. Care should be taken that CPP, which is, in terms of investment and O&M, equal or bigger than other sub-divisions, will get needed extra expertise and attention.

The O&M XEN's office has not been involved in CPP until 1999 as there was already BWDB involvement through the Project Director and XEN of CPP. Although the Project Proforma provided a role, XEN O&M was said to have no mandate or authority in CPP. When CPP started O&M Division even withdrew itself from the area, stating that CPP would have enough resources. With the already high regular workload of an XEN, the involvement of his office would have been an extra burden for himself, while adjustment of a second XEN in the project might be cumbersome.

For the monsoon 1999, arrangements on operation and maintenance were made with BWDB/CPP specifying roles of each staff member and office. See Appendix 9 Compartment O&M. CPP trained relevant BWDB staff of CPP and its O&M Division on the operation and maintenance aspects.

### **Maintenance**

Maintenance of completed infrastructure during the project has nearly all been initiated by the project and paid for by the donor. In this way, the project has not been able to work on one of the main maintenance bottlenecks, i.e. weak BWDB performance in maintenance. One of the bottlenecks for testing BWDB capabilities is the practice in BWDB projects, and apparently accepted by donors, that during a project all maintenance will be paid for by the donor.



Likewise, the project has also not been able to test the maintenance capacity of WMC's. The project has never stimulated self action and regularly has, in its efforts, to keep the system protected and running, offered assistance on occasions where clearly the local people should have solved the problem themselves. Examples are repair of small breaches, small structure repairs and removal of debris and dead cows that were blocking structure gates. Intentions to bring BWDB and WMC maintenance arrangements and testing forward in time could not be realized.

Minor works, instead of being a test for committees, became an obstacle to institutional development. Not operation and maintenance but minor works has dominated the meeting agenda of committees from September 1998. In view of the fact that of many minor works the benefits were very small and others could not be implemented, the net benefit of minor works for the system may have been negative.

Infrastructure	Operation	Maintenance Responsibilities		
		Inspection/Reporting	Preventive	Periodic
1. Embankment	BWDB	WMC's	BWDB	BWDB
2. Main Inlet	BWDB	WMC's	BWDB	BWDB
3. Peripheral structures	WMC's	WMC's	BWDB + WMC's*	BWDB
4. Structures along Lohajang	WMC's	WMC's	BWDB + WMC's*	BWDB
5. Internal Structures	WMC's	WMC's	WMC's	BWDB
6. Lohajang River	BWDB	WMC's	BWDB	BWDB
7. Secondary/Tertiary Khals	WMC's	WMC's	WMC's	BWDB
8. Protective Work	BWDB	WMC's	BWDB	BWDB
9. Bridges, Culverts, Roads	LGED & UP	WMC's	LGED & UP	LGED & UP

Table 13: Delineation of Maintenance Responsibilities

Greasing, debris clearance, emergency repairs to be done by WMC's

The project finalized a Maintenance Plan in 1999, discussed this with the Compartment Forum and trained SCWMC's along the lines of this Plan. The maintenance arrangement envisaged for the post project period was that the periphery would be maintained by BWDB and the internal infrastructure by the WMC's. This has been translated by the project in such a way that preventive maintenance of internal infrastructure will be done by WMC's, leaving the periodic maintenance still to the BWDB. The Maintenance Plan is included in **Annex B: Engineering and Construction**.

Table 14 contains the estimate of how much this arrangement will cost the various



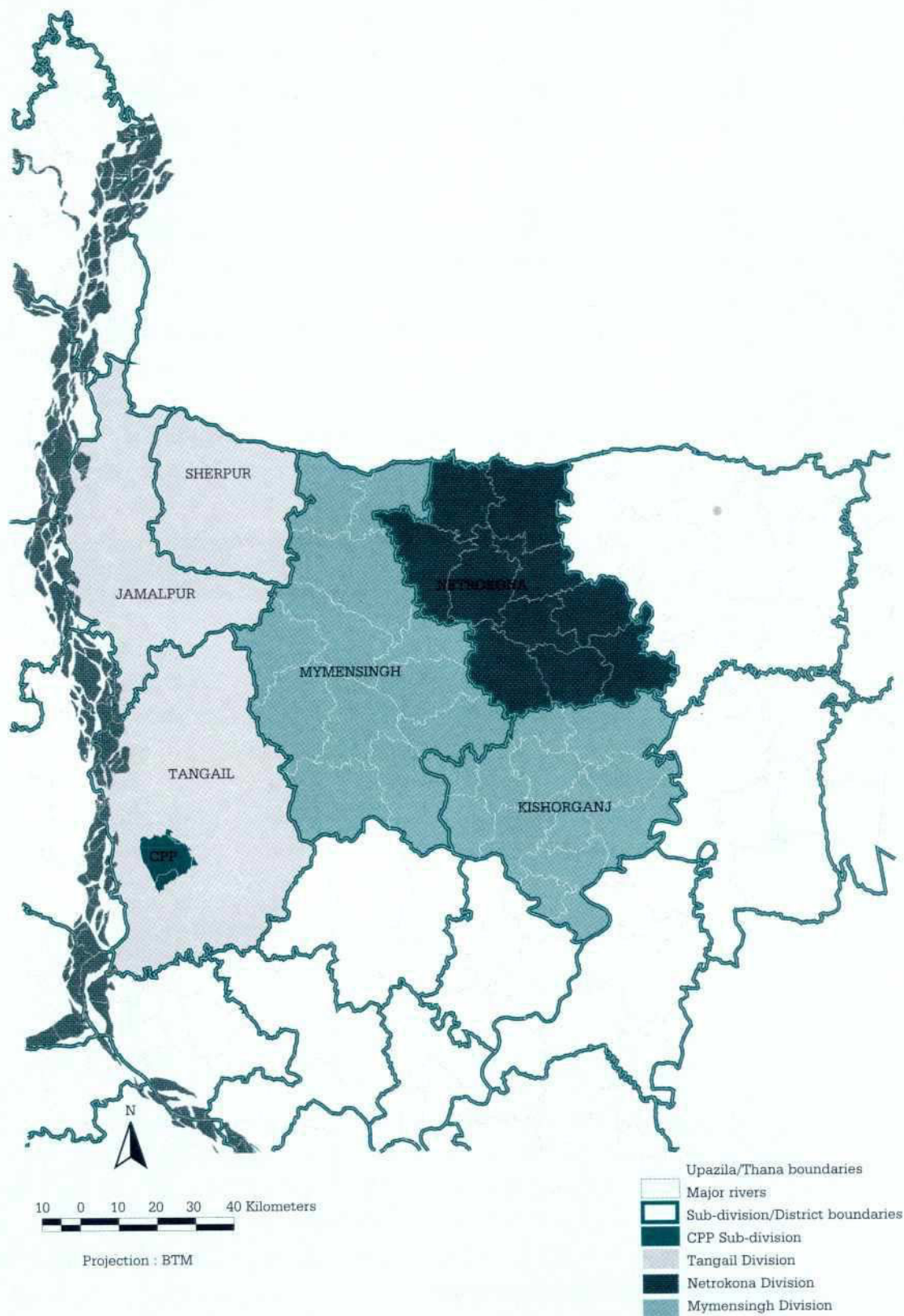


Figure 7: O & M Circle Greater Mymensingh



households in the various Chawks and sub-compartments. In the estimate it has been assumed that infrastructure that does not function will not be maintained. The total annual maintenance burden for WMC's will be around Tk 84,000, which, divided over 22,000 farmer households, comes to a compartment average of only Tk 4 per household per year. For a few Chawks, this might be Tk 20 per household per year,

SC#	Total Annual Cost (Tk)	Annual Share		Probable* WMC Cost (Tk)	Cost/Farmer hh		
		BWDB (Tk)	WMC (Tk)		Farmer hh	WDB Tk/hh	WMC Tk/ hh
1	420,534	413,475	7,059	2,238	755	548	3.0
2	374,829	364,125	10,704	2,302	1,584	230	1.5
3	411,857	396,478	15,379	9,961	2,362	168	4.2
4	204,309	199,519	4,790	4,790	1,292	154	3.7
5	181,493	176,863	4,630	200	534	331	0.4
6	762,252	749,603	12,649	8,819	1,203	623	7.3
7	485,605	476,746	8,859	8,859	1,471	324	6.0
8	683,946	674,547	9,399	5,450	1,986	340	2.7
9	483,722	475,595	8,127	5,264	873	545	6.0
10	463,801	444,587	19,215	15,696	1,751	254	9.0
11	913,382	900,027	13,355	6,893	2,085	432	3.3
12	373,268	364,132	9,136	5,432	1,883	193	2.9
13	448,743	438,702	10,041	2,909	1,180	372	2.5
12	300,881	295,959	4,922	4,922	2,166	137	2.3
15	43,229	41,879	1,350	750	1,109	38	0.7
Main**	2,025,072	2,025,072					
<b>Total</b>	<b>8,576,923</b>	<b>8,437,309</b>	<b>139,614</b>	<b>84,485</b>	<b>22,234</b>	<b>379</b>	<b>4</b>
Share		98%	2%				

Table 14: Maintenance Cost per household per Sub-Compartment

Note\*: "Probable Cost" does not include structures that will probably not be maintained  
 Note\*\*: "Main" means Main Inlet and Lohajang River

while other Chawks will not have to spend any Taka at all. The BWDB will probably have to spend some Tk 76 Lakh, if useless infrastructure is skipped. This amounts to Taka 379 per farmer household.

Commitments from BWDB have not been made official yet. Relevant other government agencies and Union *Parishads* should also commit themselves. For example, some infrastructure falls under the natural mandate of LGED, Tangail



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*Pourashava* or *Union Parishads* and their commitment to maintain should have been obtained before construction started.

Furthermore, maintenance arrangements concentrate on CPP built infrastructure, but water management infrastructure that is not built by CPP is of course just as important. Arrangements need to be made and kept with institutions that are now responsible for those works.

## **Institutional End Results**

### *Government Agencies*

The probable change that has taken place during the project period is that there is more awareness at central level on compartmentalization, on people's participation, on operation and on maintenance. This change for a small part has been due to CPP, e.g. through its feed back to national level policymaking on participatory water management.

It can be expected that some of this awareness has trickled down to division level. Participation of the CPP/BWDB staff in CPP, however, have had minimal effect, as most of the involved staff has been or will be transferred in due time and fresh staff will replace them. It can further not be expected that BWDB will increase its O&M capabilities sufficiently in terms of budget, non engineering staff, maintenance practices and water management know-how.

### *Water Management Committees*

The committees are in place, have received training, have done structure operation and have committed themselves to maintenance. It is, however, difficult to assess the committees' strengths as they have hardly been tested. Strength evaluation can only be derived from viewing present leadership, potential for leadership conflict (President, Vice-President), and the way meetings are held, minor works are implemented and structures are operated (1995 - 99). Furthermore, the required effort and the perceived benefits will determine the prospects. The following picture emerges:

For the operation, the occurrence of blocked drains and structures, misuse for fishery and the not solving of land and water conflicts are used as indicators. For meeting performance, the occurrence of meetings (1998, 1999), attendance rates and decision-making quality are used as indicators. Attendance in the 1999 maintenance training, where no allowance or lunch was provided, is also used as an indicator in the training column. For minor works, the progress over 1999 minor works is taken as indicator.



3 2

Sub-Compartment	WMC Performance						Benefit	Required	Prospects
	Leadership	Meeting	Training Attend.	Minor Works	Operation	Overall	from O&M	O&M Effort (Tk/yr)	
SC#1	o	o	o		o		low	2,200	not good
SC#2		+		++		o	low	2,300	moderate
SC#3	o	+					medium	10,000	bad
SC#4	+	++	o	o	+	+	medium	4,800	good
SC#5	o				+		medium	200	not good
SC#6	+	+	+		+		medium	8,800	not good
SC#7	+	+	+		+	+	high	8,900	good
SC#8	o				+		highest	5,500	not good
SC#9	+	++		++	+	+	highest	5,300	good
SC#10	+	+	o				high	16,000	bad
SC#11							high	6,900	bad
SC#12	+	+					high	5,400	not good
SC#13	o		+	++			medium	2,900	not good
SC#14	o	o	o		o		medium	4,900	not good
SC#15		o		+	o	o	medium	750	moderate

**Table 15: WMC Performance and Maintenance Prospects**

Note : very bad, bad, o moderate, + good, ++ very good (all scores relative)

The assessment has sufficient interpretation elements in it to be inaccurate when it comes to individual Sub-Compartment WMC's, but it will be accurate enough on the extreme cases and the overall picture. The conclusion is that the majority of SCWMC's will have problems with maintenance, particularly SCWMC's 10 and 11.

#### *Institutional Arrangements*

SCWMC's have committed themselves through by-laws, acceptance of Operation Plan and agreement to Maintenance Plans. The commitment from Government side is highly tentative, as national policies are still lacking. And even if, for example, MoWR agrees to a national policy in which BWDB will pay for periodic maintenance of internal infrastructure, this will create such a high maintenance burden for GoB, that it will not be implemented due to lack of budget. Moreover, the fact that CPP has not tested the post CPP arrangements of joint management (XEN O&M and ChWMC) and maintenance, increases the risk of failure substantially.



## Lessons Learnt

### Involvement and Consultation of Stakeholders, GO's and NGO's

As CPP is one of the very few projects where hands-on experience has been acquired on participatory project implementation and water management, it is expected that its feedback will be valuable for concept development at central level.

The following table summarizes which party has been involved, in which stage and how :

Stage	CPP TA	FPCO/ WARPO	BWDB CPP	BWDB O&M	Local People	Elected Officials	Line Agency	NGO's	Institutes
Identification and Feasibility Study	no	actor	no	no	no	no	no	no	no
Concept Development	actor	actor	actor	no	no	no	no	no	no
Need Assessment	actor	no	no	no	subject	subject	subject	subject	NA
Support Studies/ Data Collection	actor	no	actor	no	no	no	actor	actor	actor
Consultation	actor	no	no	no	subject	subject	subject	facilitator	NA
Design & Construction	actor	no	actor	no	no	no	no	no	no
WMC Formation	actor	no	no	no	subject	subject	subject	no	no
Strengthening Institutions	actor	no	no/actor	subject	subject	subject	no	actor	actor
O&M During Project	monitor	no	actor	no	actor	actor	no	no	monitor
Post-Project O&M	monitor	no	monitor	actor	actor	actor	actor	no	monitor

**Table 16: Stage of Involvement per Type of Institution, Achievements**

Note: The "no's" are shown in underlined characters for occasions where an institution should have been ideally involved, but is not.

The main institutional development principle, defining the stage and character of involvement of the various parties, is, that those who will be responsible for O&M, will also be involved in planning from the first stage (identification, need assessment, concept development, planning and design). They should feel able and commit themselves to shoulder the future burdens of operation and maintenance. The project formulators have apparently not realized this and the project has also not done enough to follow this principle, thereby strongly reducing the chances of well developed ownership feelings and O&M success.

The project was started with a concept that did not address perceived local needs, nor did it take into account what completely inexperienced local stakeholders and institutions might be capable of managing. Even the desire of starting an experiment



18

was not discussed with stakeholders beforehand. Under the circumstances, the project, which had tried initially to redress these errors, was forced by the FPCO in 1992 to sell compartmentalization to the beneficiaries. This was at odds with its own objectives of optimizing local ownership for the system.

The project should have been preceded by a pre-study or a normal feasibility study, in which stakeholders' perceptions should have been thoroughly inventoried. A good feasibility study would have found out that compartments would not match the first water management priority of the stakeholders and that the approach would have to tackle that discrepancy first. This is said with the benefit of hindsight and about a period when feasibility studies in the water sector did never include inventories of local needs, or attempts to incorporate those in project designs. Even ten years later this is not common practice.

Furthermore, the concept should have been tried out first by running a computer model on a strongly simplified situation. It might, for example be, done on the system sketch with the few sub-compartments, which were amply used in documents in the beginning of the project. This and the feasibility study would probably have avoided the project having to try out an untested complex and expensive concept on real people.

#### *Stakeholders*

The project has been able to develop workable mechanisms for need assessment; stakeholder consultation, committee formation and participation in project planning. The followed approach in these exercises has been fruitful. With the acquired expertise, it should be possible to do it a next time with much more efficiency.

The project has learnt that in participatory planning and implementation, committees should have been formed earlier, so that they can commit themselves not only to the concepts, designs and plans, but also to the involved O&M and maintenance costs.

The project has been able to adjust its approach to make it more practical, first by bringing forward the committee formation in Cluster IV (1994) and then by reforming the committees to a more coherent institutional structure.

#### *Bangladesh Water Development Board*

It is understandable that the project started with a separate BWDB office under FPCO/WARPO, probably because of fears that a regular BWDB O&M office would not



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have enough time and flexibility to handle an experiment. However, when for the final Phase, the emphasis came to lie on O&M, the Tangail XEN O&M of the BWDB should have been brought prominently in the institutional picture. The XEN should have been prepared and made responsible for the system's operation and maintenance during the last project years.

#### *Other Government Agencies and Institutes*

In addition, the project has made maximum use of government agencies and institutes in collection of data and conducting of studies. It is clear, however, that the line agencies should have been involved in identification and concept development. This would have allowed, for example, defining clear fishery objectives for the project as basis for design criteria. Also clear arrangements could have been made with LGED about maintenance or about any new LGED works that might alter drainage patterns.

Also, during the project, more regular co-ordination and information exchange among involved GO's and NGO's would have benefited the project.

#### *NGO's*

The project has learnt also about more optimal involvement of NGO's. The project has achieved useful involvement of NGO's and their groups in the consultation process. Without them, the consultation of landless, women and fishermen would have been problematic, as these are more difficult to reach for a new project. If the NGO's had been involved in identification and concept development, too, this would also have prevented much of the anti CPP activities by NGO's. Similarly, they might have played roles in monitoring project performance from the perspective of their groups of normally resource poor stakeholders.

However, it was sound policy not to give local NGO's key roles in mobilization for water management. Beside the fact that there were no NGO's with experience in institutional development for water management projects, NGO's would have had problems to work with all stakeholders, poor as well as elite and larger farmers. Most NGO's are used to working in small areas, would also have had problems mounting their efforts over large areas.

### **Infrastructure Design, Planning and Implementation**

Although this subject belongs to other parts of the Final Report, a few aspects must be dealt with, that provide the context for institutional achievements and failures.



63

The flooding and draining pattern with new infrastructure is now understood to the extent that WMC's can be advised on optimizing intra and inter sub-compartment water management. As there has been no opportunity to test operation, it is not known whether committees are able to follow this advice. More time is needed.

It has not been possible to create simple management units to which one committee can be assigned. Many structures will have to be managed by more than one SCWMC and most SCWMC's have to manage more than one outlet or inlet.

The complexity of water management units at *Chawk* level is less than for sub compartment, but still forms an obstacle to institutional survival. Some *Chawks* in the eastern half are dependent on as many as ten structures in different directions

## **Water Management Institutions**

### *General Composition*

The project has sufficiently established which interest groups should be represented in which committee and how committees should be formed. Further operating of the committees in the O&M phase will have to be monitored to make conclusions on the involvement of interest groups in the post project period.

The project has been able to achieve proportionate participation of women, landless and fishermen in the consultation process, committees and committee management. This has been effective in dissemination of project messages among the general population. It will not be able to ensure a sustained role for women, fishermen and landless in the post CPP phase. It has learnt that representation of area wise interests (highlanders, lowlanders, upstream, downstream, insiders and outsiders) is the most important composition condition in all stages.

### *Women and Landless*

Representation of women<sup>5</sup> and landless in identification and during project implementation is important. Women have been enthusiastic committee members. Their contributions are different from those of farmers. However, much more experience, also in other projects, should be gained before it can be established whether their contributions are sufficiently different and useful to justify the extra effort and resources to reach them. In addition, care should be taken to involve farmwomen, who are more difficult to reach. They should, however, be involved, not only until it is sure how beneficial their involvement is, but at least to optimize the

<sup>5</sup> Women are mentioned here as seemingly one group, although CPP has of course concluded that women are farmer women, fisher women, and landless women.



29  
information flow from and to the project, as they form the majority of beneficiaries. In CPP, landless and women probably count for at least 68% of the population, if the Stakeholder Survey is used: some 32% of families are landless and of the remaining 68% (farmers) about half are women.

Involvement during O&M, however, should not be imposed on committees. The chance that the committee leadership will continue to involve them meaningfully after CPP and its staff has retreated from the area is very low. There might be a sustainable case, if women or landless were strong as a group or had strongly shared interests, but this is not the case at all. Mostly their interests overlap much more with the farmers of their area (male partners) than with women respectively landless elsewhere. Now, they might be called to meetings, but in O&M most deliberations and decisions are made outside formal meetings. If women are not involved in the informal circuit, their presence in the meetings also becomes ineffective. It might be even argued to have the committees reconstitute themselves as per what they expect to be an effective committee. This will prevent that in the O&M phase many members will be either absent or ineffective in meetings. It is very probable that decisions or water management practices will hardly differ if landless and women are absent.

#### *Fisherfolk*

Fishermen form a distinctly different case as their interests might oppose those of farmers. The project has not been able to involve fishermen meaningfully in project planning and committees. In cases like CPP, where their interests are not addressed during system design, it is not useful to have them involved in O&M committees. If however, the system and the committee have clear cut fishery objectives, both the system and the committee need to be designed for this. Fishermen in that case should be supported to play a sustained meaningful role in O&M committees. There is, however, no experience with this, and chances of success should be called dim. In all cases, fisherfolk should be involved in committees during implementation for reasons of information dissemination.

#### *Union Parishad Officials*

The project has been able to avoid parallel institutions by involving UP officials in WMC's, but it has not been able to neutralize the disadvantages of the local power structure to SCWMC functioning. There is a genuine risk that UP officials will not keep WMC's active, while in his turn, the XEN O&M might keep his contacts with stakeholders limited to calling only the UP Chairmen in emergencies. These politicians are most visible and accessible for BWDB or other government officials.



This situation can probably not be improved as changing the chairman's status in the committees after so long involvement might have more negative than positive effects.

#### *Tangail Town and Adjacent Areas*

The project should not have refrained so long from including Tangail Town in the institutional set up, although it is a difficult task. Considering that the town dwellers are actually the biggest beneficiaries from the protection works, their inclusion would have given more weight to protection efforts and have brought in parties with important possibilities for resource mobilization.

In addition, institutional support to Adjacent Area Committees should have got much more attention, so that they would give meaningful input in compartment level decision-making.

#### *Compartment Water Management Committee*

The project was late in formalized the Compartment WMC. This was done in order to wait for the new government guidelines and the upcoming new local government set up. The Compartment Forum was very useful, but a formal committee is needed to become more effective. This committee, moreover, should include representatives from Tangail Town and the Adjacent Areas and have formal links with local government, *Pourashava*, LGED, etc. Then it can be timely and sufficiently prepared for the post CPP period. The prospect is that the guidelines and new local government set up will not be timely finished to adjust the set up by the project. It is not clear who will implement this adjustment if it occurs after June 2000.

#### *Timing of Committee Formation*

The project has learnt the limitations of its institutional set up with committees. Firstly, the project should have formed committees before infrastructure decision making was done, as at present it has created a situation in which committees are made responsible for O&M of infrastructure that they have not requested or endorsed. However, at the other hand, O&M committees should have been fixed later. Changing water management insights, particularly those acquired in 1998/99, show that the unit area boundaries for systems and sub-compartments are incorrect at places. This means that the wrong people sit together on management of some systems. They also show that, especially in the eastern area, regular communication between certain Sub-Compartments is essential, while the set up does not provide formal platforms for these. The Compartment WMC would be too big, if two Sub-Compartments want to meet regularly. The project has also not been able to ensure a sustained role for the



majority of *Chawk* Committees in O&M, as there are too many to be supported and to be made sustainable organizations. Moreover, quite a few have hardly any future role in O&M. The lesson is that, during planning and implementation, beneficiary committees are needed, but that these should not necessarily be the same as the ones doing O&M. Committees at *Chawk* level might also be replaced by annual meetings.

### **Strengthening Water Management Institutions**

The project has been able to train all SCWMC's and other persons crucial to structure operation in system operation. Operation might remain slightly sub-optimal for some years, but beneficiaries will further develop their insight and skills through practice during the monsoons to come.

The project has not been possible to prepare WMC's adequately for their maintenance tasks nor has it achieved well-established resource mobilization arrangements in time. The project has often justified this with the explanation that it would have been unwise to raise the subject of maintenance earlier. People had not seen yet the unproved benefits of a still incomplete system and would have reacted negatively. Moreover, it was feared that the anti CPP lobby would have capitalized on it and created more problems. After the floods of 1998, discussing the issue with WMC's has become indeed much easier. However, the fact that no policy was developed until the last year, also shows that the importance of maintenance was under estimated.

Consequently, it has not been possible to monitor the WMC's in these aspects. These arrangements, moreover, should have involved all stakeholders, including third agencies and inhabitants from Tangail Town and the adjacent areas. That would have considerably reduced the risks of public periphery cuts by outsiders (three during 1998 flood), of more holes and culverts in the internal sub-compartment boundaries and of more obstructions in *khals*.

Considering that WMC tasks consist of operation and maintenance, and that the project has as foremost task to ensure proper O&M arrangements through them, the project's activities, training, and campaigns, should have been much more focused on O&M. For example, the subjects of "what CPP does for people", minor works and gender have received far more attention than maintenance.

Women were supported separately, although difficulties in defining their role might have reduced the effect of the support. However, fishermen should have been more supported as a group, because their stakes are higher. They were only targeted by



96

the fishery section for fishery program purposes, without much institutional support.

The project should, as mentioned earlier, have been set up differently in order to prepare BWDB O&M more optimally for its post project tasks. Arrangements to be tested in the 1999 monsoon have been made with BWDB/CPP.

The project had operation arrangements, task divisions and maintenance principles in place for the monsoon 1999, but could hardly test them due to relative dry circumstances. Still consultants played the role that BWDB CPP should play and BWDB CPP played the role that BWDB O&M and Compartment WMC should have played. Now in hindsight it can be said that actually these and the maintenance arrangements between BWDB O&M Division, relevant WMC's, Union *Parishads* and other relevant agencies, should be in place before the start of construction.





# Conclusions and Recommendations

## Overall Results

The project will leave a complex water management system behind with institutions that cannot be expected to manage it adequately. Nevertheless, from both government side and stakeholder side the responsibilities in operation and maintenance are defined. The management committees are in place and responsible parties have been instructed in optimal operation and maintenance.

## Prospects under the Most Likely Scenario

In order to give the prospects, assumptions should be made. Firstly, it should be assumed that BWDB policies and guidelines as well as the new local government set up will be finalized to everybody's satisfaction. Secondly, it can be assumed that BWDB practice; work force situation, skills and fund allocations will remain more or less the same as at present. Under the assumptions, the most likely situation after some years will be that:

- Personnel of BWDB who have been trained in system operation and maintenance will all have been transferred and project prepared O&M manuals will not be found if looked for.
- Periphery breaches and public cuts as well as non-functioning of periphery structure gates will occasionally occur. As per experience in other projects, about half of these problems will be solved by BWDB within one year of occurrence, but hardly ever immediately or during the monsoon. The exception will probably be the Main Inlet.
- Most internal WCS will not be maintained properly by BWDB and stakeholders will lose their function. The maintenance costs will be too high and the benefits too low, especially if the periphery or upstream structures, on which they depend, are not managed and maintained properly.
- Those very few Chawk WMC's that have a clear operation role and will remain existent, will probably be reduced to occasional meetings and/or the activity of a few individuals supervising structure operation.
- Only a few SCWMC's will continue to remain active, but probably only as Executive Committee. Others will come to revival only by initiation from third parties (e.g. BWDB). Most will be reduced to its President or to its Vice President and Secretary. The WMC's will only be called during emergencies or when resource allocation issues have to be solved, but mostly these meetings will be public meetings.



- 92
- The Compartment WMC might not (often) convene due to lack of regular responsibilities and lack of interest from the UP Chairmen's side. Compartment management will be left to the BWDB, with an occasional exchange with sub-compartment representatives. Most frequently, if BWDB O&M wants to consult or instruct beneficiaries as a group, it might only call the Union Chairmen.
  - Women, Fishermen and Landless will become inactive members of WMC's sooner than others, mostly due to lack of efforts by the WMC leadership to keep them involved).

### **Requirements to Enhance the Project Output**

The following is required in order to enhance the output:

- To have signed and quantified maintenance arrangements in place, which involve SCWMC's, Union *Parishads*, BWDB, and LGED, Department of Roads & Highways.
- GoB and BWDB should commit itself to specific allocation of funds for maintenance.
- Extra effort needs to be made to further strengthen the fledgling BWDB - WMC relationship during the post project years. Specialist staff will be needed for some time. This should be policy for many other projects, too. It makes no sense to create an exception for CPP. It might be sufficient to have two field level Institutional Development staff work under the XEN to promote BWDB - WMC communication and to monitor the committees. Furthermore, a specialist should monitor O&M practices during the coming two monsoons, in a similar way as intended by CPP for monsoon 1999. On basis of findings, the operation plans and maintenance plans might be adjusted. It is probable that BWDB will have to hire a specialist, as it does not have sufficient expertise within the organization at present. Good institutional development specialists with relevant practical experience are very scarce on the market.
- Post project adjustments of the institutional set up to new guidelines and laws should be guided by specialists, too. As this will be needed for more projects, BWDB will have to hire experts to translate the new national guidelines and policies for each type of project and to adjustment by-laws, operational plans and maintenance plans.



## Conclusions

The project was to design and test institutional arrangements for O&M of a compartment and to involve stakeholders in the project development. The final Phase Terms of Reference added that these arrangements must be sustainable.

The following evaluative conclusions can be drawn:

- The Terms of Reference, with which the first phase started, stressed the fact that compartmentalization had to be tested, and that beneficiaries had to be involved from the start. These two notions appeared in practice to be in contradiction with each other. The conceptual confusion resulting from the Terms of Reference has never been solved. Therefore, CPP never achieved proper participation or proper compartmentalization in the way envisaged in 1991.
- For proper participation to take place, first the concept should have been well elaborated and tested through a simplified model. Further, a feasibility study should have been done. This would have found that stakeholders are not ready for full compartmentalization. It might be that a motivation campaign during the consultation phase could have brought people to choose the full compartmentalization option instead of the full drainage option. But in view of the conclusions on the feasibility of the institutional set up to be made hereafter, the people appear to have been right in their inclination against full compartmentalization.
- Since people in hindsight are positive about the system's degree of protection, compartmentalization (controlled flooding) should not be excluded as a possibility. It could have been probably achieved phasewise over a period of maybe ten to thirty years, starting with what stakeholders were ready for in 1992. With management systems being practiced over the years, there might be sufficient progress in the evolution of the institutions and resource mobilization capabilities to increase the level of control over the environment.
- In view of the social, political and institutional environment, the project has developed an O&M institutional set up, which, with adjustments after learning lessons, comes probably very close to what is optimal in Bangladesh. This set up does, however, not guarantee proper O&M. A set up of joint beneficiary BWDB management is the national policy for systems of this size. This is obviously the best model as neither beneficiaries nor BWDB would be able to manage the system alone. However, no model or guideline exists still for this arrangement. A thorough evaluation under for, example NWMP, might further



72

establish an upper boundary in terms of system size and complexity to what the BWDB and beneficiary Committees are at present able to manage well. Later, this upper limit might increase to a size and level of complexity that is similar to CPP now. BWDB should concentrate first improving its O&M performance in smaller and more simple systems.

## **How CPP-like Projects Should Be Done a Next Time**

### *A Pilot Project*

As there might be new pilot projects with other objectives, CPP's findings might be relevant. Any new concept should at first be better elaborated than was the case for CPP. Secondly, it should, if applicable, be tested in a computer model for a simplified situation. Thirdly, the people's attitudes, their water management priorities and their O&M capabilities all should be inventoried in a feasibility study to check what type of project they are at that moment ready for. The type of experiment will have to be adjusted to the findings of those studies. In case institutional arrangements have to be experimented with, the project should, from the start, formally involve the proper offices of the envisaged institutions, e.g. BWDB O&M. For the rest the project can be implemented like a normal water management project, albeit with an experimental character.

### *A Compartmentalization Project*

Institutional affairs for a compartmentalization project, regardless whether such will ever be built again, are not different from those for a water management project.

### *A Water Management Project*

In principle water management projects in the floodplains should have the same engineering and institutional objectives as CPP: protection, controlled flooding and controlled drainage. In view of the fact that the present system is institutionally not feasible, the quantity of infrastructure and the level of control in new water management systems should be strongly reduced. The level of sophistication should be determined in an integrated exercise applying institutional, technical, economical and environmental factors.

In addition, the sequence and the contents must be adjusted. The table below gives an example of how the involvement per stage and institution could be improved.



96

Stage	Project Year	CPP TA	BWDB O&M	Local People	Elected Government	Line Agency	NGO's
Identification/ Feasibility	1	no	no	subject	subject	subject	subject
Need Assessment	1	actor	actor	subject	subject	subject	subject
Concept Development	1	actor	actor	actor	actor	actor	actor
Studies/ Data Collection	1	actor	actor	assist	assist	actor	actor
Consultation	1	actor	actor	subject	subject	support	support
WMC Formation	1	actor	subject	subject	subject	subject	support
Institutional Support	13	actor	subject/actor	subject	subject	no	support
O&M Arrangements	12	advice	actor	actor	actor	actor	no
Planning and Design	12	actor	actor	endorse	endorse	support	no
Construction	2	monitor	actor	actor	monitor	monitor	no
Construction Funding	25	no	sharing	sharing	sharing	no	no
O&M During Project	35	monitor	actor	actor	actor	no	no
Post-Project O&M	6	monitor	actor	actor	actor	actor	no
Monitoring & Evaluation	15	actor	actor	actor	actor	actor	actor

Table 17: Stage of Involvement Per Type of Institution, Recommendation

Note : actors in construction and O&M also contribute in funding

The following approach proposals are made, which reflect the table above:

- Not to have a separate BWDB/CPP office, except for a Project Director, and to have BWDB more actively involved in need assessment and consultation.
- To split the program between "one time" activities, e.g. consultation meetings and training, and "to be sustained" activities, e.g. monitoring, operation and maintenance. The one-time activities can be done by consultants, but the other activities should be done by the BWDB. This will highly limit the possibilities and the quality. It will probably result in a project with very low ambitions in terms of engineering and institutional development, but with a far more sustainable result.
- To do concept development only after needs assessment and active involvement of all parties in concept development. For need assessment, basically the same methodology might be used, but with incorporation of useful aspects of the System Rehabilitation Project (SRP) Rapid Water Management Appraisal.
- To schedule beneficiary committee formation and strengthening before planning, design and construction, with the committees endorsing the overall and detailed design and agreeing to bear resulting future O&M costs.



- 95
- To have two phases in stakeholder committee formation: first a project committee including all possible interest parties during planning and implementation phase, and for the operation and maintenance phase a water management committee with only a few key members who are best able to sustain communal system management.
  - To form those Project Committees with area representatives and union officials. Landless and fishermen will be represented when inhabiting an area with sufficient numbers. Women will get a fixed proportion of every category. These committees are the consultation platform for the project. They commit the area's people to the design and the future O&M responsibilities. They will be involved in planning and implementation, especially works for which the local people have to contribute in cash or kind.
  - Then, once the first infrastructure is completed and opportunities of system management occur, to form Water Management Committees, maybe as sub committees of the project committees. The WMC's will be formed by the people themselves. In these committees, union officials become ex-officio members, and only full time present stakeholders can become president. All areas should be represented. Fishermen should only be compulsorily allocated seats, if the system has clear fishery objectives and practices. The formation of these committees at a later stage in the project also allows the project to adjust the jurisdiction boundaries to the latest water management insights. The boundaries might be different from those of the initial beneficiary committees.
  - To define the *Chawks* in the same way as under CPP. Size of area for system committees depends on hydrological unit area size. There will be big and small WMC's in one project. Most systems will have an inlet and an outlet. Much depends on the type of design, for which the CPP Final Report chapters and Annex C on Water Management should be consulted.
  - To form project committees at only sub-compartment, compartment level, and WMC's only at system level and compartment level, with one maybe intermediate tier for complex areas such as Tangail CPP's eastern half. System level committees have more chance of survival than *Chawk* Committees, while the involvement of UP officials can remain limited or absent. In this set up, most UP officials would mainly be involved in the compartment level committees, as involvement in each system level committee would become impractical for most. *Chawk* Committees will be replaced by annual *Chawk* meetings, in which the *Chawks* representatives are elected, brief the meeting about the



94

project and get a priority list to take to the System level Committees or WMC's. These *Chawk* meetings remain important to ensure that interests of each area are looked in to

The model sketched above would look like this:

Level	Project Phase	O&M Phase
Interest Groups	Consultation Meetings	
<i>Chawk</i> (110-142)	Consultation Meetings & Annual Meetings	Annual Meetings
System (20-30) or Sub-Compartment (15)	Sub Compartment Project Committee (similar to SCWMC in CPP)	System/Sub Compartment WMC (1 representative/ <i>chawk</i> )
Compartment (1)	Compartment Project Committee (similar to CPP's Compartment Forum )	Compartment WMC (similar to CHWMC in CPP)
Table 18: Committee Structure, Recommendation		

Note : CPP types of names are still used. Once new national guidelines are in force, these will probably have to change.

- To make agreements on distribution of O&M duties and funding and to have them signed by BWDB and Committees before construction starts.
- To involve line agencies like LGED in planning and O&M arrangements for proper co-ordination and ensuring good O&M.
- To make BWDB and Committees bear the cost of O&M of completed infrastructure during the project as per their agreed O&M arrangements.
- To have beneficiary committees as well as the BWDB contribute to the construction costs to show their ability and willingness to bear post project O&M costs. Allotting certain cost percentages for each piece of infrastructure to Donor, GoB and beneficiaries will not work well, because experience points out that the percentages for BWDB and beneficiaries can be easily adjusted within the estimates and contract amounts. Not percentages but specific types of infrastructure should be allotted. Completion might be made a condition for the other parties to start or fund their works. If post project annual maintenance cost is estimated to be 3% of the total investment and the project lasts for 5 years, BWDB should at least fund 15% (=5yrs\*3%) of the total project cost. And if, for example, the beneficiaries are supposed to pay for 10% of annual maintenance, their contribution would amount to at least 1.5% of total



investment ( $10\% \times 3\% \times 5$  yr.). This will probably bring down the amount of infrastructure to levels that can be and might be well maintained and operated.

- To prove first the feasibility of institutional arrangements in smaller water management systems (with structures), maybe below 2,000 ha. Flood control for large rivers like the Lohajang might be attempted in a next development stage again, when local expertise has increased, and societal structure and BWDB are more ready for such an enterprise.



## Appendix 1



## Consulted Documents

Documents most consulted for drafting the Institutional Development Final Report:

### Basic Documents

- Identification Mission Report, Flood Action Plan, December 1989
- TOR CPP, FPCO, June 1990
- Consultants Technical Proposal, Euroconsult et al., March 1991
- History and Boundaries of the Tangail Compartment, Technical Note-91/02, November 1991
- Inception Report, April 1992
- Interim Report, including the Household Survey and Multidisciplinary Sub-Compartmental Baseline Survey, September 1992
- Reformulation Report, October 1995
- Completion Report Phase I, September 1996
- Inception Report Phase II, April 1997

### Institutional Development Reports

- Consultation Process, Technical Note TNT-45, November 1992
- Water Management Sub-Compartment 9,10 and 11; Tangail Compartment, May 1994
- Institutional Setting SC 9,10&11, Tangail, July 1994
- Guidelines on People's Participation in Planning & Design Phase, May 1994
- Guidelines for People's Participation in Water Development Project, MoWR, August 1994
- Proceedings of Consultation Meetings in Clusters II and III (June 1996) Adjacent Areas (June 1996), Cluster IV, February 1996
- People's Involvement in Planning of water Management Interventions, September 1996
- Legal and Institutional Frameworks for Beneficiaries organizations in Water Management, August 1995



- Strategy Paper Beneficiaries organizations in Water Management, September 1995
- Workshop on Institutional Strategies for Compartmentalization and Participants- Activities Matrix, October 1992
- Report on Discussion Meetings with SCWMCs, Monzurul Hoq/IDS, November 1996
- People's Participation and Institutionalization in CPP Phase I, Jean Louis Leterme, 1998
- Mission Reports(8 nos.), 1996-98, Piet Jan Zijlstra, Institutional Development Specialist
- Mission Reports(4 nos), 1998-99, Arend van Riessen, Institutional Development Specialist
- 15 Courses for Sub-Compartment Water Management Committees, Communica, July 1998

#### **Other CPP Reports**

- Construction Programme 1991-1992, December 1991
- Integral Planning and Detailed Construction Cost Estimate, December 1993
- Implementation Programme and Progress for years 1993, 1994 and 1995
- Annual, Semi-Annual and Quarterly Progress Reports from 1992 to 1998
- Mission Report, Rens Verstappen ID & Training Specialist, December 1993
- Directory of Training Programmes in CPP, September 1996
- Mission Reports and training modules by Jan Groot, Water Management Expert, 1997-99
- Mission Reports Marianne Nugteren(WID Expert) and training reports of WID-section

#### **Surveys, Studies and Missions**

- Organizational Profiles for all NGOs (print out from computer data), 1996
- Socio-economic Profile of Professional Fishermen, SSS , June 1996
- Boat Traffic Survey, February 1994
- Report on the quality of People's Participation in Tangail FAP-20, UST, April 1995



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- People's Perception, Participation and Payment of Compensation, SGK/US, February 1997
  - The Study on Apraisal of WM Organizations in CPP and Gender Impact of project Activities, Communica, March 1997
  - Flood Preparedness Training, September 1996
  - Water Management Workshop, Experiences of Monsoon 1995
  - Flood Policy Study, UNDP, May 1989 ( not available in CPP-Library)



## Appendix 2

4



Organization	Organizational Details		Co-operation with CPP					
	Type of Programme*	Office in CPP-area	Consultation	Study/ Data Collection	Training	WUG Training	Implementation	Steering Committee/Council
UP			yes	-	-	-	yes	yes
BRDB	IRD	yes	yes	yes	yes		LCS	
BWDB Hydrology	Hydrology	no		yes				
BWDB O&M Division	O&M	yes						
DAE	Agriculture	yes	yes	yes	yes		yes	
DOF	Fishery	yes	yes	yes	yes		yes	
FD	Forestry	yes					yes	
BBS	Statistics	no	-	yes				
DU	University	no	-	yes				
ICDDR	Health	no	-	yes				
DPH	Health	yes	-	yes				
DPHE	Health Engin.	yes	-	yes				
SWMC	Study	no	-	yes				
LGED	Engineering	yes	-	yes				
Pourashava	Adm./Eng.	yes	-	yes				
BUET	University	no	-	yes				
WAD	Women Affairs	yes			yes			
BADC	Inputs, Agric.	yes		yes				
SRDI	Soil Study	yes		yes				
DLS	Livestock	yes		yes				
University of Leeds	University	no		yes				
EGIS	GIS, Env.	no		yes				
Government and Semi-Government Organizations								



Organization	Organizational Details						Co-operation with CPP				
	In Tangail Since	Type of Programme*	Office in CPP-area	Staff in Tangail Dt	Group in Tangail Dt**	Group Member in Tangail Dt	Consultation	Study/Data Collection	Training	WUG Training	Implementation
ASPU	1993	Env., IRD	no	12	25	250					
BHWS	1995	IRD	no	13	30	570					
BIDS	NA	Studies	-	-	-	-		yes			
BRAC	1978	IRD	yes	70	70	2,100	yes				
BURO	1990	IRD	5 offices	240	450	26,000	yes				
BWHC	NA	Women Health	no					yes	yes		
CARE	1996	Aids	no	24	-	-					
Coalition Project			no						yes		
Communica	NA	Training	no	-	-	-		yes	yes		
CWFP	1978	Fam.Planning	no	25	5	40					
EDP	1994	Env., IRD	no	7	100	500					
FPAB	1978	Fam.Planning	no	32	?	12,000					
Grameen Bank		IRD	yes				yes		yes		LCS
IREC	1991	IRD	no	39	29	400					
Jagoroni Jube Sango	1984	IRD	no	11	40	800					
Jalabhum	NA	study	no	-	-	-		yes			
Joutho Udyog	1991	IRD	3 offices	22	250	2,500			yes		LCS
NACOM	NA	study, env.	no	-	-	-		yes			
Nijera Kori		IRD					yes				
Organ. for Poverty Alleviation	1995	Fam.Planning	no	5	8	240					
PSDP	1995	Fam.Planning	no	27	22	660					
RASDO	1990	IRD	yes	72	300	7,000			yes		
RASPO	1986	Child Skill Devt	no	28	6 centre	1,200					
SABALAMBI	1994	IRD	2 offices	34	30	750					
SAFE	1993	IRD	no	13	22	700					
SATU	1991	IRD	yes	34	?	?	yes				
Save (Australia)	1995	NGO-support	no	3	-	-					
SDO	1989	IRD	no	26	7 25	800					
SDS	1987	IRD	7 offices	660	centres	(150000)					
Shukhi Nir	1991	Fam.Planning	yes	7	-	-					
SRWOT	1994	Skill Devt	no	13	105	300					
SSS	1990	IRD	3 offices	280	532	8,000	yes	yes	yes		
TARD	NA	Training	-	-	-	-			yes	yes	
TSUS	1989	IRD	no	24	38	923					
UPAMA		IRD	no	5	40	1,000			yes	yes	LCS
Unnayan Sahayogi Team		IRD					yes				
USHA	1991	IRD	no	15	22	446			yes		
<b>Total NGOs</b>				<b>1,741</b>	<b>2,143</b>	<b>67,179</b>					
Non-Governmental Organizations in CPP Area, dd 1996											



## Appendix 3





Activity	No.	Per son	91	1992		1993		1994		1995		1996		No.	96	1997		1998		1999		00
				I	II	I	II	I	II	I	II	I	II		III	I	II	I	II	I	II	I
Surveys																						
Baseline Surveys																						
Needs Assessment		96 of 211 villages																				
Stakeholder List													110									
Compartment																						
Design, Final Planning Compartment																						
Seminar with Elite and GoB																						
Construction Periphery and Main Inlet											1											
Operation Main Inlet Started	1											1					1		1			
Project Council Formed & Functioning	1											1	1	1								
Compartment Forum Formation/Meeting	1																	1	2	2		
Formation CWWC														1								
Comp. Maintenance Arrangement														1								
Cluster 1B																						
Consultation Meetings 1B	20	975			20																	
Design, Final Planning 1B																						
Structure Construction 1B	18					1	11	12	14	17	17	17	On going							18		
(Re-)Formation WUG/Chawk WMC 1B	28	252						25					28	new				28				
(Re-)Formation SCWMC 1B	3	49					3						3	new				3				
SCWMC WM Training	2	47											3						3	3		
Operators Trained	2	29											18									
Structure Operation Started								low WL		15		16	18				16		16			
SC Maintenance Orientation/Training													3								3	
Maintenance Arrangement In Place													3									
Cluster II																						
Consultation Meetings II	51	2191				39	3															
Design, Final Planning II																						
Structure Construction II	15					1				10	12	12	On going		12	15						
(Re-)Formation WUG/Chawk WMC II	24	216								15	15	15	18	24	new				24			
(Re-)Formation SCWMC II	4	71										4		4	new				4			
Endorsement by the WMCs II																						
SCWMC WM Training	4	82											4						4	4		
Operators Trained	1	9											15									
Structure Operation Started	15							low WL				11	15				11		15			
SC Maintenance Orientation/Training													4								4	
Maintenance Arrangement In Place													4									
Cluster III																						
Consultation Meetings III	26	1241				26																
Design, Final Planning III																						
Structure Construction III											13	16	On going			17						
(Re-)Formation WUG/Chawk WMC III	27	216								9	13	19	19	27	new				27			
(Re-)Formation SCWMC III	4	72										4		4	new				4			
SCWMC WM Training	3	81											4						4	4		
Operators Trained	1	10											17									
Structure Operation Started	17							low WL				13	17				14		14			
SC Maintenance Orientation/Training													4								4	
Maintenance Arrangement In Place													4									
Cluster IV																						
Consultation Meetings IV	78	4085				11*	59															
Design, Final Planning IV																						
Structure Construction IV	12									2	3	4	On going			8	10					
(Re-)Formation WUG/Chawk WMC IV	31	288								25	31		31	new				31				
(Re-)Formation SCWMC IV	4	73									4		4	new				4				
SCWMC WM Training	4	103											4						4	4		
Operators Trained	1	2											12									
Structure Operation Started	12							low WL				3	12				3		11		12	
SC Maintenance Orientation/Training													4								4	
Maintenance Arrangement In Place													4									
Cluster VI/Adjacent Area																						
Consultation Meetings AA	20	977				6				14												
Formation AARCs E2, E3, E4	3	27								3												
Design, Final Planning AA																						
Road/Khal Construction AA E2-4																						
Flood Preparedness Training( AA women)	6	117																				
Flood Preparedness Training(AARC)	1	24																				

