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BANGLADESH FLOOD ACTION PLAN

Ministry of Water Resources
Flood Plan Coordination Organization (FPCO)

45

Environmental Impact Assessment Skills Training
Trainer's Manual
Volume II: Supplemental Handouts

April 1995

Prepared by

Environmental Study

FAP 16

ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

Sponsored by the U.S. Agency for International Development

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ACKNOWLEDGEMENTS

This manual has been a team effort, and has therefore benefitted from the contributions of many people, whose efforts were coordinated by Keith Pitman, Chief of Party, ISPAN, and initially under the direction of Stan Hirst, Team Leader, FAP 16, and later under Darrell Deppert and Haroun Er Rashid.

The training design, materials development, and initial field testing were done by a team of training and environmental specialists from the United States in collaboration with the ISPAN/FAP 16 scientists who did the original environmental study and wrote the Environmental Impact Assessment (EIA) Guidelines.

ISPAN thanks the Training Resources Group (TRG) for allowing the use of some of its materials in the training guide and for the services of Dick Wall; PRC Environmental Management Inc. for the services of J.A. Atchue III; and ISTI for the services of Richard Maze.

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The manual was revised after it was field tested in four EIA skills workshops by the FAP 16 training team. With each training experience, the team modified the materials in order to address trainee needs and interests, the realities of time and local logistics. ISPAN would like to acknowledge the contributions made to the second edition by: Asgari Ahmad, Mustafa Alam, Darrell Deppert, Abu Md. Ibrahim, Khurshida Khandakar, Mokhlesur Rahman, Haroun Er Rashid, Qazi Salimullah, and Dara Shamsuddin.

We are grateful to the Flood Plan Coordination Organization for providing overall direction to this project and to the United States Agency for International Development for providing funding.

INTRODUCTION

The workshop presented in this training guide is designed to improve the skills of engineers, social scientists, environmental scientists, and other specialists working in the field of natural resources who review environmental impact assessments. It accompanies the Environmental Impact Assessment Guidelines and Manual developed by the Irrigation Support Project for Asia and the Near East (ISPAN) as part of the USAID-funded Eastern Waters Initiative (EWI) in collaboration with the Flood Plan Coordinating Organization (FPCO) and the Department of the Environment (DOE).[1]

In January of 1993, an EIA training needs assessment of 28 Dhaka consulting firms and 5 parastatal organizations revealed that there was a strong interest in a training program that would develop a group of specialists as either EIA practitioners or reviewers.[2] This workshop responds to that need.

The four-week workshop focuses on the process outlined in the EIA Guidelines. The subject matter is divided into eight modules, including an introduction to the workshop and and an introduction to the methodology.

The methodology used in the workshop is based on the research into the theory of adult learning developed by Dr. Malcolm Knowles, Professor Emeritus of North Carolina State University. It uses an experiential learning model that attempts to involve the participant in the learning process to the fullest extent possible. The training aims to develop skills in applying the knowledge the various participants have, within the framework of the EIA process. Toward that end, the focus is less on providing extensive and detailed information about content and more on allowing the participant to see how his or her learning can be profitably used in the EIA process. The workshop further tries to help the participant to understand the importance of the multidisciplinary approach to the overall importance of EIAs in successfully implementing projects.

1. Training Approach

The workshop is designed to meet its overall goal through an approach that is consistent with adult learning needs. The participants are expected to take an active role in their learning based on their experiences in the environmental sector.

The training content is divided into modules, and the modules are divided into sessions. Please note that it is important not to confuse module and session. A **module** is a complete unit of instruction that includes all the material needed to teach a skill or task. A **session** is a unit of expression that focuses on one aspect of the module. Thus a module contains several sessions, each session devoted to a different aspect of the subject matter.

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[1] The EIA Guidelines were approved by FPCO in October 1992.

[2] See FAP 16 Environmental Study EIA Proposed Training Plan, ISPAN, March 1993.

INTRODUCTION

Module 1 is the course introduction. Modules 2-8, as shown in the table below, correspond to the stages in the environmental impact assessment process found in the EIA Guidelines. Thus, the modules are most effectively taught in succession.

EIA Process Stage	Module
Stage 1: Project Design and Description	Module 2: Introduction to EIA in the Water Sector
Stage 2: People's Participation	Module 3: People's Participation
Stage 3: Environmental Baseline Description	Module 4: Developing Environmental Baseline
Stage 4: Scoping	Module 4: Developing Environmental Baseline
Stage 5: Bounding	Module 4: Developing Environmental Baseline
Stage 6: Major Field Investigations	Module 4: Developing Environmental Baseline
Stage 7: Impact Assessment	Module 5: Impact Assessment
Stage 8: Impact Evaluation	Module 5: Impact Assessment
Stage 9: Environmental Management Planning	Module 6: Environmental Management Plan
Stage 6: Feedback to Improve Project Design	Module 7: Documentation, Communication, and Reporting
Stage 7: EIA Reporting	Module 7: Documentation, Communication, and Reporting
Stage 8: EIA Review	Module 8: EIA Review

Each session focuses on one important aspect of the module. Each of the sessions is designed to take the participants through a seven-step process that allows them to experience a presentation (which may be an interactive lecturette, case study, demonstration, role-play, or small group task or exercise), analyze the experience, draw conclusions from it, and examine possible ways of applying the conclusions in the real world.

2. Finding Your Way Around

This manual has been structured in a way that makes the materials easy for the trainer to use. Volume 1 contains all of the training procedures and their associated exercises and handouts. Volume 2 contains supplemental handouts.

Within Volume 1, the materials are separated according to module, and each module is indicated by a tabbed separator. Separator pages distinguish the training procedures from their associated exercises and handouts. The exercises and handouts are printed on one side to facilitate duplication. The pages of the exercise materials and handouts pages are numbered (at the bottom center of the page) only for multi-page documents.

Within Volume 2, the supplemental handout materials are separated according to module, and each module is indicated by a tabbed separator.

MODULE 1

SUPPLEMENTAL HANDOUTS

The materials on the following pages are intended for duplication and distribution to skills workshop participants. Exercises and other handouts for this module are located in Volume I of the EIA Skills Workshop Trainer's Manual.

TO THE TRAINER:

Attached are two documents outlining our course activities for the next month. Since the EIA process lends itself to being broken down into discrete steps, we have organized the course in a modular manner. These EIA modules are interrelated, however, and although each one addresses a discrete aspect of the EIA process, its information is built upon by the other modules.

The first attachment is our weekly schedule broken down by the number of periods we will spend in each module. It is organized as a daily calendar of activities so that you will be able to see where you are in the course sequence. The next document is a brief description of the objectives we wish to accomplish for each module we work on during the workshop.

COURSE OBJECTIVES BY MODULE

Introduction to EIA

- Understand the need of EIA in the project development cycle.
- Understand the importance of habitat and ecosystem in the EIA process.
- Understand the place of EIA in the project development cycle.
- Understand the overall EIA process.
- Understand the impact of water structures on the environment.

People's Participation

- Understand the importance of people's participation in the overall EIA process and indicate where it should occur.
- Understand the methodology of people's participation in the overall EIA process.

Development of Environmental Baseline

- Understand