CPP Stakeholder Institutional Development History Bar Chart

CPP Stakeholder Institutional Development History Bar Chart



## Appendix 4

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## STRUCTURE FUNCTIONALITY VS. PARTICIPATION IN PLANNING

1. Some indicators on whether and how people have been involved in planning of structures  
 2. Actual functioning of structures: operation frequency, obstacles, usefulness (quick & dirty, still to finalize with WME)

Sl. No. Structure	Participation in Planning			Structure Functionality				Remarks	Overall Marks
	First Proposed	By Whom	People Consulted	Completed	Function	Operated	Useful		
Cluster 1B									
2 Binafar	existing	Cons.	yes	Jun '94	Inlet	regular	yes		Good
3 Fatehpur	existing	Cons.	yes	Jun '94	Inlet	rarely	less	khal silted up	Moderate
4 Dithpur	1992	CPP	yes	Jun '94	Outlet	regular	yes		Good
5 Khorda Jugini	1992	CPP	yes	Jun '94	Inlet	rarely	yes		Moderate
6 Karmari	1992	NA/CPP	negative	Jun '95	Outlet	regular	yes		Good
7 Dighulia-1	1992	NA/CPP	no	Jun '94	Outlet	regular	yes		Good
8 Dighulia-2	1993	CPP	yes	Jun '99	Outlet	NA	yes	finished 1999	?
9 Dy Chow	1992	CPP	no	Jun '94	Outlet	open	yes	khal excavated 1999	Less
10 Chulabari	1992	CPP	no	Jun '94	Outlet	regular	yes		Good
11 Krishnapur	1993	CPP	no	Jun '94	WCS	rarely	less	culvert closeby	Less
12 Beel Baghul	1993	CPP	yes	Jun '94	WCS	wet year	yes		Good
13 E-Maidan	1992	CPP	yes	Nov '95	WCS	wet year	yes		Good
14 Bhargabari	1993	NA/CPP	no	Jun '94	WCS	regular	yes	overtopped '98	Good
15 Rampal	1993	Cons.	yes	Jun '94	WCS	regular	yes		Good
16 Singerkona	"1992"	CPP	no	Jun '94	WCS	wet year	yes		Good
17 Chowdhari	1993	NA/CPP	no	Jun '94	WCS	not	yes	...	Moderate
18 Sapua	1993	CPP	no	Aug '95	WCS	wet year	no	culvert close by, land level high	Useless
19 Santosh	1992	CPP	yes	Nov '94	WCS	wet year	less	culvert close by, overtopped '98	Less



## Cluster II

Sl. No. Structure	Participation in Planning			Structure Functionality				Remarks	Overall Marks
	First Proposed	By Whom	People Consulted	Completed	Function	Operated	Useful		
Cluster II									
20	Sadullahpur	1989	Id.Miss/NA	yes	Jun'97	Inlet	regular	yes	Good
21	Rasulpur	1992	CPP	yes	Aug'96	Inlet	regular	yes	Good
22	District	1992	CPP	yes	Sep'95	Outlet	not	yes	Moderate
23	Enayetpur-1	1993	CPP	no	Jun'95	WCS	not	no	location problem Useless
24	Salina	1993	NA/Cons.	yes	Jun'94	WCS	regular	yes	Good
25	Enayetpur-2	1992	CPP	yes	Jun'97	WCS	not	yes	operation problem Moderate
26	Beel Ghannda	1993	CPP	no	Dec'95	WCS	not	no	culvert closeby location Useless
27	Agbetur	1993	CPP	yes	Jun'95	WCS	not	less	problem Less
28	Bhatchanda-1	1993	CPP	no	Jun'96	WCS	regular	yes	Good
29	Bhatchanda-2	1993	CPP	no	Feb'96	WCS	regular	yes	Good
30	Magurhata	1993	CPP	no	Jun'96	WCS	regular	yes	overtopped '98 Good
31	Dharechar	1993	CPP	yes	Dec'95	Inlet	not	less	land is high Less
32	Char Kagmara	1993	CPP	no	Jun'98	WCS	regular	yes	Good
33	Pauli	1993	Cons.	yes	Jul'96	Inlet	regular	yes	Good
34	Passbetur	1992	CPP	yes		Inlet	yes	yes	Good
35	Barana	1993	Cons.	yes	Jun'97	Inlet	rarely	no	land is high Less

## Cluster III

Sl. No. Structure	Participation in Planning			Structure Functionality				Remarks	Overall Marks	
	First Proposed	By Whom	People Consulted	Completed	Function	Operated	Useful			
Cluster III										
								u/s kha/ silted		
36	Soruj	1989	Id.Mission	yes	Sep'95	Inlet	regular	less	up	Less
37	Nagar Jajai	1989	Id.Mission	yes	Apr'96	Outlet	regular	yes		Good
38	Bhakura	1992	CPP	yes	Sep'95	Outlet	regular	yes		Good
39	Khudirampur	1989	Id.Mission	yes	Jun'97	Outlet	wet year	yes		Good
40	P.Pauli	1992	CPP	yes	Jun'95	WCS	wet year	less	repair problem	Less
41	Karaha	1989	Id.Mission	no	Jun'95	WCS	open	no	obstructed	Useless
42	Birnali-1	1993	CPP	no	Apr'96	WCS	dry year	yes		Good
43	N.Kumuli-1	1993	CPP	no	Jun'96	WCS	regular	less	repair problem	Less
44	Nongjor	1993	GPP	no	Dec'95	WCS	not	no	location	Useless
45	Gosajor	1993	CPP	no	Jun'95	WCS	open	no	obstructed	Useless
46	Hatila	1993	CPP	no	Jun'96	WCS	dry year	yes		Good
47	Polla	1993	CPP	no	Jun'95	WCS	dry year	yes		Good
48	Mirenbetka	1993	CPP	no	Jun'95	WCS	regular	yes	overtopped '98	Good
49	N.Kumuli-2	1993	CPP	no	Jun'95	WCS	regular	yes		Good
50	Karatia Chy	1993	CPP	no	Jun'95	WCS	open	open	obstructed	Useless
51	Dharat	(1993)	CPP	no	Jun'95	WCS	not	less		Less
52	Birnali-2	(1993)	CPP	no	Jun'95	WCS	closed	no	obstructed	Useless



## Cluster IV

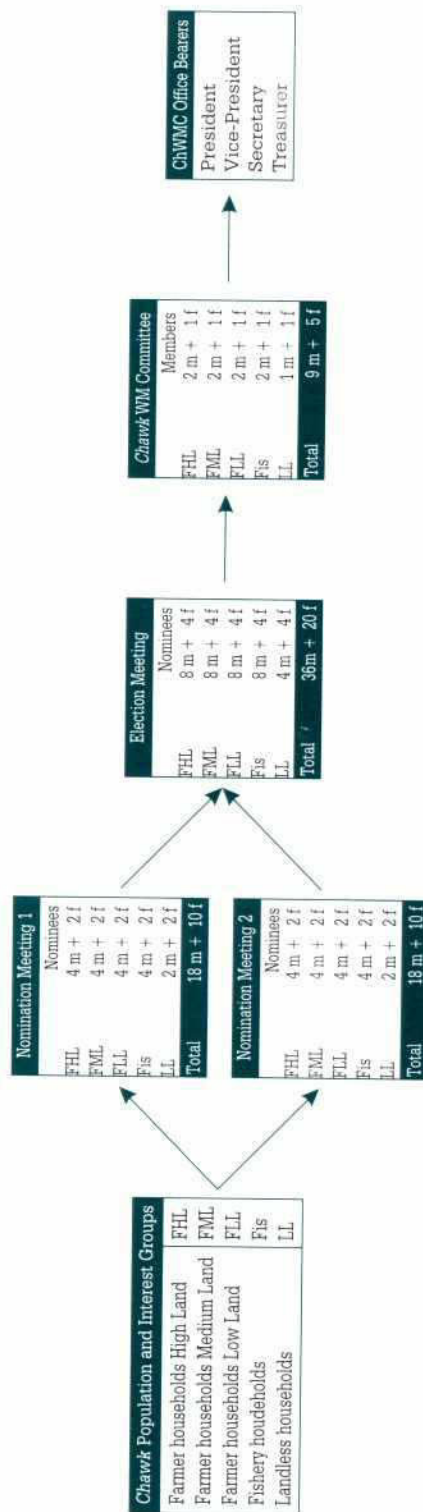
Sl. No.	Structure	Participation in Planning			Structure Functionality				Remarks	Overall Marks
		First Proposed	By Whom	People Consulted	Completed	Function	Operated	Useful		
Cluster VI										
53	Indrabelta	existing	NA/Cons.	yes	Jun'95	Inlet	regular	yes	d/s khal	Good
54	Barabelta	existing	NA/Cons.	yes	Jun'95	Inlet	regular	yes	d/s khal	Good
55	Baruha	1992	NA/CPP	yes	Sep'95	Inlet	regular	less	unconnected	Less
56	Aloya Raypara	1992	CPP	yes	Jun'99	Outlet	no gates	no gates	finished 1999	?
57	Deojar	1992	CPP	yes	Jun'97	Outlet	regular	yes		Good
58	Kumuli	1992	CPP	yes	Dec'97	Outlet	no	less	size too small?	Less
59	Bhurbuna	1993	CPP	yes	Jun'98	WCS	no	less	khal problem	Less
60	Bara Atia	1993	CPP	yes	Jun'97	WCS	no	?	too new	?
61	Aloya Bhabani-1	1993	CPP	yes	Jun'97	WCS	no	less	khal problem	Less
62	Aloya Bhabani-2	1993	NA/Cons.	yes	Jun'97	WCS	regular	yes	khal excavated	Good
63	Khagiana	1992	CPP	yes	Dec'97	Outlet	no	yes	1999 u/s khal	Moderate
64	Bera Buchna	1993	CPP	yes	Jun'98	WCS	regular	yes	problem	Good



## Appendix 5



### Election Procedure for Chawak Water Management



#### STEP 1

Chawak Population is invited to attend Nomination Meetings through mobilisation:

- Stakeholders receive invitation by letter
- Letters and leaflets handed over by village facilitators and CPP staff (2 m, 2 f)

Maximum 180 households invited for one meeting

#### STEP 2

In general meeting the 'why's and how's of re-formation are explained

People propose candidates for each interest group

Candidates accepted in general meeting

#### STEP 3

In the election meeting the nominees elect the committee members:

In each category men and women elect separately the members. In case no agreement is reached, members are elected in the general meeting with men and general with women.

All members to be accepted in general election meeting

#### STEP 4

The committee members elect the office bearers

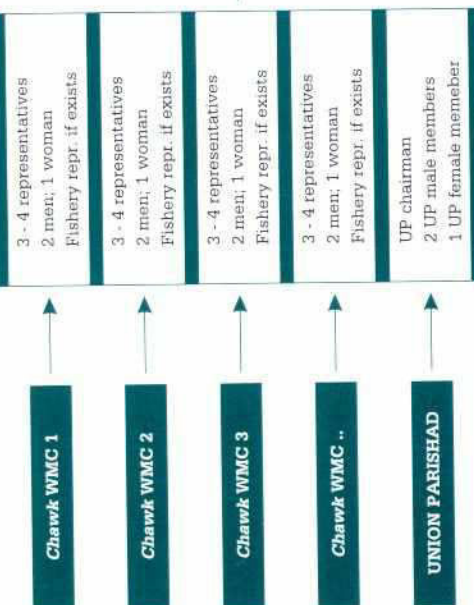


### Election of Subcompartment Committee and Executive Committee

#### COMPARTMENT-LEVEL FORUM

#### EXECUTIVE COMMITTEE

#### SCWMC



#### STEP 5

ChWMCs in sub-compartment elect representation for SCWMC: 2 men, 1 woman, 1 fishery (wo)man if existing in ChWMC

UP chairman is ex-officio President of SCWMC  
2 male and 1 female UP representatives elected by the Union Parishad

#### STEP 6

SCWMC elects 8 candidates for Executive Committee with at least 5 *chawk* representatives

- \* President is UP Chairman
- \* Office bearer are *chawk* repr (1/3 = women)
- \* Executive Members are either *chawk* or UP representatives (1/3 = women)

#### STEP 7

President and Vice President represent the SCWMC in Compartment level Forum  
CPP Director chairs the Forum Meeting



## Appendix 6



23

SC	ChWMC (nos)	Farmers		Landless		Fishers		UP		Total		Grand Total (nos)
		Male (nos)	Female (nos)	Male (nos)	Female (nos)	Male (nos)	Female (nos)	Male (nos)	Female (nos)	Male (nos)	Female (nos)	
1.	4	8	4	-	-	-	-	3	1	11	5	16
2.	8	14	4	2	4	-	-	3	1	19	9	28
3.	8	15	6	1	2	2	-	3	1	21	9	30
4.	7	12	6	2	1	-	1	3	1	17	9	26
5.	2	4	2	-	-	1	-	3	1	8	3	11
6.	6	12	4	-	2	1	-	3	1	16	7	23
7.	8	16	7	-	1	-	1	3	1	19	10	29
8.	8	16	8	-	-	1	-	3	1	20	9	29
9.	6	12	6	-	-	1	-	3	1	16	7	23
10.	8	16	6	-	2	-	-	3	1	19	9	28
11.	14	26	12	2	2	2	-	3	1	33	15	48
12.	7	13	6	1	1	1	-	3	1	18	8	26
13.	4	8	4	-	-	-	-	3	1	11	5	16
14.	13	24	9	2	4	1	-	3	1	30	14	44
15.	7	11	6	3	1	1	-	3	1	18	8	26
Total	110	207	90	13	20	11	2	45	15	276	127	403
A. Composition of Sub-Compartment Committees												

Average size : 27

SC	Farmer			Landless			Fisher			UP	Total	
	hh	Member	hh/ Member	hh	Member	hh/ Member	hh	Member	hh/ Member		hh	Member
1.	755	12	63	204	-	-	1	-	-	4	960	16
2.	1,584	18	88	543	6	91	3	-	-	4	2,130	28
3.	2,362	21	112	430	3	143	57	2	29	4	2,849	30
4.	1,292	18	72	594	3	198	47	1	47	4	1,933	26
5.	534	6	89	155	-	-	13	1	13	4	702	11
6.	1,203	16	75	897	2	449	10	1	10	4	2,110	23
7.	1,471	23	64	462	1	462	16	1	16	4	1,949	29
8.	1,986	24	83	286	-	-	20	1	20	4	2,292	29
9.	873	18	49	285	-	-	69	1	69	4	1,227	23
10.	1,751	22	80	886	2	443	18	-	-	4	2,655	28
11.	2,085	38	55	2,160	4	540	61	2	31	4	4,306	48
12.	1,883	19	99	1,271	2	636	69	1	69	4	3,223	26
13.	1,180	12	98	268	-	-	5	-	-	4	1,453	16
14.	2,166	33	66	1,186	6	198	45	1	45	4	3,397	44
15.	1,109	17	65	519	4	130	11	1	11	4	1,639	26
Total	22,234	297	75	10,146	33	307	445	13	34	60	32,825	403
B. SCWMC Composition in Relation to Population (Households)												

Household / member average : 8



## Appendix 7



26

# ROLE, TASKS, RESPONSIBILITY & ACCOUNTABILITY AND RIGHTS OF WATER MANAGEMENT COMMITTEES

Draft Guidelines CPP, July 1998

## 1. THE SUB-COMPARTMENT WATER MANAGEMENT COMMITTEES

### 1.1. General

The SCWMC is fully responsible for the operational issues which relate to the water conditions within the boundaries of the sub-compartment. Water management issues which exceed the boundaries of the sub-compartment will either be

- the joint responsibility of the two SCWMCs in case the water conditions remain within two concerned sub compartments, or
- the responsibility of the Compartment Water Management Committee (CWMC), in case the water conditions exceed the boundaries of two sub-compartments.

For the time being, maintenance of sub-compartment level water management infrastructure will remain the responsibility of the BWDB (for BWDB (CPP) infrastructure) and the LGED (for LGED infrastructure). The SCWMC will advise the BWDB and LGED in proper maintenance of the system.

### 1.2. System Operation

#### 1.2.1. Tasks and responsibilities

Operation of the system at sub-compartment will entail the following tasks:

- To formulate operational plans for system-operation,
- To operate the system according to the operational plan,
- To assign tasks to the Executive Members in supervising the structure operation according to the operational plan,
- To nominate, supervise and control gate operators on proper structure operation for the structures for which the responsibility for its operation has been assigned to the SCWMC,
- To represent the SCWMC interests in the CWMC,



- To liaise with neighbouring SCWMCs, in case joint responsibility of the two SCWMCs exists for particular structures and elaborate working agreements on joint decision-making for operation of the concerned structures,
- To implement the tasks given by the CWMC for the operation of the structures which are situated in the sub-compartment, but for which the decision-making rests with the CWMC,
- To inform the ChWMCs on decision-making of SCWMC level structures which influence the *chawk* level water management situation,
- To develop an internal organisation for proper decision-making on system operation, which includes:
  - conducting regular meetings with all SCWMC-members: at least one before the monsoon, monthly meetings during the monsoon and one after the monsoon and at any time when at least 25% of the SCWMC members requests for such a meeting,
  - conducting regular meetings with the Executive Committee: at least weekly or bi-weekly during the monsoon, or at any time when at least 25% of the Executive Committee members requests for such a meeting,
- To solve water management conflicts which may occur:
  - between ChWMCs within the sub-compartment, or
  - with adjacent SCWMC in case of joint responsibility on structures
  - between water users within a *chawk* case the concerned ChWMC could not solve the conflict satisfactorily, and
- To liaise with and properly inform the BWDB (CPP) on system operation.

#### 1.2.2. Accountability

The SCWMC is accountable to:

- the water users in the sub-compartment through the ChWMCs for proper operation of the system, and
- the CWMC for proper operation of compartment level structures in the sub-compartments.



### 1.2.3. Rights

The SCWMC has the right to:

- take decisions on system operation within the area of command. These decisions are based on majority vote and are binding, even if these decisions have a negative impact on the water management situation in some of the *chawks*,
- be properly consulted and/or informed by the CWMC and Government Agencies on any intervention or government decision affecting the water management system in their area of jurisdiction, and
- be properly informed by the ChWMCs within the sub-compartment on decisions taken related to *chawk* level water management.

## **1.3. Maintenance**

### 1.3.1. Tasks & Responsibilities

- To advise the BWDB and LGED on the preparation of annual maintenance plans for sub-compartmental infrastructure, which includes a.o.:
- To liaise with and inform the concerned agencies on identified maintenance problems,
- indicate priorities in system maintenance,
- To implement maintenance tasks as assigned to the SCWMC by the BWDB (CPP) and LGED,
- To coordinate the maintenance of *chawk* level infrastructure with the ChWMCs in the sub-compartment,
- To develop an internal organisation for proper decision-making on system maintenance, which includes:
  - conducting meetings of the Executive Committee at least once a year to discuss priorities in maintenance and to prepare proposals to be discussed and approved by the full SCWMC
  - conducting meetings with all SCWMC-members: at least once a year to assess the priorities in maintenance; and whenever required during implementation of maintenance, and
- At any time when at least 25% of the SCWMC members requests for such a meeting.



202

### 1.3.2. Accountability

The SCWMC is accountable to:

- the water users in the sub-compartment through the ChWMCs for properly handling their interests with the BWDB and LGED in system maintenance, and the BWDB and LGED for proper implementation of the maintenance tasks assigned to the SCWMC by the concerned agency.

### 1.3.3. Rights

The SCWMC has:

- the right to consult the BWDB and LGED on identified priority maintenance works in the sub-compartment,
- the right to be properly consulted and/or informed by the CWMC and Government Agencies on any intervention or government decision affecting the water management system in their area of jurisdiction, and
- in conjunction with the BWDB and LGED, the right to initiate legal action against anyone causing damage to the infrastructure of the project endangering its inhabitants or their livelihood.

## **1.4. Tasks & responsibilities, accountability and rights of the SCWMC members.**

### 1.4.1. The President

- As president of the SCWMC, he is overall responsible for the proper implementation of the tasks assigned to the committee.
- He is accountable to
  - the CWMC in such cases where the SCWMC has to implement decisions from the CWMC
  - the full SCWMC for the implementation of the operational and maintenance plans.
- He will be responsible for timely organising and chairing meetings of the Executive Committee of the SCWMC; at least once in a month at the time of structure operation.
- He will be responsible for timely organising and chairing meetings of the full SCWMC; at least twice a year and submit the annual report for approval by the SCWMC.





- He will seek approval from the full SCWMC meeting in case decisions have to be made (or have been made) which deviate from the approved operational plan.
- He will take decisions in day-to-day water management issues, in case the Vic-President seeks his advise.
- He will be responsible for solving water management conflicts:
  - in case conflicts at lower levels could not be solved i.e.: *chawk* level or by the Vice -President at sub-compartment level
  - in case conflicts arise with other sub-compartment, he will liaise with the President of the SCWMCs concerned
  - he will take conflict cases which could not be solved at the SC level at a higher level: the CWMC.

#### 1.4.2. The Vice-President

- The Vice-President is responsible for the day-to-day implementation of the tasks assigned to the SCWMC.
- (S)he is accountable to the President of the SCWMC
- (S)he will be acting President in case of the President's absence.
- (S)he may assign tasks to (and supervise) other members of the Executive Committee in system operation and maintenance.
  - At the time of full system operation (s)he will call weekly or bi-weekly meetings with those members of the Executive Committee who have been assigned tasks in structure operation.
  - (S)he will regularly liaise with the President to inform him properly on the day-to-day management.
- (S)he will be responsible for solving water management conflicts:
  - in case conflicts at lower levels could not be solved i.e.: *chawk* level,
  - in case conflicts arise within the sub-compartment,
  - he will take conflict cases to the President in case these could not be solved by him.



206

#### 1.4.3. The Secretary

- The secretary is accountable to the Vice-President.
- (S)he is responsible for proper execution of the tasks as assigned to him/her by the Executive Committee.
- (S)he will engaged in preparation of meetings of the SCWMC and the Executive Committee:
  - timely invitation of the committee members.
  - preparation of relevant documents to be discussed in the meetings,
  - prepare the agenda and the meeting minutes,
  - distribution of meeting minutes,
- (S)he will be responsible for preparation of (annual) budgets and submit these to the SCWMC for approval.
- (S)he will be responsible for preparation of the actual state of income and expenditure, at least annually or whenever any of the SCWMC members requests for it and submit these to the SCWMC for approval.
- (S)he will receive and liaise with audit teams whenever the CWMC commissions such an audit.

#### 1.4.4. The Treasurer

- The treasurer is accountable to the Vice President.
- (S)he is responsible for proper execution of the tasks as assigned to him/her by the Executive Committee.
- (S)he will responsible for the financial management of the SCWMC which involves a.o.: setting up of a proper book-keeping system according to the rules and regulations of the country.
- (S)he will assist the Secretary in the preparation of the annual budgets and the preparation of income & expenditure statements.

#### 1.4.5. Executive Members

- Executive members are accountable to the Vice-President.
- They are responsible for proper execution of the tasks as assigned to him/her by Executive Committee.



- They have the right and responsibility to attend the meetings of the Executive Committee and participate in decision-making.

#### 1.4.6. SCWMC-members

The SCWMC-members consist of ChWMC representatives and UP-representatives  
The ChWMC representatives:

- are responsible to represent the interests of the water management aspects of the *chawk*,
- are accountable to the *chawk* water users through the ChWMC,
- are responsible for properly discussing and decision-making of *chawk* level water management issues prior to attending the SCWMC meetings,
- are responsible for informing the ChWMCs on decisions taken in the SCWMC while all SCWMC members have the right to:
- be properly informed on and to comment on decisions taken in the Executive Committee
- reject or change decisions of the Executive Committee by majority vote
- request for SCWMC meetings at any time. Such a request should be supported by the Executive Committee or at least 25% of the SCWMC members

## **2. ROLE, TASKS, RESPONSIBILITY & ACCOUNTABILITY AND RIGHTS OF THE CHWMC**

### 2.1. General

The ChWMC is fully responsible for the operational issues which relate to the water conditions within the boundaries of the *chawk*. Water management issues which exceed the boundaries of the sub-compartment will either be

- the joint responsibility of the two ChWMCs in case the water conditions remain within two concerned *chawks*, or
- the responsibility of the Sub-Compartment Water Management Committee (SCWMC), in case the water conditions exceed the boundaries of two *chawks*.

Maintenance of *chawk* level water management infrastructure will be the responsibility of the ChWMC.



## 2.2. SYSTEM OPERATION

### 2.2.1. Tasks and responsibilities

Operation of the system at *chawk* level will entail the following tasks:

- To formulate operational plans for system-operation,
- To operate the system according to the operational plan,
- To assign tasks to the ChWMC Members in supervising the structure operation according to the operational plan,
- To nominate, supervise and control gate operators on proper structure operation for the structures for which the operation has been assigned to the ChWMC,
- To represent the ChWMC interests in the SCWMC,
- To liaise with neighbouring ChWMCs, in case joint responsibility of the two ChWMCs exists for particular structures and elaborate working agreements on joint decision-making for operation of the concerned structures,
- To implement the tasks given by the SCWMC for the operation of the structures which are situated in the *chawk*, but for which the decision-making rests with the SCWMC,
- To inform the water users in the *chawk* on decision-making in the ChWMC and in SCWMC,
- To develop an internal organisation for proper decision-making on system operation, which includes:
  - conducting regular meetings with all water users in the *chawk*: at least one before the monsoon, and one after the monsoon and at any time when at least 25% of the water users requests for such a meeting.
  - conducting regular committee meetings: at least weekly or bi-weekly during the monsoon, or at any time when at least 25% of the *chawk* stakeholders requests for such a meeting,
- To solve water management conflicts which may occur in the *chawk* between (groups of) water users, or between *chawks* in case of joint responsibility in structure operation, and
- To liaise with and properly inform the SCWMC and the BWDB (CPP) on system operation.



### 2.2.2. Accountability

The ChWMC is accountable to:

- the water users in the *chawks* for proper operation of the system and for proper representation of the *chawks* interests in the SCWMC, and
- the SCWMC for proper operation of sub-compartment level structures in the *chawk*.

### 2.2.3. Rights

The ChWMC has the right to:

- take decisions on system operation within the area of command. These decisions are based on majority vote and are binding, even if these decisions have a negative impact on the water management situation of (groups of) water users, and
- be properly consulted and/or informed by the SCWMC and Government Agencies on any intervention or government decision affecting the water management system in their area of jurisdiction.

## 2.3. Maintenance

### 2.3.1. Tasks & Responsibilities

- To prepare annual maintenance plans for *chawk* level infrastructure,
- To implement the maintenance plan according to schedule,
- To mobilise resources for the implementation of the maintenance plan,
- To implement maintenance tasks as assigned to the ChWMC by the SCWMC or BWDB (CPP) and LGED,
- To develop an internal organisation for proper decision-making on system maintenance, which includes:
  - conducting committee meetings: at least once a year to discuss priorities in maintenance and to prepare proposals to be discussed and approved by the all water users
  - conducting meetings with all water users: at least once a year to assess the priorities in maintenance; and whenever required during implementation of maintenance works.
- At any time when at least 25% of the SCWMC members requests for such a meeting.



209

### 2.3.2. Accountability

The ChWMC is accountable to:

- the water users in the *chawk* for properly handling their interests with the SCWMC, the BWDB and LGED in system maintenance, and
- the SCWMC, BWDB and LGED for proper implementation of the maintenance tasks assigned to the ChWMC by the concerned agency or SCWMC.

### 2.3.3. Rights

The ChWMC has:

- the right to consult the SCWMC, BWDB and LGED on identified priority maintenance works in the sub-compartment,
- the right to be properly consulted and/or informed by the SCWMC and Government Agencies on any intervention or government decision affecting the water management system in their area of jurisdiction.
- in conjunction with the SCWMC, BWDB and LGED, the right to initiate legal action against anyone causing damage to the infrastructure of the project endangering its inhabitants or their livelihood

## **2.4. Tasks & responsibilities, accountability and rights of the ChWMC members.**

### 2.4.1. The President

- As president of the ChWMC he is overall responsible for the proper implementation of the tasks assigned to the committee.
- (S)he is accountable to
  - the SCWMC in such cases where the ChWMC has to implement decisions from the SCWMC,
  - all *chawk* water users for the implementation of the operational and maintenance plans.
- (S)he may assign tasks to (and supervise) other members of the ChWMC in system operation and maintenance.
- At the time of full system operation (s)he will call weekly or bi-weekly meetings



with those members of the ChWMC who have been assigned tasks in structure operation.

- (S)he will be responsible for timely organising and chairing meetings of the ChWMC; at least once in a month at the time of structure operation.
- (S)he will be responsible for timely organising and chairing meetings with all water users, at least once a year and submit the annual report for approval by the water users.
- (S)he will be responsible for the day-to-day water management issues.
- (S)he will be responsible for solving water management conflicts:
  - in case conflicts arise within the *chawk* between (groups of) water-users
  - in case conflicts arise with other (adjacent) *chawks*
  - (s)he will take conflict cases which could not be solved at the *chawk* level at a higher level: the SCWMC.

#### 2.4.2. The Vice President

- The Vice President is accountable to the President of the SCWMC
- (S)he will be acting President in case of the President's absence.
- (S)he is responsible for proper execution of the tasks as assigned to him/her by the ChWMC

#### 2.4.3. The Secretary

- The secretary is accountable to the President.
- (S)he is responsible for proper execution of the tasks as assigned to him/her by the ChWMC.
- (S)he will engaged in preparation of meetings of the ChWMC:
  - timely invitation of the committee members,
  - preparation of relevant documents to be discussed in the meetings,
  - prepare the agenda and the meeting minutes, and
  - distribution of meeting minutes.
- (S)he will be responsible for preparation of (annual) budgets and submit these to the ChWMC for approval.



22

- (S)he will be responsible for preparation of income and expenditure statements,  
at least annually or whenever any of the SCWMC members requests for it and submit these to the ChWMC for approval.
- (S)he will receive and liaise with audit teams whenever the SCWMC commissions such an audit.

#### 2.4.4. The Treasurer

- The treasurer is accountable to the President.
- (S)he is responsible for proper execution of the tasks as assigned to him/her by the ChWMC.
- (S)he will be responsible for the financial management of the ChWMC which involves a.o.: setting up of a proper book-keeping system according to the rules and regulations of the country.
- (S)he will assist the Secretary in the preparation of the annual budgets and the preparation of income & expenditure statements.

#### 2.4.5. ChWMC Members

- ChWMC members are accountable to the President.
- They are responsible for proper execution of the tasks as assigned to him/her by the ChWMC.
- They have the right and responsibility to attend the meetings of the ChWMC and participate in decision-making.

#### 2.4.6. The Water Users

The water users:

- are responsible to implement the decisions of the ChWMC on system operation and maintenance,
- have the right to be properly informed on decisions taken by the ChWMC, the SCWMC, the CWMC, the BWDB and the LGED.
- have the right to attend the annual water user meeting and to discuss, approve or reject decisions made by the ChWMC by majority vote.



- have the right to request for water user meetings with the ChWMC at any time. Such a request should be supported by the ChWMC or at least 25% of the water users

### 3. ROLE, TASKS, RESPONSIBILITY & ACCOUNTABILITY AND RIGHTS OF THE CWMC

As stated in par.1.4: The CWMC will be formed at a later stage, awaiting the revised People's Participation Guidelines of the BWDB. However, for the monsoon 1998, a forum is required for advising CPP on management aspects of the main system. This forum will consist of the Presidents and Vice-Presidents of the SCWMCs and if required also the Presidents and Vice-Presidents of the Adjacent Area Committees. Meetings of this forum will be chaired by the CPP Project Director.

For the monsoon 1998, the following rules and regulations are considered:

- The forum is an advisory body to the BWDB (CPP). Decisions on water management issues are taken in the full meeting with the consent of the CPP Project Director.
- The forum is responsible for the operation of the compartment level infrastructure.
- The forum is responsible to seek advise from the forum of Presidents and Vice-Presidents of the SCWMCs in major decisions on structure operation.
- The forum is responsible for solving water management conflicts in case these could not be solved by the SCWMCs.
- The forum has the right to take decisions on structure operation of the compartment level infrastructure, even if these decisions have a negative impact on the water management situation in (some of) the sub-compartments.
- The forum has the right to be properly informed on decisions taken by the relevant committees at sub-compartment and chawk level.
- Meetings will be called by the CPP Project Director.
- Presidents or Vice-Presidents of the SCWMCs can request for a meeting. In that case the meeting will be held either when the CPP Project Director agrees or when such a request is supported by 25% of the forum members.





## Appendix 8



## STRUCTURE OPERATION & OPERATION FREQUENCY

- 1.Per structure the responsible committee & supervisor as per Communica Training Report(draft), July 1998  
2.Actual gate operations per year as indicator of committee's operation work load(WM-section's Status of Gate operation charts)

### Cluster IB

Sl. No.	Structure	Management		Number of openings/closings			
		Overall	Daily Supervision	1995	1996	1997	1998
Cluster 1B							
1	Main	CWMC	BWDB Operator	2	1	3	4
2	Binnafair	SC#11	M-SC11	1	1	3	2
3	Fatehpur	SC#11	M-SC11	1	3	-	1
4	Dithpur	SC#9	M-EC9+M-SC9	19	5	4	7
5	Khorda Jugini	SC#9	M-EC9+S-SC9	24	2	-	1
6	Kagmari	SC#11	VP-SC11	2	2	2	4
7	Dighulia-1	SC#11	M-EC11+M-SC11	4	8	4	6
8	Dighulia-2	SC#11		NA	NA	NA	NA
9	Dy Chow	SC#10	M-SC10	open	open	open	open
10	Chillabari	SC#11	M-EC11+M-SC11	18	-	2	4
11	Krishnapur	SC#9	M-EC9+M-SC9	-	2	-	2
12	Beel Baghil	SC#9	VP-EC9+M-SC9	2	1	-	3
13	E.Maidan	SC#10	VP+M-SC10	6	1	-	4
14	Bhangabari	SC#10	M-SC10	-	4	2	4
15	Rampal	SC#10	M-EC10+M-SC10	3	-	2	5
16	Singerkona	SC#10	M-EC10+M-SC10	1	3	-	2
17	Chowbari	SC#10	M-EC10+M-SC10	-	2	-	-
18	Sapura	SC#10	S+M-SC10	-	-	-	2
19	Santosh	SC#11&SC12	M-EC11	-	-	-	2
Total Cluster 1B				83	35	22	53

### Cluster II

Sl. No.	Structure	Management		Number of openings/closings			
		Overall	Daily Supervision	1995	1996	1997	1998
Cluster II							
20	Sadullahpur	SC7	VP+2M-SC7	NA	-	-	5
21	Rasulpur	SC6	P-6, P+S-11C	NA	-	2	3
22	District	SC8	M-8,S-9M	NA	4	-	-
23	Enayetpur-1	SC8	S+VP-SC8	NA	NA	NA	-
24	Salina	Ch11AB	S-11AB	NA	-	3	6
25	Enayetpur-2	SC7	VP+2M-SC7	NA	-	-	-
26	Beel Gharinda	SC5	2M-SC5	NA	-	-	-
27	Agbetur	SC6	VP+2M-SC6	NA	-	-	-
28	Bhatchanda-1	SC7	P+VP 10G+10HJ	NA	6	-	6
29	Bhatchanda-2	Ch10AB+10JH	S-SC7+VP10JH	NA	6	-	2
30	Magurhata	SC7	VPSC6+M-10E	NA	8	-	6
31	Dharerbari	Ch8A+9E	M-SC8+M-8A	NA	2	-	-
32	Char Kagmara	SC8	VPSC8+P-9CDK	NA	NA	NA	5
33	Pauli	Ch11AB	P+M-11AB	NA	NA	NA	3
34	Bararia	SC5	2M- SC5	NA	NA	NA	1
Total				-	26	5	37



Cluster III

Sl. No.	Structure	Management		Number of openings/closings			
		Overall	Daily Supervision	1995	1996	1997	1998
Cluster III							
35	Suruji	SC1	VP+M-SC1	NA	-	2	3
36	Nagar Jalfai	SC4	2M-SC4	NA	4	6	3
37	Bhatkura	SC3	S-SC3	NA	4	2	2
38	Khudirampur	Ch21A	S-Ch21A	NA	open	-	4
39	P.Pauli	Ch17B	VP-Ch17B	NA	4	-	1
40	Karatia	Ch18A	M-Ch18A	NA	-	open	-
41	Birnali-1	Ch15A	S-Ch15A	NA	-	2	-
42	N.Kumuli-1	Ch16A	VP+M-Ch16A	NA	6	2	2
43	Niogijoir	Ch19A	P-Ch19A	NA	2	-	-
44	Gosaijoir	Ch14D	P-Ch14D	NA	-	-	open
45	Hatila	SC3	S-SC3	NA	4	3	-
46	Poila	SC3	S-SC3	NA	2	2	-
47	Mirerbetka	Ch22EF+Ch22GJ	T-22EF	NA	4	6	6
48	N.Kumuli-2	Ch16C+17A	M-16C+P-17A	NA	6	2	2
49	Karatia Chy	Ch18A+18B	P-18B+M-18A	NA	open	open	open
50	Dharat	Ch19B+19B	S-19B+M-19D	NA	3	-	-
51	Birnali-2	Ch15A	S+M-15A	NA	closed	closed	closed
Total				-	39	27	23

Cluster IV

Sl. No.	Structure	Management		Number of openings/closings			
		Overall	Daily Supervision	1995	1996	1997	1998
Cluster VI							
52	Indrabelta	Ch23AB+Ch23CD	P-23AB+UPM	NA	5	4	6
53	Barabelta	SC12	S-SC12	NA	5	4	8
54	Baruha	SC13+14	2M-SC13	NA	4	2	5
55	Aloya Raypara	SC12+14	EC-SC12+14	NA	NA	NA	no gates
56	Deojan	SC14	EC-SC14	NA	NA	NA	2
57	Kumulli	SC15	M-SC15+P-31A	NA	NA	NA	-
60	Bhurburia	SC13+14	EC-SC13+14	NA	NA	NA	-
61	Bara Atia	SC13+14	EC-SC13+14	NA	NA	NA	-
62	Aloa Bhabani-1	Ch23E	P-23E	NA	NA	NA	-
63	Aloa Bhabani-2	Ch23CD	P-23CD	NA	NA	NA	4
58	Khagjana	SC15	VP-SC15+M-32A	NA	NA	NA	-
59	Bera Buchna	SC12+14	M-SC12	NA	NA	NA	2
	Total			-	14	10	27
	Grand Average: Operations per Structure			4.88	2.53	1.42	2.46

Grand average does not include unfinished or permanently open / closed structures

**Note:** M=Member, P=President, T=Treasurer, VP=Vice-President, S=Secretary, SC=Sub-Compartment WMC, EC=SC Executive Committee



## Appendix 9





## ROLES IN OPERATION & MAINTENANCE

The arrangements were in place before monsoon 1999

### Water Management Committees

- Daily management of those structures for which they(SCWMC or ChWMC) have been made responsible
- Repair of internal infrastructure: emergency repair during monsoon, dry season repairs before next monsoon
- Keep informed about water management beyond the boundaries of the WMC-area.
- Seek agreement on structure operation with all chawks related to concerned structure
- Seek advice from BWDB-staff when necessary

### Executive Engineer(XEN) and Sub-Divisional Engineer(SDE)

- Keep informed about O&M conditions in the area through SOs and XOs
- Check conditions in the field
- Call meetings or joint field visits of involved WMCs whenever a misunderstanding or a conflict arises or may arise
- Arrange emergency measures in periphery repair or structure operation
- Keep SCWMCs informed about decisions, whether it concerns one-sided ones, agreed-upon decisions or acceptance/rejection of requests
- Only interfere in operation of periphery structures by WMCs, if interests at compartment-level or higher are at stake.

### Sectional Officers(SO)

#### Periphery Embankment and Structures

- Daily tour their part of the periphery embankment
- Record on periphery maintenance condition and structure operation
- Discuss and advise on O&M with responsible WMCs along the periphery
- Report to XEN any needed action or other matter of urgency
- Inform WMCs of any emergency order given by XEN regarding periphery structure operation.



224

- Inform SCWMCs on compartment-level O&M issues and policy
- Oversee emergency repairs by BWDB

#### Interior Infrastructure

- Weekly visit each interior structure in their part of the Compartment
- Record operation and maintenance condition of interior infrastructure
- Advise responsible WMCs on interior infrastructure O&M

#### Extension Overseers(XO)

- Keep for their assigned area contact and share information with relevant WMCs
- Attend meetings of WMCs
- Keep informed about compartment-level O&M issues
- Mobilize WMC-members for meetings with BWDB, including CWMC
- Motivate WMCs to solve their internal problems and those with other WMCs
- Report to XEN any needed action or other matter of urgency
- Perform agricultural extension tasks, advising WMCs and linking up with DAE-staff

#### Main Inlet Gate Operator

- Operate gate on instruction from XEN
- Read gauges as per established routine and report daily to XEN and SDE
- Report any other needed action or matter of urgency to XEN or his designate



229

## Appendix 10



## UNION CHAIRMEN AND SCWMC-LEADERSHIP

### 1. INTRODUCTION

This text is meant to provide background information to the present role of UP-Chairmen in SCWMCs and considers alternative courses of action with regard to the position of UP Chairmen in the WMCs.

### 2. CHAIRMEN AS SCWMC-PRESIDENTS

Before reformation in 1998, the SCWMCs consisted of representatives from interest groups (farmers, fishermen, women and landless), technical departments, Union Parishads and NGOs. They were chaired by UP Chairmen. Often one UP Chairman was chairperson of two or even four SCWMCs. CPP tried to change this as the Chairmen often were not genuinely interested, paid more attention to the SC in which they lived, and were also often not available for SCWMC-work when needed.

SC	President's Name	Chairman's Union	Living in SC
SC#1	Sohel Kashem	Gharinda Union	no
SC#3	do.	do.	yes
SC#5	do.	do.	no
SC#2	Khalequzzaman Chowdury (Majnu)	Karatia Union	no
SC#4	do.	do.	no
SC#6	Faziul Haque	Gala Union	no
SC#7	do.	do.	no
SC#8	Salamatullah Majnu	Baghil Union	no
SC#9	do.	do.	no
SC#10	Rafiqul Islam Farooq	Daynna Union	no
SC#11	do.	do.	yes
SC#12	Faziuzzaman (Rashid) Fazal	Porabari Union	officially yes
SC#13	Zahirul Islam Badal	Silimpur Union	no
SC#14	Helaluddin	Patrail Union	no
SC#15	do.	do.	yes

Table 2-1: The Chairmen and their Sub-Compartments



222

After reformation the SCWMCs consist of 3 representatives from each Chawk WMC and four UP representatives. The UP representatives are member because of the following reasons:

- WMC Legal Status. WMCs have not enough legal status to perform their tasks of fund raising and settling of disputes. The present alternatives of acquiring legal status(register as cooperative or society) are all unattractive and CPP like others is waiting for the upcoming local government law as well as newly elaborated participatory water management guidelines. In absence thereof, a link with local government will provide a type of legal status. And if it is still not possible to do fund raising and settling of disputes as WMC (chairman), a SCWMC (chairman) might do these as a UP (Chairman).
- Access to external resources. A link with local government will give better access to available but scarce local government funds (for O&M).
- Role in Conflict Resolution. The link provides a framework for settling of conflicts with people outside the SC. If they fall under the same Union the Chairman will handle the matter. When it concerns another Union, he can settle affairs with the Chairman of concerned Union. Anyhow for conflict resolution people go more often to UP representatives than to anyone else.
- Avoidance of parallel decision making. The inclusion of UP Chairmen makes them visible and will reduce the possibility of them maintaining parallel decision making structures on water management, which could render the WMC an empty exercise.

In order to mitigate the disadvantage of having politicians dominate the WMC, CPP proposed a maximum number of UP members of four, including one woman member and chairman. UP-Chairman could moreover only become SCWMC- President, if he resided within the Sub-Compartment. UP-Members could not become office bearers like Vice-President, Treasurer or Secretary. Also Vice-Presidents were given the day-to-day management role. Some SCWMCs have during re-formation even requested to leave the Chairmen out of the WMCs all together.

The UP-chairmen did not agree to give up presidentship of certain SCWMCs. They would lose privileges and also would lose face after four years as President. After long discussions CPP-management accepted them to continue as in the First Phase, as it felt the link with local government was too essential to lose in conflict. The following is the position at present:





### 3. LESSONS FROM A CONFLICT

In March- April 1999 SCWMC and CPP had two joint operations, minor works through SCWMCs and water management training of SCWMC. When the Chairmen found that the estimates of minor works were too low they made SCWMCs boycott the trainings. Very few of the SCWMC members actually agreed with the Chairmen's decision to boycott the training over the estimates. They expressed this to CPP-staff. Moreover, there were some chairmen, who also did not agree with the chairman's group decision. Ultimately, the chairmen gave in, as by continuing the conflict they would lose much more than minor works.

Some lessons:

- The gap between the chairmen and the SCWMC-members seems quite big, with the latter ones caring much more about water management, and the former ones seemingly only interested in money and politics.
- The fact that a majority of members can not contain the chairmen has shown how vulnerable the institutional arrangement is to the wrong intents of a few UP Chairmen.
- The Chairmen acted on their own, without consulting their members, indicating that they see their SCWMC-presidentship only as a tool for their own benefit. And as they do not seem to need the committees, the committees will with them not survive long.

### 4. PROSPECTS

The CPP institutional structure will be in place before the local government structure is finalized and the MoWR-guidelines are brought in line with those and finalized.

All the lessons and conclusions would point to abandoning the involvement of UP Chairmen as WMC Presidents. This would reduce the maximum number of WMCs chaired by UP Chairmen to only four. But the Chairmen actually have not only a stranglehold over the SCWMCs, but over the whole institutional set-up, as introduced by CPP. At the lowest level and for most SCWMC-affairs Chairmen are not needed, but efforts of maintenance fund raising and conflict settling will probably fail in the short or medium term without their involvement. If being left out, the Chairman will just wait till the day the Committee will have to come to him for funds, access to food for work, solving of conflicts. Or individual members will have to come to him for local government purpose (certificates, recommendations, etc.). Or he might otherwise quite easily de-rail SCWMC-efforts.



At Compartment level, their involvement seems even more unavoidable, as under the present political/administrative culture, not many will allow a set of non-politicians (users) govern such an important thing as flood protection for 10,000 ha, including Tangail Town (albeit together with BWDB).

The following aspects should be taken into account when considering alternative arrangements:

- Effective day-to-day management
- Effective coordination with other WMCs
- Effective leadership in emergencies
- Effective internal resource mobilization
- Workable WMC Legal Status
- Access to available external resources for maintenance
- Conflict Resolution within WMC
- Conflict resolution with parties outside WMC
- Compliance with MoWR-Guidelines. The applicability of the present draft guidelines is doubtful as they are quite confusing (see separate comments on Guidelines, to be drafted). As for Chairmen, they are mentioned as ex-officio members of the second tier (WMA, Thana-level), who may be elected as representatives to Federation of WMAs (supra-Thana level).
- Risk of new occasions where Chairmen will put WMC-interests lower than their own.
- Risk of parallel decision making
- Risk of creating new conflicts within WMC. E.g. when Chairman is member and new President is a defeated Chairman or other adversary of Chairman.
- Risk of negative treatment for WMC-members by UP outside WMC

The options:

- The present set-up where actual management is with the Vice-President and the President (UP Chairman)'s role can be as active or inactive/ceremonial as he wishes.



- Alternative arrangements, where the old condition is strictly applied that only inhabitants of the Sub-Compartment can be President. There are few sub alternatives:
  - Chairmen not residing in Sub-Compartment have no official role anymore
  - Chairmen become ex-officio members of SCWMCs
  - Chairmen become ex-officio Advisers like Member of Parliament is Adviser to District Development Council. The Adviser is only asked for a role by WMC if needed
  - Chairmen head Council of Advisers per SCWMC in which also e.g. the "defeated Chairman" and schoolteachers sit.
  - The various Chairmen constitute a Compartment-level Council of Advisers, to mediate in case of problems and conflicts beyond SCWMC-level

The options with their comparative advantages/disadvantages are given in the table

Criteria	Present Chairman As President	Alternative Arrangements: Chairman			
		Out	As Ex- Officio Member	As Adviser	In Compt. Advisory Council
a) Effective day-to-day management	o.k.	O	O	O	O
b) Effective coordination with other WMCs	weak	-	-	-	+
c) Effective leadership in emergencies	moderate	?	-	O	O
d) Effective internal resource mobilization	weak	?	O	O	O
e) Workable WMC Legal Status	moderate	-	O	O	O
f) Access to available external resources	o.k.	-	O	O	-
g) Conflict Resolution within WMC	moderate	O	O	O	O
h) Conflict Resolution with parties outside WMC	weak	-	-	O	O
i) Compliance with MoWR-Guidelines	moderate	O	+	O	O
j) Risk of new adverse action by Chairmen	weak	+	-	+	O
k) Risk of parallel decision making	o.k.	--	-	O	-
l) Risk of creating new conflicts within WMC	o.k.	+	--	O	O
m) Risk of negative treatment outside WMC	o.k.	--	O	O	O

Table: The Relation between Chairmen's Position and WMC-Functioning



26  
This assessment shows that the present arrangement has many weak points, but that alternative arrangements with regard to the UP Chairman's position do not appear better. This assessment is of course done for the present situation in CPP, where changes will not be received well by all parties. In a new situation where UP Chairmen have a lesser or different role from the start, or where separate O&M committees are formed, the prospects would look brighter. See further the main text recommendations.



028

**Annex E**  
**Agriculture**



# Table of Contents

<b>Introduction and Overview of Program</b> .....	1
Phase I .....	1
The final Phase .....	2
<b>Agriculture in the Jumuna Floodplain</b> .....	3
Agricultural Seasons .....	3
The Traditional Cropping System .....	4
Land Types, Land Use and Cropping Patterns .....	4
Palam .....	5
Tan Land ( $F_0$ ) .....	5
Patchot Land ( $F_0 - F_1$ ) .....	8
Dopa Land ( $F_2 - F_3$ ) .....	8
Chemical Soil Analysis .....	8
Expansion of Boro Cultivation .....	10
The Annual Cropping Cycle .....	10
Crops and Yields .....	11
Expected Impact of Improved Water Management on Cropping .....	11
<b>Concepts, Approaches and Activities</b> .....	14
Monitoring Changes in Land Use and Yields .....	14
Designing Water Management Strategies .....	14
Identifying New Opportunities for Crop Production .....	15
On-farm Demonstrations .....	15
Participatory Development of New Cropping Practices .....	15
The Pilot Chawks .....	16
Participatory Rural Appraisals (PRA) .....	18
Institutional Collaboration .....	18
<b>Analysis of Changes due to CPP's Interventions</b> .....	19
Changes in Hydrological Conditions in Different Land Types .....	19
Changes in Land Types According to The MPO Classification .....	19
Farmers' Land Type Classification .....	22
Seasonal Land Use .....	25
Monsoon (Kharif-II) .....	25
Rabi and Kharif-I .....	31
Cropping Patterns and Land Use Intensity .....	31
Yields .....	32
Irrigation .....	32
Optimizing Monsoon Water Management for Agricultural Production .....	36
The Maximum Drainage Scenario .....	36



27

Adjustments Needed for Different Land Types .....	40
Land Inundated to 0-30 cm .....	40
Land Inundated to 30-90 cm .....	42
Land Inundated to 90-180 cm .....	42
Verification: the 1999 Monsoon Season .....	43
Operational Bandwidth for Water Management .....	44
Conclusions and Lessons Learned .....	45
<b>Exploring New Options for Agricultural Production</b> .....	47
Demonstration of improved Aman varieties, 1993-1997 .....	47
The On-Farm Testing and Demonstration Program, 1997-2000 .....	48
The Participatory Rural Appraisals .....	48
Tests and Demonstrations .....	49
Improved Mustard, Rabi Season .....	50
Boro Varieties .....	51
Alternative Crops for The Boro Season .....	52
Jute And Alternatives, Kharif-I Season .....	53
T-Aman Varieties, Kharif-II Season .....	54
Composting .....	55
IPM .....	56
Conclusions and lessons learned .....	57
<b>Future Trends</b> .....	59
Future cropping patterns and yields .....	60

## List of Table

Table 1:	Chemical and textural analysis of some soils in the Compartment .....	9
Table 2:	Baseline data on crops areas and yields, Tangail compartment, 1992 .....	11
Table 3:	Change in maximum water depths due to CPP's water management .....	12
Table 4:	Expected maximum water depth distribution due to CPP's water management .....	22
Table 5:	Monsoon cropping area, expressed as percentage of net cultivable area (NCA) in the Tangail compartment and surrounding Thanas, 1991-1999.....	25
Table 6:	Estimated areas of monsoon crops in the Tangail compartment, 1991-1999.....	28
Table 7:	Area (ha) under monsoon crops, and as percentage of net- cultivable Area (between brackets) in the compartment, the northern adjacent area, Delduar and Kalihati Thana .....	30
Table 8:	Estimated areas of Rabi and Kharif-I crops in the Tangail compartment, 1991-1999 .....	31
Table 9:	Estimated areas in the compartment used for major cropping patterns in the 1995 - 1999 cropping seasons. ....	33
Table 10:	Yields of the major crops in the compartment, 1992 - 1999 .....	34
Table 11:	Installed irrigation equipment, total area irrigated (ha) and percentage of NCA, CPP Compartment .....	35



Table 12:	Mean yields (t/ha) of improved varieties in 110 demonstration plots, 1993-1997 .....	47
Table 13:	Mean yields (t/ha) in demonstration plots with and without supplementary irrigation in different land types, 1993-1997 .....	47
Table 14:	Overview of on-farm tests and demonstrations conducted in the 4 pilot <i>chawks</i> , 1997-2000 .....	50
Table 15:	Yield (t/ha) and growth duration of two mustard varieties in on-farm demonstrations .....	50
Table 16:	Yield (t/ha) of two Boro paddy varieties, compared with the local standard (IR8) in on-farm demonstrations, 1999.....	51
Table 17:	Mean yields (t/ha) and net benefit (Tk/ha) of okra and jute in on-farm tests, 1998 Kharif-I season .....	53
Table 18:	Yields of T-Aman paddy varieties in on-farm tests in pilot <i>chawks</i> , 1997 - 1999 .....	55
Table 19:	Projected future cropping patterns and crop yields in the compartment .....	60

### List of Figures

Figure 1	Mean monthly rainfall, Atia station, and agricultural seasons .....	3
Figure 2	Cropping patterns associated with the three major land types in the CPP project area, according to the seasonal climate .....	6
Figure 3	Agricultural monitoring plots .....	7
Figure 4	Pilot <i>chawks</i> , beels, major water ways and water control structures .....	17
Figure 5	Maximum flood map, "base situation" .....	20
Figure 6	Maximum flood map, "with project" .....	21
Figure 7a	Comparison of farmers' and model land type classification, Chawk 3F; .....	23
Figure 7b	Comparison of farmers' and model land type classification, Chawk 19E; .....	24
Figure 9	Kharif-II land use shift 1993 - 1997 .....	26-27
Figure 10	Flood map for July 30, scenario 4 .....	37
Figure 11	Kharif land use a) 1996, b) 1997 .....	38-39
Figure 12	Percentiles of (a) 10 and (b) 20-day rainfall totals (overlapping), 1961-1998 .....	41

Appendix 1 .....	61
Methodological Notes .....	63
Appendix 2 .....	69
Plant species of Economic Importance in The Tangail Area .....	71





## Introduction and Overview of the Program

### Phase I

At the start of project phase I (October 1991 - September 1996) the following targets were set for agricultural development:

- Prevention of crop damage from flooding and drainage congestion;
- A gradual increase in cropping intensity from 196% to 220%;
- Expansion of High Yielding Varieties (HYV) of transplanted Aman to more than 2,000 ha (about 25% of the Net Cultivable Area);
- Increase in annual rice production by 9,000 tons;
- Environment-friendly agriculture with the application of Integrated Pest Management; and;
- Nutritionally rich agriculture through crop diversification.

It was expected that most of these targets would be attained as a direct result of improved water management. The program was to carry out farming systems studies and land use surveys and assist the Department of Agricultural Extension (DAE) in conducting demonstrations with new paddy varieties and cultural practices related to new water management situations.

A detailed agricultural monitoring system was designed and a monsoon land use map of the compartment was produced for 1993, which has since served as the base map for the project. All individual chawks were demarcated in the entire compartment. A compartment-wide irrigation survey was conducted, which has since been repeated every two years. In 1996, a monsoon land use map was produced again and since 1997, land use was surveyed in each season. A sample based detailed farming systems analysis was conducted in 1995.

From May 1994 onward, information was collected on cropping patterns through a network of 290 fixed location monitoring plots. Two hundred and fifty of these were inside the compartment and 40 in the northern adjacent area.

On-farm demonstrations of High Yielding Varieties (HYV) of Transplanted Aman (T-Aman) were carried out from 1993 until 1996 by DAE with CPP technical and financial support. Farmers were trained by DAE personnel on general production issues and on Integrated Pest Management (IPM) methods.



## The Final Phase

The objectives of the agriculture component for the final phase (September 1996 - June 2000) were not reformulated, but the new job description of the Farming Systems specialists included additional elements:

- To develop cropping and crop diversification programs in close co-ordination with farmer user groups, government agencies (in particular DAE) and the drainage engineer;
- To organize and co-ordinate integrated pest management programs; and
- To advise the drainage engineer and the institutional expert on, respectively, operational rules for the water management infrastructure, and establishing and Training water user groups.

In the inception report (February 1997), continuation of the Phase I monitoring program was proposed with some modifications, while the following additional objective was defined:

*"Exploring with the farmers and demonstrating new options for crop production, including new cropping patterns, alternative Rabi crops and more productive rice production methods and varieties".*

Monitoring activities remained a major component of the program, with the land use survey now extended to the three seasons. For the testing and demonstration component, four representative pilot chawks were chosen. Participatory Rural Appraisals (PRA) were conducted in 1997 and 1998 and a participatory On-Farm Testing and Demonstration (OFTD) program was started in the monsoon season of 1997, in collaboration with the Bangladesh Agricultural Research Institute (BARI). The earlier varietal demonstrations were incorporated in this program.

Intensive collaboration took place between the water management, agriculture, fisheries and Institutional Development Sections for the development of a water management strategy for optimizing monsoon water conditions for the major interest groups.

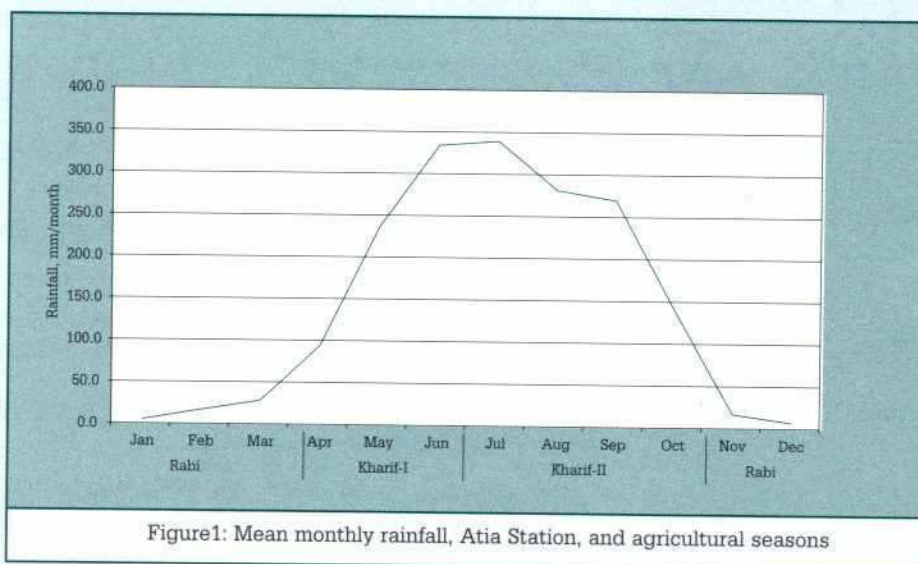


# Agriculture in the Jamuna Floodplain

## Agricultural Seasons

Agriculture in the Jamuna floodplain can be understood as man's best answer to the vagaries of the monsoon and the unpredictability of the mighty river system. A production system has evolved which exploits the area's peculiar weather and hydrological cycle, while anticipating the very real chances of damaging monsoon floods coming down the Jamuna River and its branches. The floodplain agriculture is a classic example of a system that is attuned very well to the environment in which it has evolved.

Three seasons are distinguished (Fig. 1):



- The Kharif-I or pre-monsoon season, which starts with the first rains in March;
- The Kharif-II or monsoon season, starting in July, which is characterized by submerged land conditions in a large part of the flood plain by accumulating rain and river flooding;
- The Rabi or dry season when agriculture is practiced on residual moisture; and later in the season, with groundwater irrigation (for *Boro* paddy).

Monsoon land use has received most attention during the project, because it is most affected by CPP's water management intervention. It is determined by the topography of the land and by the variation in monsoon inundation depths of different land elevation classes. Apart from the flooding cycle caused by the rise and fall of the Jamuna and its branches, water conditions are also affected by seasonal rainfall. Fig. 1 shows mean monthly rainfall, measured at the Atia station (Tangail). The average annual rainfall from 1961 to 1998 was 1,782 mm.



## The Traditional Cropping System

Before the expansion of groundwater irrigation and Boro paddy growing since the nineteen seventies, cropping patterns were attuned to the three seasons and the field water conditions in a remarkably balanced way. In the higher lying fields, Aus paddy and jute would be broadcast or dibbled at the start of the rains in April. The crops would complete most of their cycle under 'upland' conditions, but towards the end of their cycle, the fields would be inundated. Aus thus changed from upland to paddy rice. Often mixtures of Aus and Aman would be sown and after the Aus harvest the Aman continued in the same field during the monsoon (Kharif-II) season. Jute sometimes matured in standing water, which formed at the same time the medium for retting and fiber extraction. Transplanted Aman (T-Aman) was planted in the monsoon immediately after jute. After the harvest of the monsoon crops dry land Rabi crops, such as wheat, barley and pulses were grown on residual moisture.

In the lower lying fields, deep water Aman (DW-Aman) paddy was broadcast around May and the crop's growth in height would follow the rise of the water. The crop matured when the water had retreated. Khesari (*Lathyrus sativus*), a pulse crop, was broadcast in the maturing paddy and developed on residual moisture. After its harvest, the field would remain fallow until the following monsoon.

Consistent with this cropping system, the start of the rainy season (Kharif-I) was traditionally considered as the start of the annual agricultural cycle. It will be argued in the next section that the major changes in land use which have occurred during the past 25 years necessitate a re-definition of the annual cropping cycle.

## Land Types, Land Use and Cropping Patterns

Depth of inundation determines the cropping pattern, which may be practiced in a particular field. Land types are, therefore, defined in Bangladesh based on flooding depths during the monsoon (Kharif-II) season. Five land types are distinguished, denominated  $F_0$  to  $F_4$ , with the following definitions by the Master Planning Organization (MPO):

Land type	1 in 5 yr. flooding depth (cm)
$F_0$	0-30
$F_1$	30-90
$F_2$	90-180
$F_3$	180-300
$F_4$	> 300



Farmers use their own land type classification that is more directly related to land use. Three land types are distinguished, from high to low:

- *Tan jomi*;
- *Patchot jomi*; and
- *Dopa jomi*;

The major cropping patterns as they are currently practiced in each land type are shown in Fig. 2. *Tan* land is mostly located higher in the topography and *Dopa* land lower, with *Patchot* in intermediary positions, but the two extremes may even be found side by side due to micro-variation in topography or because of removal of topsoil for brick making or raising the homestead. The difference in elevation between adjoining *Tan* and a *Dopa* field may be as little as 40 - 50 cm.

#### *Palam*

Land directly adjacent to the homestead is called *Palam*. The land is above the maximum flood level and it is used for year-around vegetable and fruit production, especially by women.

#### *Tan Land (Fo)*

No floodwater enters *Tan* land, except under exceptional flood conditions (1988, 1998). Soil texture is sandy loam. Winter crops (wheat, potatoes, pulses, and vegetables) are grown in the early *Rabi* season. These are usually followed by jute, which is planted during the pre-monsoon with the first rains in March-April and harvested from late July to early September. *Tossa* jute is grown in the highest locations, which are too high for transplanted *Aman* (T-*Aman*), and the land is often left fallow in the following monsoon. In the wetter *Tan* land, *Deshi* (white) jute is grown, which tolerates waterlogged conditions, often followed by T-*Aman*. In the past, *Aus* paddy was planted in the pre-monsoon but in the compartment, this crop is now practically non-existent. In some areas, especially in Cluster 4, sugarcane is grown in *Tan* land.

*Dhaincha* (*Sesbania sesban*) is planted to a limited extent in *Tan* land for stick production and as a green manure crop, particularly after removal of topsoil for brick making or homestead raising. The grain is also used as animal feed.





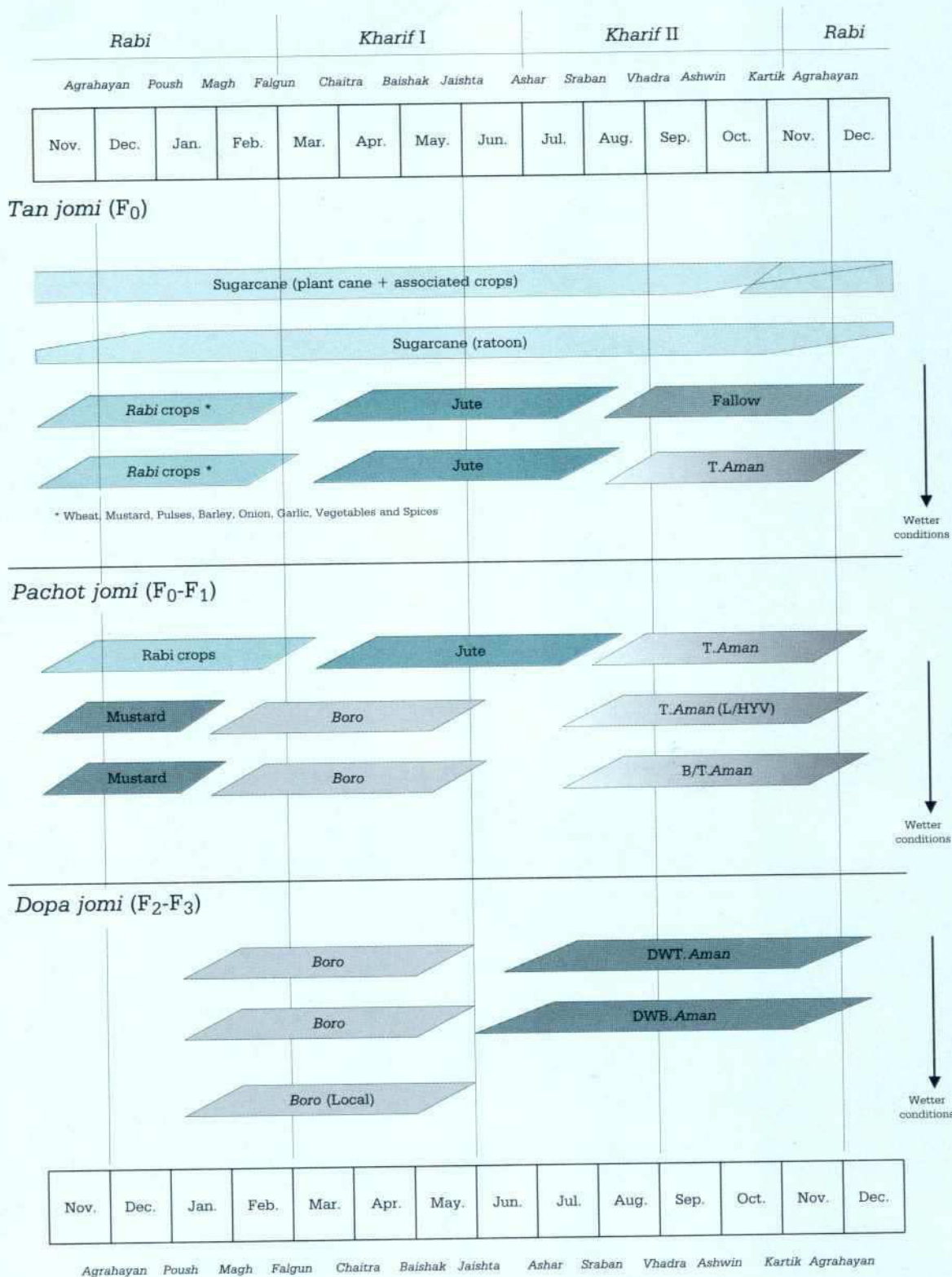


Figure 2: Cropping Patterns Associated with the Three Major Land Types in the CPP Project Area, According to the Seasonal Climate.



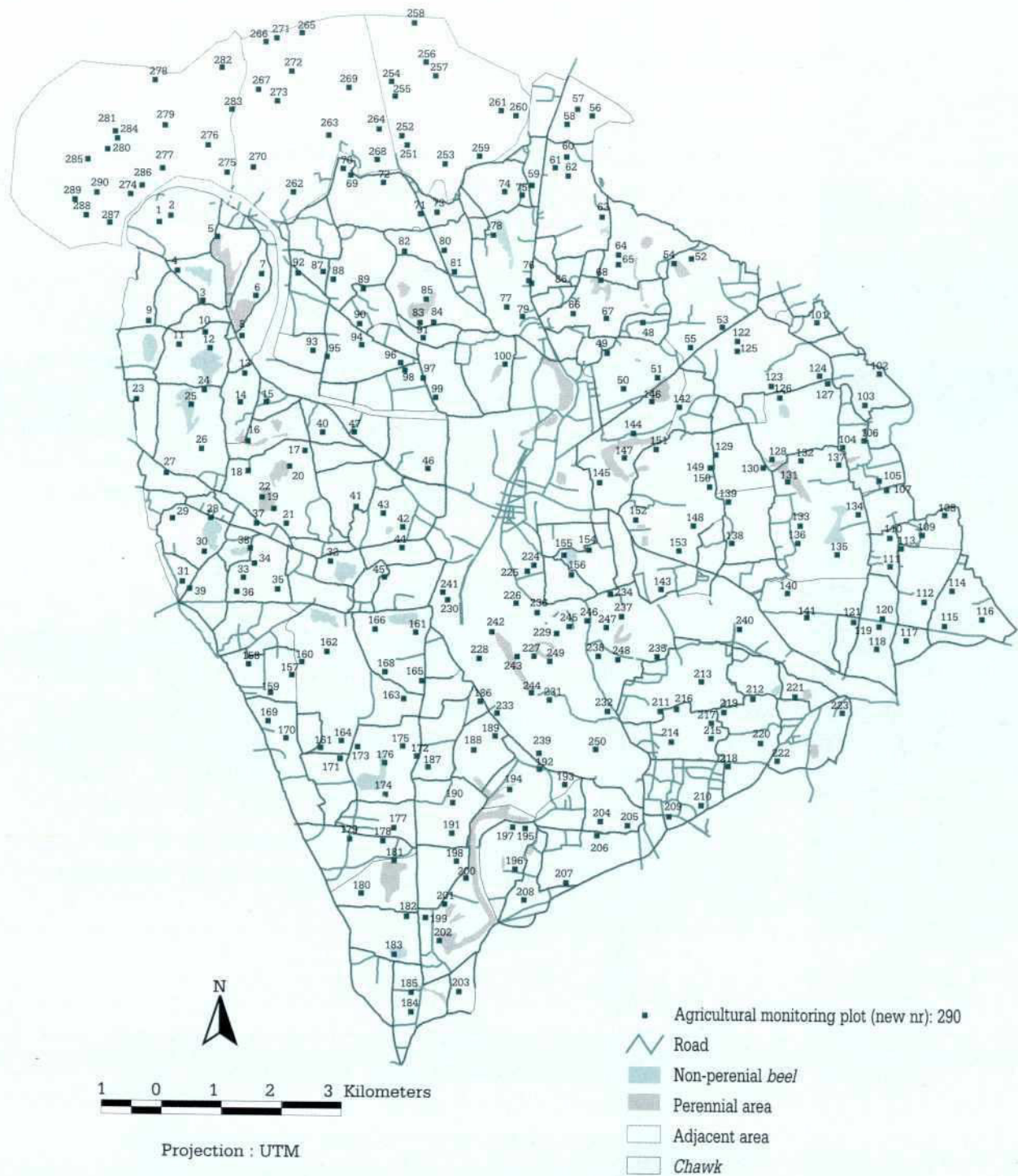


Figure 3: Agricultural Monitoring Plots



266  
*Patchot Land ( $F_0 - F_1$ )*

Monsoon rainwater is retained in banded *Patchot* land for 3-4 months and sometimes the land is inundated by floodwater (30 - 90 cm). Soil texture is loam to clay loam. *Patchot* is the prime land, which allows growing of three crops annually. The early Rabi crop is usually mustard, grown on residual moisture, followed by *Boro* paddy with groundwater irrigation. *Boro* is harvested in the first half of June and followed by T-Aman. There is an on-going expansion of High Yielding Varieties (HYV) of T-Aman in this land type.

In the higher *Patchot*, fields, *Deshi* jute may be grown, followed by T-Aman. In the lower lying, *Patchot* land, transplanting T-Aman may not be possible immediately after the *Boro* harvest in wet years, due to water depth. In that case, farmers delay T-Aman planting to the middle of August or they cultivate deep water transplanted Aman (DWT-Aman) of the variety *chamara*. Late planted T-Aman may need supplementary irrigation in October, which is available from shallow tube wells in some *chawks*.

*Dopa Land ( $F_2 - F_3$ )*

Dopa land remains inundated throughout the monsoon for up to 7 months (June-December). Water depths may be up to 2 m for 3-4 months (July - October). Soil texture is clayey. Slow drainage makes Dopa land unsuitable for winter crops until December when *Boro* is planted. Early planted *Boro* escapes inundation at harvest (May) and DW-Aman (varieties *Chamara* and *Hijoldigha*) may be broadcast or transplanted, provided the water level increases gradually. If the land remains dry long enough, DW-Aman is broadcast. If the land is under water DW-Aman may be transplanted. The lowest Dopa land is usually deeply inundated as early as June and is only suitable for *Boro* cultivation.

*Chemical Soil Analysis*

Soil analyses were carried out in 1996 and 1998 by SRDI in 15 monitoring plots. Eleven of these turned out later to be classified by farmers as Dopa land, so the sample is skewed. The results of the analyses (Table 1) suggest that SRDI have changed their analytical methods in 1997, so comparison of the two years must be done with caution.

- The  $p^H$  given for 1996 is most likely for  $p^H_{\text{water}}$ , and those for 1998 for  $p^H_{\text{KCl}}$ , which for this type of soil gives a considerably lower result. The soils are slightly acidic to neutral.
- In 1998 apparently a new method for available P was used, probably P-water. P-status was classified as low to very low;



land type	pH <sup>1</sup>		% CM		ppm P		meq/100g K		ppm S		ppm Zn		meq/100g B		texture
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	
Tan	6.7	5.7	0.92	0.89	3	1.23	0.26	0.11	17	9	2.9	0.3	0.26	0.43	silt loam
	7.9	5.1	0.52	1	3	2.11	0.25	0.11	11	14	2.7	0.5	0.06	0.55	fine sandy loam
	6.9	4.8	1.47	1.86	11	4.2	0.35	0.17	48	24	2.9	0.5	0.31	0.58	fine sandy loam
Patchot	6.1	4.7	1.55	1.63	22	2.53	0.45	0.16	52	16	3	0.5	0.36	0.84	silty clay loam
Dopa	8.2	5.8	0.45	1.87	10	4.2	0.26	0.21	61	26	2.7	0.4	0.05	0.53	silt loam
	6.5	4.5	1.41	2.21	3	1.87	0.21	0.35	24	58	1.7	0.8	0.04	0.72	silt loam
	4.9	5.6	2.11	1.27	13	3.44	0.8	0.19	33	32	3.9	0.5	0.42	0.32	silt loam
	5.4	4.9	1.79	2.93	19	2.01	0.48	0.31	56	74	3.2	1	0.13	0.83	silty clay
	7	4.6	1.9	2.05	5	2.98	0.22	0.22	34	34	2.4	0.8	0.41	0.67	silty clay loam
	6.5	4.8	1.83	2.29	5	2.45	0.31	0.15	25	52	3.7	1.1	0.04	0.7	silt loam
	7.2	6.2	1.2	1.49	54	2.17	0.32	0.11	24	13	4.4	0.6	0.25	0.55	silt loam
	5.8	4.5	1.61	2.28	6	2.29	0.25	0.29	32	42	2.6	1.1	0.02	0.75	silty clay loam
	6.0	5.0	0.9	2.98	11	0.91	0.43	0.26	28	9	2.8	0.5	0.15	0.66	silty clay
	7.7	4.8	0.7	2.46	14	1.55	0.31	0.22	54	61	2.4	0.9	0.16	0.61	silty clay

Table 1: Chemical analysis of soil samples

Table 1: Chemical and textural analysis of some soils in the Compartment

<sup>1</sup> In 1996 the analysis was for pH<sub>water</sub>, in 1998 for pH<sub>KCl</sub>



269

- The K-status of most samples was adequate to moderately low;
- The 1998 Zn data look suspicious and suggest analytical problems. Data by BARI for the Palima On Farm Research site, measured in 1999 shows Zn contents similar to the 1996 data;

Keeping in mind the flaws in the analytical results, it may be concluded that fertilizer response may be expected for N and P in most soils. K and Zn response may sometimes be expected.

#### *Expansion of Boro Cultivation*

The most significant development in flood plain cropping has been the introduction of groundwater irrigation for Boro paddy since the nineteen seventies. Boro is planted from late December in Dopa land up to early February in Patchot. It is harvested from May to June, i.e. in the middle of the Kharif-I season. Consequently, Aus paddy, which used to be grown from April to July, has practically disappeared in many areas,

including the compartment. Boro yields are much higher than those of the best T-Aman and the crop is more secure. Only modern Boro varieties are grown with high inputs, especially fertilizer. In 1999, more than 70% of the cultivable area in the compartment was used for Boro compared to 36% in the base year 1992.

#### *The Annual Cropping Cycle*

The annual agricultural cycle in Bangladesh used to be reckoned from the start of the rains in March/April, i.e. the Kharif-I season. This was consistent with the traditional cropping system, since the monsoon dominated the cropping cycle and was the major factor in farmers' decision making. With the expansion of Boro and mustard, however, the situation has changed drastically. Boro paddy is now the dominant crop and decision making on the entire cropping cycle revolves around the requirements and timing of Boro cultivation. Decisions have to be made immediately after the monsoon, i.e. at the start of the Rabi season. Choices made for Rabi cropping affect the entire cropping cycle. It is, therefore, more appropriate now to consider the Rabi season as the start of the annual agricultural cycle and this will be done in this Annex. It has the added advantage that the cropping cycle coincides with the calendar year, provided all crops are assigned to the year in which they are harvested.



## Crops and Yields

At the beginning of phase I, CPP collected baseline data about cropping areas in the compartment from its own surveys and crop yield data from the official DAE statistics. Changes occurring in the compartment were assessed against this baseline data set. The data are shown in Table 2.

Apart from the crops mentioned in Table 2, a large number of other species of economic importance are grown. These are presented in Appendix 2 with the season and locations in which they are grown.

Paddy				Other crops			
Crop	area (ha) <sup>1</sup>	yield (t/ha) <sup>2</sup>	production (t)	Crop	area (ha) <sup>1</sup>	yield (t/ha) <sup>2</sup>	production (t)
B-Aus (L)	2664	1.45	3,863	Jute	1,614	1.73	2,792
T-Aus (HYV)	726	2.75	1,996	Wheat	1,963	2.10	4,122
				Mustard	1,277	.86	1,098
T-Aman (L)	848	2.16	1,832	Potato	138	9.45	1,304
T-Aman (HYV)	222	3.24	720	Pulses	733	0.74	548
DWB-Aman	1,464	1.52	2,225	Vegetables/minors	135	7.97	1,076
DWT-Aman	2,254	1.81	4,080	Sugarcane	691	30.77	21,262
				Others	68	2.77	136
Boro (L)	431	2.92	1,258				
Boro (HYV)	3,390	4.47	15,153				
Net Cultivable Area	9,763						
(NCA)							
Cropped Area	18,618 Ha						
Cropping intensity	191						

Table 2: Baseline data on crops areas and yields, Tangail compartment, 1992

<sup>1</sup>CPP survey, Tangail compartment<sup>2</sup> DAE official statistics for Tangail Sadar Thana  
Note: - = Data not available

## Expected Impact of Improved Water Management On Cropping

According to the original project concept, improved water management was expected to result in the following changes in water conditions in the Compartment:

- Controlled flooding in the pre-monsoon by capturing and distributing early increases in river flow, allowing (i) deposit of silt carried by the rivers, (ii) restocking of fish populations and (iii) early land preparation for T-Aman;
- Adequate drainage in the pre-monsoon, reducing damage to standing Boro



267

crops and to B-DW Aman seedlings due to accumulation of rainwater in lowlying areas;

- Reduced flooding depths during the monsoon by controlling water inflow and distribution inside the compartment, thus allowing a shift in monsoon rice production to HYV-Aman; and
- Earlier evacuation of water by improved drainage, allowing earlier planting of Rabi crops.

Reduced monsoon flooding depth can be interpreted as a change in land type distribution, since the official land type classification is based on flooding depth. CPP generated theoretical flood maps using the Flood Management Model (FMM) under different water management scenarios. Table 3 shows the change in distribution of maximum water levels under one of these scenarios, as compared with the base situation without water control.

maximum depth (cm)	base situation (no water control) <sup>1</sup>		with control
	land type	%	%
0-30	F <sub>0</sub>	32.2	52.0
30-90	F <sub>1</sub>	38.4	32.5
90-180	F <sub>2</sub>	26.3	13.3
>180	F <sub>3</sub>	3.1	2.2

Table 3: Change in maximum water depths due to CPP's water management

<sup>1</sup> with horseshoe embankment but all water management structures kept open permanently  
Source: CPP GIS Atlas, 1999

During the final phase it became clear that controlled flooding in the pre-monsoon was impossible in most years because of insufficient water levels in the Dhaleswari and Pungli rivers (see Annex-B). The other three factors remain valid and their expected impact on cropping in the three seasons is as follows:

Pre-monsoon season (*Kharif-I*). Inundation of low-lying areas by accumulating water from early rainstorms can be delayed by improved drainage. This reduces damage to the standing Boro rice crop and facilitates its harvest, while it prevents damage to DW Aman seedlings and Kharif-I crops (jute and potential alternative crops)

Monsoon season (*Kharif-II*). Better water control results in an overall decrease in water levels during the *Kharif-II* season. This will result in an increase in the area suitable for T-Aman HYV, as well as making previous fallow land suitable for DW-Aman cultivation.



Post-monsoon and *Rabi* seasons. Improved post-monsoon drainage results in earlier land availability for *Rabi* season crops and *Boro* paddy. This would allow a larger area to be planted to winter crops like mustard, wheat and potatoes and increasing the area where both *Rabi* crops and *Boro* can be grown.

These changes should lead to increased rice production in the monsoon and possibly also in the *Boro* season. Furthermore, increased annual rice production would create opportunities for diversified cropping in the *Rabi* season. The water management strategy of the compartment was designed in order that these potential benefits for agriculture can be realized, while taking into account the interests of other groups.





## Concepts, Approaches and Activities

The agriculture program consisted of three major components:

- Monitoring changes in land use and crop yields as indicators for the impact of project interventions on agriculture;
- Contributing to the development of water management strategies, in collaboration with other project sections
- Identifying potential innovations to exploit new opportunities for crop production, through demonstration plots in the first phase and through a participatory on-farm testing and demonstration (OFTD) program in the final phase.

In this section, the approaches and activities of the agriculture program are described, while the findings and achievements are discussed in later sections.

### Monitoring Changes in Land Use and Yields

Monitoring of farmers' land use practices and collection of economic data consisted of four components:

- Detailed land use surveys were carried out in the entire compartment in the *Rabi* and *Kharif-I* & *II* seasons. Land use in the monsoon was recorded since 1993 and in all seasons since 1997. This was done by sketching the areas under different crops in each *chawk* onto a *chawk* map and transferring this to the GIS system;
- 250 monitoring plots inside the compartment since 1994 and 40 in the northern adjacent area since 1997 were visited monthly to record the current crop. The scatter of the plots is shown in Fig. 3. In part of the plots, inputs and yields of monsoon paddy were monitored, based on farmer recall. Since 1997, inputs and yields of other crops were also monitored by the Economics Section;
- DAE data on crop areas and yields were analyzed for accuracy and used for comparison with trends in the *Thanas* surrounding the compartment; and
- An irrigation survey was conducted in alternate years since 1993 to monitor the increase in installed irrigation capacity and irrigated area.

### Designing Water Management Strategies

During the first project phase, it was assumed that more or less full water control would be possible. Operational rules were drafted using the FMM model, based on a compromise between projected monsoon land use for each *chawk* and the needs of fisheries (CPP GIS Atlas, 1996). This led to a set of rules that it was impossible to implement, partly because the required level of control was not possible, partly because the rules were too complex.



During the final project phase, a number of possible water management scenarios were developed by the Water Management Section, based on model calculations, which represent the room for maneuver inherent in the design of the compartment. The scenarios are discussed in detail in Annex-B (Water Management and Modeling).

## Identifying New Opportunities For Crop Production

### *On-farm Demonstrations*

During phase I, conventional demonstrations were carried out in collaboration with DAE with improved varieties of T-Aman paddy and homestead vegetable production. At the inception of the final phase, it was felt that the demonstrations, although useful for extension purposes, did not contribute to the immediate objectives of the project because they were not conducted in the context of changes in land use. The demonstration program was, therefore, discontinued and transferred to DAE. From 1997 onwards, an On-Farm Testing and Demonstration (OFTD) program was carried out to identify new options for cropping in close collaboration with farmers.

### *Participatory Development of New Cropping Practices*

#### **Rationale and Implementation**

CPP's intervention in water management was expected to open new avenues to farmers to increase the efficiency, diversification and profitability of farming. In a conventional extension program, improved varieties and cultural practices would be demonstrated, based on on-farm research results generated by research institutions. CPP being a pilot testing program for integrated water management, the implications of its interventions were not known *a priori* and it was impossible to give reliable recommendations for improved cropping patterns and practices without a period of testing. It was, therefore, necessary to conduct an On-Farm Testing and Demonstration (OFTD) program in partnership with farmers to explore new options for cropping practices, varieties, crop diversification, fertility management, etc. Four representative pilot *chawks* were chosen with contrasting conditions as regards hydrology, soils and cropping patterns, where many farmers would participate in the program. Promising results obtained in the pilot *chawks* were expected to be extended by DAE to other *chawks*. Some activities on pond and beel fisheries were also conducted in the pilot *chawks*.

On-farm research in Bangladesh is the task of the Bangladesh Institute of Agricultural Research (BARI) which operates a permanent On-Farm Research site in Palima, close to the CPP area. In order to ensure long term sustainability, the project established a formal MoU with BARI to jointly conduct OFTD in the compartment. An OFTD team



was formed consisting of senior and junior staff of the Agriculture and Women in Development Sections and BARI. Other CPP sections and DAE participated on an *ad hoc* basis.

An essential principle of the OFTD program was that farmers were at the center of all activities. The Inception Report stated:

*"[Farmers] will decide on the priorities for testing and demonstration in consultation with and with advice from the OFTD team. They will carry out the tests and demonstrations with a minimum of interference from the team. The team guides the process and gives advice on implementation but does not impose its opinion."*

In the day-to-day practice, this principle has only been partially adhered to and there were frequent relapses into the conventional extension attitude. Nevertheless, there has been real progress in participatory attitude by all involved, although the process is far from complete.

#### *The Pilot Chawks*

Four pilot *chawks* were chosen in consultation with different CPP sections based on the following criteria:

- There should be one pilot *chawk* in each of the four Clusters.
- They should together cover the full range of conditions regarding soil and land type occurring in the compartment.
- They should cover the full range of water management conditions (drainage, flooding, water control structures, beels) occurring in the compartment.

The location of the pilot *chawks*, their connection to the main drainage systems of the compartment and other features are shown in Fig. 4.



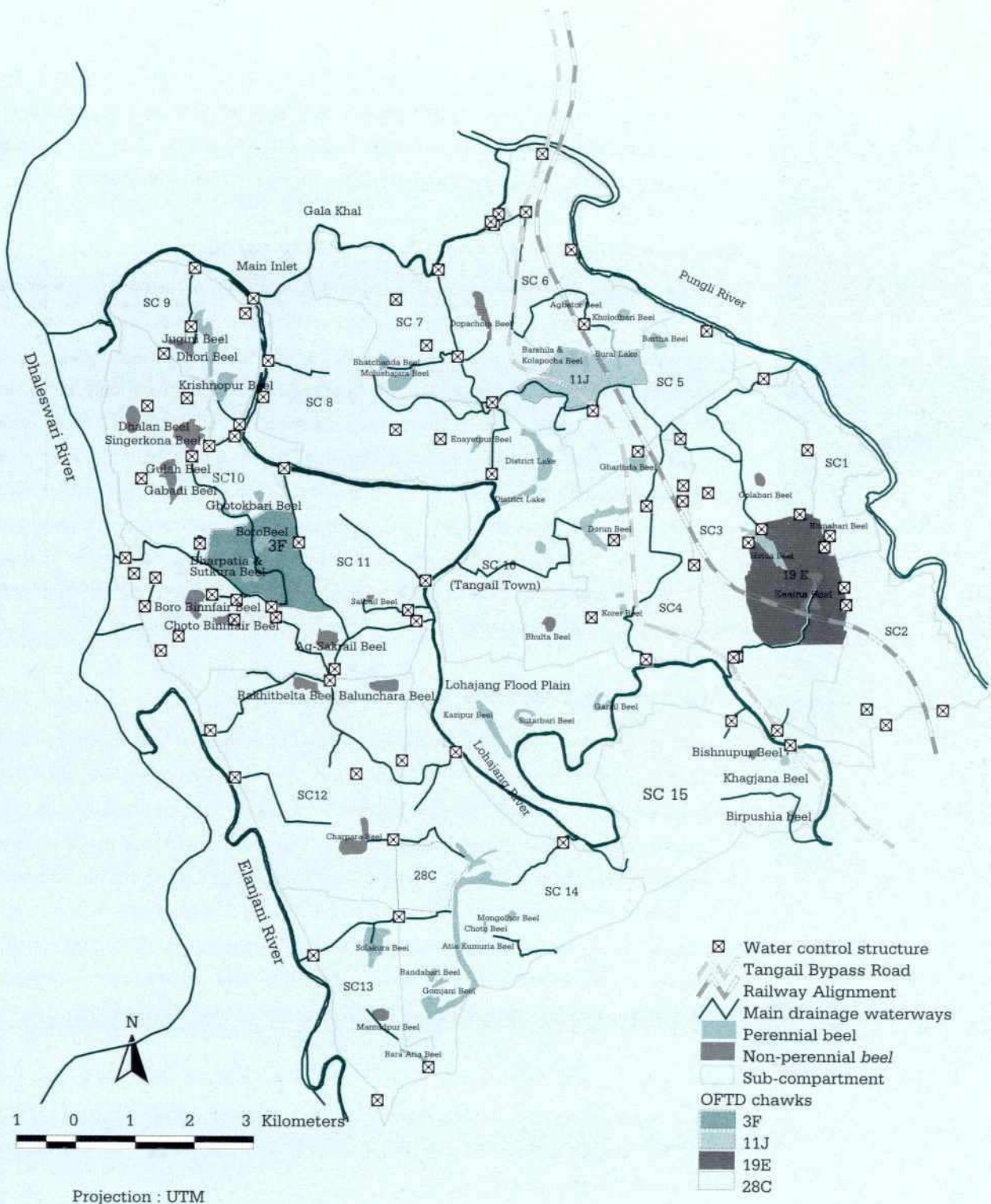


Figure 4 : Pilot Chawks, Major Waterways and Water control Structures





### *Participatory Rural Appraisals (PRA)*

PRA were conducted in the pilot *chawks* to initiate the OFTD program and make CPP and line agency staff familiar with participatory concepts. All CPP sections as well as personnel from DAE and BARI participated. Details about the methodology and findings may be found in the PRA Report (CPP, 1998: Living with the Water).

### ***Designing and Conducting On-farm Tests and Demonstrations***

The PRAs and the subsequent workshops and farmer meetings resulted in proposals for technologies to be tested and demonstrated in the following seasons. Relevance in the context of the project, potential profitability, risk and marketing outlets were assessed *ex-ante* and discussed with the farmers. The OFTD team only provided inputs as far as they were different from farmers' usual practices. Tests and demonstrations were carried out with a maximum of farmer management. Farmer field days were held during the season. In each *chawk*, a Farmer Testing Group was formed, as well as sub-groups ('focus groups') consisting of members participating in specific parts of the program. Farmers could join and drop out of the groups as they wished. The groups formed the main mechanism for participation, consultation and evaluation of the OFTD program.

### **Institutional Collaboration**

The project, apart from the infrastructure it built, was temporary and meant to set a sustainable process in motion. Collaboration with national institutions was therefore essential. DAE, with financial support by CPP contributed staff time to CPP-initiated surveys and carried out on-farm demonstrations. The year-around land use mapping, for example, was only possible because the Block Supervisors carried out the mapping in the field, with training and supervision by CPP staff. With BARI, a MoU was established in 1997 for the implementation of the OFTD program. BARI staff inputs and other expenses were funded from CPP resources. At the end of the project, a contract was negotiated between BARI and the BWDB to continue the OFTD program.

In retrospect, the project did too many things on its own, thereby creating insufficient sense of ownership by the national agencies. This may affect the sustainability of the results. Projects like CPP should be better embedded in national institutions to ensure ownership and sustainability.



# Analysis of Changes Due To CPP's Interventions

283

CPP's interventions in water management were expected to result in the following favorable effects for agricultural production:

- Adequate drainage in the pre-monsoon season to reduce damage by standing (Boro) rice crops and to B-DW-Aman seedlings flooding due to accumulation of rainwater in low-lying areas
- Reduced flooding depths during the monsoon by controlling the water inflow into the compartment and by improved distribution inside the compartment, thus allowing a shift in monsoon rice production to HYV-Aman
- Earlier evacuation of water from the compartment by improved drainage, allowing earlier planting of Rabi crops

Controlled pre-monsoon flooding, which was one of the original objectives, was found impossible, because the rivers surrounding the compartment do not reach the necessary level.

Initially, the degree of possible monsoon water control was known in insufficient detail to develop a precise water management strategy. Operation was, therefore, done on an 'informed trial and error' basis, while understanding of the complexities of the system improved gradually. In the final project stage an explicit water management strategy was developed, incorporating the lessons learned and aided by the FMM model.

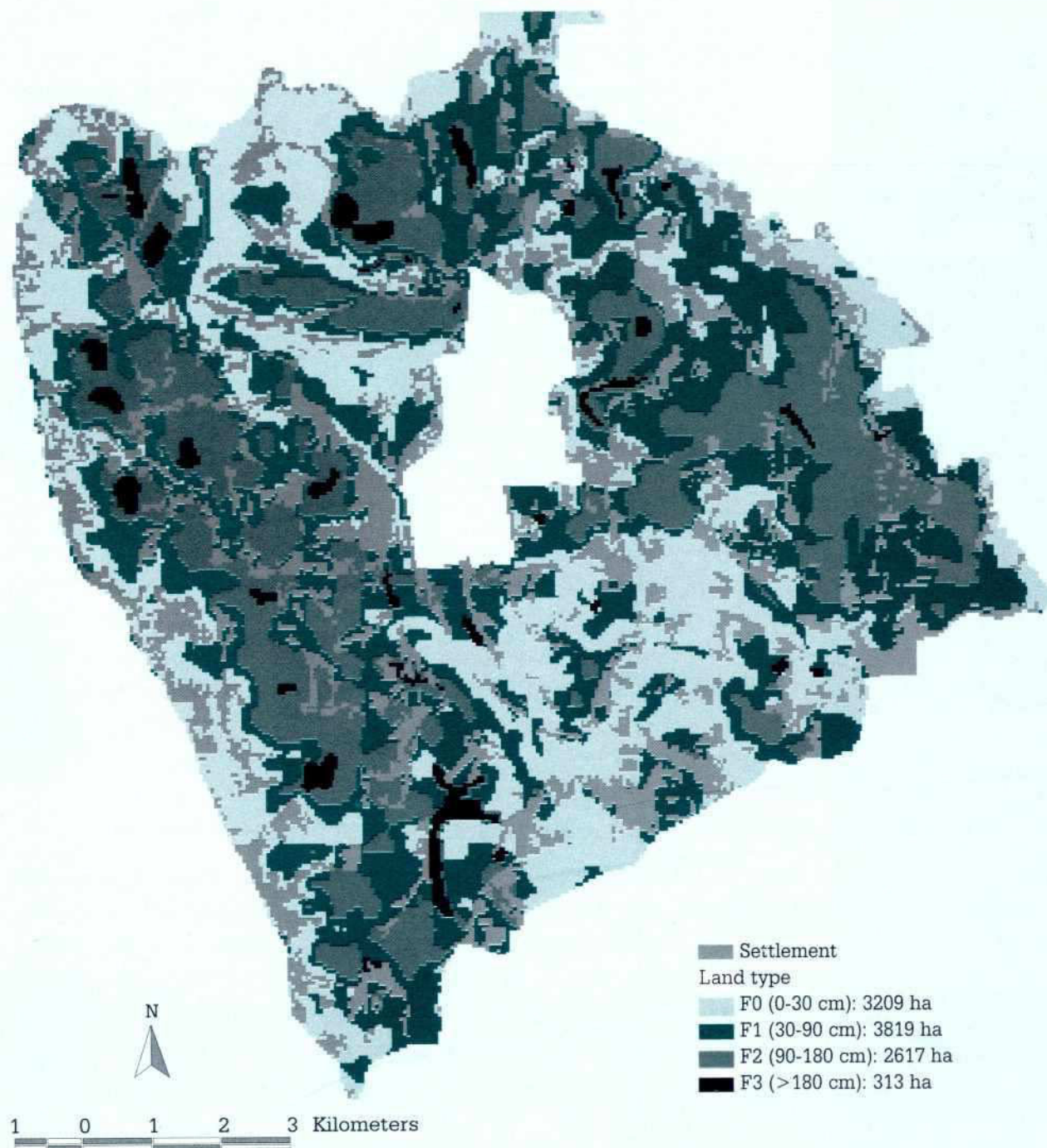
## Changes in Hydrological Conditions in Different Land Types

Land types are officially defined based on maximum water depths, while farmers' classification is based on a combination of expected water depths and suitability for different crops and cropping patterns. Permanent changes in water management by definition result in changes in land types according to the official classification. Farmers' own classification would also be expected to reflect this, but with a time lag. Some of the land that was previously known as *Dopa* land, for example, may gradually become considered as *Patchot* land, if the changes are perceived to be stable.

### *Changes in Land Types According to the MPO Classification*

The base situation for monsoon flooding in the compartment was defined as the distribution of water depths with 1 in 5 years maximum water levels and rainfall, in the absence of CPP infrastructure but with the embankment. These conditions were simulated with the FMM model, using 1966 outside water levels and 1977 rainfall data. These were assumed to represent 1 in 5 year's maxima (Annex-B). Land types were then defined on the basis of the simulated flood map at the time of maximum outside





Projection: BTM

Figure 5: Maximum Flood Map, "Base Situation"



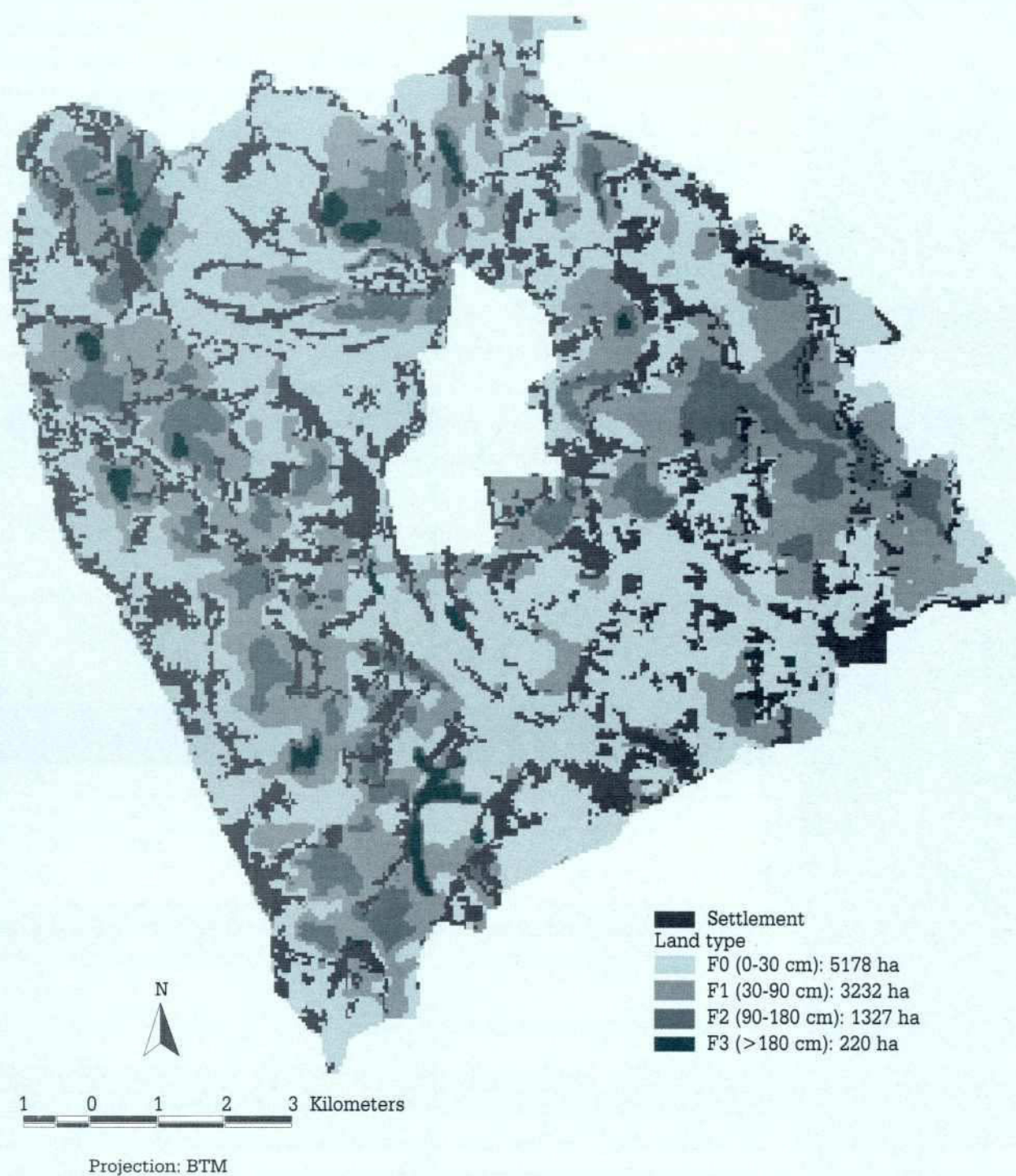


Figure 6: Maximum Flood Map, "with Project"



water levels and with all the CPP water management structures left open at all times. The resulting theoretical flood map (Fig. 5) was defined as the 'base situation' and the distribution of land types in the compartment (Table 4, second column) was obtained from this map. Thus, Fig. 5 represents the CPP definition of land types in the compartment based on the 'without project' situation.

The 'with project' situation depends on how the infrastructure is operated. Fig. 6 (CPP GIS Atlas, 1999) shows the maximum flood map for one possible water management scenario, defined as follows:

*The main regulator is operated to keep the downstream Lohajang level at a maximum of 10.5 m + PWD. All peripheral inlets and the outlets on the Lohajang are kept open, while a number of internal structures are closed to obtain separation of drainage flows between clusters.*

The distribution of inundation depths corresponding with this scenario is shown in table 4, fourth column ('with control'). The difference with the base situation represents the change in land conditions due to this modest water management scenario.

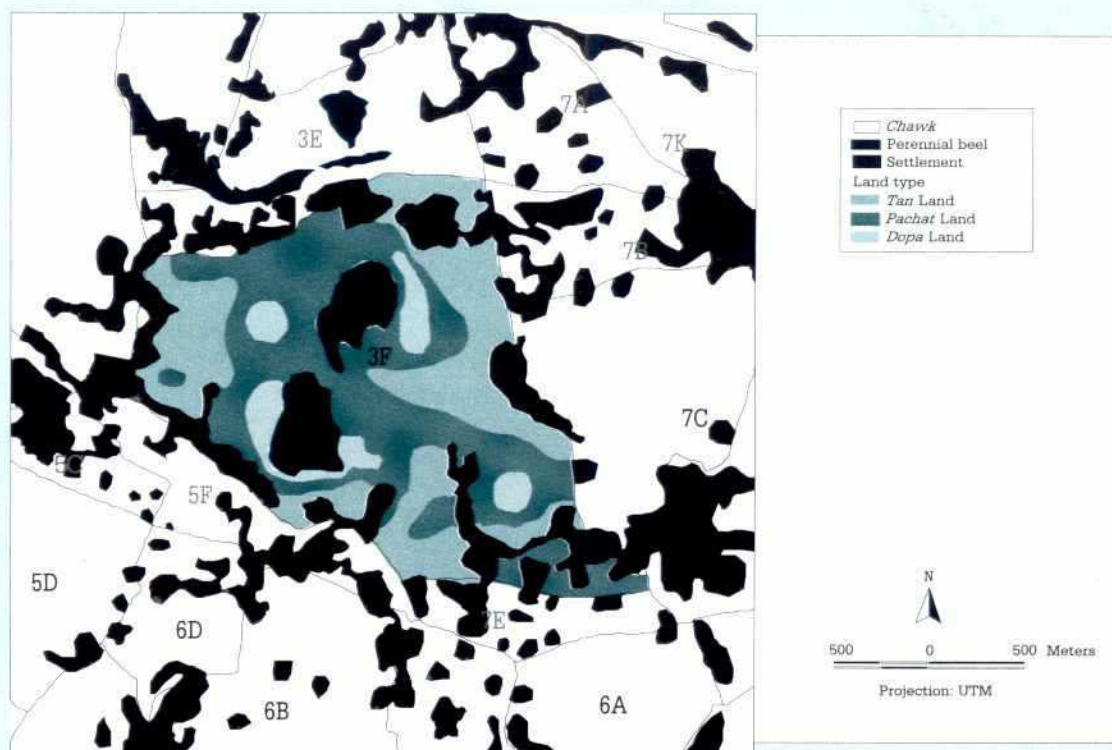
maximum depth (cm)	Base situation		with control	scenari <sup>1</sup>
	land type	%	%	%
0-30	F <sub>0</sub>	32.2	52.0	77.9
30-90	F <sub>1</sub>	38.4	32.5	16.8
90-180	F <sub>2</sub>	26.3	13.3	3.6
>180	F <sub>3</sub>	3.1	2.2	1.7

Table 4: Expected maximum water depth distribution due to CPP's water management

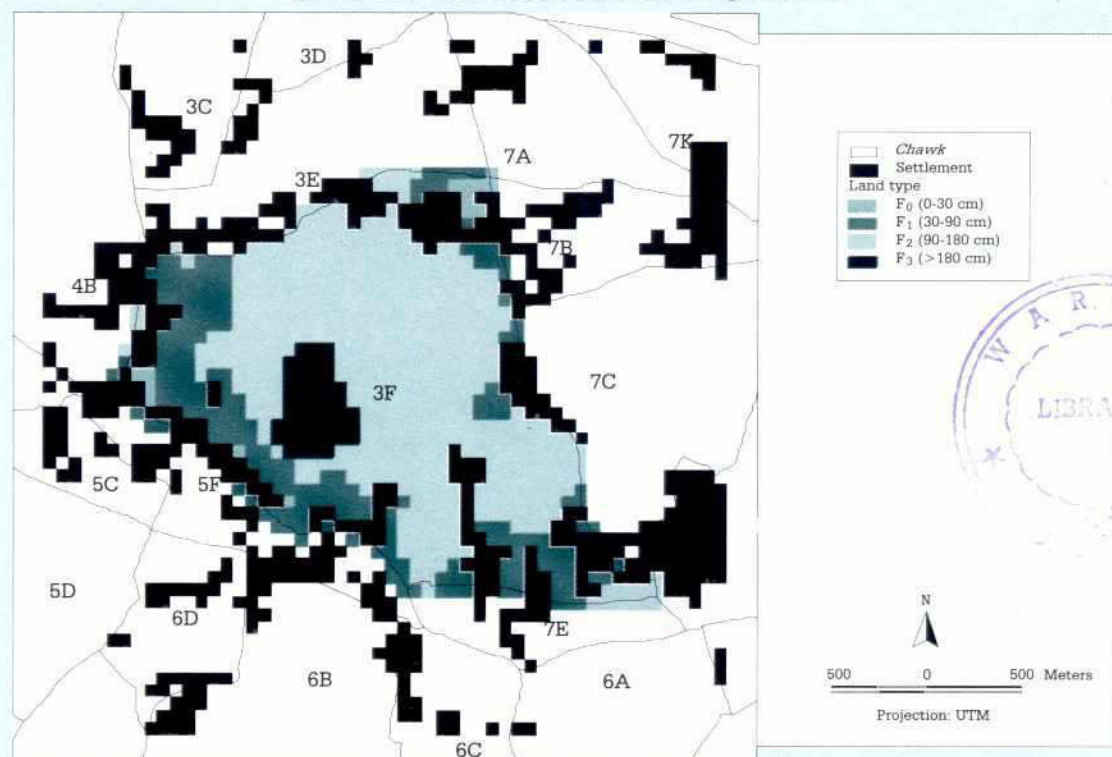
#### *Farmers' Land Type Classification*

During the PRAs, land type maps were prepared for the pilot *chawks* according to farmer classification and later such maps were prepared for the whole compartment. For comparison of the 'farmer land type maps' with those generated by model simulation, both are shown for two of the pilot *chawks* in Fig. 7a and b. Although the location of the different land types is similar in both classifications, the model-derived base situation is much wetter than farmers' own classification. Since farmers' classification reflects their expectations, conditions must have been considerably more favorable for several years than the base situation suggests. The simulated base





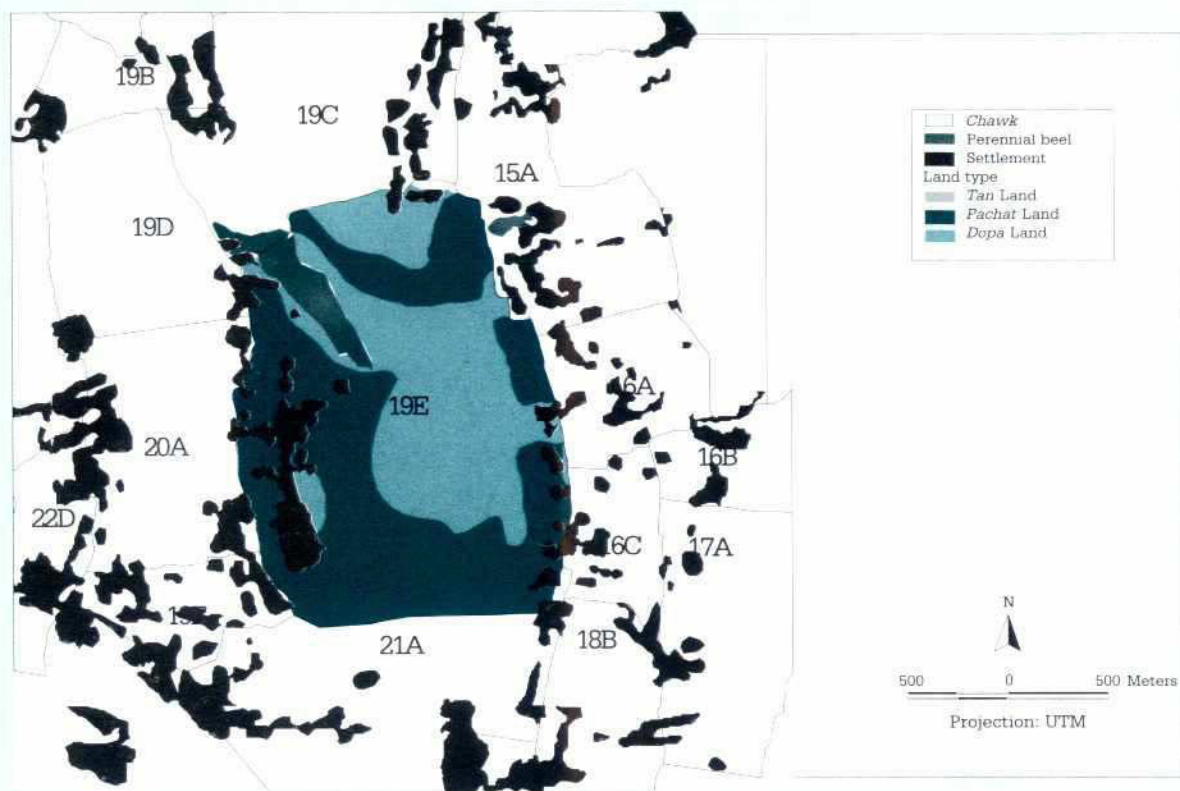
(i) Farmers' Land Types and Drainage Pattern



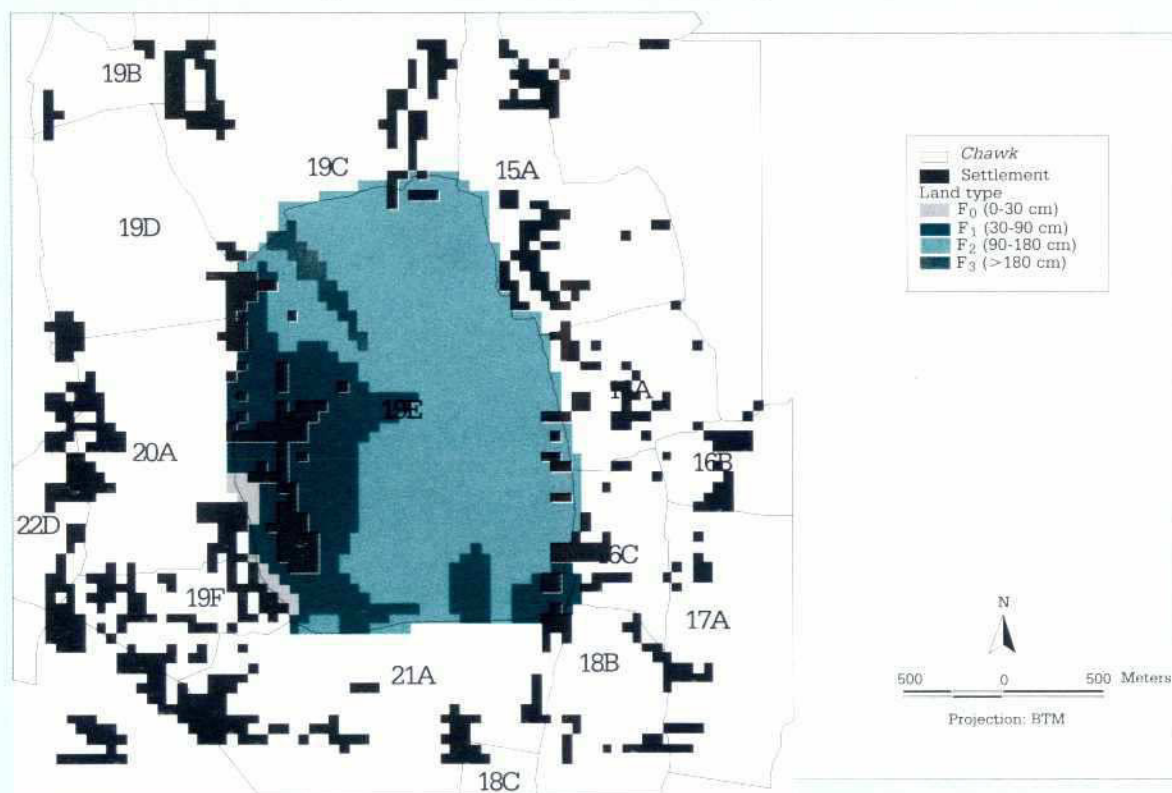
(ii) Land Types According to Model, Base Situation

Figure 7a: Comparison of Farmers' and Model Land Type Classification, Chawk 3F





(i) Farmers' Land Types and Drainage Pattern



(ii) Land Types According to Model, Base Situation

Figure 7b: Comparison of Farmers' and Model Land Type Classification, Chawk 19E



situation represents 1 in 5 years peak flooding, which may not be the best criterion for land use capability. Persistence (duration) of a flooding situation is probably more important than instantaneous flooding depth. Thus, the base map gives too pessimistic a picture of the situation without CPP infrastructure but with the embankment.

Land type mapping based on farmer classification is needed as it reflects farmers' assessment of land suitability and their intended land use. In a future compartment project, farmer land type maps should be established as a baseline against which interventions are planned and progress is assessed.

### Seasonal land use

#### *Monsoon (Kharif-II)*

CPP's intervention is expected to have most impact in the monsoon season and Table 5 presents the trends in overall monsoon land use in the Compartment and in the surrounding *Thanas*, in terms of the percentage of Net Cultivable Area (NCA) which was used for monsoon cropping. The figures for the Compartment are a combination of the LUS and MP data, as explained in Appendix 1. The DAE data on crop areas appeared sufficiently reliable and were used for comparison with areas outside the compartment. Kalihati, to the North, is most similar in geography and location relative to the river system and includes most of the Northern Adjacent Area (NAA). It borders directly on the Jamuna river and is more exposed to its direct influence, although an embankment at its western side provides protection in most years. Delduar, located to the South (a small part is inside the compartment) also shows similarity, but its center and east are low-lying and poorly drained. Bhuapur *Thana* borders on the Jamuna over its full western boundary; its geography is not comparable with the compartment. Finally Basail to the East is lower than the compartment and it is centered on the confluence of the Pungli and Bangshi rivers, making it prone to inundation.

Area	percentage of NCA used for monsoon cropping						
	NCA	1994	1995	1996	1997	1998	1999
CPP Compartment	9,763	66	77	72	77	45	74
Kalihati Thana	21,385	55	57	60	58	6	61
Delduar Thana	13,057	55	66	58	58	36	73
Basail Thana	13,113	37	23	38	58	14	29
Bhuapur Thana	24,033	18	17	22	26	11	38

Table 5: Monsoon cropping area, expressed as percentage of net cultivable area (NCA) in the Tangail compartment and surrounding *Thanas*, 1991-1999



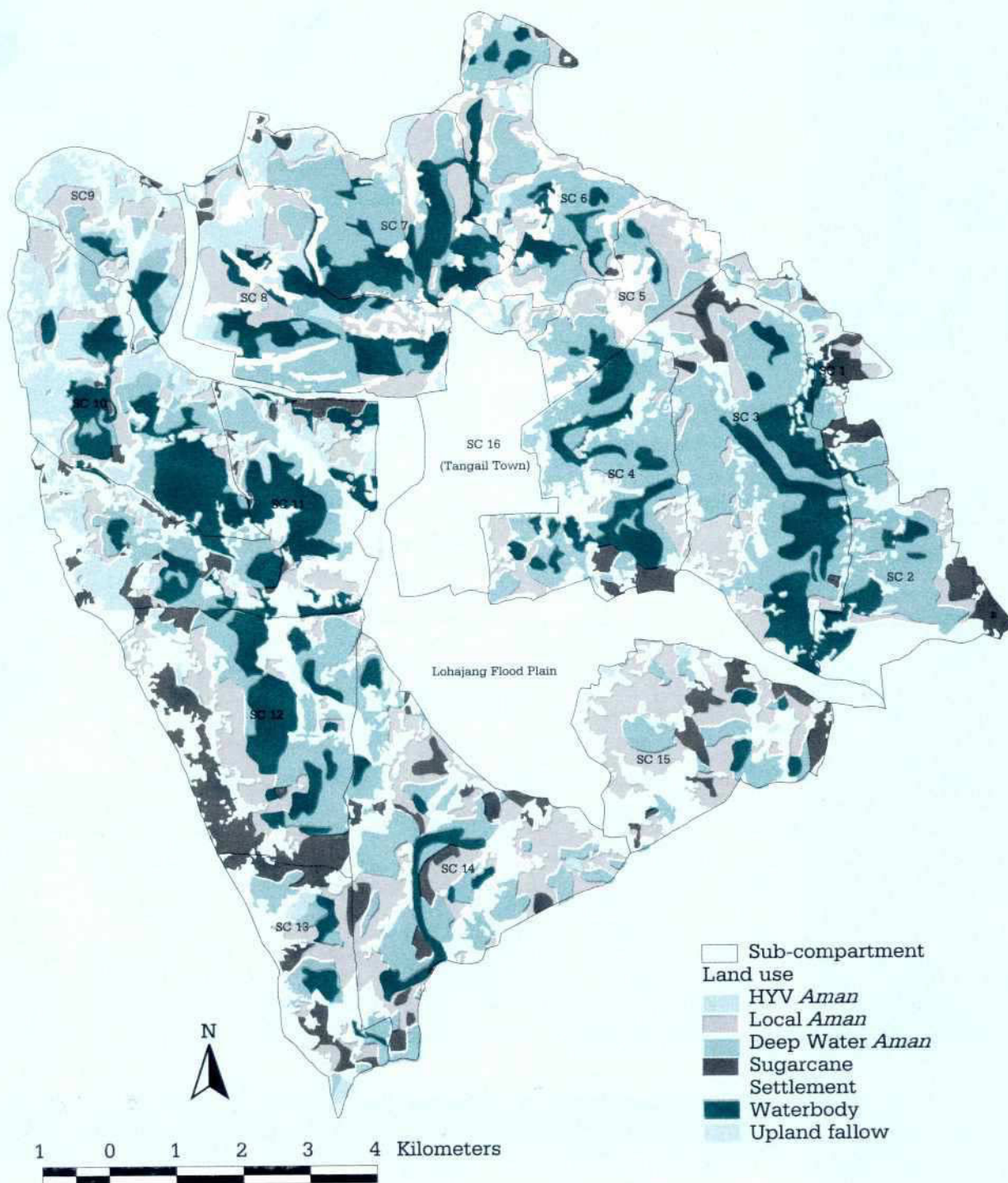


Figure 9: *Kharif* -II Land Use Shift 1993-1999



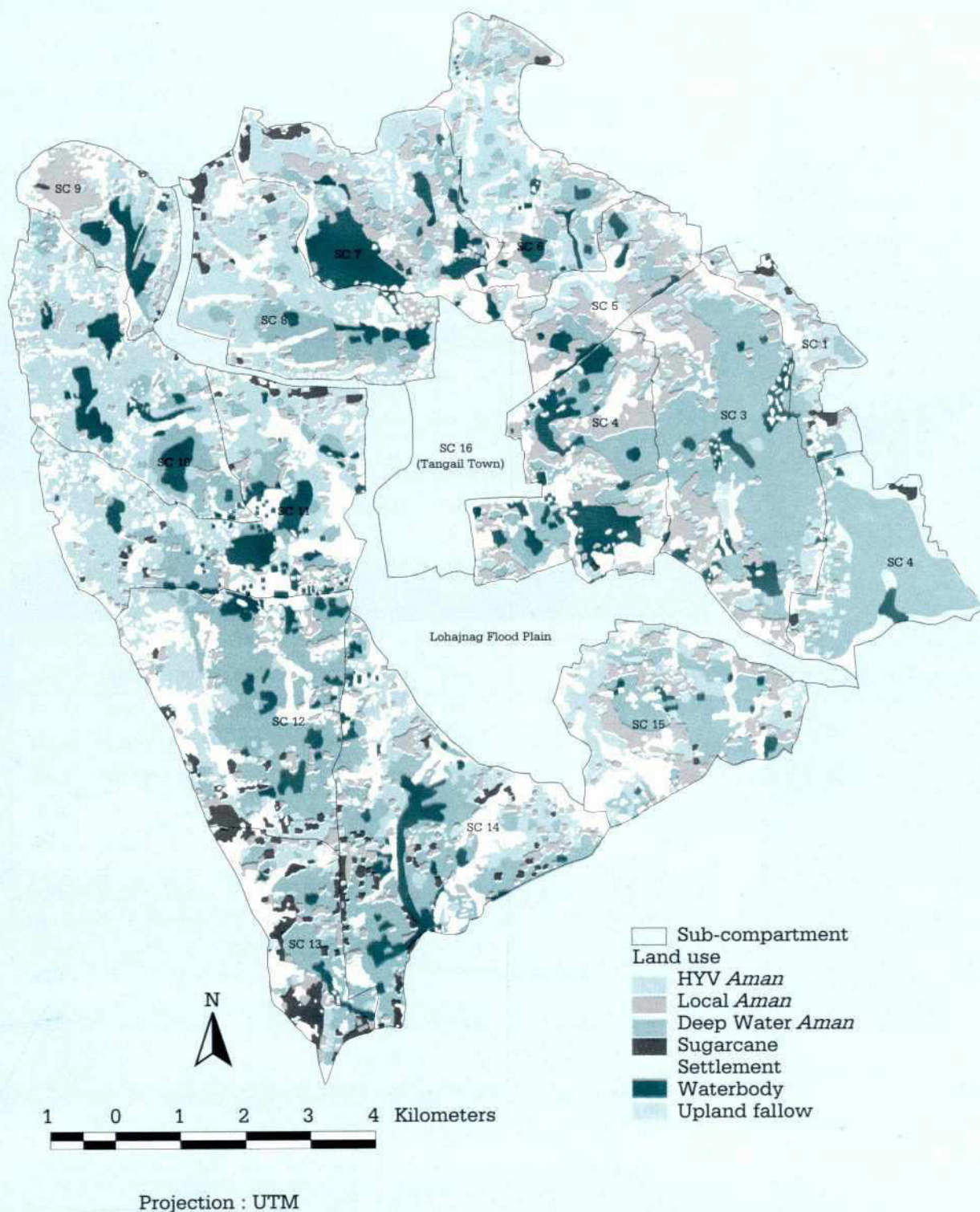


Figure 9: *Kharif -II* Land Use Shift 1993-1999



The data (table 5) show that:

- Overall monsoon land use was higher in the compartment than in the two most similar *Thanas* throughout the period; this is probably due to the presence of the horse shoe embankment around the compartment;
- The increase in land use observed in the compartment between 1994 and 1997 did not occur to the same extent in the two most similar *Thanas*; this may be attributed to the CPP interventions, in particular improved drainage.

The 1998 flood resulted in a sharp decrease in monsoon land use in the compartment and in Delduar. In Kalihati, however, the decrease was much more dramatic, because of the direct exposure to the Jamuna. In the NAA monsoon land use went down to only 1% of NCA.

The contribution of the different crops to overall monsoon land use over the years inside the compartment is shown in table 6.

Crop	1991	1993	1994 <sup>1</sup>	1995	1996	1997	1998
B-Aus+B/T-Aman <sup>2</sup>	1,734						
T-Aman (L)	848	2,655	2,531	2,462	2,601	2,438	991
T-Aman (HYV)	222	931	482	905	1,603	2,382	1,503
<b>Total T-Aman</b>	<b>2,804</b>	<b>3,586</b>	<b>3,013</b>	<b>3,367</b>	<b>4,204</b>	<b>4,820</b>	<b>2,494</b>
DW-Aman	3,718	2,704	1,788	2,649	1,932	2,089	1,241
Sugarcane	691	1,258	1,625	1,503	846	594	623
Fallow	2,550	2,215	3,337	2,244	2,781	2,260	5,405

Table 6: Estimated areas of monsoon crops in the Tangail compartment, 1991-1999

<sup>1</sup>very dry year

<sup>2</sup>only recorded in 1991, thereafter inter-cropped *Aman* was lumped with T-Aman (L)

Some important shifts in land use are apparent, as illustrated by table 6 and by the 1993-1997 land use shift map of Fig. 6, viz.:

- T-Aman has increased sharply through 1997, mainly at the expense of DW-Aman and Sugarcane. DW-Aman was partly replaced by T-Aman (L), while part of the T-Aman (L) and sugarcane were replaced by T-Aman (HYV). Fallow land has not decreased systematically,
- All *Aman* paddy types declined in 1998 due to the September flood which damaged a large part of the crop,



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- In 1999, HYV was back at the pre-flood level, but for the other paddy types there was a shift to more conservative choices: from T-*Aman* (L) to DW-*Aman* and an increase in fallow. This indicates uncertainty about the future but it is probably temporary,
  - There has been a steady increase in HYV, only interrupted by the 1998 flood, which is explained by the fact that it is grown in the higher, less flood-prone land types, and
  - The return of T-*Aman* (HYV) to the 1997 level immediately after the flood testifies to farmers' confidence that it is safe to grow flood-sensitive modern *Aman* varieties in *Tan* and the higher reaches of *Patchot* land.

The increase in T-*Aman* in replacement of sugarcane implies an increase in T-*Aman* production in *Tan* land. Supplementary irrigation would be required in some years. After the *Boro* season, however, practically all Shallow Tube Wells (STW) are dismantled and supplementary irrigation requires re-installation before the next *Boro* season. This is a simple operation that should not present undue problems in case of need.

To what extent the shift from DW-*Aman* to T-*Aman* and from local varieties to HYV is due to CPP's intervention was examined by comparison with trends in the two most similar adjacent *Thanas* (Table 7). In Kalihati, there has been a similar upward trend of T-*Aman*, as well as a similar increase in T-*Aman* HYV. The effect of the 1998 flood, however, was much more severe. After the flood, overall land use intensity returned to the 1997 level, but there was also a shift to more conservative crop choices, i.e. more DW-*Aman* and somewhat less T-*Aman*. Contrary to the compartment, the area under T-*Aman* HYV did not yet return to the 1997 level.

In Delduar, the cropping pattern is dominated by DW-*Aman* and sugarcane in respectively the eastern and western parts of the *Thana*. There has been little effort by DAE to introduce HYV, because most of the higher land in the west is used for sugarcane. With declining profitability of this crop, part of the area may eventually be planted to T-*Aman* HYV, although the soil was said to be too sandy for *Aman* paddy. Few changes have occurred in land use during the last few years, but the area under DW-*Aman* varied considerably from year to year at the expense of uncultivated water bodies. This probably reflects the poor drainage conditions in the lower lying eastern parts of the *Thana*. The upsurge in DW-*Aman* in 1999 was the result of early *Boro* cultivation after the 1998 flood that allowed more land to be planted to DW-*Aman*.



22

	Compartment <sup>1</sup>	Adjacent Area <sup>2</sup>	Kalihati Thana <sup>3</sup>	Delduar Thana <sup>3</sup>
<b>1996</b>				
T-Aman (L)	2,601 (27)	579 (33)	3,105 (15)	1,270 (10)
T-Aman (HYV)	1,603 (16)	102 (6)	2,964 (14)	450 (3)
DW-Aman	1,932 (20)	101 (6)	6,581 (31)	3,187 (24)
Sugarcane	846 (9)	35 (2)	140 (1)	2,685 (21)
<b>Total</b>	<b>6,982 (72)</b>	<b>817 (47)</b>	<b>12,790 (61)</b>	<b>7,592 (58)</b>
<b>1997</b>				
T-Aman (L)	2,438 (25)	801 (46)	3,605 (17)	1,000 (8)
T-Aman (HYV)	2,382 (24)	235 (14)	3,912 (18)	650 (5)
DW-Aman	2,089 (21)	28 (2)	4,867 (23)	3,200 (25)
Sugarcane	594 (6)	9 (<1)	105 (<1)	2,730 (21)
<b>Total</b>	<b>7,503 (76)</b>	<b>1,073 (62)</b>	<b>12,489 (58)</b>	<b>7,580 (59)</b>
<b>1998</b>				
T-Aman (L)	991 (10)	15 (1)	972 (5)	294 (2)
T-Aman (HYV)	1,503 (15)	0	134 (1)	240 (2)
DW-Aman	1,241 (13)	0	50 (<1)	2,280 (17)
Sugarcane	623 (6)	7 (<1)	85 (<1)	1,885 (14)
<b>Total</b>	<b>4,358 (44)</b>	<b>22 (1)</b>	<b>1,241 (6)</b>	<b>4,699 (35)</b>
<b>1999</b>				
T-Aman (L)	1,550 (17)	323 (28)	3,447 (16)	850 (7)
T-Aman (HYV)	2,362 (25)	377 (15)	3,403 (16)	868 (7)
DW-Aman	2,543 (26)	0	6,080 (28)	5,076 (39)
Sugarcane	547 (6)	0	105 (<1)	2,550 (20)
<b>Total</b>	<b>7,002 (74)</b>	<b>700 (43)</b>	<b>13,035 (61)</b>	<b>9,344 (73)</b>

Table 7 : Area (ha) under monsoon crops, and as percentage of Net Cultivable Area (between brackets) in the compartment, the northern adjacent area, Delduar and Kalihati Thana

<sup>1</sup>calculated from a combination of LUS and MP data as described in Appendix 1, except 1999, which is from adjusted MP data only.

<sup>2</sup>from LUS only, except 1999, which is from MP. 3 DAE data.

In conclusion: the favorable water management situation in the compartment has resulted in more intensive and more productive land use than in Kalihati. This is partly due to the presence of the horse-shoe embankment and partly to better drainage. The compartment provided much better protection against the disastrous flood of 1998. The predominance of DW-Aman in Delduar as compared with the compartment also reflects the lesser water control in the former. The compartment, however, suffered as much as Delduar from the 1998 flood, once the breaches in the embankment had occurred.



### *Rabi and Kharif-I*

Although the effects of CPP's interventions will be felt most strongly during the monsoon, crop production in the other seasons will also be affected, through prevention of early inundation in the pre-monsoon and earlier evacuation of the water after the monsoon. The trends in planted areas since 1992 are shown in Table 8.

Crop	1992 <sup>1</sup>	1993 <sup>2</sup>	1994	1995	1996	1997 <sup>2</sup>	1998	1999
<i>Rabi</i>								
Mustard	1,277	-	1,297	2,239	1,431	1,507	2,072	2,684
Wheat/barley	1,963	-	1,264	1,498	1,567	1,368	1,533	1,618
Potato	138	-	140	140	157	241	146	134
Pulses	733	-	941	837	436	793	845	756
Veg./spices	135	-	88	113	182	252	325	276
Total	2,246	-	3,730	4,827	3,773	4,161	4,921	5,468
<i>Kharif-I</i>								
Aus	1,864	556	477	605	359	303	203	139
Jute	1,614	1,801	2,110	1,824	2,597	3,089	2,276	1,350
Boro	3,821	-	5,845	5,871	5,876	5,691	6,321	7,125
Total	7,299	-	8,432	8,300	8,832	9,083	8,800	8,614

Table 8: Estimated Areas of Rabi and Kharif-I Crops in the Tangail Compartment

<sup>1</sup>1992: official CPP baseline data.

<sup>2</sup>1993 - 1996 from adjusted MP data only, 1997 - 1999 combined data from MP and LUS (see Appendix 1); all crops are assigned to the year in which they were harvested. (Note: - = Data not available)

The most significant trend has been the increase in mustard and Boro, The simultaneous decline of jute in recent years reflects the fact that most of the recent increase in Boro is in the higher land where new Shallow Tube Wells (STW) have been installed. Aus paddy has practically disappeared and sugarcane is declining steadily.

### *Cropping Patterns and Land use Intensity*

Table 9 shows the evolution of the cropping patterns between 1994 and 1999 as well as the annual cropping intensity, as observed in the monitoring plots. The annual agricultural cycle is reckoned to start with the *Rabi* season as this best reflects the farmers' decision making process. There has been a clear increase in cropping intensity since 1994, which may be attributed mainly to more favorable drainage conditions in the compartment. These allow farmers to:

- Prepare *Patchot* land earlier after the *Aman* harvest for *Rabi* crops, especially mustard



- Prepare *Dopa* land earlier for *Boro* and harvest *Boro* timely before inundation, allowing DW-*Aman* transplanting or broadcasting
- Consequently, the increased cropping intensity up to 1997 has mainly resulted from shifts in the *Boro*-based patterns from double to triple cropping (from pattern 6 to 4) and from single to double cropping (pattern 7 to 6). The situation in 1998 was anomalous because of the flood, but in 1999, intensity was back at the 1997 level.

### *Yields*

All yield data recorded by the project are shown in table 10. Yields fluctuated between years but for most crops, there was no systematic trend. Only *Boro* yield seems to have increased, but the shortness of the CPP record does not allow firm conclusions. DAE yield data for Tangail Sadar and *Kalihati Thana* also suggest an upward trend, from about 3.5 t/ha in 1995 to 5 t/ha in 1998 and 6 - 6.5 t/ha in 1999. The cause of the increase in *Boro* yield is not fully clear. It is probably due to a combination of improved management, increased inputs and favorable weather. The upsurge in 1999, after the 1998 flood, may reflect farmers' increased care to compensate for the monsoon crop losses, as well as exceptional weather and increased fertility due to the preceding 'flood fallow'. It remains to be seen whether the combination of extended *Boro* area and high yield can be maintained. In particular the effect of increased extraction of groundwater on groundwater levels must be closely monitored by the BWDB in view of a possible decrease in groundwater levels. Diversification of *Rabi* cropping by the introduction of high value irrigated crops as a partial alternative for *Boro* could help to reduce the amount of groundwater used.

### *Irrigation*

Groundwater irrigation for *Boro* paddy production has increased tremendously in Bangladesh during the past decade. In many areas, *Boro* has replaced monsoon paddy as the major rice crop, due to its high and stable yield, in spite of the high investments in inputs, including irrigation water. The expansion is independent of CPP's interventions, but there could be an indirect relationship: increased exploitation of groundwater may lead to accelerated ground water depletion, while recharge during the monsoon may be reduced due to the reduction of flood water entering the compartment.



nr	pattern			1994		1994		1996		1997		1998		1999	
	Rabi	Kharif-I	Kharif-II	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
1	Sugarcane	Sugarcane	Sugarcane	967	9.9	1,162	11.9	752	7.7	478	4.9	517	5.3	596	6.1
2	Rabi crops	jute	fallow	840	8.6	927	9.5	469	4.8	1,201	12.3	1,250	12.8	508	5.2
3	Rabi crops	jute	T-Aman	469	4.8	517	5.3	1,191	12.2	908	9.3	722	7.4	1,113	11.4
4	mustard-Boro	Boro	T/DW-Aman	976	10.0	1,191	12.2	976	10.0	1,923	19.7	849	8.7	2,353	24.1
5	Rabi crops-Boro	Boro	fallow	234	2.4	156	1.6	156	1.6	195	2.0	937	9.6	439	4.5
6	Boro	Boro	T/DW-Aman	2,587	26.5	3,212	32.9	3,554	36.4	3,398	34.8	2,304	23.6	2,285	23.4
7	Boro	Boro	fallow	2,636	27.0	1,709	17.5	1,709	17.5	1,103	11.3	2,743	28.1	1,669	17.7
	minor patterns			1,054	10.8	888	9.1	937	9.6	566	5.8	449	4.6	742	7.6
	annual cropping intensity <sup>1</sup>				181		192		199		215		184		214

Table 9: Estimated areas in the compartment used for major cropping patterns in the 1995 - 1999 cropping seasons.

Table 9: Estimated areas in the compartment used for major cropping patterns in the 1995 - 1999 cropping seasons.

Note: the percentage of each pattern is multiplied by the number of crops in that pattern; sugarcane is multiplied by 1.35 because of inter-cropping with annual crops; minor patterns are multiplied by 2.



### A: Pre-monsoon

Crop	1992 <sup>1</sup>	1994	1995	1996	1997	1998	1999
Rabi							
Wheat	2.10	Data not available				2.25	2.10
Pulses	0.74					0.67	0.75
Mustard	0.86					0.58	0.85
Potato	9.45					8.30	9.10
Kharif-I							
Boro (HYV)	4.47	Data not available				5.18	6.19
Aus	1.45					0.56	1.32
Jute	1.73					1.49	1.58

### B: Monsoon

Crop	1992 <sup>1</sup>	1994	1995	1996	1997	1998	1999
Kharif-II							
T-Aman (L)	2.16	1.69	1.83	1.83	1.70	1.41	1.77
T-Aman (HYV)	3.24	2.22	2.78	2.97	2.78	2.50	2.90
BDW-Aman	1.52	0.89	1.09	1.49	1.00	1.05	1.97
TDW-Aman	1.81	1.86	0.80	1.82	1.26	1.18	1.61
Sugarcane	30.77	-	-	-	-	35.422	44.00

Table 10: Yields (t/ha) of the major crops in the compartment, 1992 - 1999

<sup>1</sup>1992 data from DAE statistics, all other years are farmer recall data from the monitoring plots

<sup>2</sup>estimated from a sugarcane survey conducted in 1998. 1998 was long lasting high flood year.

Four types of irrigation equipment are in use in the Compartment:

- Traditional manual swing baskets and don,
- Low Lift Pumps (LLP), motor operated pumps with moveable suction pipe to pump water from open water bodies,
- Shallow Tube Wells (STW) with a discharge capacity between 17 and 21 l/sec and a depth of 25 to 60 m, and
- Deep Tube Wells (DTW) with a capacity of 56 l/sec and a depth of 75 to 125 m.

The use of traditional equipment and LLP for irrigation is now negligible, serving only about 32 ha in 1999. Traditional equipment remains important, however, for watering



	STW				DWT				Total			
	1993	1995	1997	1999	1993	1995	1997	1999	1993	1995	1997	1999
number	774	619	881	1,441	78	85	81	71				
area irrig.	2,819	2,236	2,961	4,745	1,438	1,836	1,797	1,492	4,257	4,072	4,758	6,237
% of NCA	29	23	30	49	15	19	18	15	44	42	48	64
area/unit	3.64	3.61	3.36	3.29	18.43	21.60	22.18	21.00				
Table 11: Installed irrigation equipment, total area irrigated (ha) and percentage of NCA, CPP Compartment												

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Boro seedbeds. The increase in installed pumping capacity in the Compartment since 1993 is shown in Table 11. After a dip in 1995, the number of STW has increased sharply, especially between 1997 and 1999. No new DTW have been installed since 1993, the differences between years being caused by operational and/or financial problems. The 1999 Boro area estimated from the land use surveys suggests an even larger irrigated area (7,000 ha) than calculated from the irrigation survey.

Practically all DTW use electrical pumps, while 59 % of the STW operate on diesel engines, the rest on electricity (1999 data). More than 60% of the STW are owned by individuals, the rest by groups of farmers. For the DTW, these percentages are 12 and 88, respectively. The only mode of payment for STW irrigation is now a 25% share of the Boro crop. For 70 % of the DTW, this is also the case, while 30% charges between 8 and 20 Tk per decimal (40 m<sup>2</sup>). All STW work considerably below their capacity: the potential command area of all the installed pumps is at least 10 ha.

After the Boro season the STW are dismantled, to be re-installed again for the next Boro crop. Supplementary irrigation at the end of the monsoon therefore requires pressure on the pump owners to install the pumps earlier than usual. Furthermore, only diesel pumps can be used, because electricity is only supplied as from January. In the dry year of 1994, some supplementary irrigation was provided in 6 Sub-compartments located in the higher parts of the compartment. In 1996, 149 ha received supplementary irrigation, in 1998 there was none.

### **Optimizing Monsoon Water Management for Agricultural Production**

During the first project phase it was assumed that a high degree of water control was possible. Thus, operational rules were developed up to the *chawk* level. These turned out to be unworkable, as shown in Annex-B. During the final phase, development of appropriate water management strategies was resumed; using the lessons learned during the first phase.

#### *The Maximum Drainage Scenario*

The Water Management Section developed a number of feasible scenarios, which represent the room for manipulation inherent in the design of the compartment (Annex-B). For an analysis of the implications for crop production, the driest, maximum drainage scenario (scenario 4 in Annex-B) was taken as a starting point. In that scenario, all peripheral inlets are kept closed throughout the monsoon while all the outlets on the Lohajang are kept open for maximum drainage. The main regulator is controlled to a maximum level of 10.5 m downstream. A number of



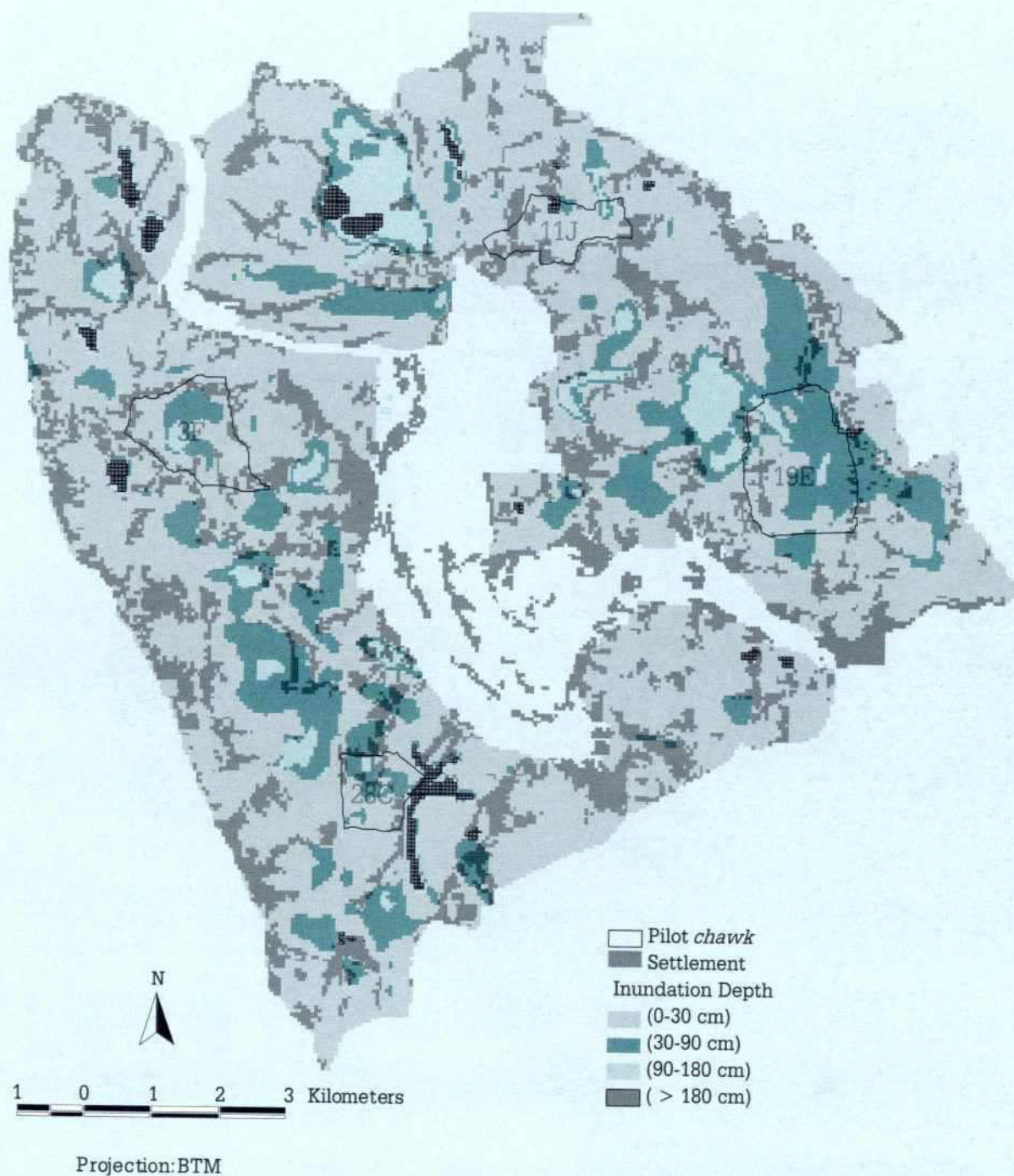


Figure 10: Flood Map for July 30, Scenario 4

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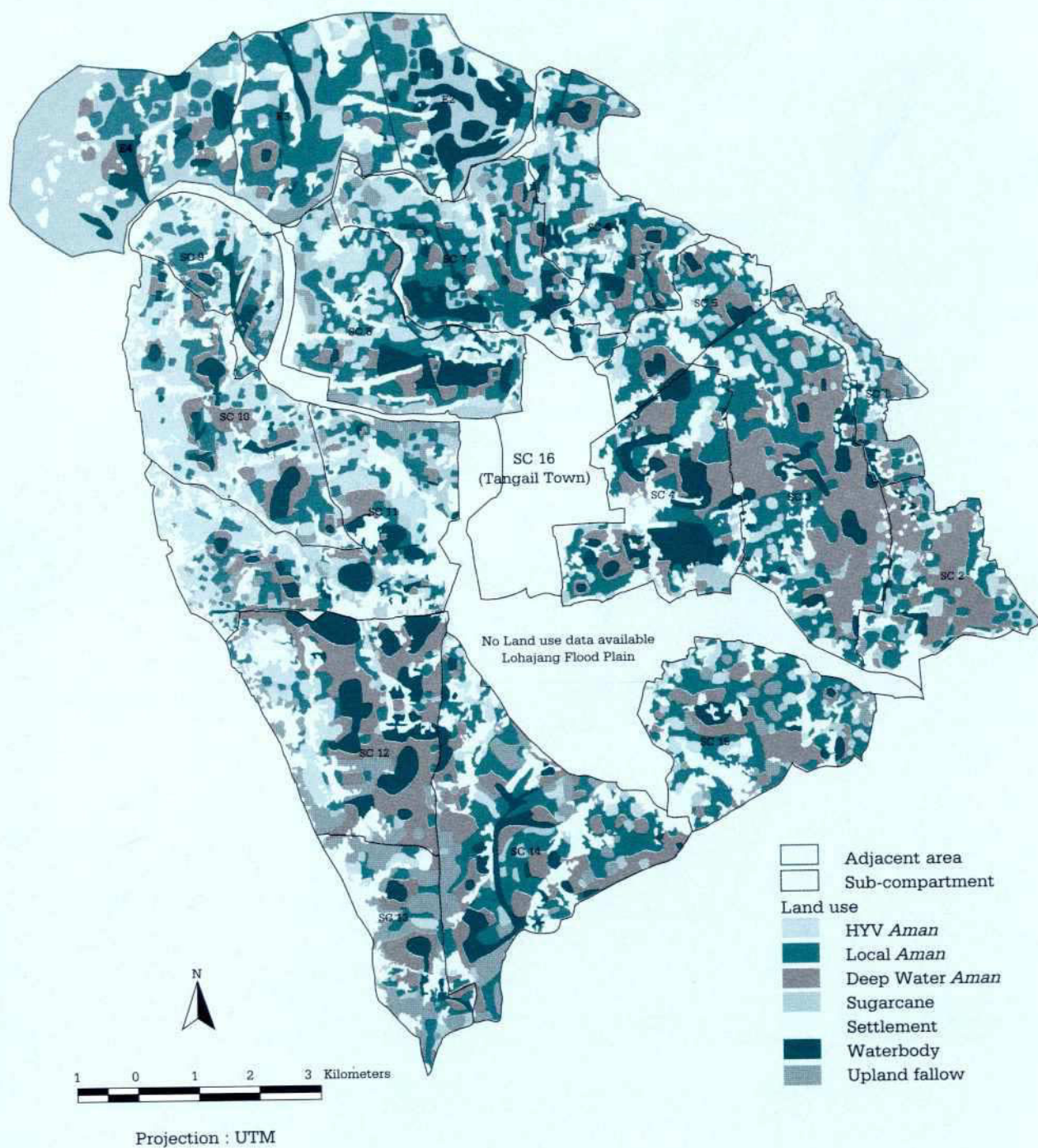


Figure 11(a): *Kharif-II* Land Use 1996



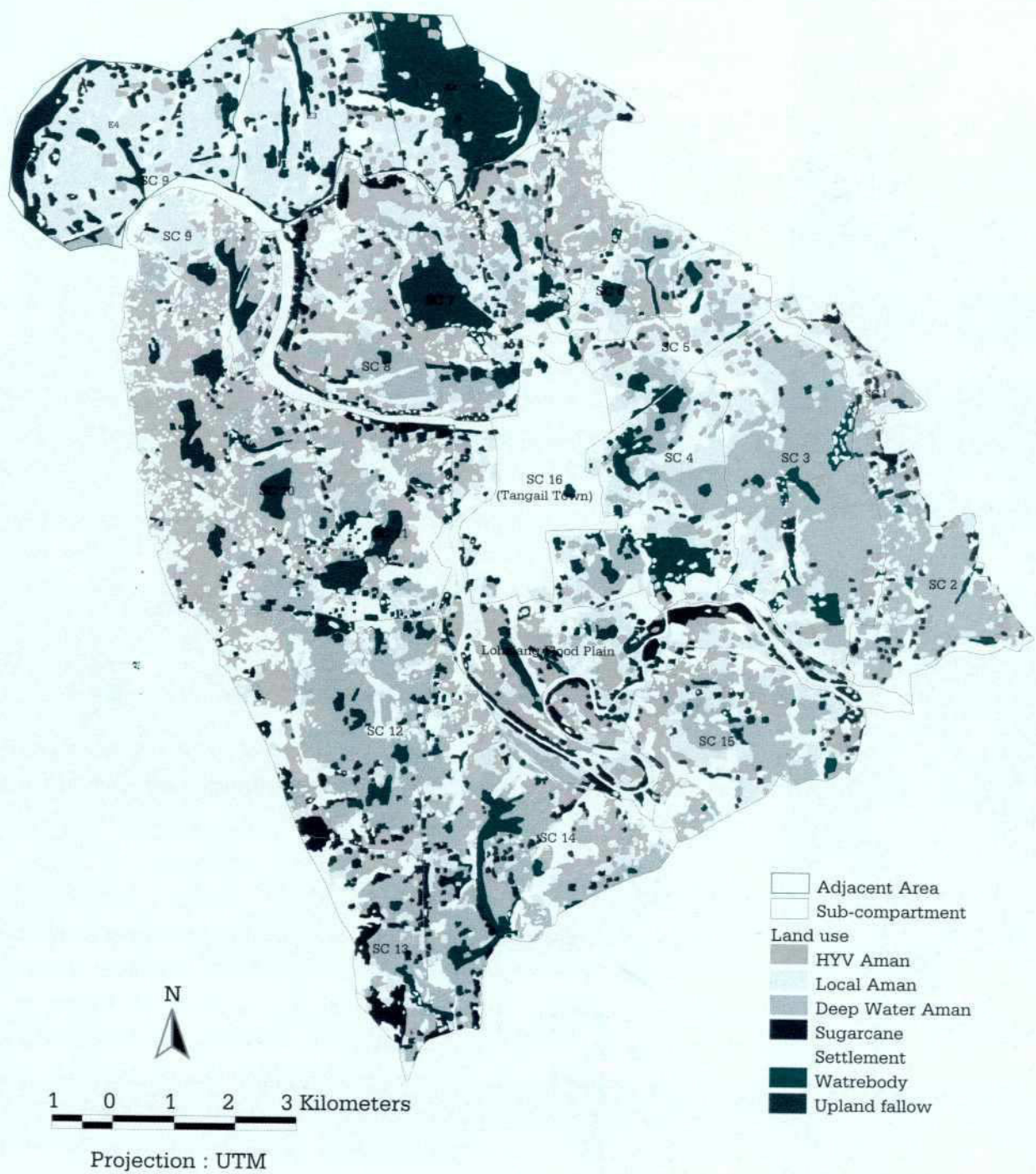



Figure 11 (b): Kharif-II land Use 1999



internal structures are kept closed to obtain separation of drainage flows between clusters. Fig. 10 shows the resulting flood map for July 30 generated by computer simulation with the FMM model. The flood map corresponds quite well with the monsoon land use patterns, as observed in 1996 and 1997 (figs.11 a and b). Analysis of the flood maps of the dry scenario and the actual monsoon land use maps shows three sets of conditions:

- Land which is inundated to no more than 30 cm throughout the monsoon. Under the simulated conditions, this area is suitable for T-Aman and in principle for adoption of HYV. It comprises what farmers classify as Tan land and most of Patchot land,
- Areas inundated between 30 and 90 cm expand and contract during the monsoon. The stable part of these areas consists of Dopa land which is used for DW-Aman, while the variable part corresponds with the lower parts of Patchot land and is used for DW-Aman in some years and for T-Aman in others, and
- Small areas, which are inundated to between 90 and 180 cm, are scattered across the compartment, with a concentration in the low-lying cluster 3. They are stable throughout the monsoon and consist of temporary beels or are used for DW-Aman or left fallow.

### Adjustments Needed for Different Land Types

Monsoon water conditions under the driest scenario and modifications needed to optimize water management for agriculture are discussed for each of the three situations.

#### *Land Inundated to 0-30 cm*

Under the driest scenario, most of this land will only occasionally be reached by floodwater and paddy production is essentially rain-fed. Adequacy of rainfall for rainfed production can be assessed from a frequency analysis of rainfall. Fig. 12 a and b, shows the frequency of 10 and 20-day rainfall events from 38 years of data recorded at the Atia station, Tangail. June rainfall will generally be adequate to recharge the profile (20-day total will be in excess of 120 mm in 4 out of 5 years). Rainfall in excess of evapotranspiration plus percolation is needed for land preparation and transplanting. Assuming 4-mm daily evapotranspiration and 1 mm of percolation, a minimum average of 5 mm per day is needed. This condition is satisfied in 4 out of 5 years during July. Land preparation for Aman paddy can take place from late June/early July onwards.



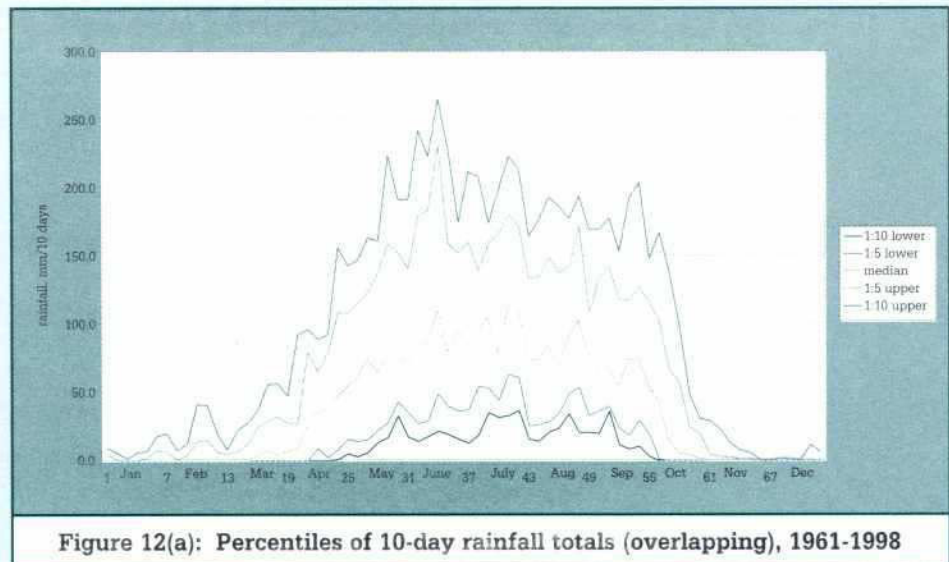


Figure 12(a): Percentiles of 10-day rainfall totals (overlapping), 1961-1998

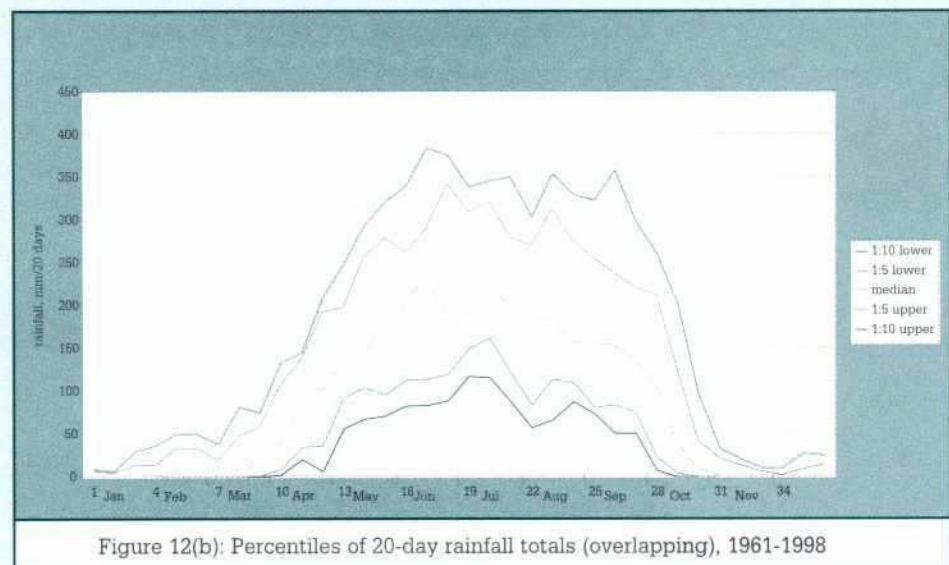


Figure 12(b): Percentiles of 20-day rainfall totals (overlapping), 1961-1998

In the first part of August a temporary shortfall in rainfall may occur in 1 out of 5 years, with less than 25 mm in 10 days and less than 80 mm in 20 days (12 a and b)<sup>1</sup>. Field water levels may then fall below the surface. Water intake into the compartment should be considered when this occurs, but water control is insufficient for supplementary surface irrigation in the higher lying areas.

<sup>1</sup>note that the frequencies in the figures are only valid for the individual 10 or 20 day periods and may not be added; two successive low points in the graph does not mean that they will occur in the same year

Water shortages can be expected more frequently from early October onwards. In the first 10-day period of October, the probability of 10-day rainfall below 50-mm reaches 50% and drought risk increases steeply afterwards. In most years, the paddy fields will, therefore, start drying in the course of October. Water intake at that time is impossible in most years. Late planted Aman will often suffer from drought in October and November and in some areas supplementary groundwater irrigation is provided. Closing the outlets on the Lohajang may help in conserving moisture.

In summary, water can be taken in August for supplementary irrigation in some areas, and the outlets should be closed in October. Field-level rainwater storage may be improved by proper bunding of the fields. Supplementary groundwater irrigation should be considered in some years in October.

#### *Land Inundated to 30-90 cm*

There is little risk of drought in this land, but inundation in most years will be too deep for growing short straw HYV varieties of Aman. Farmers must decide early in the season whether to grow DW-Aman or a T-Aman variety that tolerates some degree of inundation, such as Pajam.

#### *Land Inundated to 90-180 cm*

DW-Aman will be broadcast if the fields are not too wet in June or transplanted in June or July. With the outlets on the Lohajang open, water levels will not increase too steeply, except in some low-lying areas with local drainage congestion, in which case the land remains fallow. Once the crop has grown to its maximum height, water levels should not decrease too much; otherwise, the straw may collapse. In the first part of August, this may sometimes happen, in which case farmers will ask for water. Taking in water and guiding it to the lower-lying areas should be considered. It will also allow upstream farmers to use some of the water for their higher lying field. Temporary closure of some of the outlets may also be considered for example the Bhatkura outlet that drains a major part of Cluster 3.

In early October, water levels will start declining and closing the outlets on the Lohajang should be considered. In most years, this will have no negative effects for the higher lands. In fact, it may help to maintain field water levels there as well by decreasing drainage outflows. By late October or early November, the gates can be opened again to drain all the land for the Boro season.



29 0

In summary, the following broad strategies would result in favorable conditions for agricultural land use:

- Overall water management is based on scenario 4, i.e. maximum monsoon drainage through the Lohajang and all the peripheral inlets routinely closed,
- When drought occurs in early August, water is taken in through peripheral inlets and through the outlets by opening the main regulator partly or completely. The water is channeled to lower lying DW-Aman areas but it can also be used for supplementary irrigation in higher places where the water can reach. Drainage outlets such as Bhatkura may be temporarily closed to conserve water in low lying areas,
- Early October the outlets on the Lohajang can be closed in most years to reduce drainage and conserve moisture for the T-Aman and DW-Aman crops, and
- By late October or early November all the drainage outlets are opened to drain the land for Aman harvest and preparation for the Rabi season.

It is unnecessary to develop guidelines that are more precise. There are many imperfections in the system: drainage in many areas is sub-optimal resulting in local water congestion and it is difficult to predict water flows precisely at any time. Also, there will be conflicts of interest between different groups that have to be resolved at the local level. CPP has initiated a system of operation based on consultation by the water management committees at different levels, as discussed in Annex-D (Institutional Development) This should gradually lead to a system which finds the best compromises under given circumstances.

#### *Verification: the 1999 Monsoon Season*

The 1998 flood showed that it is risky for farmers to bet on optimum water management conditions for monsoon cropping. Wet conditions in July led to delays in Aman planting which was then prevented by the flooding in the following months, especially in the low-lying clusters. Consequently, there was a shortfall in planted Aman of about 50%, compared with 1997. Furthermore, part of the planted Aman was lost.

During the 1999 monsoon, farmers made more conservative cropping decisions, resulting in a considerable shift towards more DW-Aman and less local T-Aman (table 6). Therefore, conditions were considered too dry by farmers in most parts of the compartment. A survey conducted during the 1999 monsoon showed that farmers considered the water levels as more or less adequate for HYV T-Aman, while for local



29  
T-Aman they were considered somewhat too low (6-11 cm). In Clusters 3 and 4, where DW-Aman was the dominant Aman crop, the perceived shortfall for DW-Aman was considerably higher, viz. 22-28 cm.

The actual gate operations during the monsoon showed that the Bhatkura outlet was kept closed from the last week of July until August 21, when it was opened to take in water from the Lohajang. The main regulator was fully or partially open throughout the monsoon. This apparently was not sufficient to satisfy the needs of DW-Aman in cluster 3, where most of this crop was grown. The Water Management Section addressed the question whether the situation could have been improved by operating the structures in a different way by modeling the 1999 situation. The results are given in Annex-B.

#### *Operational Bandwidth for Water Management*

The 1999 situation shows that the maximum drainage scenario (scenario 4) was too dry for that year. Farmers had opted for more conservative land use than in previous years and consequently requested more water, especially in the lower lying parts of the compartment. It also shows that gate operations cannot be fixed *a priori* but should be determined in the course of the season according to the cropping choices farmers have made. It seems likely that in the coming few years, if no further major floods occur, land use will gradually return to the pre-flood situation and more drainage will be required than in 1999.

Rather than fixing target gate settings, an operational bandwidth was developed by the Water Management Section for some of the major structures including the main regulator, corresponding with the range of likely land use patterns in the coming years. Scenario 4 is driest extreme of the range. The wettest extreme corresponds with the land use observed in the compartment in 1999 (see Annex-B).

Generally, the experiences show that effective operation of the infrastructure needs a learning process of all parties involved. Every year will present a different picture, not only in terms of hydrological conditions, but also in respect of farmers' cropping choices. Farmers' opinions on the adequacy of water levels in the *chawks* for the different Aman crops should be monitored. This may be done by the DAE Block Supervisors using the simple format used by the Agriculture Section in 1999. The learning process should be assisted by modeling, which allows to analyze the actual operations and their consequences in a particular year. The results can then be used to update and refine the operational guidelines.



## Conclusions and Lessons Learned

In Bangladesh land is classified in terms of maximum flooding depth with 1 in 5 years return periods. Farmers use a classification (*Tan*, *Patchot* and *Dopa*) reflecting suitability of the land for particular crops and cropping patterns, which is also closely related to expected flooding. In the compartment, farmers classify more land, as *Tan* and *Patchot* than would be expected from the modeled 'without project' situation. This may be due to project interventions, although the time since completion of the infrastructure appears too short for a permanent change in farmers' perception. Another factor may be that the model simulation did not consider duration of flooding. In future simulations, land types should be defined by inundation depths over a longer period, e.g. 2 days. In a future project, land types should be mapped based on farmers' own classification, in addition to classification based on (simulated) maximum flooding depths. This will allow more precise monitoring of land use changes.

Land use in the compartment is more intensive and more productive than in Kalihati Thana, which is most similar and the compartment provided much better protection against the disastrous flood of 1998. The more productive land use is partly due to the presence of the horseshoe embankment and partly to better drainage. After the flood, the HYV area in the compartment returned to the pre-flood level immediately, whereas in Kalihati there was still a shortfall in 1999 as compared to 1997. This testifies to the confidence of farmers in the compartment that it is safe to grow flood-sensitive modern *Aman* varieties in *Tan* and the higher reaches of *Patchot* land.

The most significant trend in *Rabi* cropping has been the increase in mustard and *Boro* paddy. Most of the recent increase in *Boro* production was in the higher lands where new STW have been installed, at the expense of jute and sugarcane. *Boro* yield has increased significantly, from about 3.5 t/ha in 1995 to about 6 t/ha in 1999, both in the compartment and in Tangail Sadar and Kalihati Thana. It remains to be seen whether the combination of extended area and high yield can be maintained in the coming years. In particular the effect of increased extraction of groundwater on groundwater levels must be closely monitored.

There has been a clear increase in annual cropping intensity in the compartment since 1996, from 181% in 1994 to 214% in 1999, which may be attributed mainly to more favorable drainage conditions in the compartment. The increased cropping intensity has mainly resulted from shifts in the *Boro*-based system from double to triple cropping and to a lesser extent from single to double cropping.

296

A modified 'maximum drainage' scenario will be appropriate for areas where T-Aman is the main monsoon crop. In some of the lower lying areas, however, farmers continue growing DW-Aman extensively and maximum drainage is not to their advantage. The CPP infrastructure should be operated in such a way that, while aiming at maximum drainage for most of the compartment in most years, the DW-Aman growing areas can obtain and hold sufficient water for this crop. Operational guidelines have been developed which specify ranges of target water levels for some of the major structures, rather than fixed levels. The guidelines need testing and revision through a number of years of learning by doing, assisted by computer modeling and monitoring of farmer assessment of water conditions in their *chawks*.



# Exploring New Options for Agricultural Production

During both project phases, CPP has promoted improved crop production practices that would enable farmers to benefit from the improved water management conditions in the Compartment. During the first phase, a conventional paddy variety demonstration program was carried out by DAE with CPP support, as well as an IPM training program through IPM field schools. In 1997 a more participatory On Farm Testing and Demonstration (OFTD) program was started in four pilot *chawks*. DAE continued its variety demonstrations on a smaller scale. Results from both programs are discussed below.

## Demonstration of Improved Aman Varieties, 1993-1997

Improved monsoon paddy varieties were demonstrated across the compartment from 1993 to 1997. In many cases, supplementary irrigation was provided in October, especially in the medium high land plots. Yields in the demonstration plots are shown in Table 12.

Variety	Yield <sup>1</sup> , t/ha	Growing cycle <sup>2</sup>	Number
BR30	5.62a	116	17
BR22	4.19b	96	63
BR11	4.07bc	108	20
BR25	3.20c	103	10
Overall mean	4.30	102	110
Table 12: Mean yields (t/ha) of improved varieties in 110 demonstration plots, 1993-1997			

<sup>1</sup>yields of varieties with the same letter are not significantly different; those with different letters are significantly different at the 5% level (LSD test).

<sup>2</sup>days from transplanting to harvest.

On average, BR30 yielded better than the other varieties, while BR25 yielded significantly less than BR30 and BR22. BR30 matured considerably later than the other varieties. A more detailed analysis (Table 13) showed that mean yields in medium high land were about 0.5 t/ha higher than in medium low land and almost 1.5 t/ha higher than in low land. Supplementary irrigation increased yield by about 1 t/ha.

Irrigation	Low	Land type	
		Medium low	Medium high
No	2.72 (6)	3.57 (19)	4.10 (47)
Yes	-	4.72 (7)	5.26 (31)
Table 13: Mean yields (t/ha) in demonstration plots with and without supplementary irrigation in different land types, 1993-1997 (nr. of plots between brackets)			

876

The results show the potential importance of supplementary irrigation. The frequent occurrence of October drought and the increasing importance of T-Aman HYV will make supplementary irrigation increasingly desirable. In the last few years, there is a slight increasing trend in supplementary irrigation, which may accelerate with the recent strong increase in installed irrigation equipment.

In 1997, an adoption survey was conducted among the 30 demonstration farmers of 1996. Out of the 12,300 kg of paddy produced in the demonstration plots, 4,200 kg was kept or sold as seed for the next season, i.e. 35%. The survey showed further that 70 kg of seed kept by the farmers eventually resulted in 1 ha of transplanted paddy, because farmers always establish seedbeds in excess of the theoretically needed for risk reduction. Each demonstration plot thus resulted in about 2 ha planted to the demonstrated variety in the next year. In following years, the multiplication rate will go down, but even if only 10% of the paddy is used for seed in the next 3 years at a modest yield of 2.5 t/ha, enough seed would have been distributed from 30 demonstration plots to plant 2,700 ha of HYV in year 4 after the demonstration. Thus, the potential expansion rate is high and the 110 demonstration plots sponsored by CPP between 1993 and 1997, scattered over the compartment, should have exposed the farmers sufficiently to new genetic material to satisfy their demand. It also demonstrates that:

- A rapid increase in HYV as occurred in the Compartment between 1991 and 1997 (Table 6) can take place entirely through farmer-to-farmer seed exchange after introduction through demonstration plots, properly scattered over the target area,
- A new superior variety can reach considerable dissemination in a few years if the variety is demonstrated in a sufficient number of scattered demonstration plots for a few years; tentatively, a density of 1 demonstration for every 100 of (potential) T-Aman area would appear to be adequate.

The size of the DAE variety demonstration program was decreased after CPP to a total of 18 demonstration plots in the Compartment. This number is probably insufficient for rapid dissemination of a promising new variety.

### **The On-Farm Testing and Demonstration Program, 1997-2000**

#### *The Participatory Rural Appraisals*

PRAs were conducted in the four pilot chawks in 1997 and 1998. The following categories of technologies were proposed and reviewed with the farmers, taking into account the identified constraints:



- *Improved varieties for T-Aman.* Growing conditions vary greatly from place to place and from year to year. Varieties should tolerate occasional inundation as well as drought at the end of the season. Tolerance to seedbed duration exceeding 60 days is needed in view of delayed transplanting in very wet years. Early maturing varieties for late transplanting would be useful.
- *Improved varieties for Boro.* Medium straw length is preferred and varieties must be tolerant to long seedbed periods,
- *Alternative crops for jute.* Apart from home use, growing jute is unattractive because of its consistently low market price. Alternative cash crops are wanted for the *Kharif-I* season, especially in *Tan* land. The following potential crops were listed: mungbean, eggplant, amaranth, Indian spinach, okra (lady's fingers), cocoyam
- *Alternative crops for Boro.* Boro is used partly as a cash crop. When Boro and Aman yields are high, the price of paddy is low. Improved water management is expected to boost *Aman* production, which is an argument to explore alternative irrigated cash crops for part of the *Boro* area. Irrigation need would be substantially lower. Possible crops are: onions, garlic, tomatoes, and groundnuts, summer vegetables such as cabbage. Since these crops have a shorter life cycle than Boro, there is room to relay a green manure crop such as *Dhaincha* (*Sesbania*) or a *Kharif-I* crop such as Okra,
- *Multi-purpose legumes.* The role of legumes in the cropping pattern has declined with the introduction of *Boro* paddy. Legumes are needed, which fit in one or more of the patterns and produce a product for human and animal use, in addition to bringing nitrogen into the system,
- *Composting of water hyacinth;* water hyacinth may be turned into a resource if it can be composted and used in vegetable and paddy growing, and
- *Integrated Pest Management;* intensification of paddy production will increase pest pressure. Adoption of IPM as a result of phase I field schools was investigated, prior to further interventions in this area.

#### *Tests and Demonstrations*

In 1997, the first tests were carried out with improved *Aman* varieties in *Chawk 3F*, where the first PRA had been completed. In the following two years, tests and demonstrations were carried out in all four pilot *chawks* and in all three seasons with a range of technologies, as shown in table 14.

397

year	Rabi	Boro	Kharif-I	Kharif-II
1997				- Aman varieties
1998	- Mustard variety		- Okra, alternative for jute	- Aman varieties
	- Composting		- Indian spinach, ibid.	
			- Jute varieties	
1999	- Mustard variety	- Boro varieties	- Okra, alternative for jute	- Aman varieties
	- Use of compost	- Onion, alternative for Boro		- Compost use
2000		- Onion - Okra		

Table 14: Overview of on-farm tests and demonstrations conducted in the 4 pilot chawks, 1997-2000

#### Improved Mustard, Rabi Season

*Tests and demonstrations.* After the 1998, flood the land became available for *Rabi* cropping much earlier than usual, which allowed farmers to grow a later maturing and more productive mustard variety. It was, therefore, decided to demonstrate the high yielding variety BARI-7 in the pilot *chawks*, compared with the local variety *Tori-7*. The plots were entirely farmer-managed and only seed of the new variety was provided. Sixty-six farmers participated with results as shown in Table 15.

Chawk	Variety	number of plots	Growth duration	Yield, t/ha
3F	BARI-7	17	92	1.32
	Tori-7	17	73	0.71
11J	BARI-7	17	93	1.33
	Tori-7	17	72	0.73
19E	BARI-7	19	88	1.28
	Tori-7	19	78	0.64
28C	BARI-7	13	91	1.28
	Tori-7	13	72	0.81
All	BARI-7	66	91	1.33
	Tori-7	66	74	0.72

Table 15: Yield (t/ha) and growth duration of two mustard varieties in on-farm demonstrations

The yield of the improved variety was almost double that of the local, with the same inputs. Its major disadvantage was its lateness which would interfere with timely *Boro* planting in normal years, except where *T-Aman* is planted early and/or an early maturing *T-Aman* variety is used.



*Adoption and constraints.* After the tests, a survey was carried out to examine the adoption rate of the new variety, from seed kept from the previous year and through seed exchange. Only about 20% of the farmers planted the BARI-7 variety again in 1999, in spite of the impressive results in 1998. The following reasons were given by farmers for not replanting:

- Late harvest of the 1999 T-Aman crop did not allow room for a late maturing mustard variety to be grown before Boro,
- The market price of BARI-7 was lower than for the local variety, and
- Seed viability of BARI-7 declined more rapidly than that of the local variety under local storage conditions.

These observations show that a future dissemination program should emphasize early maturing varieties (80 days or less). There will only be a small niche for a late maturing variety such as BARI-7. Special attention should also be paid to seed viability and seed storage.

#### *Boro Varieties*

**Tests and demonstrations.** In 1999, the area under Boro increased considerably, compensating for the Aman crop lost due to the 1998 flood. This once more showed that the cropping system is an integrated system: events affecting one part of the system affect other parts as well. Since farmers had requested improved Boro varieties, the OFTD team decided to conduct a simple farmer-managed demonstration with two improved varieties, in comparison with IR8, which is the standard in the area. The results are shown in Table 16.

Variety	Variety								Mean <sup>2</sup>		
	3F		3F		19E		28C				
	Nr	yield	Nr	yield	Nr	yield	Nr	yield	Nr	yield	cycle <sup>2</sup>
BR-29	9	7.33	9	7.30	15	7.35	15	7.19	31	7.29a	106
BR-26	11	6.95	6	6.77	9	6.99	5	7.18	48	6.96b	92
IR8	20	5.69	15	5.31	24	5.51	20	5.40	79	5.49c	103
Mean		6.41		6.20		6.36		6.29		6.33	

Table 16 : Yield (t/ha) of two Boro paddy varieties, compared with the local standard (IR8) in on-farm demonstrations, 1999

<sup>1</sup>yields of varieties followed by the same letter are not significantly different

<sup>2</sup>days from transplanting to harvest

892

Boro yields in 1999 were generally above average. In fact, the compartment-wide average was even higher than the IR8 yield in the tests (Table 16). This is probably due to under-representation of early-planted fields in *Dopa* land in the tests. Both BR varieties produced consistently better than the old IR8, but BR26 is the more interesting one because of its early maturity. It should be kept in mind, however, that the new varieties remained in the seedbed for 55 days, while the average for IR8 was 86 days.

*Adoption and constraints.* Nothing can be said about adoption yet, but the experiences with the earlier *Aman* demonstrations have shown that farmer-to-farmer dissemination can be rapid. Unfortunately, the issue of seedbed duration was not addressed. *Boro* seedbeds are generally established in November or early December when there is still enough moisture in the fields, while transplanting is done in January and February. Farmers should have sown the seedbeds of the improved varieties together with the local check for valid comparison. A suitable *Boro* variety must tolerate late seedling transplanting; otherwise, it is less suitable.

#### *Alternative Crops for the Boro Season*

*Tests and demonstrations.* In 1999, onions were tested as an alternative for *Boro* paddy with 7 farmers. The test was a failure with all yields being below 0.5 t/ha. This was due to the following factors:

- The onion variety used was a 'winter variety', which must be planted in December, while the intention was to use a summer variety, which was not available,
- The OFTD team insisted that the onions be planted at the same time as the *Boro* paddy, in spite of farmers' warning that this was too late. If the onions had been planted two weeks ahead of the *Boro*, the results might have been better, and
- The OFTD team purchased onion seedlings from BADC instead of providing seed for farmers to grow their own seedlings. This resulted in further delays.

The failure of the tests, therefore, neither proved nor disproved the feasibility of growing onions, it rather demonstrated that the tests were not conducted as a farmer led activity. Therefore, a new test is being conducted in 2000 with 8 farmers. They were given onion seed and raised their own seedlings in November for planting in December. All nurseries looked excellent. Irrigation will be applied as needed. Once the onions are nearing harvest in March, farmers will have the option to relay Okra into them after applying a final irrigation. They may produce their own seed for next year, since seed supply is not assured. In the past, farmers in the area did produce their own onion seed and the skills are still available locally.



### *Jute and Alternatives, Kharif-I Season*

*Tests and demonstrations.* Two species were chosen by farmers as possible alternatives for jute, viz. okra or lady's finger (*Abelmoschus esculentus*) and Indian spinach (*Basella Alba*). Besides, farmers requested tests with new jute varieties. Three tests were conducted in 1998 in the two pilot *chawks* where jute is grown extensively (3F and 28C):

- Comparison of the virus resistant BARI *Dherosh-1* variety of okra with jute,
- Comparison of Indian spinach and stem amaranth with jute, and
- Comparison of two improved jute varieties with the local.

The results with Indian spinach and amaranth were disappointing in terms of benefit. They cannot be considered as alternatives for jute. The improved jute varieties did not produce significantly better than the local did. No further work was, therefore, carried out with jute varieties, Indian spinach and stem amaranth. The okra tests were repeated with different farmers in 1999. Yields and net benefits for both years are shown in Table 17.

Okra appeared to be attractive as an alternative for jute. The results were similar in both years, but jute yields were considerably higher in 1999. Farmers confirmed that 1999 was generally a very good jute year. After maturity, the okra stems were retted and a good glossy fiber was produced. Whether okra fiber as an additional product is a feasible option depends on timing. If the okra is planted early enough, mature fiber may be produced in time before T-Aman planting.

Crop	Chawk	nr. of farmers		Yield, t/ha		Net benefit, Tk/ha	
		1998	1999	1998	1999	1998	1999
Okra	3F	17	6	7.93	7.94	27,857	42,452
	28C	17	8	5.28	3.77	14,474	68,317
	11J		9	-	5.33	-	22,202
	19E		4	-	3.92	-	18,289
Jute	3F	14	5	1.47	2.11	36	11,661
	28C	14	5	1.50	2.57	- 497	13,481
	11J		6	-	2.45	-	16,881
	19E		-	-	-	-	-
Table 17: Mean yields (t/ha) and net benefit (Tk/ha) of okra and jute in on-farm tests, 1998Kharif-I season							

Note : - = Data not available



272

*Adoption and constraints.* An adoption survey was carried out in 1999 with the following results:

- In *chawk* 3F, 12 out of the 17, 1998 growers planted okra again in 1999. An additional 4 farmers planted a mixture of BARI-1 and local seed. Part of the seed was purchased immediately after the harvest by a former CPP staff for distribution through a local NGO.
- In *chawk* 28C only 3 out of the 12 original growers planted okra again in 1999. The reason was said to be the priority given to *Boro* because of the 1998 flood damage. In addition, most of the seed was purchased by the same NGO.

Three technical problems were observed: (i) timely planting, (ii) seed deterioration in storage and (iii) top borers (*Earias sp.*). Earlier planting of okra would require a preplanting irrigation. Seed deterioration will require some simple storage tests with farmers. Top borers are probably a problem which farmers have to live with, although some IPM methods may be tried.

The conclusion is that okra could be an attractive alternative for jute, but the above mentioned problems must be addressed. If the crop can be relayed into an early Rabi onion (or tomato) crop as discussed above, an attractive combination would result.

#### *T-Aman Varieties, Kharif-II Season.*

*Tests and demonstrations.* A number of recently released varieties were tested in 1997, 1998 and 1999. In 1997, the tests were largely managed by the field staff but in the following two years the tests were fully farmer-managed. No inputs were provided except seed. A summary of the test results is shown in Table 18.

In 1997, BR25 and BR31 were less productive than the other varieties, including the local standard HYV, BR11. More detailed analysis showed that in Tan land, where supplementary irrigation was applied, BR31 produced significantly less than all the others. In the Patchot fields, without irrigation, BR11 and BR25 produced significantly less than the other 3 varieties. Based on this test, only BR30 and BR32 were retained for further testing and demonstration.

In 1998, the year of the flood, none of the test plots in *chawks* 11J and 19E survived, while in 28C and 3F respectively 75% and 40% were damaged. Average yield of the remaining plots was almost 1 t/ha higher in 3F, where some of the higher land was not or only shortly inundated. Yields of all three varieties were practically equal in 28C, while the yields of BR30 and BR32 were almost 800 kg/ha higher than that of BR11.



202

variety	1997		1998		1999		mean cycle
	yield	nr	yield	nr	yield	nr	
BR 25	3.38	11	-	-	-	-	99
BR 30	3.94	11	3.57	30	5.06	9	99
BR 31	3.40	11	-	-	-	-	97
BR 32	3.92	11	3.52	30	4.95	70	96
BR33	-	-	-	-	4.89	20	85
BR 11	3.60	10	3.05	23	4.83	33	101
local	-	-	1.76	6	2.12	28	
nr. test plots							
damaged		1		144		10	

Table 18: Yields of T-Aman varieties in on-farm tests in pilot chawks, 1997 - 1999

Note : - = Data not available

In 1999, the yields were considerably higher than in 1997 and 1998. The differences between the varieties were not significant. Most farmers applied between 130 and 180 kg/ha of Urea, while some did not apply fertilizer. On average, fertilizer application resulted in an additional yield of about 700 kg/ha. The fertilizer effect is partially confounded with the *chawk* effect, as most of the farmers who did not apply fertilizer were in *chawk* 19E, which had the lowest overall yield. If this factor is taken into account, the fertilizer effect will even be lower. None of the farmers applied P or K. In view of the P-status of the soils this may explain the disappointing urea effect. There is need for some simple P response tests to quantify the importance of P.

The newer HYV did not show a convincing yield advantage over BR11. The major advantage of especially BR33 is its early maturity without sacrificing yield. It therefore fits very well in the system that is moving towards more intensive three-crop patterns.

*Adoption and constraints.* It seems likely that BR33 will be appreciated by the farmers, for its earliness, which should be verified next year. The variety should be demonstrated by DAE across the compartment. The other BR varieties are also being promoted by DAE in replacement of BR11, because of BR11's sensitivity to diseases and pests. More attention is needed for nutrient responses in HYV T-Aman as well as in Boro.

#### Composting

Infestation of Dopa land and open water by water hyacinth was one of the constraints raised by farmers during the PRAs. The idea was raised to introduce composting of

276

water hyacinth and other organic material. Composting of water hyacinth was tested as a source of income for landless women during phase I (in 1994) but failed because there was no demand. The target group for this new attempt was farmers, who could use the compost on their own vegetable and paddy crops. The large number of participants in the initial training (134, of which 83 were male and 51 female) showed that farmers found the idea interesting.

Initially, a single large pit was used in the tests, later changed to a three-pit cascade system, each pit measuring 1.5 x 1 x 1 m. The first 8 pits were made with CPP financial assistance in 1998, later 8 more were established by farmers themselves without further financial assistance. A further 36 were established in 1999, bringing the total to 52.

*Adoption and constraints.* Water hyacinth turned out to be less of a problem than originally thought. Most of it is worked into the soil in Boro fields. Nevertheless, farmers felt that the pits were useful for disposing of crop residues and households refuse. Some commented that composting was common in the past but had been abandoned with the arrival of fertilizer. The practice may be revived, especially for use of the compost on vegetables. Simple demonstrations should be initiated by DAE and the active adoption by non-participants in the program should be monitored.

#### *IPM*

Integrated pest management was introduced in phase I as a mitigation measure for the expected increase of insecticide use. An adoption survey in 1998 with 30 of the 180 farmers from phase I showed that only 3% continued using light traps, 57% practiced insect netting, while 93% used perching, which is the simplest method for farmers to use. 100% said they also destroyed insect eggs, but this is difficult to assess. In 1999, a new round of field schools was conducted during the Boro season with 120 farmers in the four pilot chawks.

*Adoption and constraints.* The adoption rate of some elements of IPM due to the Phase I field schools was satisfactory. Especially perching is a reasonably effective method of insect control, which is cheap and easy to use. Nevertheless, and in spite of DAE's adoption of IPM as an important extension message, massive adoption has not been observed so far in the compartment. A more systematic investigation of the reasons for the apparently slow adoption is needed.




## Conclusions and Lessons Learned

The demonstrations and the OFTD program have shown that there is good scope for participatory technology testing and demonstration in a project like CPP. The earlier T-Aman variety demonstrations contributed to their rapid dissemination. Time has been too short for the program to have a major impact across the compartment, but some promising directions have emerged which should be pursued further:

- Simple farmer-managed tests can quickly identify suitable T-Aman varieties, both for early and late planting. So far only BR33 had a definitive advantage over BR11, because of its earliness,
- There is a niche for high yielding, late maturing mustard varieties such as BARI-7, but adoption will be limited; earlier maturing varieties should be identified,
- Feasibility studies should continue with irrigated onions and possibly tomatoes relayed with okra, as an alternative for Boro; farmers themselves may come up with other innovative ideas,
- Okra planted early in the *Kharif-I* season, possibly with one pre-planting irrigation, appears to be a good alternative for jute and should be disseminated by DAE. Early onions relayed with okra appears an excellent combination for further onfarm testing,
- Farmers have responded well to double or triple pit composting, using water hyacinth, kitchen refuse and other materials; active adoption and farmer-to-farmer dissemination must be assessed and wider demonstration by DAE should take place, and
- The minimum density of demonstration plots for rapid farmer-to-farmer dissemination of improved varieties and other technologies should be verified to optimize the impact of demonstration programs.

The program has also shown the importance of following up on issues that emerge during testing. A new technology will always generate new questions and reveal constraints to adoption that need to be addressed. Intensive dialogue with farmers is the best way to obtain their views on what is needed for a technology to be adopted. Examples of new issues that arose from the OFTD program were:

- The need for proper on-farm seed production and storage of okra and mustard to prevent early loss of viability,
- The importance of pre-planting irrigation of okra for early planting,

- 
- The need for attention to seedbed duration of *Boro* and *T-Aman* varieties,
  - The need for simple nutrient response tests, especially with P, and
  - The need for explaining the slow adoption of perching as an IPM method, in spite of its simplicity and ease of use, in order to improve on the technology.

Truly participatory methods are essential to assist farmers in the search for new more productive technology. Such methods require a change in attitude and a willingness to treat farmers as partners, rather than as passive consumers of the extensionists' 'wisdom'. CPP staff and BARI scientists had difficulty adopting this attitude and, although much progress was made, the program at times remained prescriptive and top-down.

Once a promising technology has been identified, it should be further disseminated by the regular extension service. For this to happen, it is crucial that the extension service themselves are closely involved with the project from the start.

The BWDB has reached an agreement with BARI to continue the OFTD program after the end of the project. It is essential that the lessons learned so far are applied in the follow-up program.



## Future Trends

The observed trends in land use and production in the compartment were used to develop a vision of likely future developments. The predictions are necessarily hypothetical in that they extrapolate past developments, which may be broken by unexpected events. The key observations on which they are based were the following:

- There has been a clear intensification of the annual cropping intensity in terms of the number of crops grown annually, from 181% in 1994 to 214% in 1999 (Table 9), interrupted by a fall in 1998 due to the flood,
- High yielding *Aman* varieties have been adopted for monsoon cropping in those part of the compartment where conditions are favorable; they now occupy about 25% of the net cultivable area, and
- Total output has increased significantly through the increase in cropping intensity, the shift to higher yielding T-*Aman* varieties as well as an increase in Boro yields. The yields of the other crops have remained largely unchanged.

The question is now what is required for these trends to continue in the coming years.

*Annual cropping intensity.* There remains scope for further intensification, provided operation of the infrastructure continues to favor good drainage in the pre- and post-monsoon, as well as during the monsoon for those areas which are most suitable for HYV of *Aman*. The lower lying areas, especially in clusters 3 and 4, will continue to prefer DW-*Aman* and gate operation should accommodate more water there while favoring drainage in other areas. It is expected that cropping intensity in that case may increase to a maximum of 220%.

*Increase in Rabi and Kharif-I crop areas.* Jute and sugarcane will probably stabilize at 1,500 and 500 ha respectively, unless attractive alternative crops take their place. The ceiling for Boro paddy will be around 7,000 ha, a level which has already been attained in 1999.

*Increase in HYV area in the monsoon.* Considering the trends so far, it is expected that the maximum area used for T-*Aman* will stabilize at around of 5,000 ha. The experiences of 1999 show, however, that it may decrease to a lower level if the compartment's infrastructure does not provide reliable protection in the future. Under continued protection and adequate infrastructure operation, the area under HYV T-*Aman* may eventually reach 3,000 ha.

*Crop yields.* Crop yields have not increased systematically, except for *Boro* paddy. Yields of other crops are quite low, but increasing them will require progress in the area of input supply, better-adapted fertilizer recommendations and probably supplementary irrigation.

*Crop diversification.* There is good scope for crop diversification, especially during the Rabi and Kharif-I seasons. The area appears to be particularly suited to intensive vegetable production with irrigation. This would be partly in competition with *Boro* and with jute. An OFTD program should emphasize this area.

#### *Future Cropping Patterns and Yields.*

The trends discussed above are summarized in Table 19. They do not make excessive claims that are not substantiated by the data, but they depend on continued functioning of the infrastructure and the further participatory development of operational procedures.

Cropping patterns			Projected areas		projected	
Rabi	Kharif-I	Kharif-II	ha	%	Crop	yield(t/ha)
Sugarcane	Sugarcane	Sugarcane	500	5	wheat	2.2
Rabi crops	jute	fallow	250	2.5	mustard	0.9
Rabi crops	jute	T-Aman	1,250	13	Boro	5.0
mustard-Boro	Boro	T-Aman	2,500	25.5	Jute	1.8
Boro	Boro	T/DW-Aman	3,000	31	T-Aman (L)	1.8
Boro	Boro	fallow	1,500	15.5	T-Aman (HYV)	2.8
					DW-Aman	1.5
minor patterns			763	7.5	Sugarcane	35
annual cropping intensity, %				220		

Table 19: Projected future cropping patterns and crop yields in the compartment



## Appendix 1

## Methodological Notes

### *Monitoring plots*

The yield data collected by CPP in the monitoring plots were based on farmer recall. The accuracy of farmer recall data for Aman paddy was verified in 1997 and 1998, by comparing yield estimates from farmers' recall with crop cuts (table A-1.1).

paddy type	1997		1998	
	measured	Farmer recall	measured	Farmer recall
T-Aman (L)	1.56	1.35	1.93	1.67
T-Aman (MV)	2.99	2.50	3.10	3.23
DWT-Aman	1.56	1.52	1.53	1.25
B-DW Aman	0.98	0.88	1.03	0.93

Table A-1. 1: Yield estimates (t/ha) of monsoon paddy based on crop cuts and farmer recall, 1997 (26 fields) and 1998 (20 fields)

The farmer estimates were consistently lower by about 10 %, except for T-Aman (HYV) where the farmer estimate was slightly higher.

### *DAE Data on Yields and Cropping Areas*

Routinely, DAE's Block Supervisors (BS) collect information on crop areas from a sample of farmers in their block, based on recall and on 'visual estimation'. They carry out crop cuts for yield measurement in 3 fields per block for each crop ('good', 'medium' and 'low' yielding plots). DAE information was used for comparison of crop areas and yields inside and outside the compartment. The quality of the DAE data was assessed against those collected by CPP by identifying the extension Blocks inside the compartment and obtaining the corresponding area and yield from the DAE records. In the CPP area, which represents about 40% of the area of Tangail Sadar Thana, there are 30 extension Block Supervisors (BS), each covering an average of 2-4 *chawks*.

### *Comparison of Area and Yield Data from LUS, MP and DAE*

In order to compare the DAE figures with those of the project, the crop areas and yields measured in each block inside the compartment were obtained from the DAE records. The crop areas reported for each block were multiplied with the fraction of the block that belongs to the compartment. This allowed calculation of crop areas and yields for the compartment, according to DAE raw data and comparison with CPP results from the land use surveys (LUS) and the monitoring plots (MP).



### Monsoon Crop Areas

The crop areas estimated in a number of years from DAE, LUS and MP data are shown in Table A-1.2. Generally, the differences between the data sets are large. Especially the large differences for T-Aman and DW-Aman between the MP and the LUS are conspicuous. Therefore, an analysis was carried out by the GIS Section to examine whether there was a bias in the location of the MPs. It was found that lower lying fields were over-represented: there were 30% more plots in the lower strata than there should be if their number were proportional to the overall areas in different elevation classes in the compartment. The deficit is mainly found in the higher class, the intermediate altitude plots being more or less proportional. This means that the area under DW-Aman will also be over-estimated by some 30%, while T-Aman (HYV) will be under-estimated by the same percentage, since it is mainly grown in higher places, and T-Aman (L) by some 15%. The MP bias will also result in an under-estimation of jute, wheat, sugarcane and potato areas by some 30%, since they are grown in the highest locations only. As regards Boro, up to 1999 this crop was grown mainly in the lower and intermediate land types and to a lesser degree in the higher land. In 1999, the area expanded especially in the higher areas. The MP bias would, therefore, not be as important as for Aman, but may still have been in the order of 10% in the years reported in Table A-1.2.

The land use data collected through the LUS should be reliable for *Kharif-I* and *Rabi* season. It is difficult, however, to obtain an accurate estimate of DWT-Aman and DWB-Aman areas during the monsoon, because the two may be confused from a distance. The distinction between T-Aman (L) and T-Aman (HYV) on the other hand is more obvious in the field. So some degree of over-estimation of T-Aman (L) cannot be excluded.

If the MP data are adjusted with the percentages indicated above, the estimated areas of Table A-1.3 are obtained. There remain deviations between LUS and MP, but the differences are now much smaller. In chapter 4, the averages between the LUS and the adjusted MP data will be used to analyze the time trends in crop areas when both are available. Otherwise, the adjusted MP data are used.

The quality of the DAE data for crop areas looks reasonably accurate. DAE data were, therefore, used to compare trends in crop areas inside and outside the compartment.

	(a) Pre-monsoon										
	Boro			Jute			Sugarcane			Total <sup>1</sup>	
	LUS	MP	DAE	LUS	MP	DAE	LUS	MP	DAE	LUS	DAE
1995	-	6,464	5,576	-	1,430	1,805	-	1,156	979	9,050	8,565
1996	-	5,786	5,266	-	1,790	1,500	694	740	789	8,316	7,555
1997	5,307	6,682	7,025	3,440	2,106	1,596	517	518	831	9,306	9,452
1998	6,484	6,774	8,571	2,443	2,082	1,683	464	519	950	9,375	11,204
	(b) Monsoon										
	Aman (L)			Aman (HYV)			DW-Aman			Total <sup>1</sup>	
	LUS	MP	DAE	LUS	MP	DAE	LUS	MP	DAE	LUS	DAE
1995	-	2,141	1,576	-	696	641	-	3,444	2,311	7,437	5,807
1996	2,703	1,946	1,781	1,327	1,296	877	1,921	2,353	2,647	6,645	6,094
1997	2,852	1,759	1,974	2,691	1,440	2,195	1,716	3,200	2,613	7,976	7,613
1998	634	1,172	1,368	1,538	1,129	1,140	1,028	1,890	808	3,664	3,316

Table A-1. 2: Areas (ha) under (a) pre-monsoon and (b) monsoon crops in 1996 and 1997 (1996 excluding LFP), according to CPP and DAE data

LUS = Land use survey

MP = Monitoring plots

1 including sugarcane

Note : - = Data not available

200



	(a) Pre-monsoon										
	Boro			Jute			Sugarcane				Total
	LUS	MP	DAE	LUS	MP	DAE	LUS	MP	DAE	LUS	
1995	-	5,876	5,576	-	1,859	1,808	-	1,503	979	-	9,238
1996	-	5,260	5,266	-	2,327	1,500	694	862	789	-	8,449
1997	5,307	6,075	7,025	3,440	2,738	1,596	517	673	831	9,264	9,486
1998	6,484	6,158	8,571	2,443	2,707	1,683	464	675	950	9,391	9,540
(b) Monsoon											
	Aman (L)			Aman (HYV)			DW-Aman				Total <sup>1</sup>
	LUS	MP	DAE	LUS	MP	DAE	LUS	MP	DAE	LUS	
	LUS	MP	DAE	LUS	MP	DAE	LUS	MP	DAE	LUS	
1995	-	2,462	1,876	-	905	641	-	2,649	2,311	-	7,519
1996	2,703	2,238	1,781	1,327	1,685	877	1,921	1,810	2,647	6,645	6,595
1997	2,852	2,023	1,974	2,891	1,872	2,195	1,716	2,462	2,613	7,976	7,030
1998	634	1,348	1,368	1,538	1,468	1,140	1,028	1,454	808	3,664	4,945

Table A-1.3: Adjusted areas (ha) under (a) pre-monsoon and (b) monsoon crops in 1996 and 1997 (1996 excluding LFP); according to CPP and DAE data

LUS = Land use survey

MP = Monitoring plots

1 including sugarcane

Note : - = Data not available

### Crop Yields

Yield data were collected through the monitoring plots, on-farm demonstrations and OFTD tests. In addition, DAE data were obtained, both for the compartment and for the surrounding *Thanas*. The data are shown in Table A-1.4. The differences for *Aman* paddy are conspicuous. The original data as recorded by the Block Supervisors were more 50% higher than those collected by CPP. The consolidated yield data, which are eventually reported by DAE for the Thana and District, however, are much closer to those recorded by CPP. It appears that the BS tend to choose above average fields for their crop cuts and the data are later adjusted at the *Thana* and District levels to correct for these biases. This could not be confirmed.

The DAE data for Boro paddy and for jute were much closer to those of CPP. This makes sense, because these crops are more uniform than *Aman* paddy and major sampling biases are therefore less likely.

	(Rabi/Pre-monsoon)				Monsoon					
	Boro		Jute		Aman (L)		Aman(HYV)		DW-Aman	
	MP	DAE	MP	DAE	MP	DAE	MP	DAE	MP	DAE
1995	-	5.65	-	1.31	1.83	2.80	2.78	4.53	0.95	1.92
1996	-	5.54	-	1.34	1.83	2.88	2.97	4.50	1.651	1.99
1997	-	5.55	-	1.28	1.70	2.70	2.78	4.01	1.13	1.74
1998	5.18	4.96	1.49	1.18	1.41	1.40	2.50	2.15	1.11	1.00
1999	6.19	6.64	1.61	1.81	2.43	2.20	3.33	3.50	2.04	1.80

Table A-1.4: Yields (t/ha) of (a) pre-monsoon and (b) monsoon crops, 1995 - 1999; according to CPP (monitoring plot) and DAE data

<sup>1</sup>probably overestimated because of small sample size before 1997

Note : - = Data not available



## Appendix 2



225

## Plant Species of Economic Importance in the Tangail Area

### A. Agricultural Species

Local name	English name	Botanical name	Product	Season <sup>1</sup>	Location <sup>2</sup>
Dhan	Rice	<i>Oryza sativa</i>	Grain	all	T, P, D
Gam	Wheat	<i>Triticum aestivum</i>	Grain	R	T, P
Deshi pat	White Jute	<i>Chorcorus capsularis</i>	Fiber	K-I	P, D
Tosa pat	Jute	<i>Chorcorus olitorius</i>	Fiber	K-I	T, P
Sarisha	Mustard	<i>Brassica campestris</i>	Oil seed	R	T, P
Akh	Sugarcane	<i>Saccharum officinarum</i>	Sugar	all	T
Bhutta	Maize	<i>Ze a mays</i>	Grain	R, K-I	T
China	Millet	<i>Panicum miliaceum</i>	Grain	R	T, P
Pairst	Barley	<i>Hordeum vulgare</i>	Grain	R	T, P
Chhola	Chick pea	<i>Cicer arietinum</i>	Pulse	R	T
Misti alu	Sweet potato	<i>Ipomoea batatas</i>	Tuber	R	T
Kaon	Foxtail millet	<i>Setaria italica</i>	Grain	R	T
Mosur	Lentil	<i>Lens culinaris</i>	Pulse	R	T
Kheshari	Grasspea	<i>Lathyrus sativus</i>	Pulse	R	P, D
Maskalai	Black gram	<i>Vigna mungo</i>	Pulse	R	P, D
Arohor	Pigeon pea	<i>Cajanus cajan</i>	Pulse	K-I, K-II	T
Kalkalai	Black gram	<i>Vigna phaseolus</i>	Pulse	R	T
Mug	Golden gram	<i>Vigna radiata</i>	Pulse	R	T
Kesur Alu			Tuber	R	T
Til	Sesame	<i>Sesamum indicum</i>	Oil seed	K-I	T
Tishi	Tishi	<i>Linum usitatissimum</i>	Oil seed	R	T
Surjamukhi	Sunflower	<i>Helianthus annuus</i>	Oil seed	K-I	T

<sup>1</sup>R = Rabi, K-I = Kharif-I, K-II = Kharif-II

<sup>2</sup>H = Homestead, T = Tan, P = Patchot, D = Dopa



329

**B. Trees**

Local name	English name	Botanical name	Product	Season <sup>1</sup>	Location <sup>2</sup>
Amm	Mango	<i>Mangifera indica</i>	Fruit/timber		H
Jam	Blackberry	<i>Eugenia jambolana</i>	Fruit/timber		H
Kathal	Jackfruit	<i>Artocarpus heterophyllus</i>	Fruit/timber		H
Shupari	Betel nut	<i>Areca catechu</i>	Fruit		H
Tal	Palm	<i>Borassus flabellifer</i>	Fruit/fuel		H, T
Narikal	Coconut	<i>Cocos nucifera</i>	Fruit/oil		H
Tetul	Tamarind	<i>Tamarindus indica</i>	Fruit/fuel		H
Khejur	Date	<i>Phoenix sylvestris</i>	Fruit/fuel/gur		H
Dalim	Pomegranate	<i>Punica granatum</i>	Fruit		H
Jambura	Pomelo	<i>Citrus grandis</i>	Fruit		H
Kala	Banana	<i>Musa spp</i>	Fruit		H
Litchi	Litchi	<i>Litchi chinensis</i>	Fruit		H
Bel	Wood apple	<i>Aegle marmelos</i>	Fruit		H
Kadbel	Wood apple	<i>Feronia elephantum</i>	Fruit/fuel		H
Amra	Hog plum	<i>Spondias dulcis</i>	Fruit		H
Pepe	Papaya	<i>Carica papaya</i>	Fruit		H, T
Peara	Guava	<i>Psidium guajava</i>	Fruit		H
Kul/Boroy	Plum	<i>Zizyphus jujuba</i>	Fruit/fuel		H
Lebu	Lemon	<i>Citrus spp</i>	Fruit		H
Gub		<i>Diospyros embryopteris</i>	Fuel		H
Ata	Custard apple	<i>Annona squamosa</i>	Fruit		H
Kamranga	Bilimbi	<i>Averrhoa carambola</i>	Fruit		H
Deophal	Deophal	<i>Artocarpus lacucha</i>	Fruit		H
Jamrul	Jamrul	<i>Eugenia malaccensis</i>	Fruit		H
Jalpai	Olive	<i>Olea europaea</i>	Fruit		H
Bangi	Melon	<i>Cucumis melo</i>	Fruit	R	T, P
Tormuj	Watermelon	<i>Citrullus lanatus</i>	Fruit	R	T, P

### C. Vegetables

Local name	English name	Botanical name	Product	Season <sup>1</sup>	Location <sup>2</sup>
Fulkapi	Cauliflower	<i>Brassica oleracea</i> var. <i>totritis</i>	Vegetable	R	H, T
Badhakapi	Cabbage	<i>Brassica oleracea</i> var. <i>capitata</i>	Vegetable	R	T, P
Olkapi	Knolkhol	<i>Brassica caulorapa</i>	Vegetable	R	H, T
Gagor	Carrot	<i>Daucus carota</i>	Vegetable	R	H, T
Mula	Radish	<i>Raphanus sativus</i>	Vegetable	R	H, T
Palong sak	Spinach	<i>Spinacea oleracea</i>	Vegetable	R	H, T
Pudina	Pudina	<i>Mentha arvensis</i>	Vegetable	all	H, T
Sim	Country bean	<i>Lablab purpureus</i>	Vegetable	R	H, T
Barbati	Yard long bean	<i>Vigna unguiculata</i>	Vegetable	R	H
Motorsuti	Peas	<i>Pisum sativum</i>	Vegetable	R	T, P
Alu	Potato	<i>Solanum tuberosum</i>	Vegetable	R	H, T
Begun	Brinjal/eggplant	<i>Solanum melongena</i>	Vegetable	all	H, T
Tomato	Tomato	<i>Lycopersicon esculentum</i>	Vegetable	R, K-I	H, T
Lau	Bottle gourd	<i>Lagenaria siceraria vulgaris</i>	Vegetable	all	H
Pani kachu	Taro	<i>Colocasia esculenta</i>	Vegetable	K-I, K-II	D
Mankachu	Mankachu	<i>Colocasia antiquorum</i>	Vegetable	all	H
Thankooni pata	Thankooni leaves		Vegetable	all	H, T
Kakrol	Teasel gourd	<i>Momordica cochinchinensis</i>	Vegetable	K-I, K-II	H
Dumur	Glomerata	<i>Ficus glomerata</i>	Vegetable	all	H
Potol	Pointed gourd	<i>Trichosanthes dioica</i>	Vegetable	K-I, K-II	T
Korola/Uchhe	Bitter gourd	<i>Momordica charantia</i>	Vegetable	all	T
Dharos	Lady's finger	<i>Abelmoschus esculentus</i>	Vegetable	all	T, P
Chalkumra	White gourd	<i>Benincasa hispida</i>	Vegetable	K-I, K-II	H
Jhenga	Sponge gourd	<i>Luffa acutangula</i>	Vegetable	K-I, K-II	H, T
Chichinga	Snake gourd	<i>Trichosanthes anguina</i>	Vegetable	K-I, K-II	H, T
Shasa	Cucumber	<i>Cucumis sativus</i>	Vegetable	all	H, T
Lalsak	Red amaranth	<i>Amaranthus tricolor</i>	Vegetable	all	H, T
Datasak	Green amaranth	<i>Amaranthus tricolor</i>	Vegetable	all	H, T
Puisak	Indian spinach	<i>Basella alba</i>	Vegetable	K-I, K-II	H, T
Kolmi	Kangkong	<i>Ipomoea aquatica</i>	Vegetable	K-I, K-II	T, P, D
Piaj	Onion	<i>Allium cepa</i>	Spices	R, K-I	T, P
Bathua		<i>Chenopodium album</i>	Vegetable	K-I	T
Pat sak	Jute leaves	<i>Capsularies leaves</i>	Vegetable	K-I	T, P, D
Helencha sak		<i>Jussiaea repens</i>	Vegetable	all	T, P, D
Bati Shak				all	T
Dhekisak	Dhekisak		Vegetable	K-I, K-II	T
Mistikumra	Sweet gourd	<i>Cucurbita moschata</i>	Vegetable	R, K-I	T
Dhundai			Vegetable	K-I, K-II	H
Shapla	Water lily	<i>Nymphaea nouchali</i>	Vegetable	K-II	D
Olkuchu	Elephant foot	<i>Amorphophallus campunulatus</i>	Vegetable	all	H
Sajna	Drumstick	<i>Moringa oleifera</i>	Vegetable	R	H
Mukhi kachu	Zeddoe	<i>Colocasia esculenta</i>	Vegetable	K-I, K-II	H, T



*Wt*

**D. Spices**

Local name	English name	Botanical name	Product	Season <sup>1</sup>	Location <sup>2</sup>
Ada	Ginger	<i>Gingiber officinales</i>	Spices	all	H
Halud	Turmeric	<i>Curcuma domestica</i>	Spices	all	H, T
Rashun	Garlic	<i>Allium sativum</i>	Spices	R, K-I	T
Marich	Chilli	<i>Capsium annum</i>	Spices	all	T
Dhania	Coriander	<i>Coriandrum sativum</i>	Spices	R	T, P

202

**Annex F**  
**Fisheries**



# Table of Contents

<b>Introduction</b> .....	1
<b>General Characteristics of Fisheries in Bangladesh</b> .....	2
Fisheries.....	2
Freshwater aquaculture.....	3
<b>Fisheries in CPP</b> .....	4
Introduction.....	4
Fisheries Monitoring.....	4
The Habitat Fisheries Monitoring Program.....	5
<i>The selected sites</i> .....	6
<i>The monitoring program</i> .....	12
Data Analysis.....	13
<i>Introduction</i> .....	13
Validation of the method.....	15
Fisheries in CPP during 1992-1999.....	16
<i>Total Fish catch</i> .....	16
Distribution of the Catch among Different types of Fisherman.....	23
<i>Professional fishermen</i> .....	23
<i>Occasional fishermen</i> .....	24
<i>Subsistence fishermen</i> .....	24
<i>Income generation and Socio-economics</i> .....	25
<i>Professional fishermen</i> .....	26
Conclusions, Lessons Learned and Recommendation.....	30
<i>Method used by CPP</i> .....	30
<i>Total catch and impact on livelihood</i> .....	30
<b>Reproductive Strategies and Consequences for</b>	
<b>Water Management</b> .....	32
Introduction.....	32
Results of the Study on Reproductive Strategies of Beel resident Fish species.....	32
The Beel-concept as Developed by CPP.....	34
Economic Evaluation of Drainage of Seasonal or Perennial Beels.....	36
The Implementation of the Beel-Concept in CPP and Present Status of Beel Fisheries .....	38
<b>Fish Bio-Diversity, Fisheries and Water Management</b> .....	40
Garinda and Ghotokbari Beel.....	40
A Rapid Fish Bio-Diversity Appraisal for Floodplain Ecosystems.....	42
Lessons Learned and Recommendations.....	44



282

<b>Hatchling Migration and Consequences for Water Management</b> .....	45
Hatchling Migration.....	45
The Main Regulator.....	48
<b>The Aquaculture Extension Program of CPP</b> .....	50
The Aquaculture Extension Project.....	50
Chari in the Bari.....	52
Aquaculture Losses Due to the Flood of 1998.....	54
<b>Reference</b> .....	57



## Tables

Table 1:	Changes in average per capita protein intake in Bangladesh.....	2
Table 2:	MPO land type classification.....	9
Table 3:	Specified gears for fish catch monitoring.....	12
Table 4:	Specified fish species for fish catch monitoring.....	12
Table 5:	Inundated areas for August 1998 as calculated with water levels and the DEM and inundated as calculated with classified radar satellite images (source EGIS).....	16
Table 6:	Annual fish catch in the CPP project area (1992-1999) and its distribution among the different land types/habitats.....	16
Table 7:	Average annual yields of the different habitats in CPP.....	18
Table 8:	Distribution of the annual yield obtained from F3 and F2 Land types among the different type of fishermen in the CPP project area.....	24
Table 9:	Total no of fishing days and income generated by different types of fishermen in the CPP project area during the period 1994-1999.....	25
Table 10:	Some socio-economic parameters of professional fishermen in the CPP project area.....	26
Table 11:	Land type distribution for three types of interventions in Singerkona Beel.....	36
Table 12:	Net profits (Tk/ha/year) for fisheries and agriculture in different land types in CPP and stages of water management.....	37
Table 13:	Net annual profits for Singerkona Beel calculated for three types of interventions.....	37
Table 14:	Net annual profits for Singerkona Beel calculated for three types of interventions.....	38
Table 15:	Mortality rates of the Lohajang regulator on released carp hatchlings.....	48
Table 16:	Mortality rates of carp hatchlings ( $\pm$ standard error) for different modes of operation of the regulator (different superscripts indicate significant difference $P \leq 0.05$ ).....	49
Table 17:	Base aquaculture production and attained production in 1998.....	51
Table 18:	The Chari in the Bari program of CPP.....	54
Table 19:	Details of the catch analysis carried out for escaped Indian carps during the flood of 1998.....	56

## Figures

Figure	1: Relational diagram of the Habitat Fisheries Monitoring Program of CPP.....	5
Figure	2: Natural aquatic resources in CPP.....	7
Figure	3: Water level and inundated area of an imaginary floodplain system at three moments during the year.....	8
Figure	4: Sampling sites of the CPP fisheries monitoring program.....	11
Figure	5: Pathway of determination of monthly-inundated area per habitat in the CPP project area.....	14
Figure	6: Inundated areas as calculated with the GIS model with a classified radar image (source EGIS, 1998) for August 1998.....	17
Figure	7: The monthly total fish catch on the CPP area, its distribution among the different habitats and the average monthly water level as registered at Ghotokbari Beel.....	18
Figure	8: Annual deviation from the mean catch (1992-1998) for F3, F2 and F1 land types.....	19
Figure	9: The relation between the average annual summed water level (m+PWD) and the average annual yield (kg/ha/year) of all F3 sites monitored in the CPP project area during 1992-1999.....	20
Figure	10: Observed yields and calculated yields.....	21
Figure	11: Relation between CPUE and fishing effort as observed at Gotokbari Beel.....	22
Figure	12: Growth of <i>Puntius sophore</i> and fishing effort as observed 1992 and 1993 at Gotokbari Beel.....	23
Figure	13: Fishing villages of professional fishermen and their fishing grounds.....	27
Figure	14: Average daily income obtained from fishing by professional fishermen in the CPP project area during the period 1992-1999.....	28
Figure	15: Average daily catch by professional fishermen in the CPP project area during the period 1992-1999.....	28
Figure	16: Deviation of the average annual yield of the different fishermen during the period 1992-98.....	29
Figure	17: A schematic view of water and agriculture around Beels in the pre-CPP period, a complete drainage for agriculture land reclamation and the situation with implementation of the Beel-concept.....	35
Figure	18: Average species composition of the monitored Beels in the CPP project area, 1992-1998.....	39
Figure	19: Species composition Garinda Beel, 1992-1999.....	41
Figure	20: Species composition Ghotokbari Beel, 1992-1999.....	41
Figure	21: The ratio between the water area in May and of September for Gharinda and Ghotokbari Beel, 1992-99.....	42



Figure	22: Species composition and yields of floodplain fisheries (F3 land types) in relation to intensifying fisheries and flood control.....	44
Figure	23: Hatchling migration in the Lohajang river 1993.....	45
Figure	24: Distribution patterns of drifting hatchlings in the Lohajang river.....	46
Figure	25: The main regulator in the Lohajang river with the fish gates.....	47
Figure	26: Average daily catch per fishermen of Catla, Rui and Mrigal in the CPP project area, 1996-1999.....	55

## Introduction

The floods in Bangladesh in 1987 and 1988 were catastrophic. Many people lost their lives, thousands became homeless, crops in the fields were destroyed and infrastructure was severely damaged all over Bangladesh including Tangail district. Immediately after the 1988 flood disaster, several studies were carried out by the Government of Bangladesh (GoB) and the international community to find a lasting solution for the flood problem. In June 1989, the World Bank agreed with the GoB to co-ordinate the various flood control and related initiatives from which the Flood Action Plan (FAP) emerged.

The Compartmentalization Pilot Project, (CPP, also called FAP-20) which started in 1991, is a water management project situated on the east bank of the Jamuna. The basic aim of CPP was to control the unpredictable and variable flooding patterns and improve the drainage congestion. In June, 1992, the Flood Plan Coordination Organization (FPCO) decided that this was to be obtained through flood protection at the peripheral embankment. It was expected that fisheries would be affected by interventions such as construction of gated regulators in the main river and the peripheral embankment, improvement of drainage through excavation of khals and the construction of minor regulators within the project area. Fisheries aspects have, therefore, been included in the project since its start.

The objectives of the fisheries component of CPP were to increase the availability of fish by securing fisheries production and by improving aquaculture production by focussing on the following aspects:

- Determining the impact of CPP on natural fisheries production,
- Determining hatchling migration patterns and incorporation of the results in water management options and design of water management structures,
- Development and implementation of mitigation measures to compensate the expected negative impacts of the implementation of CPP, and
- Development of proper water management scenarios for fisheries production.

This report presents the major results of the fisheries program as executed from May 1992 until July 1999. More detailed information have been presented in a number of technical papers published by CPP.



# General Characteristics of Fisheries in Bangladesh

## Fisheries

Being a country of rivers and floodplains with a high potential of aquatic resources, fish plays a very important role in daily life of many people in Bangladesh. The Bengali expression "Mache bhate Beangali", - Fish and rice make a Bengali - expresses this importance. Bangladesh produces 1,400,000 Mt. of fish annually. Inland capture fisheries and aquaculture are the main contributors to this production with respectively 53% and 24% of the total. The total fish production accounts for 6% of GDP and 12% of the export earnings. About 12 million people depend on fisheries of which 1.2 million people are dependent full-time on fish and fishing activities. Sixty percent of the animal protein consumption comes from fish. With a total population of 117.5 million the availability of fish is 32g/person/day and total availability of protein is 40 g/person/day with 13 g/person/day available through meat, eggs, and milk. A progressive decline in protein intake over the last 30 years has been indicated and at present, there is a protein deficiency (Table 1).

	1962-64	1975-76	1981-82	1995-96	Requirement
Protein intake (g/capita/day)	57.9	58.5	48.4	40.0	45.3

Table 1: Changes in average per capita protein intake in Bangladesh

Fish production in Bangladesh, like in other floodplain areas in the world, can not be properly considered without knowing the hydrological features of the area. In Bangladesh, extensive seasonal flooding by high water levels during the monsoon generally occurs between July and November. This flooding has a high variation in terms of timing, duration and intensity which is caused by interaction of the three river systems: Ganges, Brahmaputra (Jamuna) and Meghna, which have independent cycles. Together with the extremely high monsoon rainfall in some years, it creates a highly dynamic floodplain system. In contrast to the abundance of water in the monsoon, water areas decline rapidly during the dry season (December-April), this is characterized by very low rainfall and high evaporation rates. This contraction and expansion of aquatic habitats greatly influences fisheries production.

Fish and prawn populations in Bangladesh are adapted to these variations and their life cycles are tuned to it. Breeding and growth are strongly related to the sequence of flooding. The floodplains, which inundate during monsoon, are nutrient and food rich and play a significant role for 4-5 months of the year. Larvae, juveniles and adults



209

grow in this habitat after which they migrate back to rivers or depressions at the end of the monsoon when waters recede. They become concentrated in channels and beels in this period and fish are more vulnerable to fishing activities.

Based on their behavior, mainly related to migration and reproduction, the fish species of Bangladesh can be divided in two groups:

- The so-called "**white fish**" migrate upstream and laterally to the inundated oxbow lakes and floodplains adjacent to the river channel in the late dry season or early rainy season to spawn in the quiet sheltered and nutrient rich waters. The eggs and newborn 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 escape to the main channel and most likely to the deeper beels, to avoid the harsh conditions of the floodplain during the dry season. White fish belong mainly to *Cyprinidae* and *Pangasidae*, (*Mrigal*, *Rui*, *Catla*, *Pangash*, etc). In this report this group will be referred as "**river fish**".
- The so-called "**black fish**" are mainly omnivorous/carnivorous bottom dwellers; they reproduce at the onset of the pre-monsoon as the water level in the beels starts to rise due to the congestion of rainwater. At the end of the rainy season the young of the year and adults migrate back to, or get trapped in the low lying beels where they can survive the harsh conditions of these permanent water bodies during the dry season. They are adapted to resist low dissolved oxygen concentration 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*) and *Anabantidae* (*Koi*, *Kolisha*). In this report this group will be referred to as "**beel fish**".

### Freshwater Aquaculture

Bangladesh has an estimated 1.3 million ponds covering an area of 150,000 hectares. Not all ponds are used. Lack of technical knowledge of the pond operators is the major bottleneck in fresh water aquaculture. Aquaculture production increased rapidly in the last decade in Bangladesh. The total production of cultured fresh water fish increased from 144,000 Mt./year in 1985 to 340,000 Mt./year in 1997. The development of proper husbandry techniques and the dissemination of these techniques through aquaculture extension programs formed the basis of this success.



# Fisheries in CPP

## Introduction

Fish production in floodplains is directly related to the magnitude of the flooding and the type of floodplain. Because of the close relation between the hydrological cycle, fish production and fish ecology, the envisaged negative consequences for fisheries due to interventions in the CPP area were:

- Loss of flooded habitat and fisheries habitat during the monsoon with lower fish catches as a result,
- Decreased catch of adult and juvenile riverine fish due to blockage of migration routes,
- Decreasing dry season fisheries habitat due to improved drainage and due to decreased monsoon water levels. This may result in reduced numbers of adult brood stock, reduced recruitment, delay of spawning time, increased fishing pressure, and
- Easier catching of fish near the regulators.

The results of the fisheries monitoring program dealing with the first point in presented in this chapter. Results of other monitoring programs dealing with fish migration, reproduction of beel resident fish species and developed mitigation measures are presented in other chapters.

## Fisheries Monitoring

To assess the impact of CPP on fisheries in 1992 a fisheries monitoring program was started. This program monitored the catch in the pre-CPP phase (May 1992 - May 1995) and the post-CPP phase (May 1995 - May 1999). Fisheries is traditionally monitored through so called "Catch and Effort" monitoring systems in which "effort" is the number of fishermen or gears operated in a water body and "catch" is the daily catch obtained by the fishermen or gear. The total catch is obtained by multiplying the catch with the number of gears or fishermen. A pre-requisite for a "Catch and Effort" monitoring system is that the total effort, the total number of fishermen or gears operated is known. For CPP, it would have meant that the total number of fishermen and the number of used gears had to be known on an annual basis. A preliminary survey executed in 1991 indicated that almost 68% of the rural population, or 17,300 households were engaged in some form of fishing (subsistence fishing) and that this activity varied highly throughout the year. This means a large number of households had to be followed throughout CPP if a traditional catch and effort-monitoring program would be used; in practice, this was impossible. Therefore, a more practical monitoring system was implemented: A Habitat Fisheries Monitoring Program.

## The Habitat Fisheries Monitoring Program

In principle the Habitat Fisheries Monitoring Program is a stratified Catch and Effort Monitoring program, which means that the Monitoring program is divided into several smaller parts, whereby the stratification is done through water body/land type classification.

The different water bodies were classified into land type (F0-F4), khals, and rivers, after which representative sites for each type were selected. Annual production rates for each type of water body were obtained through a traditional catch and effort monitoring program implemented at each representative site. The total area for each type of water body and its seasonal fluctuation in the CPP area was obtained by applying Geographical Information Systems (GIS) techniques, which allowed to calculate the annual production per type of water body. Finally, the total annual fisheries production of CPP was obtained by summing the total annual production of the different water bodies. The basic principle of the Habitat Monitoring Program is schematized in Figure 1.

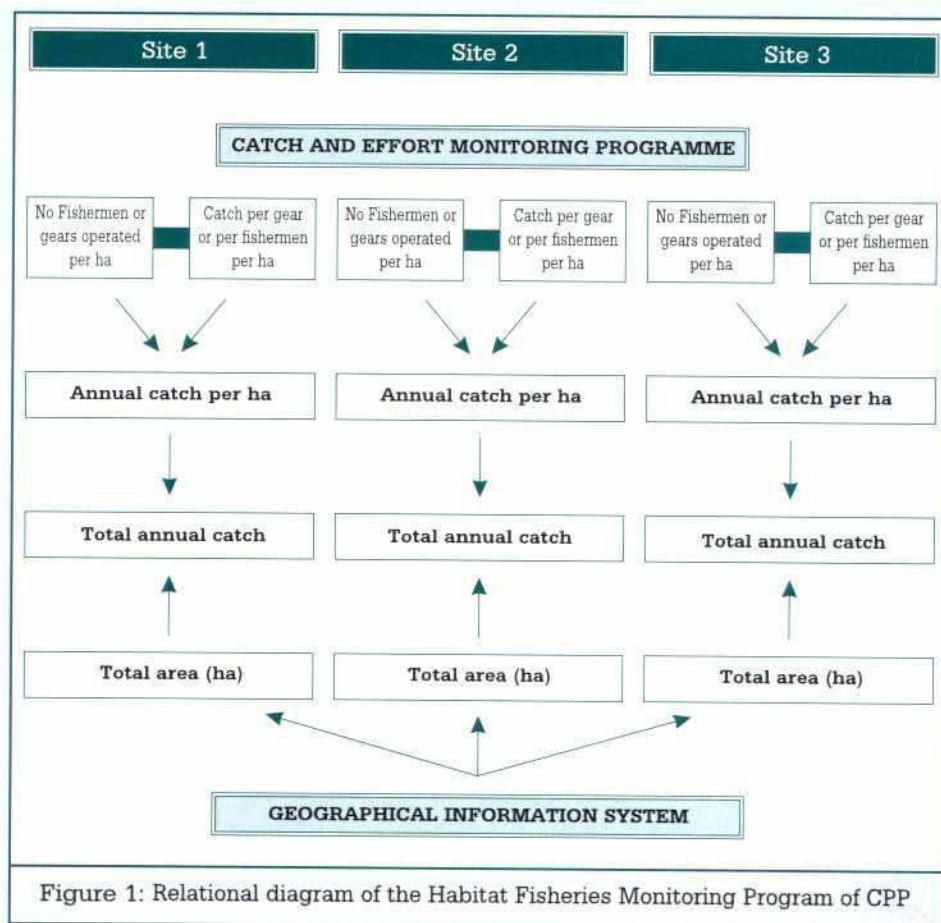


Figure 1: Relational diagram of the Habitat Fisheries Monitoring Program of CPP



### *The selected sites*

The natural aquatic resources in the project were classified as follows (Figure 2):

**Beels:** These are the low-lying depressions in the floodplain (small lakes). They may have a permanent character, containing water throughout the year (perennial beels) or dry completely out during a part, mostly 4-5 months, of the year (seasonal beels). The area of these water bodies expands and decreases with the hydrological cycle.

**Floodplains:** Inundated land formed during the monsoon as a result of rainwater congestion and river flooding. The floodplain can be associated with a beel but it can also be formed on top of relatively flat lands. Floodplains have thus a clear seasonal character. The level of the floodwater determines the extent of flooding.

**Rivers:** The Lohajang river is the only river in the CPP area. Dhaleswari, Elanjani and Pungli rivers are located outside of the project, though they impact the area to a large extent. The Lohajang has a seasonal character. It is a branch of the Dhaleswari River. Its total length within CPP is 27 km.

**Khals:** These are channels, which connect rivers with beels and floodplains. Floodwaters can enter these khals and rainwater can be drained out. The total length of khals in CPP is 93 km.

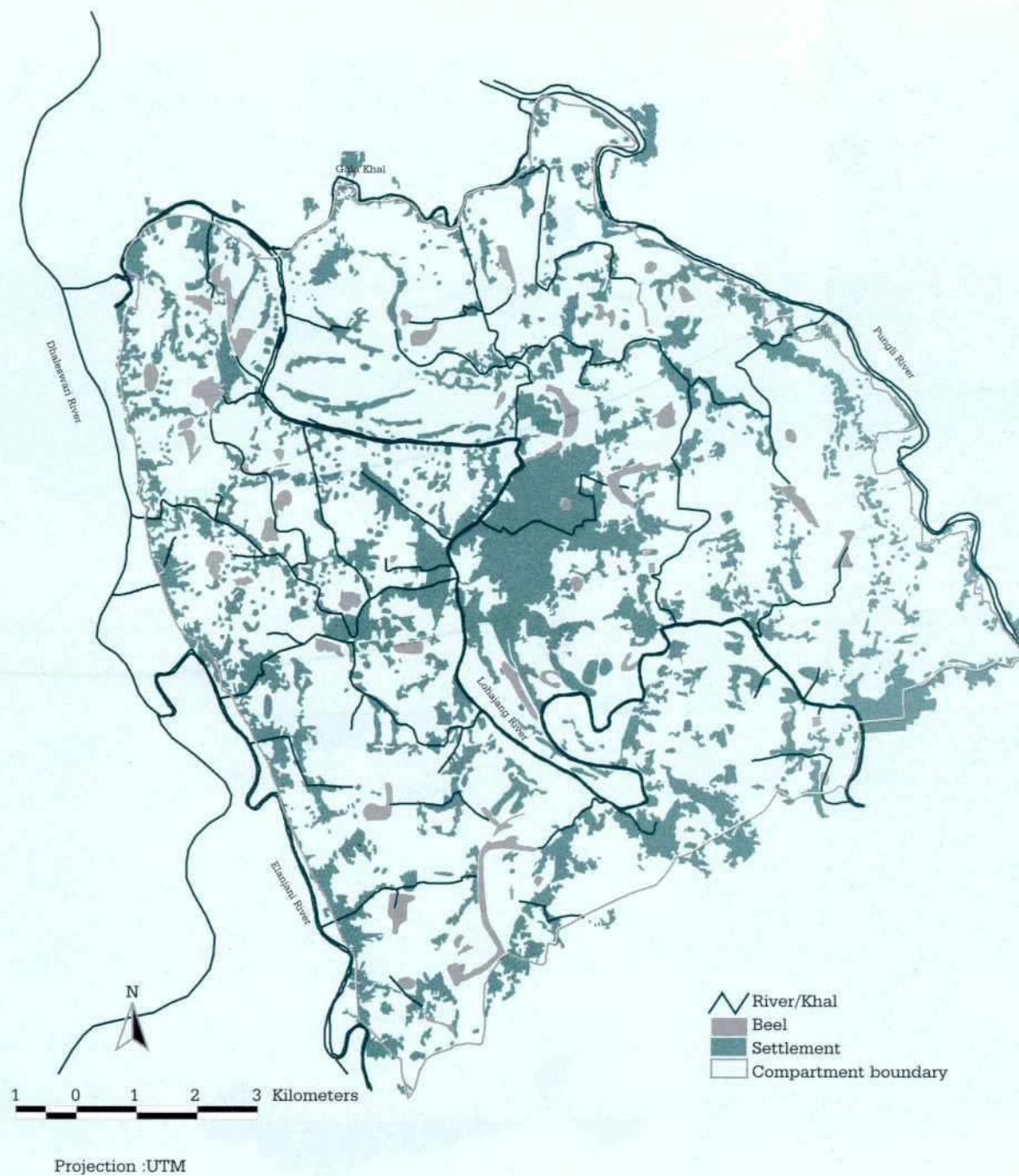


Figure 2: Natural Aqiatic Resorces in CPP



282

This classification, however, could not directly be used for the representative fisheries habitat monitoring program, as the classification of "seasonal *beel*", "perennial *beel*", and "floodplain" is too broad. Using water levels as major criteria also proved to be unpractical. The latter can be explained as follows: In Figure 3, flood levels and the inundated area of a floodplain during the months April, June and September are presented.

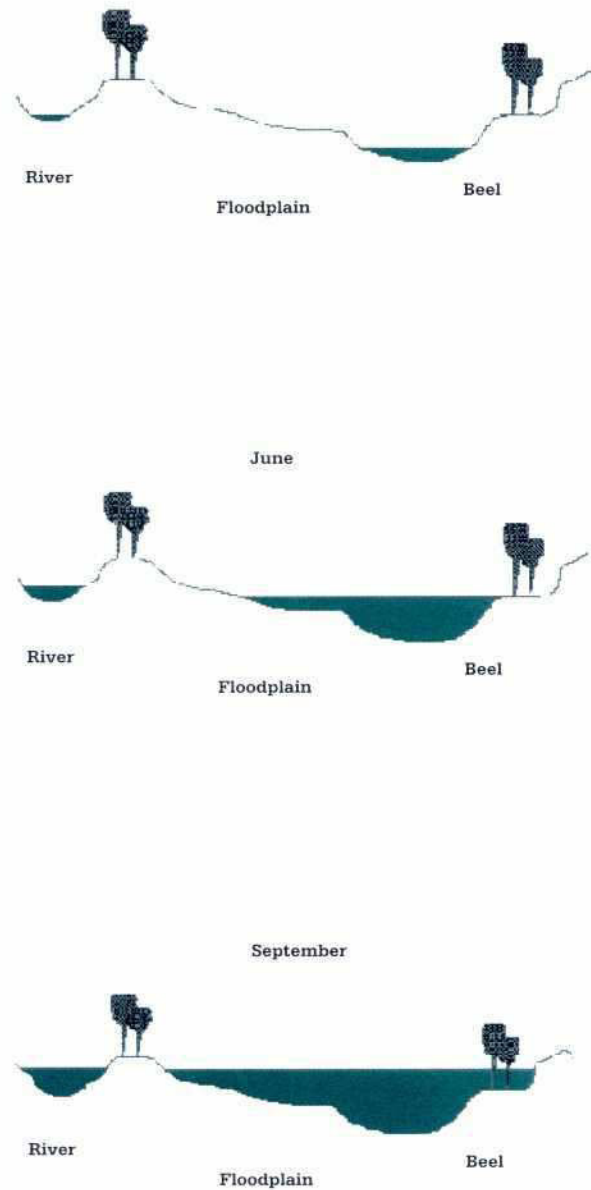


Figure 3: Water lable and inundated area of a floodplain system at three moments during the year

At a certain location, for example the beel, the water level varies largely, throughout the year. In this example, water levels are given at dates rather far apart, but even within one month during the flood season the water level varies significantly. This phenomenon makes it difficult to use water level as a selection criteria for habitat fisheries monitoring, as it would mean that these habitats are moving within the area. In our example, areas with water levels of 0-90 cm are found in the beel during May, in the low floodplain during July and in the high floodplain during September.

In principle criteria which can be quantified, replicated, used all over Bangladesh and are practical for implementation of fisheries monitoring programs have to be used. It was concluded that the land-type-classification as defined by the Master Plan Organization (MPO) was the best and most practical way to define fisheries habitats and well because of the following reasons:

- The classification is well known by large groups of planners, scientists, and GoB departments,
- The classification is precisely defined and uniform for the whole of Bangladesh, with as a basic input a Digital Elevation Model (DEM) or topographic maps, a 1 in 5 years maximum water level and a 1 in 5 years 3 days maximum rainfall,
- Land types have a fixed position and will only change due to water management interventions such as the construction of embankments and regulators, and
- The impact of water levels is incorporated as the classification works with maximum water levels.

The land type classification as defined by MPO, with 1-5 years maximum inundation depth, and its land use is presented in Table 2.

Inundation depth (cm)	Land type	Land use
0-30	F <sub>0</sub>	Sugarcane, Vegetables, T. Aman (High Yielding Variety, HYV)
30-90	F <sub>1</sub>	T. Aman (local variety, LV) and T. Aman (HYV)
90-180	F <sub>2</sub>	T. Aman (LV), Deep Water (DW) Aman, Fish
> 180	F <sub>3</sub>	DW Aman, Fish
Table 2: MPO land type classification		



228

For the fisheries monitoring program of CPP and analysis of the data, it was assumed that data obtained from a site, within a certain land type, irrespective of the actual water level measured at the site, is representative for the whole area of this land type within CPP when inundated. In Figure 4, the fisheries monitoring sites and the representing land types are presented.

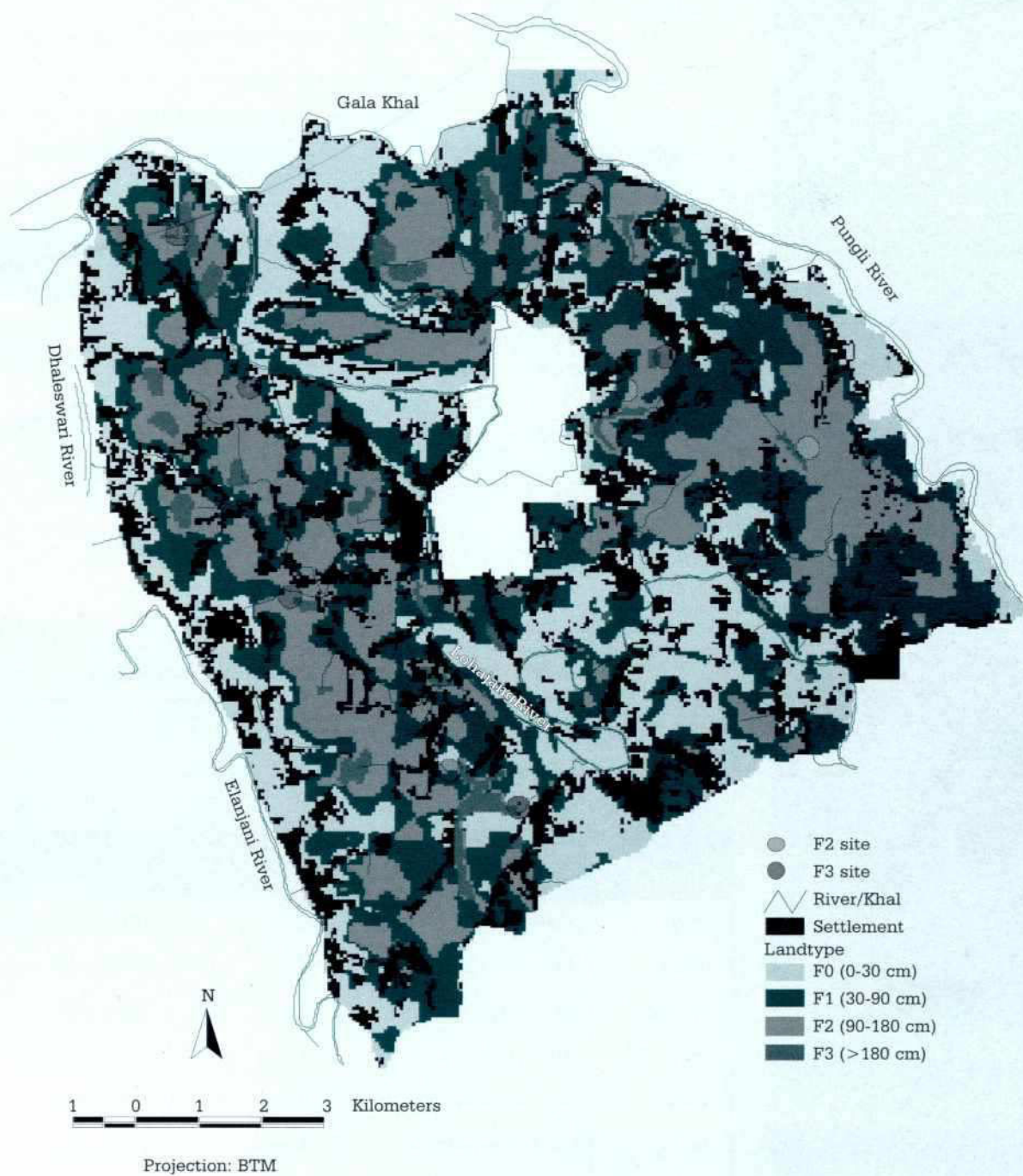


Figure 4: Sampling Sites of the CPP Fisheries Monitoring Program



### The Monitoring Program

A preliminary survey carried out in March 1992 (CPP, 1994), indicated that a certain number of gears and fish species were found to dominate in the area and in the catch. To keep the monitoring program simple and practical, the study was limited to the major gears used (Table 3), major species (Table 4) and daytime monitoring.

Bengali name	English name
Taki Jal	Cast Net
Thella Jal	Scoop Net
Dhorma Jal	Lift Net
Ber Jal	Seine Net
Karrent Jal	Gill Net
Borshi	Lining
Darki	Traps
Others (Khata, Dewatering, Hand-picking, etc.)	Others (Khata, Dewatering, Hand-picking, etc.)

Table 3: Specified gears for fish catch monitoring

Beel resident fish species		Riverine fish species	
Bengali name	Scientific name	Bengali name	Scientific name
Baim	Mastacembelus pancalus	Baila	Glossogobius giurus
Gutum	Lepidocephalus guntea	Boal	Wallago attu
Kolisha	Colisha fasciatus	Catla	Catla catla
Puti	Puntius sophore	Mrigal	Cirrhinus mrigola
Shing	Heteropneustes fossilis	Rui	Labeo rohita
Koi	Anabas testudineus	Titputi	Puntius ticto
Taki	Channa punctatus	Ayre	Mystus aor
		Kalibaus	Labeo calbasu
Others	Pisces anonymous	Others	Pisces anonymous

Table 4: Specified fish species for fish catch monitoring

The actual monitoring was done by a catch assessment and frame survey within a fixed area at the selected sites.

**Catch Assessment Survey:** The daily catch of every individual fisherman or gear was monitored bi-weekly at each site. The numbers, weight and length-frequency distributions of the dominant species in the catch were recorded. Furthermore, the gear-type, its mesh size, owner status and the number of units used per fisherman were recorded.

**The Frame Survey:** weekly standardized counting of the number of fishermen and the number of gears used at the different sampling sites.

Although the whole survey was set up and carried out "gear-based", the final data analysis was carried out "fishermen-based" to facilitate visualization of socioeconomic aspects and to make it more clear for persons not working in fisheries.

## **Data Analysis**

### *Introduction*

The principle of how the total annual catch for CPP was determined is presented in Figure 5. This methodology of incorporating GIS in traditional Catch and Effort monitoring systems is new and details have been presented in a separate technical report of CPP, but the basics of the method is summarized below.

The total annual catch for CPP is in principle calculated in three steps:

- First for each habitat the monthly Catch Per Unit of Area (CPUA) is calculated,
- Secondly the total monthly-inundated area of each habitat is determined by applying GIS techniques, and
- Multiplying the CPUA's by the inundated areas provides the monthly or annual total catch.



224

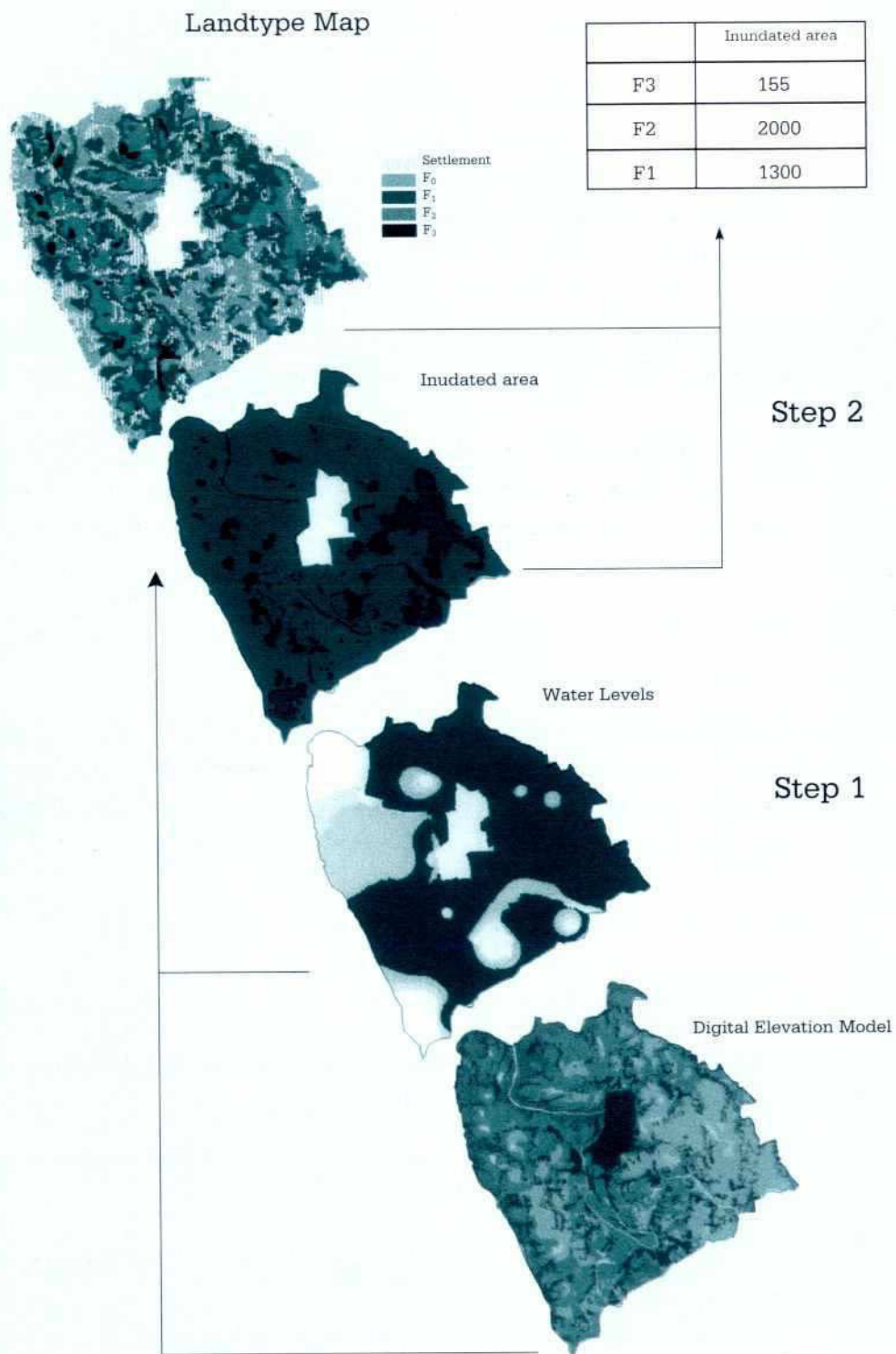


Figure 5: Pathway of Determination of Monthly-Inundated Area per Habitat in the CPP Project Area

Determination of monthly-inundated areas was done in two steps (Figure 5) with GIS techniques using the following inputs:

- A Digital Elevation Model (DEM) or Digital Terrain Model (DTM),
- Monthly water levels as registered within the CPP project area, and
- A land type map based on MPO criteria.

A Digital Elevation Model is a digitized topographic map of the area. For the CPP area, EGIS has made a new Digital Elevation Model from the FINMAP (1991, scale 1:20,000) with a 10-cm elevation level. This DEM has been used for the analysis of the fisheries data.

The first step was to calculate the water levels for each month, the inundated area within the CPP project. Since 1992, CPP installed water gauges throughout the area, which were read on a daily or weekly basis. So, for a number of locations on a daily or weekly basis the water level (m+PWD) was known. For all locations, the average monthly water level was calculated, and these were used as input for a GIS analysis with the following principles.

By connecting the average monthly water levels of each gauge location, the water level layer with a certain gradient was obtained. This water level layer was placed on top of the DEM and the inundated areas were calculated by subtracting the water level layer from the DEM elevation level (STEP1 in Figure 5), Negative values indicate a water level higher than the DEM elevation level, which means that the location was covered with water.

Finally, the grid of the total inundated area was placed on top of the Land type map (1 in 5 years, MPO classification) and overlapping allowed to calculate the monthly inundated area per land type (STEP 2 in Figure 5).

### **Validation of the Method**

The calculated flooded areas were checked by comparing them with real flooded areas obtained from optical satellite images (Dry season, March 1994 and January 1999) and radar satellite images (monsoon season, August 1998). The results of the comparison are presented in Table 5 and Figure 6.



280 220

	August 98 area (ha)	March 1994 right bank (ha)	January 1999 (ha)
Model	6064	1028	686
Satellite images	5012	766 (deep water only)	1000

Table 5: Inundated areas for August 1998 as calculated with water levels and the DEM and inundated as calculated with classified radar satellite images (source EGIS)

The difference between the calculated flooded areas and the real flooded areas were within an acceptable range.

### Fisheries in CPP During 1992-1999

#### Total Fish catch

The annual total fish catch obtained during the period May 1992 to May 1999 is presented in Table 6 and Figure 7.

Year	Catch (Mt/year)					Total
	F3	F2	F1	Lohajang river	Khals	
92/93	36	42	5	1	2	86
93/94	76	176	33	3	29	317
94/95	43	158	15	N.a.	N.a.	216
95/96	43	92	12	N.a.	N.a.	147
96/97	48	223	39	4	9	323
97/98	56	292	38	1	9	396
98/99	97	596	119	8	25	845

Table 6: Annual fish catch in the CPP project area (1992-1999) and its distribution among the different land types/habitats

On average, annually 330 Mt of fish is caught in the CPP project area, but the catch varies with the extend of flooding and a lowest catch of 85 Mt was observed in 1992 and a bumper catch of 845 Mt was observed in 1998. Further, it becomes clear that the F2 land is the major contributor to the annual catch from a production point of view they are much more important then the permanent water bodies or F3 land. In relation to flood control, this is important, as the major changes through water management will take place at the F2 and F1 Land types.

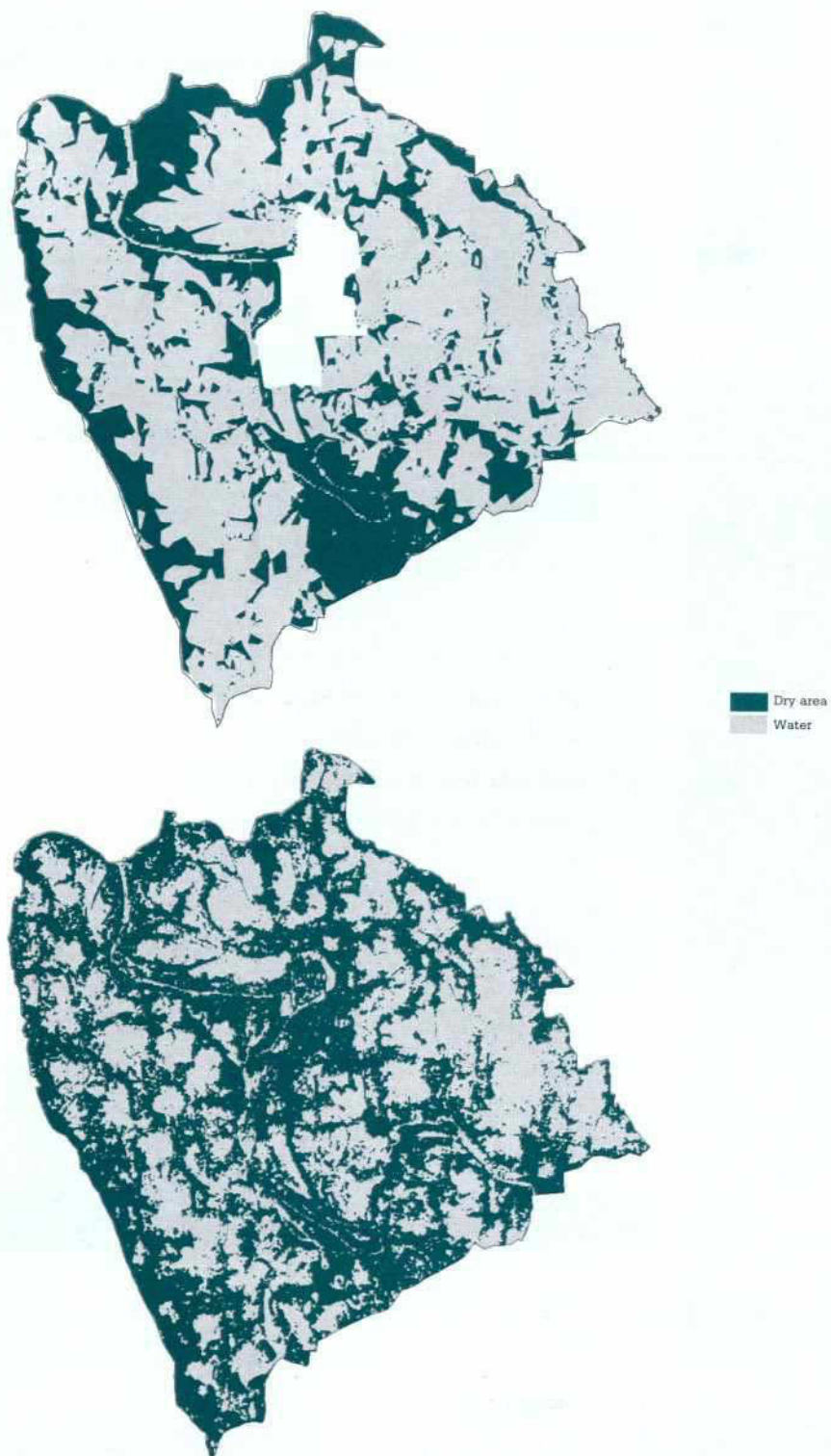
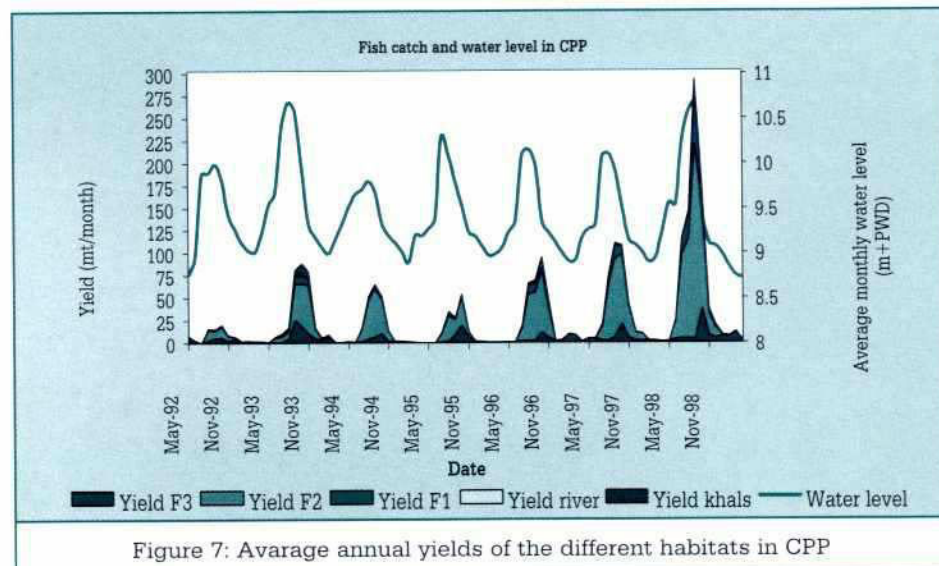


Figure 6: Inundated Areas as Calculated with the GIS Model with with a Classified  
Randar Image (Source EGIS, 1998) for Agust 1998





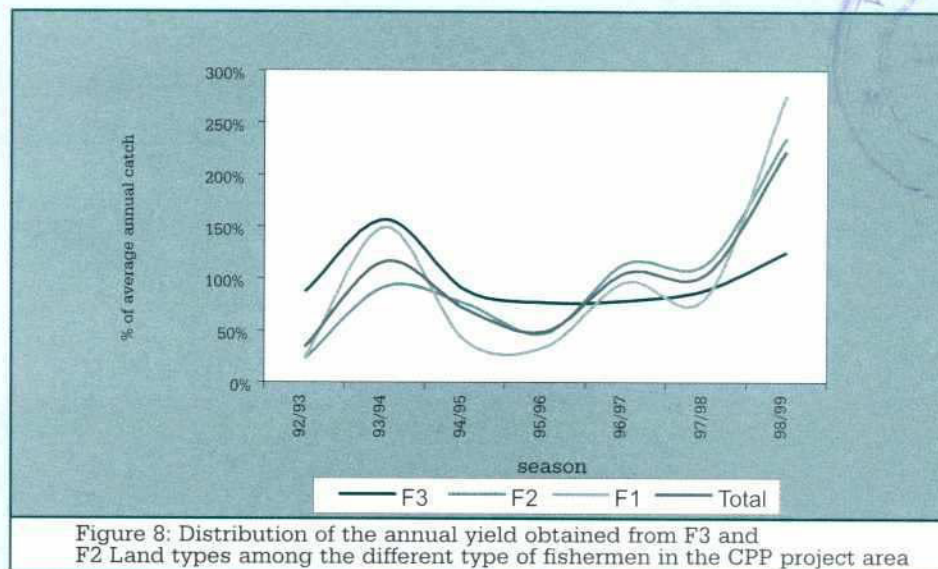
Despite earlier reports (CPP, 1994 and 1996) the conclusion is that there is **no significant trend in the fish catch within the CPP area**. The discrepancy between the present findings and earlier reports lays in the fact that during the early phase of CPP, a suitable tool for analysis of data and extrapolation of the data towards future developments was not available (see CPP, 1994, page 59).

In Table 7, the annual yield per ha, calculated with the total area of the different habitats in CPP are presented. In F3 land, about 182 kg of fish per ha is caught, the yields for F2, F1, khals and the Lohajang river are respectively 86 kg/ha/year; 10 kg/ha/year, 112 kg/km/year and 87 kg/km/year. The presented yields are minimum estimates and are further used for all analysis. Higher yields are obtained from the individual sampling sites.

Year	Annual yield (kg/ha/year or kg/km/year)				
	F <sub>3</sub>	F <sub>2</sub>	F <sub>1</sub>	River	Khals
92/93	116	16	1	33	16
93/94	241	67	9	101	315
94/95	137	60	4	N.a.	N.a.
95/96	136	35	3	N.a.	N.a.
96/97	155	85	10	136	98
97/98	179	112	10	42	93
98/99	311	228	31	296	266
Average	182	86	10	87	112

Table 7: Average annual yields of the different habitats in CPP

Comparing the different annual fish catches during the period 1992-1999 can be done, but it always must be kept in mind that 98/99 was an extreme year, with an extreme high flood and it resulted in very high fish catches, obtained from F2 and F1 land. This phenomenon is visualized in Figure 8 where the deviation from the average annual catches (average equals 100%) for the different years is plotted. The yields obtained in 98/99 were 200-250% higher than the average, and 92/93 was an extreme dry year with a yield of 20-80% of the average.



Fisheries, and catch rates are highly seasonal and are related to the flood and water level. The highest catches were always obtained during the receding of floodwater in the month of October and in most years a small peak appeared in May, when the water level in the Beel was at its lowest level. Secondly, it also became clear that the fish yields are related to the extend of flooding, i.e. in dry years such as 92/93 and 94/95, the yields were low if compared with yields obtained during the wet years 97/98 and 98/99).

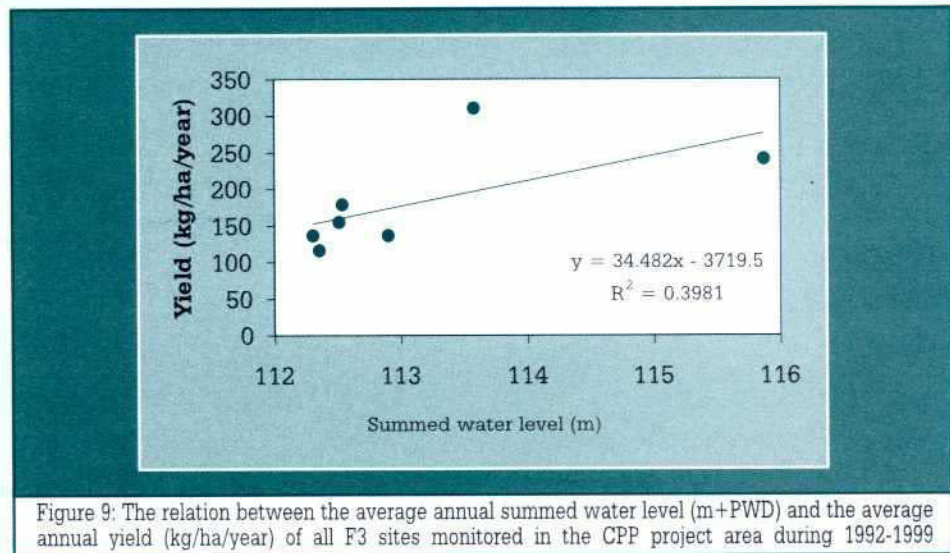
This phenomena, which is called the "flood pulse" (Junk et al., 1989) is quantified for CPP by plotting the average annual summed water levels against the annual average yields of all F3 sites monitored in CPP (Figure 9). The result is a clear relation between the flood intensity and the annual catch per hectare, the higher the summed water level the higher the average yields.



For water management in relation to fisheries this phenomena is important, as reducing the flood level will have a double impact;

- There will be less area available for fishing,
- The annual catch per hectare will be less

This is the basic input for the predictive fisheries model as developed by CPP<sup>1</sup> that is used to optimize water management scenarios for fisheries and agriculture.



Traditionally, the "flood pulse" concept is considered as a biological process, related to flood level and the quantity of nutrients entering the system, i.e. at high flood levels more land is flooded, resulting in a higher influx of nutrients and higher fish growth and higher fish production.

The question arises if the floodpulse as observed in the CPP project area is related to human factors such as fishing effort or to more natural factors such as water level or CPUE.

Mathematically Yield is expressed as;

$$Y = CPUE * f$$

Whereby;

$Y$  = monthly yield

$CPUE$  = average monthly Catch per Unit of Effort.

$f$  = average monthly effort.

<sup>1</sup>This model has been presented in a separate technical paper

The impact of the different parameters can be tested with an analysis of variance in a step-wise multi-linear regression analysis of the form;

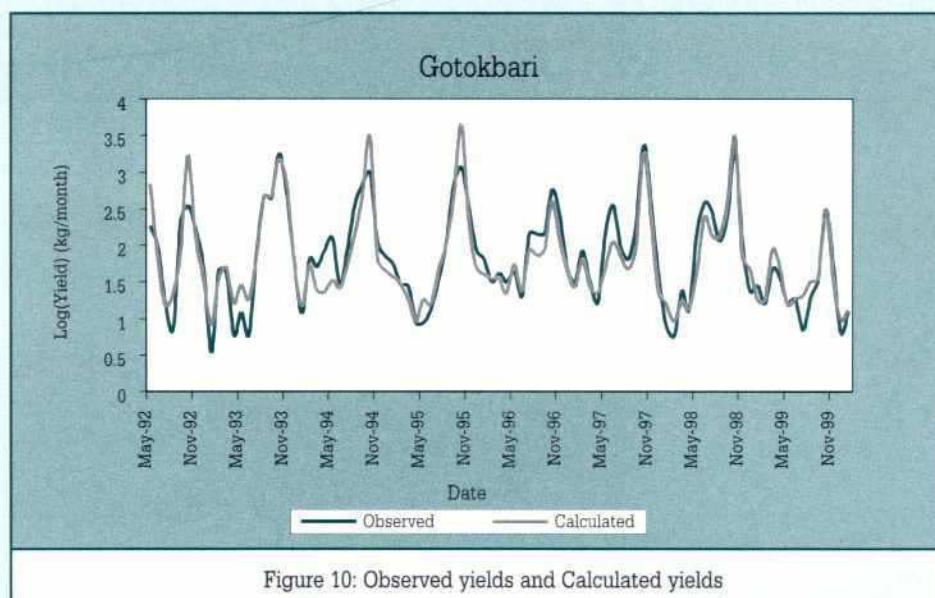
$$\text{Log(Yield)} = a + \beta_1 \text{Log(CPUE)} + \beta_2 \text{Log(effort)} + \beta_3 \text{Log(Water level)}$$

The results indicated that 74% of the variance in observed yields can be explained by changes in fishing effort, 15% can be explained by changes in CPUE and only 11% of the variance is explained by changes in water level<sup>2</sup>.

All parameters added significantly to the multi-regression line (  $P < 0.001$  ) which could be described by;

$$^{10}\text{Log(Yield)} = -10.26 + 1.64^{*10}\text{Log(CPUE)} + 2.73^{*10}\text{Log(f)} + 10.91^{*10}\text{Log(WL)}$$

In Figure 10 the observed yields and yields calculated with this multi-regression line is presented and the fit follows very well the observed values.



In contrast to the biological processes in the CPP project area the flood pulse is caused by a **human or socio-economic process, changes in fishing effort**. During the high floods, more people start fishing as more fish can be caught in one day. Another factor is that large numbers of people have no income or employment opportunity during to the high floods and go fishing and consequently the fishing effort increases rapidly.

<sup>2</sup>Within the range of observed levels of the different parameters.



224

The fact that 74% of the variation in fish yield is determined by fishing effort is of utmost importance, as most of the fisheries programs in Bangladesh (including that of CPP) do not regard this at all, but focus mainly on biological/hydrological aspects such as habitats restoration, maintaining flood levels, excavation of khals, fish passes. Therefore, it can be questioned if this path will stop the long-term downward trend of floodplain fisheries production. The exclusion of fishing effort in the discussion on fisheries programs and their implementation should be revised.

It does not mean that there is no biological basis behind the pulse, there is one; which is growth. From a fisheries point of view the positive relation between CPUE and fishing effort (Figure 11) is rather strange as in general with higher fishing efforts the CPUE decreases. This is the general concept of Surplus Production models where changes in CPUE reflect changes abundance of the fish. However, If the CPUE still reflects the abundance of fish it would mean that their abundance or density increases in years with high floods, which attract the fishermen.

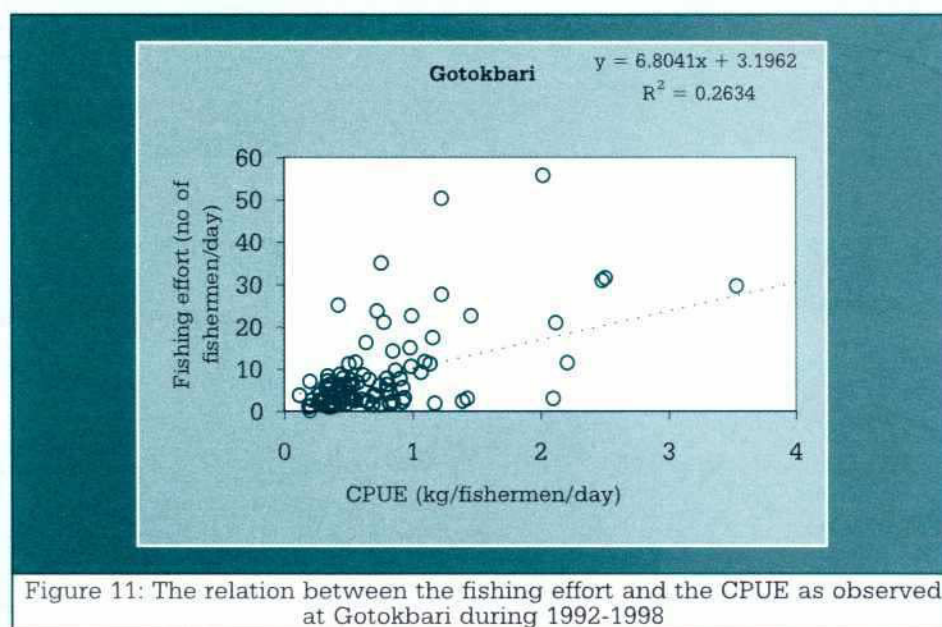
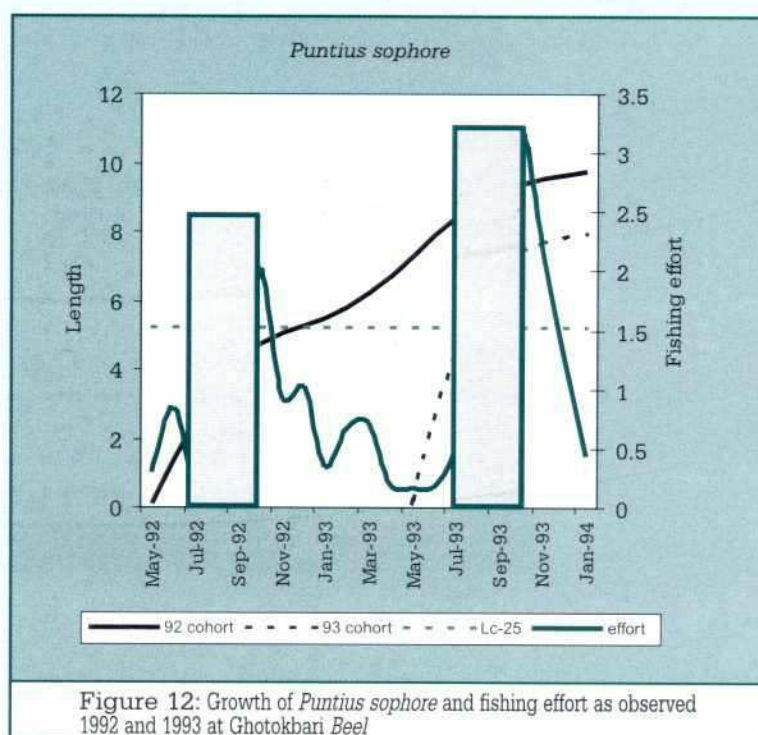


Figure 11: The relation between the fishing effort and the CPUE as observed at Gotokbari during 1992-1998

This is supported by the results of a Length Based Stock Assessment on *Puntius sophore* (Puti). In Figure 12, the growth of *Puntius sophore* is presented in relation to its length at first capture and the observed fishing effort. The flood of 1992 was relatively low and the 1992 cohort (born in May 1992) was growing slowly if compared to the 1993 cohort (born just before the high flood of 1993). Consequently, the 1992 cohort entered the catch after the flood of 1992 was over and were mainly caught

229

during the dry season of 92/93 or during the flood of 1993. In contrast, due to its high growth rate, the 1993 cohort entered the catch already during the flood of 1993 and the availability of large numbers of large specimens of the 1992 and 1993 cohort most likely raised the CPUE during this flood. The results of the stock assessment program also highlights the importance of the proper management of the water bodies during the dry season for the survival and recruitment of the stocks. Details of the Length Based Stock Assessment program have been presented in a separate Technical paper.



### Distribution of the catch among different types of fishermen

The fishermen in CPP can be classified in the following groups:

#### Professional Fishermen

Their main occupation is fishing throughout the year. Most of the professional fishermen live together in certain villages in the CPP project area (see Figure 13). The total number of professional fishing households in the CPP area was 355 at the start of CPP and this reduced to about 300 in 1998.



### *Occasional Fishermen*

In the social stratified society of Bangladesh, fishing was considered a taboo for Muslims. Nevertheless, the last decades the number of Muslims with fishing as a major occupation increased. This often in spite of intense social pressure from their co-religionists who regarded the involvement of anyone from their village in fishing as impinging on the status of the community. Because of this social stigma, people who have overcome the social barrier fish occasionally but relatively intensively during the period when fish is easily available (FAP 17, 1995). The number of occasional fishermen operating in the CPP project area could not be established due to the above-mentioned social stigma.

### *Subsistence Fishermen*

Subsistence fishermen, fish mainly for their own consumption. They use a simple gear and often it is the children or the elders who catch fish. The total number of households carrying out subsistence fishing in the CPP area was estimated at 17,290 (68% of the rural population, Household survey CPP, 1992).

In Table 8, the distribution of the catch among the different types of fishermen for F3 and F2 land types is presented.

Year	YIELD		
	Professional	Occasional	Subsistence
1992	46%	30%	24%
1993	31%	28%	41%
1994	19%	52%	29%
1995	19%	43%	38%
1996	36%	29%	35%
1997	24%	49%	27%
1998	26%	30%	45%

Table 8: Distribution of the annual yield obtained from F3 and F2 Land types among the different type of fishermen in the CPP project area

On average 37% of the catch is caught by occasional fishermen, 28% is caught by professional fishermen and 34% is caught by subsistence fishermen.

250

Fishing is an important economic activity in the CPP project area, as it generates employment and income. On average fishing in F3 and F2 land types generates 390,000 fishing days per year, with an average generated income of US\$ 450,000. However, the annual variation for these figures are very high, 138,000-946,000 fishing days/year and 156,000-1,075,000 US\$/year (Table 9) and is related again to the extent of flooding.

Year	Number of fishing days per year				US dollars generated per year			
	Prof	Occ	Sub	Total	Prof	Occ	Sub	Total
94/95	45890	104551	120416	<b>270857</b>	52148	118808	136837	<b>307793</b>
95/96	7202	94436	77235	<b>178873</b>	8184	107314	87767	<b>203265</b>
96/97	8770	86388	42968	<b>138126</b>	9965	98168	48827	<b>156960</b>
97/98	21935	259472	148568	<b>429975</b>	24926	294854	168827	<b>488607</b>
98/99	41903	512671	391579	<b>946153</b>	47617	582581	444976	<b>1075174</b>

Table 9: Total no of fishing days and income generated by different types of fishermen in the CPP project area during the period 1994-1999

#### *Income Generation and Socio-economics*

Detailed information on the socio-economic condition of the fishermen in the CPP project area at the start of the project was described in the household baseline report (Annex 1.1, Interim report CPP, 1992) a similar survey for the professional fishermen only was carried out in 1996 (CPP, 1996). The results of the fisheries monitoring program however can provide already some insight in eventual changes that occurred during the last 7 years.

In the past, the professional fishermen were complaining that they were losing income and that their situation was becoming worse due to CPP interventions. They made their complaint and the former Minister of Development Co-operation of the Netherlands, during his visit in 1996, promised to make a budget available to carry out a special program to compensate the professional fishermen.

With the present results of the monitoring program, it can be investigated if the complaints of the fishermen are correct and should be honored. During the monitoring program on average 12 professional, 16 occasional and 72 subsistence fishermen per month were covered (total number 9000). The field staff almost remained the same during the entire period and developed good relations with all fishermen. Considering the number of catches weighed and the relation with the fishermen, we can consider the monitoring program as an independent and non-biased one.



### Professional Fishermen

Traditionally, the professional fishermen in Bangladesh and also in the CPP project area are low cast Hindu with fishing mainly carried out by the Rajbankshi, the Bapari and Halder communities. The professional Hindu fishermen belong to the poorest segment of the population and some basic socio-economic data are presented in Table 10.

Average annual income per HH	14000 Tk
Percentage functional landless	94%
One room house	75%
Assets below 2000 Tk	97%
Table 10: Some socio-economic parameters of professional fishermen in the CPP project area	

The professional Hindu fishermen traditionally live in clusters, the so-called Jele Para, in 11 villages in the CPP project area. From these villages they move to their fishing grounds which are sometimes close to their village but sometime they go far away up to the Dhaleswari River (Figure 13).

From 1992, the daily income obtained from fisheries was monitored in the catch assessment survey. The results are presented in Figure 14. The daily income of the professional fishermen fluctuates around 50 Tk/day with some peaks 60-120 Tk/day during high floods in October. From the data, it can not be concluded that the average daily income of the professional fishermen became less. It can be argued that during the same period everything became more expensive and that we have to correct for inflation. This is complicated and it is easier to look at the daily catch of the fishermen (Figure 15).

From the results it can only be concluded that for the professional fishermen, the last two years (1997 and 1998) were bumper years with high daily catches due to the high floods (Figure 16). During the visit of the former Minister of Development Co-operation of the Netherlands, the fishermen were experiencing an extremely bad year which catches more than 50% below average. But this is all due to "nature", "the extent of flooding" and it is quite normal that the fishermen blame CPP for this if asked about their situation during this difficult period.





202

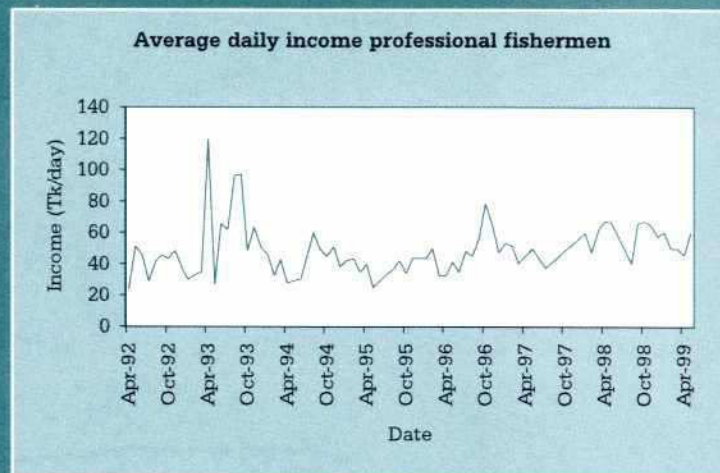


Figure 14: Average daily income obtained from fishing by professional fishermen in the CPP project area during the period 1992-1999

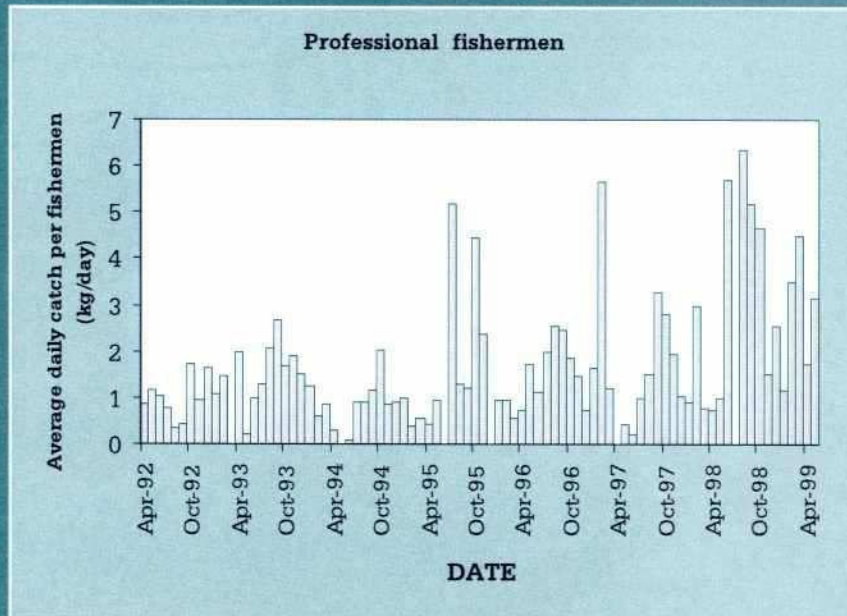
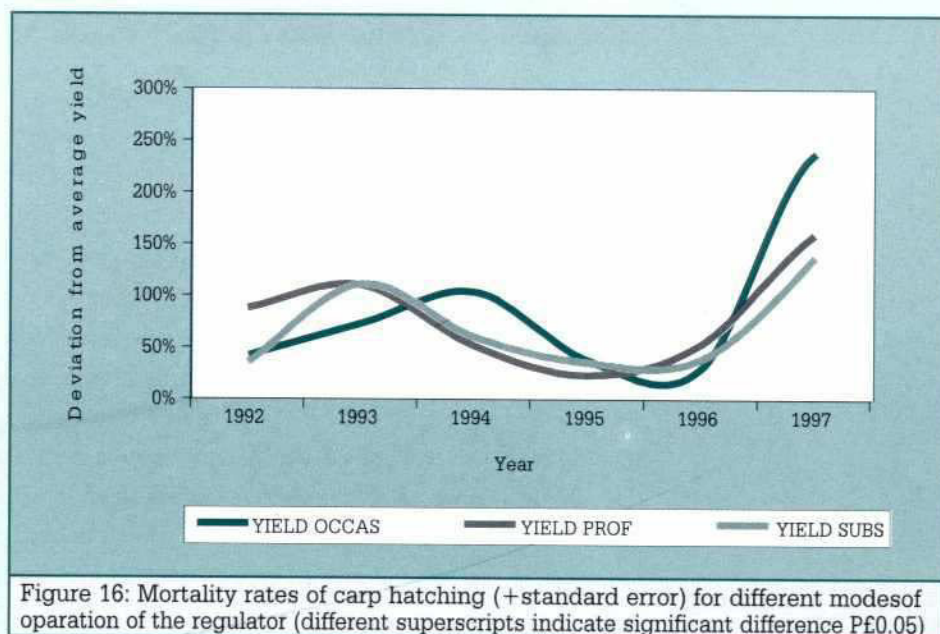


Figure 15: Average daily catch by professional fishermen in the CPP project area during the period 1992-1999



On the other hand, the professional fishermen are facing in their daily existence the following problems:

- One of the off-spins of the third fisheries project, which was carried out in Bangladesh in the early 90s, was that stocking of beels and floodplains with small fish, or transforming a beel into a large fish pond, got huge publicity. Owners of beels or influential people understood that this activity is very lucrative and now 9 out of 24 beels in the-CPP area were brought under this so called culture based fisheries system. Indirectly CPP had an influence on this process as the project area became more secure, and the people are less afraid that they will lose their fish because of flooding. One of side effects of culture based fisheries is that common access to the beel becomes restricted, in most cases the owners protect their stocked fish with armed guards or mastan and for the fishermen, their fishing grounds became less. This was the major reason why CPP did not want to include culture-based fisheries in the mitigation measures (CPP 1993),
- Jugini beel, the only khas beel in the CPP project area, which used to be leased out to professional fishermen was taken over by the mastan in 1992/93, they were the first to introduce culture based fisheries in CPP, and
- The number of occasional fishermen, competing with the professional fishermen for the same stocks increased rapidly in the last two years.



## Conclusions, lessons learned and recommendations

### *Method Used by CPP*

The long-term fisheries monitoring program provided detailed information on fish catch and biological, hydrological and socio-economic factors influencing the catch. The developed method of habitat based monitoring and integration of the results with hydrological data in a GIS environment is new, but essential, as traditional catch and effort monitoring programs can not be applied to floodplain fisheries. The method proved to be reliable and simple and it is recommended to apply this method if floodplain fisheries production has to be determined.

Integrating fish catches obtained from different habitats with results of hydrological models or GIS was already introduced during the Inception phase of CPP (CPP, 1992). Obtaining reliable results was a long process and the major problem was to determine the total inundated area in the CPP project area and to predict the future inundated area for different management scenarios (CPP, 1994). The hydrological models and flood management models made, focused on the 4-5 month of the flood, while fisheries is carried out during the whole year. Collection of water levels was mainly done for the hydrological models and this activity decreased sharply during the dry season. For a fisheries model, a complete water balance model is needed and dry season water levels are as important as monsoon season water levels. Once reliable, all season water levels and a Digital Elevation Model is available, the creation of a fisheries model becomes straightforward.

### *Total catch and impact on livelihood*

During the period 1992-1999, fish catch in the CPP project area varied largely. The variations were, however, mainly caused by the intensity of the flood and its related impact on the fishing behavior of the fishermen. Until now, there are no indications that the project affected the fish catch within the CPP area and controlled flooding has certainly less impact on fisheries if compared with complete flood control.

It can, however, be discussed how far CPP water management has been effective till now and what will happen if management of the different regulators, and maintaining certain target water levels becomes a daily reality. A predictive fisheries-agriculture model as developed by CPP will be used to estimate the impact of different water management scenarios on fisheries, agriculture and socio economics. The results of this exercise will be presented in separate technical paper.

The total fish production of F2 land is far more important than the catch obtained from the permanent water bodies. This aspect should be emphasized in the evaluation of

202

any water management scheme, as most hydrological changes will take place at the F2 and F1 land types.

The daily catch and income of the professional fishermen was not impacted by CPP during the monitored period. Their situation worsened, as they have to share the common resources with increasing numbers of occasional Muslim fishermen. This situation, however, occurs all over Bangladesh.

The results of the monitoring program indicated that a major factor influencing the annual floodplain catch is mainly a human one, the number of fishermen. The latter is of utmost importance as most of the fisheries programs in Bangladesh and discussions about the 'reduction of the natural fisheries resources focus on habitats and flood levels'. The programs must include the human aspects, such over-exploitation and fishing effort; otherwise, they are doomed to fail in the long term.

Biologically the "flood pulse" is caused by higher growth rates obtained during years of high flood resulting in capture of the young fish already a couple of month after they are born and within this respect proper management of the dry season water level is of utmost importance for the surviving specimen.



# Reproductive strategies and consequences for water management

## Introduction

During the inception phase, it was postulated that the early water rise in the beel, due to rainwater congestion could be the triggering factor for reproduction of "beel resident fish" which is directly followed by a nursing period in the shallow inundated low lands around the beel. Drainage of this rainwater could result in delayed spawning of beel resident fish species. Within this situation, the beel fish will reproduce at the moment the water rises because of the incoming river floodwater. This incoming flood water carries also thousands of riverine fish-larvae and from an ecological and fisheries production point of view a hazardous situation is created. Two groups of fish with their own reproductive strategy, living in separate ecological niches are mixed, resulting in a competition for food in their early life and it can be expected that the later born beel fish will lose this struggle.

Although this reproductive strategy is well known and described for the African catfish (*Clarias gariepinus*) little is known of the beel resident species of Bangladesh, which made it difficult to convince non-fisheries people of the importance of this matter. It makes it even more difficult because we were dealing with the so-called "miscellaneous" or "small" fish, which until the early 90's almost received no attention in Bangladesh. However, the matter was important, as 80-90% of the catch in the project area consisted of beel resident fish species. To get more detailed information on the reproductive behavior of this group of fish, the fisheries program of CPP monitored the reproductive strategies of 7 beel resident fish species during four seasons, (1992-1994). Details of the results were presented earlier in a Technical note of CPP (CPP, 1994). The results and recommendations for water management are summarized below.

## Results of the Study on Reproductive Strategies of Beel Resident Fish Species

In Jugini, Gharinda and Ghotokbari beel, the fisheries monitoring program studied the reproductive strategy of the following beel resident fish species:

- *Puntius sophore* (Puti),
- *Ophiocephalus punctatus* (Taki),
- *Heteropneustes fossilis* (Shing),
- *Anabas testudineus* (Koi),
- *Lepidocephalus guntea* (Gutum),
- *Mastacembelus pancalus* (Baim), and
- *Colisa fasciatus* (Kolisha).



During the three years study about 14,000 fish were bought from the fishermen at the three sites and from female fish the development of their eggs and the moment of reproduction was followed. This development was related to the water level, the water temperature of the different *beels* and rainfall in the CPP area.

The study indicated that the reproduction of 4 out of 7 species was triggered by the rise of the water level. Within one season these species reproduced at different times in the different *beels* and over the three seasons a similar phenomena was found within same *beels*. The timing of reproduction was found to be related to the timing of the rise in water level.

<i>Puntius Sophore (Puti)</i>	has a short distinctive reproduction period and spawning is triggered by increased water levels
<i>Ophiocephalus punctatus (Taki)</i>	has a long reproduction season (which is confirmed by the presence of juveniles in May/June) and reproduction is probably not directly triggered by an increase in water levels
<i>Heteropneustes fossilis (Shing)</i>	has a long reproduction season (which is confirmed by the early presence of juveniles in May/June) and reproduction is probably not directly triggered by an increase in water levels,
<i>Lepidocephalus guntea (Gutum)</i>	has a short and distinctive reproduction period and reproduction is directly triggered by an increase in water levels,
<i>Anabas testudineus (Koi)</i>	has a short and distinctive reproduction period and reproduction is directly triggered by an increase in water levels,
<i>Mastacembelus pancalus (Baim)</i>	has a long reproduction season and reproduction is probably not directly triggered by an increase in water levels,
<i>Colisa fasciatus (Kolisha)</i>	has a short and distinctive reproduction period and reproduction is directly triggered by an increase in water levels,

Because of the study on reproductive strategies of beel resident fish species, CPP formulated a "Beel-concept" to safeguard the spawning of the beel resident fish species in time. The basic philosophy behind the Beel-concept is a **sharing of**



264

**resources.** The agriculture sector can **reclaim** some low lying areas around the beels for improvement of paddy production and at the same time the reproduction for the *beel* resident species will be maintained. The basic concept was to maintain certain bed levels in drainage channels from the perennial *beels* to guarantee a pre-monsoon water-level rise of 1 meter. The concept has been presented at the "National Workshop On Floodplain Fisheries" organized by the FAO during 29th November to 1st December 1995 in Dhaka and the concept has been included in the official recommendation of the workshop for water management projects of the country.

### **The Beel-concept as Developed by CPP**

Figure 17 illustrates the developed beel-concept. At pre-CPP situation under normal conditions, the pre-monsoon water-level rise in the *beels* was more than 1 meter as most of the *khals* were silted and drainage was hampered. The rainwater congestion in these low lands could cause some damage to the irrigated rice crops (Boro) and the farmers wanted to improve their situation.

Completely excavating the *khals* and lowering the bed levels of the *khals* substantially would result in improved drainage and in a part of the low land the risk for Boro cultivation would be less. Implementing this scenario would, however, result in a complete loss of the earlier mentioned beel resident species, as their reproduction will be hampered.

The beel-concept includes that excavation of the drainage channels will be done until a level of 1-1.5 m above the average dry season water level of the beel concerned. Below this level, water will not be drained and consequently reproduction of *beel* resident fish is not completely hampered whereas higher levels exceeding 1-1.5 m can still be drained and the area under Boro cultivation will still increase if compared to the pre-project situation. Introduction of the beel-concept is, therefore, a compromise between fisheries and agriculture. It can not be stated enough, the beel-concept is **NOT** putting 1 meter of water on paddy fields. With the beel-concept, less water is drained of and there is still an improvement of the situation for farmers, compared to the pre-project situation. At the same time, the beel-concept will reduce the losses for fishermen. The result is that farmers will be gaining, and fishermen will be loosing, but limited compared to full drainage.

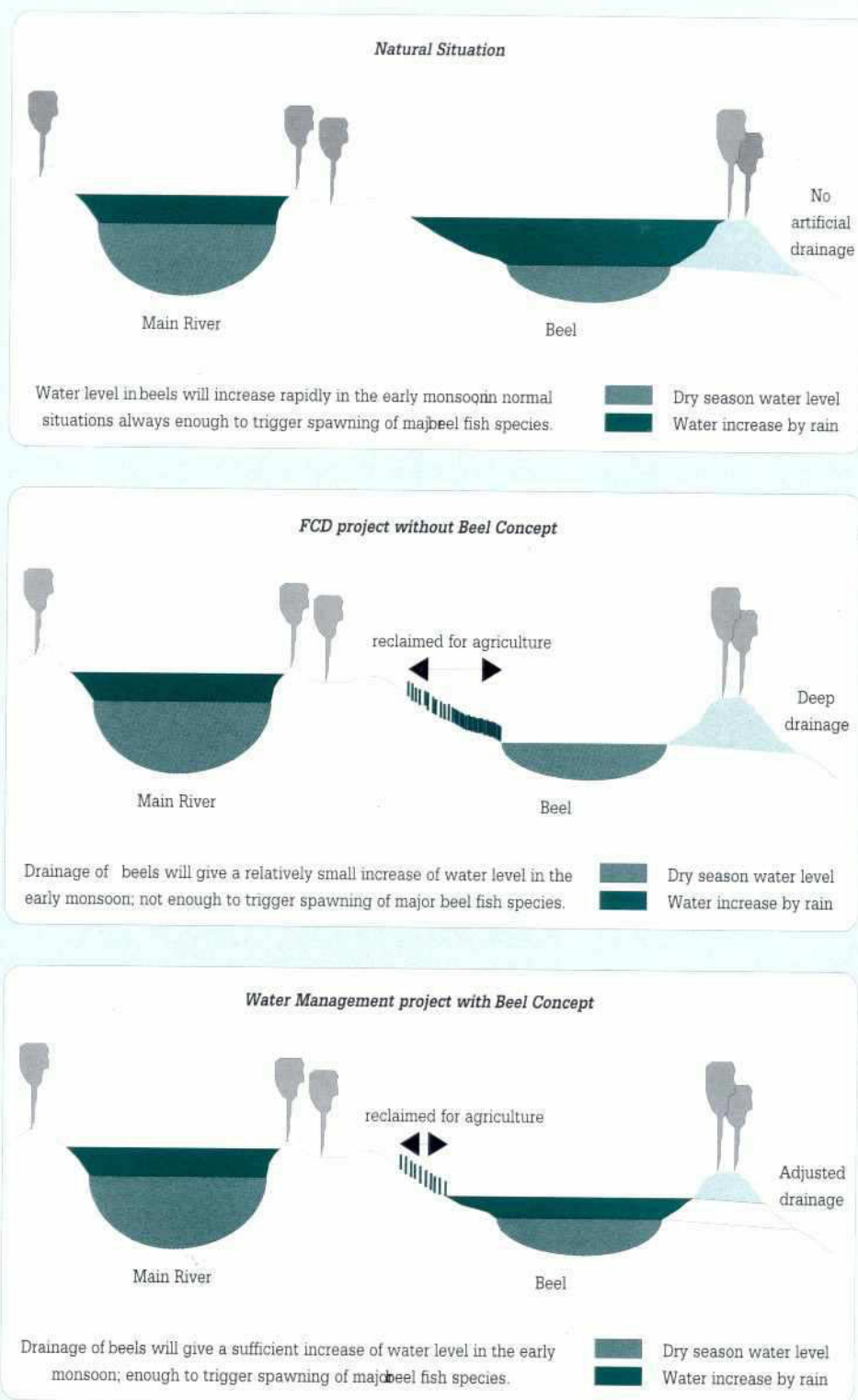


Figure 17: A schematic view of water and agriculture around beels in the pre CPP period, a complete drainage for agriculture land reclamation and the situation with implementation of the Beel-concept



## Economic Evaluation of Drainage of Seasonal or Perennial Beels

Maintaining free access to the beels and maintaining a healthy and reproducing fish population in the *beels* was a basic philosophy for the intervention programs proposed. This strategy derived from the fact that the majority of the rural population within the CPP area depended on fisheries for their daily animal protein intake. It can be stated that poverty alleviation and distribution of common resources drove the strategy.

The beel-concept and drainage of low lands can also be evaluated on pure economic terms. This evaluation can be carried out as fisheries and agriculture developments have been monitored thoroughly during the last seven years by CPP and are presented here as a case study.

Singerkona beel has been used for the economic evaluation of the following water management scenarios:

- No intervention,
- Drainage with the beel-concept, and
- Full drainage.

In GIS the land-type distribution for the three options were calculated and they are presented in Table 11.

Land type	Area (ha)		
	No intervention	Beel-concept	Full drainage
F <sub>0</sub>	143	310	310
F <sub>1</sub>	167	0	0
F <sub>2</sub>	250	250	280
F <sub>3</sub>	15	30	0
F <sub>4</sub>	15	0	0

Table 11: Land type distribution for three types of interventions in Singerkona Beel

The fisheries monitoring program provided detailed information on production levels, the number and type of fish gears used in the floodplains of the CPP project area. Interviews with fishermen provided the information of investments and life span of the gears. This allowed estimating the economics of fisheries for different phases of fisheries development.

The net profit per ha for the different stages of fisheries development and for agriculture as collected by the monitoring and evaluation section of CPP, for the different land types are presented in Table 12, details has been provided in a separate technical paper.

Land type	Net profit (Tk/ha/year)					
	Agriculture	Fisheries				
		Healthy floodplain	Over exploited Floodplain	Controlled flooding with Beel concept	Full drainage	Complete Flood prevention
F <sub>0</sub>	27000	0	0	0	0	0
F <sub>1</sub>	21000	1156	882	555	243	0
F <sub>2</sub>	14000	8696	6579	4243	1855	0
F <sub>3</sub>	9000	18161	13848	8888	3884	970
F <sub>4</sub>	0	18161	13848	8888	3884	970

Table 12: Net profits (Tk/ha/year) for fisheries and agriculture in different land types in CPP and stages of water management

From a fisheries point of view, Singerkona Beel was in a stage of over-exploitation, as the fishermen caught almost no Indian carps. This baseline situation is compared with the net total profit obtained after drainage with the beel-concept and after full drainage.

The highest net profits are obtained through implementation of drainage with the beel-concept, 13.5 million Tk/year, followed by no interventions 13.2 million Tk/year and full drainage gives a net profit of 12.8 million Tk/year (Table 13). Investment costs, operation, and maintenance for excavation of khals, construction of regulators, etc, for drainage with the beel-concept or full drainage was not included in the comparison.

Land type	Net Annual profit (Tk/year)		
	No intervention	Beel- concept	Full drainage
F <sub>0</sub>	3861000	8370000	8370000
F <sub>1</sub>	3654294	0	0
F <sub>2</sub>	5144750	4560750	4439400
F <sub>3</sub>	342720	536640	0
F <sub>4</sub>	207720	0	0
<b>Total</b>	<b>13210484</b>	<b>13467390</b>	<b>12809400</b>

Table 13: Net annual profits for Singerkona Beel calculated for three types of interventions



282

If the pre-intervention situation is better for fisheries, i.e. a healthy floodplain with Major carps included in the catch, than the highest profits are found with no interventions, 13.9 million Tk/year, followed by drainage with the beel-concept, 13.5 million Tk/year and full drainage 12.8 million Tk/year (Table 14).

Land type	Net Annual profit (Tk/year)		
	Healthy Flood plain	Beel- concept	Full drainage
F <sub>0</sub>	3861000	8370000	8370000
F <sub>1</sub>	3700052	0	0
F <sub>2</sub>	5674000	4560750	4439400
F <sub>3</sub>	407415	536640	0
F <sub>4</sub>	272415	0	0
<b>Total</b>	<b>13914882</b>	<b>13467390</b>	<b>12809400</b>

Table 14: Net annual profits for Singerkona Beel calculated for three types of interventions

From the comparison it can be concluded that converting low lying lands into paddy fields is not economically profitable and does not justify the efforts and investments.

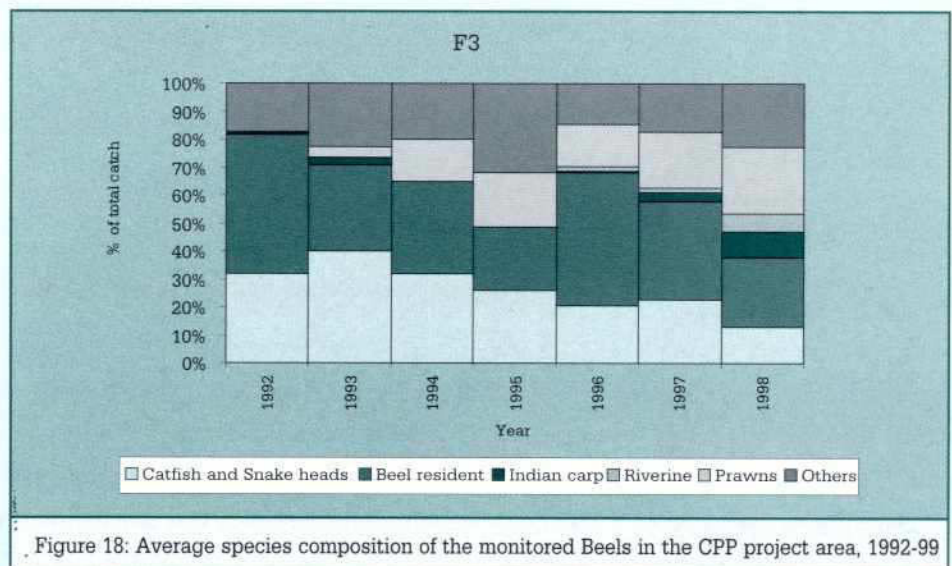
### The Implementation of the Beel-concept in CPP and Present Status of Beel Fisheries

The beel-concept has not been implemented in the CPP project area. In 15 out of the 20 perennial beels, a complete drainage system has been implemented. Around the five remaining perennial beels, drainage could not be improved due to the hydrological and topographic conditions in the area.

The fisheries monitoring program covered 3-5 perennial *beels* on a regular basis. Their average species composition over the years is presented in Figure 18. The data indicate that the catch of small prawns (*Chingri* and *Icha*) increased gradually. The major reason is drainage of one of the monitored beels; Gharinda Beel, due to interventions not related to CPP. A similar phenomena could have occurred at the *beels* drained by CPP, unfortunately this has not been monitored over time<sup>3</sup> so it is difficult to draw conclusions now. The driving force behind this change is discussed in the next chapter.

<sup>3</sup> A rapid appraisal is currently carried out at all beels in the CPP project area

286





# Fish Bio-diversity, Fisheries and Water Management

Interventions made for the improvement of water management affects fisheries in areas such as:

- The total inundated area decreases resulting in a lower total catch,
- The intensity of the flood is reduced which results in lower yields per ha of floodplain,
- Migration routes are blocked resulting in lower yields of migratory fish, and
- Spawning areas such as *beels* are disturbed or disappear resulting in lower yields of beel resident species.

The scale or intensity of the interventions determines the impact on fisheries i.e. submersible embankments will have less impact than complete flood control.

Events, which took place over the years at two monitored beels in the CPP area, provided insight in the different processes. This allowed defining a preliminary "bio-diversity/production index" for subsequent stages of water management interventions in floodplain ecosystems. The case study of Garinda and Ghotokbari Beel and its relation to bio-diversity and production is presented in this chapter.

## Garinda and Ghotokbari Beel

Garinda and Ghotokbari Beel were monitored from 1992 and in both beels the catch followed the seasonal patterns, with peak catches during the receding of the flood water in October and a high annual catch in years with high floods. However, in 1999 the catch in Garinda Beel completely collapsed while the catch in Ghotokbari Beel continued as normal. Analysis of data indicated that alteration of the spawning area was the major factor for the gradual collapse and that first sign, a changing species composition, was already visible in 1997.

Since 1996, beel dependent fish species such as *Puti*, *Baim*, *Kolisha* are gradually replaced by small prawns (*Icha* and *Chingri*) while the percentage of Catfish/Snakeheads remains more or less constant over this period (Figure 19). In Ghotokbari Beel, the species composition remained more or less stable during the same period (Figure 20).

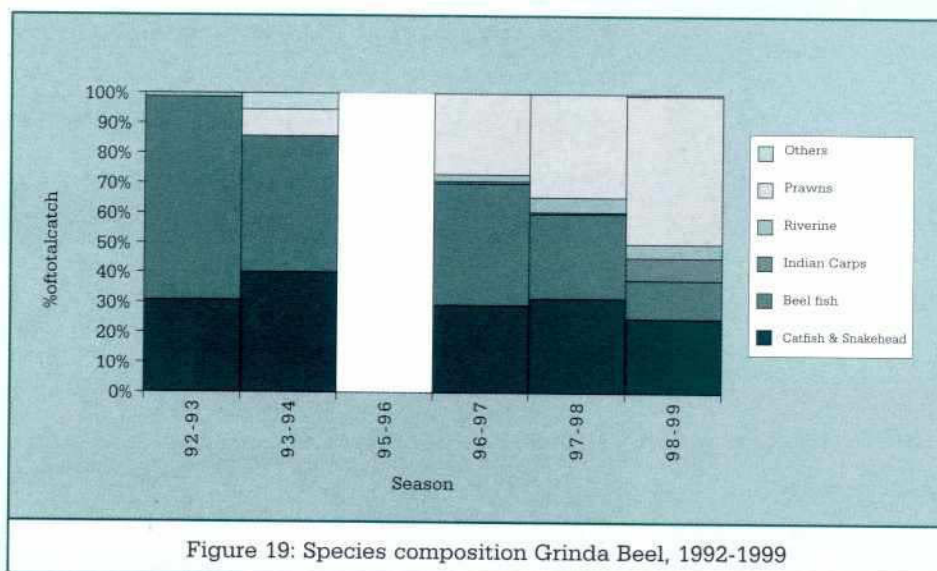


Figure 19: Species composition Grinda Beel, 1992-1999

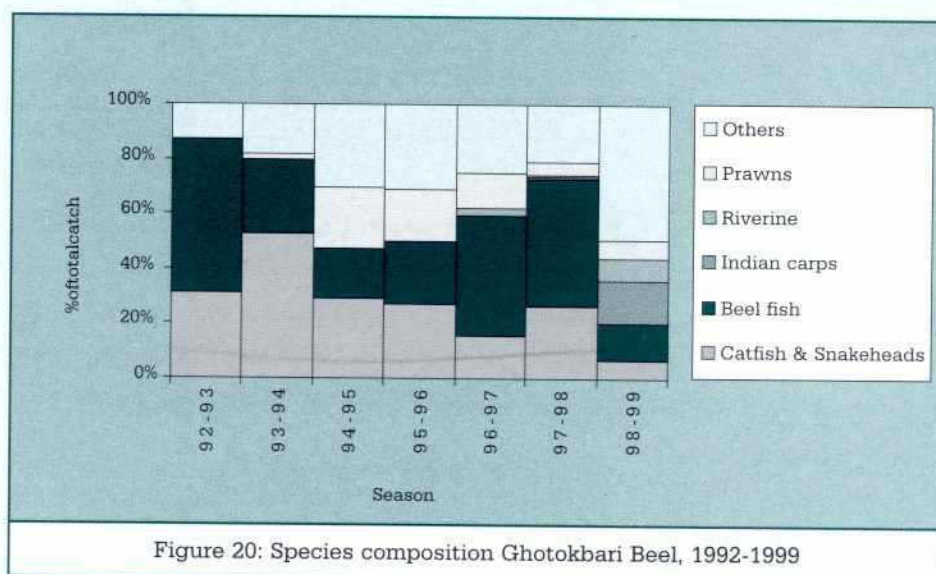


Figure 20: Species composition Ghotokbari Beel, 1992-1999

The overall number of fishermen or gears used did not differ among the two sites. The only difference was that, due to the construction of a culvert<sup>4</sup>, the dry season water-level dropped by 50 cm in Garinda Beel after 1996 and as a consequence in May 1999 Garinda beel covered 0.5 ha instead of 7 ha as measured in May 1992.

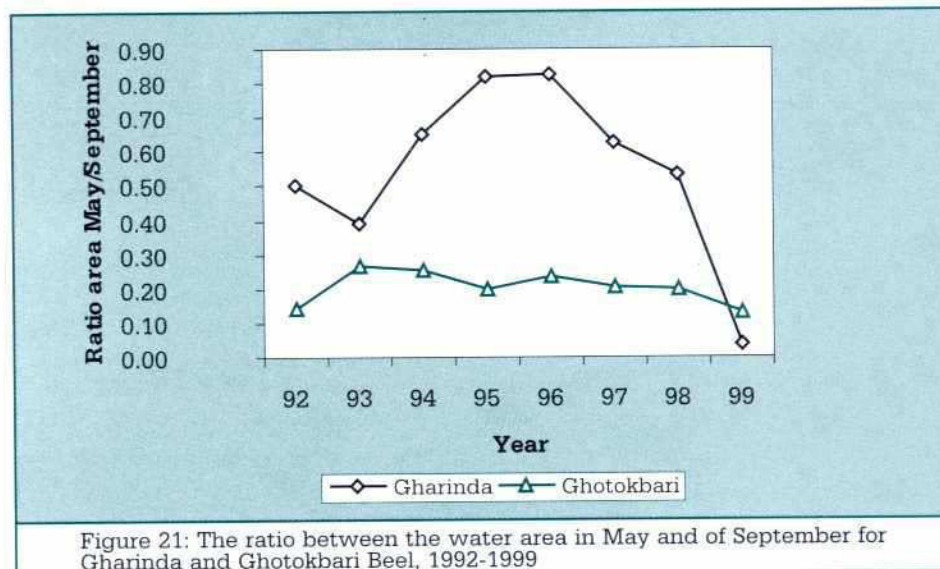
The water area covering a beel during April-May is the recruitment area for the fish. If this reduces to almost zero, recruitment will be zero and no fish will be found even if the area gets flooded soon after. This phenomena has been observed at Beel Dakatia just after implementation of the emergency dredging by BWDB (KJDRP, 1996). This

<sup>4</sup> A non-CPP intervention.



287

process gradually occurred at Garinda beel as is indicated by the gradually reducing ratio between the water area in May and the water area in September of a same year (Figure 21) for Ghotokbari beel this ratio did not change over the years.



The observation extends the beel-concept to maintain a healthy population of beel dependent fish species such as *Puti*, *Baim*, and *Kholisha*. A water level rise in the pre-monsoon is essential but the population will still collapse if the total spawning area is reduced too much and only *Shing*, *Taki* and small prawns will survive as has been observed for example in Garinda Beel and in the Chandpur Irrigation project.

### A Rapid Fish Bio-diversity Appraisal for Floodplain Ecosystems

In the previous chapter changes of species composition due to reduced spawning area was discussed. There are, however, some other examples from Bangladesh and from floodplains in other countries. These examples allow defining a broad indicator for fish bio-diversity related to fisheries and water management.

In general, it can be stated that in over-exploited floodplains, with a high fishing pressure, the large, slow growing species and the species that start to reproduce after 2-3 years are replaced by quick growing and fast reproducing species. This could be one of the reasons why the Indian carps disappeared from the floodplain catches in the last decades.

289

The results of the fisheries monitoring program at the Chandpur Irrigation project indicated that a complete "cut off" of a floodplain system from annual flooding results in a species shift towards Catfish (Shing), Snakeheads (Taki) and small Prawns (*Chingri and Icha*).

The results of Garinda Beel in the CPP area and Beel Dakatia in the Khulna Jessore Drainage Irrigation Project area indicated that even if the floodplain is not "cut off" from annual flooding, a similar shift takes place if the spawning area becomes too small. The remaining species will be Catfish, Snakeheads, Prawns and riverine species entering the floodplain with the annual flood.

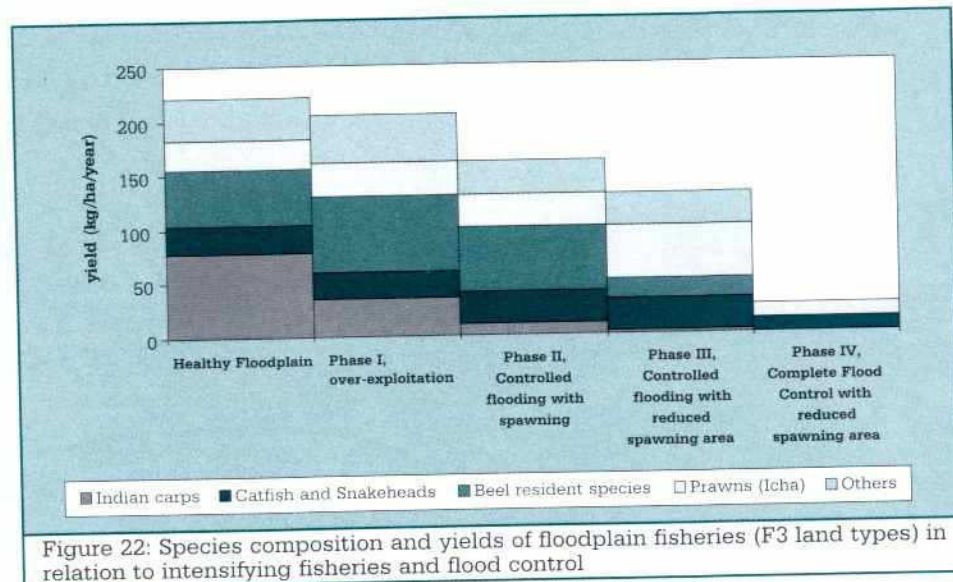
In relation to floodplain fisheries and water management the following successive phases in fish bio-diversity can be recognized:

- **Phase I** a healthy flood plain system with no over-exploitation. This situation existed some twenty years ago and maybe still exists in the large floodplains in the north of the country and in Sylhet,
- **Phase II** an over-exploited floodplain, due to the high fishing effort, and small mesh-sizes used. The Indian carp stocks and other large fish come under pressure, they disappear as they reproduce only after several years and are gradually replaced by fast growing, small but quick reproducing fish, the "miscellaneous" species,
- **Phase III** controlled flooding and improved drainage is carried out, the total beel area reduces somewhat but beel resident species are still abundant,
- **Phase IV** controlled flooding and drainage is further improved, large extraction of groundwater for Boro irrigation and the area dries out. Spawning area in the pre-monsoon is seriously reduced. Beel resident species such as *Puti, Baim, and Gutum* are under pressure and will disappear. Some riverine fish are still available because annual flooding still continues and small prawns become the bulk of the biomass, and
- **Phase V** Complete flood control. Catfish, small prawns and snakeheads are the only survivors.

In Figure 22, a first attempt is made to visualize and quantify the successive phases. The mentioned species can be used as indicators for bio-diversity and health of a floodplain system and it is strongly recommended to try out this method for floodplains in Bangladesh. This method can be considered as a Rapid Fish Bio-diversity Appraisal, whereby the dominance of small prawns is used as a key indicator for the status of the system, is most likely more practical and less time consuming than trying to cover all species in a bio-diversity index.



28



### Lessons Learned and Recommendations

One of the major lessons learned in the project concerning the perennial *beels* is that before any design is made there should be a clear policy on water and fisheries. What is the minimum area of water bodies to be maintained after a project is implemented? Policy makers, planners, economists, and biologists should set national criteria. Once the criteria are defined and provided by policy makers, designs for improved water management can be made and the criteria should be incorporated in the project design.

Defining of such criteria should be one of the priorities of the National Water Development Plan and WARPO.

# Hatchling Migration and Consequences for Water Management

## Hatchling Migration

Hatchlings from riverine fish as *Catla*, *Rui*, and *Mrigal* are entering the floodplain with the river floodwater in the early monsoon. Specific information on distribution in time and distribution in the water column could not be found in the literature. This information was crucial for the design and the establishment of operation guidelines of water management structures as planned in the CPP project area.

Therefore, CPP studied the hatchling migration during the monsoon of 1992, 1993 and 1994 and formulated design and operation criteria for the major regulator in the Lohajang River.

The results of this study were presented in an earlier technical report of CPP (CPP 1994) and in the Journal of Fisheries Management and Ecology, 1999, 6 and are summarized in this chapter.

The larvae were coming in waves (Figure 23) and it seems that the peak of the waves is related to peak water levels of the Jamuna River. In all three studied years, carps were found within the first waves only and were absent after the first of September. *Hilsa* spp. (*Tenualosa*) and other non-identified species were found throughout the monsoon.

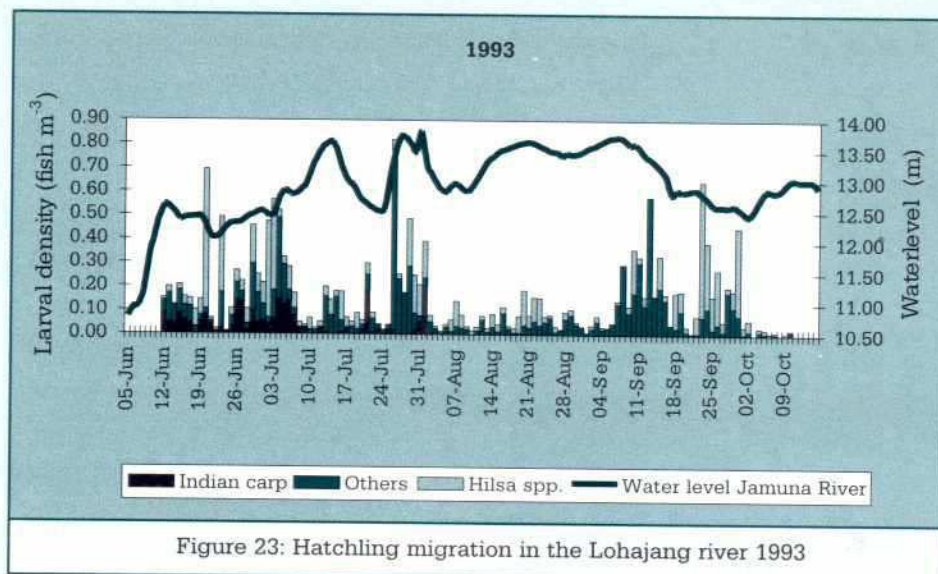


Figure 23: Hatchling migration in the Lohajang river 1993

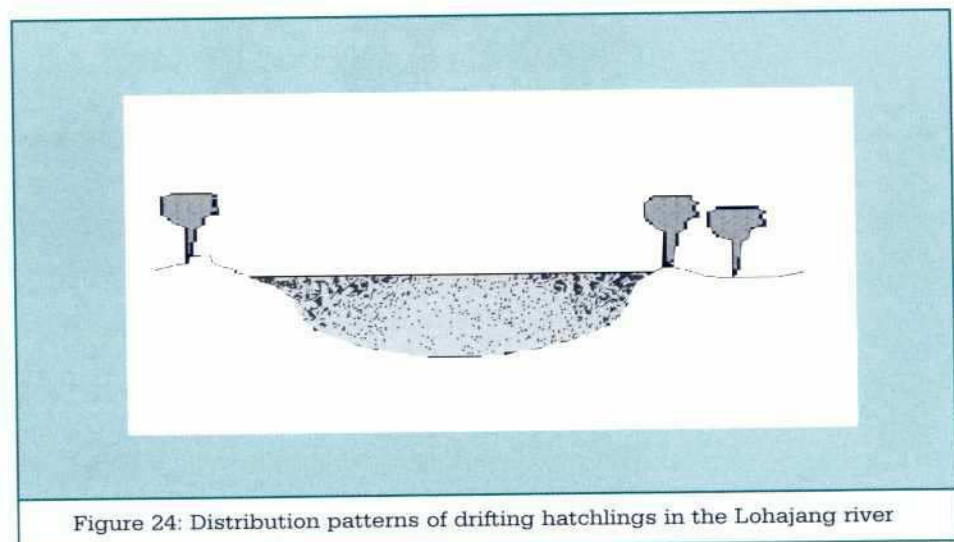


28

In 1993, which was a year with normal/high flooding, significantly higher carp densities were found than during 1992 and 1994, which were relatively dry years. Flooding of upstream spawning areas is considered important for natural stocking of downstream floodplain areas. Protection of the spawning areas is, therefore, important to the perpetuation of Indian carp stocks.

Larvae of Indian carps cannot move actively against currents  $>0.1 \text{ m.s}^{-1}$  and consequently eggs and larvae are flushed from spawning grounds with receding flood waters and are transported passively downstream to the lower lying floodplains which serve as nursery area. The hatchling study indicated that spawning of Indian carps in the Brahmaputra River took place during the first 8-10 weeks of the monsoon flood. Therefore, it was recommended to keep the main regulator open during this period.

The highest hatchling densities are found in the surface layer of the river near the embankment (Figure 24) and no diurnal (night versus day) distribution patterns were found. The turbidity of the river water is most likely the force behind the presence of vertical and horizontal distribution patterns and the absence of diurnal distribution patterns. Similar results were reported for fish larvae in the Amazon River. Pavlov (1995) found that larvae from the same taxonomic group drifted in different layers of the water column in different rivers. In a turbid river e.g. the Amazon River, *Characiformes* larvae migrated through the mid-depth/surface while in a clear-water river, e.g. the Nanay River, they migrated through the mid-depth layer. The Lohajang River is a turbid river and its turbidity or sediment load may be a regulating force in vertical and horizontal distribution patterns of fish larvae.



282

The implication for water management interventions of finding that fish larvae are drifting through the surface and near the embankments, is that gates should be constructed near the embankment, and structures should be of a free flow type, and should be operated in an over-shot condition, taking the water from the surface layer of the water course to maximize larval influx.

The recommendations for the design of the main regulator were followed and two special fish gates on the left and the right-hand side of the regulator were incorporated (Figure 25). If during the period of larval drift the water level becomes too high, then the main gates can be closed and the open side gates could still allow some hatchling drift.

There is sometimes confusion about fish passes and fish gates, especially as related to maximum flow rates. A fish pass is constructed (FAP- 6) to allow adult fish at the end of the winter to migrate actively against the current, towards the spawning places. Fish gates are constructed to allow hatchlings to drift smoothly with the current into the floodplain.



Figure 25: The Main Inlet in the Lohajang River with the Fish Gates



## The Main Regulator

The main regulator constructed in the Lohajang River could be called "fish friendly" if the location of the drifting hatchlings and the specially constructed side vents are considered. It is, however, not known what happens with the fish larvae once they pass through the main gates or the side vents. CPP studied this aspect of fish migration. In 1995 and 1996, fish larvae were caught before and after the main regulator and mortality rates were compared. From these experiments, no conclusions could be drawn as the hatchling density in the water was low and consequently, the nets had to be placed in the water for over one hour to collect some hatchlings. The mortality caused by the fact that the hatchlings were trapped in the nets for such a long period was most likely higher than the mortality caused by the regulator.

In 1998/99, a new study was started which used another technique to overcome this problem. Fingerlings/hatchlings were released<sup>5</sup> in front of the regulator and were caught just before and just after the regulator, after which mortality rates of the two groups were compared with a non-treated control group.

Date	Mortality (%)				Gate setting
	Hatchery	Upstream	Downstream	Regulator effect	
16/07/99	15	10	48	38	undershot
17/07/99	10	24	84	60	undershot
19/07/99	9	27	61	34	undershot
06/07/99	1	21	66	44	undershot
20/07/99	13	15	17	3	overshot
20/08/99	3	18	27	9	overshot
21/08/99	6	8	16	8	overshot
23/08/99	10	23	34	11	overshot
24/08/99	4	11	41	29	overshot
25/08/99	2	8	20	12	overshot

Table 15: Mortality rates of the Lohajang regulator on released carp hatchlings

In 1998, preliminary experiments were carried out with fingerlings but the results were not conclusive. In 1999, the experiments were repeated with carp hatchlings of 0.2 gram. Unfortunately, the monsoon of 1999 was very dry and only a limited number of experiments could be carried at the main gates only, due to the extreme low water

<sup>5</sup> About 20,000 per experiment.

2/16

levels. During the experiments the regulator was operated in two different modes; Overshot (water is flowing over a closed gate-door) or Undershot (water is flowing under a semi-closed gate-door). The effect of the regulator on the mortality of hatchlings for the different modes of operation is presented in Table 15 and Table 16.

Mode of operation	Mortality rate (%)	N
Overshot	$12^B \pm 3.6$	6
Undershot	$44^A \pm 5.6$	4

Table 16: Mortality rates of carp hatchlings ( $\pm$  standard error) for different modes of operation of the regulator (different superscripts indicate significant difference  $P < 0.05$ )

About 44% of the hatchlings died within 5 hours after passing the regulator if it was operated in an undershot mode, which is the standard mode of operation in Bangladesh. When the regulator was operated in an overshot mode, the mortality reduced significantly to about 12%. It can be concluded that the main gates of the Lohajang regulator are **not fish friendly**, especially if used in the standard undershot mode of operation. Overshot operation would improve the situation and this type of operation has been modeled for different water levels and management scenarios in the CPP area.

Considering the mortality rates of regulators on drifting hatchlings and the number of regulators in the different water ways (about 5000), it is strongly recommended to study the impact of improvement of existing regulators in comparison to the construction of costly "fish passes" as envisaged under the fourth fisheries project.

Considering the importance of fish migration or larval drift in the rivers of Bangladesh and the number of regulators in them, it is strongly recommended to repeat the experiments at a number of standard type regulators, operated at different modes with different head differences. Furthermore, the main regulator is the only regulator in Bangladesh<sup>6</sup> where special "fish gates" for larval fish drift are incorporated. Due to the extreme low water levels in 1999, they could not be tested, but it is recommended that the experiments at the main regulator be continued as the results could lead to an optimal design of such gates for Bangladesh.

<sup>6</sup>And most likely in the whole world.



# The Aquaculture Extension Program of CPP

2018

To increase availability of fish in the CPP area an aquaculture extension program (AEP) started in 1994 and is continuing now-a-days. The program consisted of two elements:

- A traditional aquaculture extension program, executed from 1994 -1998,
- A catfish extension program aiming at the poorest segment of the population.

## The Aquaculture Extension Project

The Aquaculture Extension Program started with an inventory of the existing ponds in the target cluster, followed by motivation, the establishment of demonstration ponds and training of the pond owners. Furthermore, the inputs were monitored for a cost/benefit analysis.

There are 3,100 ponds, with a total water area of 341 ha in the project area and they are distributed as followed:

- 50% are small ponds ( $\geq 400 \text{ m}^2$ ),
- 37% are medium sized (400-1,600  $\text{m}^2$ ), and
- 13% are large ponds (1,600  $\text{m}^2$  and more).

However, based on the total pond area, the larger ponds contribute to 51% whereas the small ponds only add 13%. 74% of the ponds were found to be suitable for fish culture. The remaining 26% are so-called "derelict ponds", covering 14% of the total pond area.

The majority of ponds are owned by a single person (65%) and 31% is multiple owned.

During and after the inventory, the pond owners were motivated, informed and invited to attend the training sessions. Each pond owner was invited twice to attend the training given for groups of 20-25 pond owners but in 1995/96 the second training session was substituted by a practical group training (5-7 persons) at the pond site. At the end of the season, all pond owners were invited for a final field day, during which the results were evaluated and awards were distributed to the best performing pond owners.

Additional to the training, the individual ponds were visited and supervised regularly by four extension officers of the project. Specific attention was paid to 12 demonstration ponds and nine demonstration pagars that were established. Pond

owners were invited to visit these demonstration ponds, and to see and discuss the management of these ponds. The average yield in the demonstration ponds and pagars was respectively 3934 and 2257 kg/ha/crop. Duckweed cultivation was demonstrated in six derelict ditches, which were unsuitable for fish culture. Duckweed yields varied between four and eight kg/day.

A total of 2,685 pond owners have been trained of whom 348 are women.

Aquaculture production was followed and compared with the pre-project production level. Before the AEP started the average production of the ponds was 1,090 kg/ha/crop and 258 MT/year of fish was obtained through aquaculture in the project area. Through the AEP, the production level of the ponds increased considerably to an average of 2,200 kg/ha/crop. A total aquaculture production of 558 MT/year has been reached, with an incremental production of 300 Mt/year

Category	Number of ponds	Water area (ha)	Pre-project production (MT/yr.)	Production after AEP in the CPP area (MT/yr.)
Culture pond	1343	230	198	471
Culturable pond	944	63	38	54
Derelict pond	814	59	22	31
Total	3101	352	258	556

Table 17: Base aquaculture production and attained production in 1998

In 1995, a training course was given to 25 nursery operators, in order to increase the availability of fingerlings in the CPP. Nine trainees indeed established nursery ponds in 1995. An estimated 0.9 million fingerlings were produced by them. The average profit was 97,000 Tk/ha.

Despite initial attempts to establish a credit line for the pond owners, the project could not provide credit support due to the high official charges that were asked by Janata Bank. This made the pond owners reluctant to ask for credit. To assess the impact of the absence of a credit line on the AEP output, a study was done on the socio-economic aspects of the pond owners with special emphasis on the investment sources. The sample size for this study was 62 pond owners. The survey showed that the vast majority of pond owners (94%) managed to finance their inputs from own recourses. It was concluded that credit support was not a major constraint to the



257

aquaculture development so far attained. Most pond owners, who were trained in the AEP, have improved their yields despite the absence of credit support.

The socio-economic study further revealed a significant correlation between the area of owned agricultural land and the size of the ponds, indicating that smaller ponds are generally owned by smaller farmers. Such a relation did, however, not exist between income and pond size that may be due to unreliable income data. The distribution of the pond owners according to land ownership was as follows:

- 41% of pond owners were medium size farmers who own 1 to 3 hectare of land,
- 24% were large farmers (>3 hectares),
- 18% were small farmers (0,4 to 1 hectare),
- 11% were marginal farmers (0.2 to 0.4 hectare), and
- 6% were landless (<0.2 hectare).

The monitoring of inputs and costs revealed that one of the main constraints for aquaculture development in the CPP was the fact that the pond owners stock too many fingerlings in their ponds, especially in the smaller ponds (< 40 m<sup>2</sup>). This overstocking increases the maintenance costs and the output is lowered, as the fish will not show optimal growth. Hence, small ponds were generally less profitable. Feed costs of rice bran and mustard oil cake make up half of the total costs, followed by fingerlings (28%). Overall cost-benefit ratios were generally high, between 2.5 and 5.2, which proves that pond aquaculture is indeed profitable.

The AEP provided training to the pond owners irrespective of their farm size and income situation. In 1999 the project decided to start a more "target oriented aquaculture program", the Chari in the Bari program.

### **Chari in the Bari**

CPP's homestead *Magur* (catfish) Culture Program, also known as the *Chari* in the *Bari* program, tried to reach the poorest of the poor, in order to show this group that it is possible to grow high valued fish with their limited resources.

The basic idea behind the program is that *Magur* (African catfish, *Clarias gariepinus*) is a good fish to be grown, because of its high growth rate, disease resistance, possibility to take up oxygen from the air, etc., but that most local people are not aware of the possibilities of this fish.

A few households in the CPP area have already been growing *Magur* on their homestead. This method proved to be successful, so CPP took up the task to spread this local knowledge among other households with emphasis on professional fishermen, landless, and other poor people. Initially 200 households joined the *Chari* in the *Bari* program.

The people from this target group have not benefited from the previous aquaculture extension program, because they do not have access to ponds. In the *Chari* in the *Bari* program, a pond is not needed, a feeding bucket (or *Chari*) or a hole in the ground of approximately 1 m<sup>2</sup> will be enough to grow 50 fish to marketable size.

Catfish fry was not available on the local market in the beginning of the year, therefore a small hatchery was build in the CPP office where local CPP-staff produced 6000 catfish-fry up to 3 grams. After production of this fry, selected homesteads were offered the possibility to buy 50 fry for a nominal fee (10 Tk), while the normal price for this number of fish would be between 25 and 50 Taka. Later in the season, CPP purchased fry from the fish market in Jessore.

One of the selection criteria for the households was that the house where the family lives consists of a straw, mud or jute wall. This to ensure that the poorest of the poor joins the program. People who wanted to join the program, but did not comply with the selection criteria were advised to buy from local fish traders, after whom they could receive, technical assistance from the fisheries section on CPP. Local fish traders were taken along to the fish market in Jessore where it is possible to buy Catfish fry.

After sale of the fry to the households, 15% of these were not able to keep the fish alive, mainly because of lack of care. This number will be reduced in the future, because local staff is now more used to the fish and able to give better information concerning *Chari*-management. In the *Chari* in the *Bari* program, first indications are that women and children mainly carry out this activity. They spend approximately one hour a day on taking care of the fish. The average growth is from 150 grams to 7 kilos in 10 weeks. More details of the results and the economic position of the participating households are provided in Table 18.



20

Number of households involved	200
Criteria for joining	Professional fishermen, destitute women, or landless people. House has to be build with straw, mud, or jute wall
Number of fry sold per household	50
Size of fry	2 - 3 inch, 3 grams
Price	10 Tk per 50 fry, normal price for these fish 25 - 50 Tk per 50 fry
Household success rate (percentage of households able to grow with this method)	85 - 90%
Feed sources	Snails, bivalves, tubifex, termites, mosquito larvae, slaughter waste, blood, wheat bran, rice bran
Growth rate	From 150 grams to 7 kilo's in 10 weeks (total fish-weight)
Time spend per day	1 - 1.5 hours
Average income household before joining	60 Tk/day
People taking care of the fish	80% women, 15% children, 5% males
Table 18: The <i>Chari</i> in the <i>Bari</i> program of CPP	

Initially, the project started with 200 households but the direct spin-off of the project is tremendous. Five months after the start of the program 158 households have taken up this activity without assistance of the project. In other words, the small program had a diffusion ratio of 80%.

CPP is confident that the peoples' abilities to grow catfish on their homesteads will develop. This program will contribute to the food and income security of the poorer segments of the population living in the CPP area and can be considered as a new poverty alleviation technique.

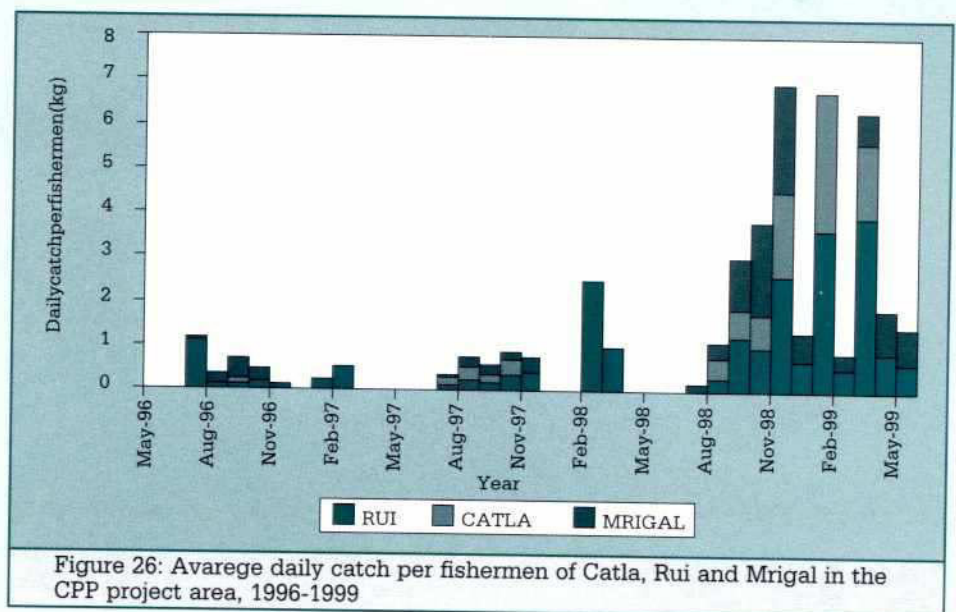
After implementation of the program, CPP became aware that the use of African catfish is under discussion at present as they are seen as an environmental threat. CPP takes this discussion seriously, but considering the perspective for poverty alleviation for the rural and the eventually urban poor it is strongly recommended to

study this more thoroughly so that conclusions made on the basis of scientific facts and international guidelines regarding this matter.

### Aquaculture Losses Due to the Flood of 1998

During analysis of the data it was observed that the catches of the Indian carps; *Catla*, *Rui* and *Mrigal* suddenly increased significantly in 1998. Careful examination of the data revealed that the catches started rising from the 14th of September, a few days after a breach in the embankment at Indra Belta and after the highest water level recorded in CPP for the monsoon of 1998 (Figure 26). It can be easily assumed that because of this high water level a large number of fishponds in the higher lands got flooded and that the fish escaped towards the open water where many fishermen were catching. In the analysis of the catches for 1996-1999, the escaped *Catla*, *Rui* and *Mrigal* have been excluded. But the method used for determining the monthly catch can be used to determine the total quantity of fish escaped from the fishponds.

The analysis indicates that at least 172 Mt ton of Indian carps with a value of 290, 000 US\$ or 25% of the total aquaculture production in the project area escaped from the ponds. Details of the analysis are presented in Table 19.





270

Production parameters	Sept	Oct	Nov	Dec
CPUA F3	16.5	19.9	0.0	0.0
CPUA F2	39.3	7.7	1.0	0.0
CPUA F1	7.9	1.5	0.2	0.0
CPUA <i>Khals</i>	282.0	2.2	2.5	0.0
CPUA Lohajang	31.1	21.0	0.0	0.0
Area F3	305	172	146	125
Area F2	2535	1182	770	589
Area F1	3268	599	265	209
Length <i>khal</i>	93	93	93	93
Length Lohajang	27	27	27	27
Catch F3	5	3	0	0
Catch F2	100	9	1	0
Catch F1	26	1	0	0
Catch <i>khal</i>	26	0	0	0
Catch Lohajang	1	1	0	0
Total Catch	157	14	1	0

Table 19: Details of the catch analysis carried out for escaped Indian carps-  
during the flood of 1998

## References

Compartmentalization Pilot Project (CPP), 1992. Tangail CPP Interim Report; Annex 1.1: Household Survey, main report. [Euroconsult/Lahmeyer International/Bangladesh Engineering & Technical Services/House of Consultants under Assignment to Directoraat Generaal Internationale Samenwerking, Government of the Netherland and Kreditanstalt fur Wiederaufbau, Federal Republic of Germany].

Compartmentalization Pilot Project (CPP), 1992. Tangail CPP Interim Report, Annex 3. Fisheries and Aquaculture. [Euroconsult/Lahmeyer International/Bangladesh Engineering & Technical Services/House of Consultants under Assignment to Directoraat Generaal Internationale Samenwerking, Government of the Netherland and Kreditanstalt fur Wiederaufbau, Federal Republic of Germany].

Compartmentalization Pilot Project (CPP), 1993. Mitigation measures for Fisheries. [Euroconsult/Lahmeyer International/Bangladesh Engineering & Technical Services/House of Consultants under Assignment to Directoraat Generaal Internationale Samenwerking, Government of the Netherland and Kreditanstalt fur Wiederaufbau, Federal Republic of Germany].

Compartmentalization Pilot Project (CPP), 1994. Final report Special Fisheries Study; Technical Note 94/10. Dhaka; [Euroconsult/Lahmeyer International/Bangladesh Engineering & Technical Services/House of Consultants under Assignment to Directoraat Generaal Internationale Samenwerking, Government of the Netherland and Kreditanstalt fur Wiederaufbau, Federal Republic of Germany].

Compartmentalization Pilot Project (CPP), 1996. Fish catch in the CPP: an analysis of 1992-1995 results. Technical note 96/05. Dhaka; [Euroconsult/Lahmeyer International/Bangladesh Engineering & Technical Services/House of Consultants under Assignment to Directoraat Generaal Internationale Samenwerking, Government of the Netherland and Kreditanstalt fur Wiederaufbau, Federal Republic of Germany].

Flood Action Plan/ FAP 17. Fisheries Studies and Pilot Project, 1995. Main Volume, Dhaka. Report funded by ODA prepared for the Government of Bangladesh.

de Graaf, G.J., Born, B., Uddin, A.M.K. and Huda, S., 1999, Larval fish movement in the Lohajang River, Tangail, Bangladesh, Fisheries Management and Ecology, 6; 109-120.



292  
Junk W.J. , Bayley P.B. & Sparks R.E., 1989. The flood pulse concept in River Floodplain systems. In: D.P. Dodge (ed.) Proceedings of the International Large River Symposium. Canada Special Publication of Fisheries and Aquatic Sciences No 106, pp. 110-127.

Khulna Jessore Drainage Rehabilitation Project, 1996. (Component A: Mobilisation of Beneficiary Participation), TECHNICAL REPORT NO. 6 Comments on ;The Fisheries Management Plan for the Khulna-Jessore Drainage Rehabilitation Project. [Euroconsult/Bets prepared for the Government of Bangladesh and the Asian Development Bank].

Pavlov, D.S., Nezdoliy, V.K., Urteaga, A.K. and Sanches, O.R. 1995. Downstream migration of juvenile fishes in the rivers of Amazonian Peru. Journ. Ichthyol., 35 (9); 227-248.

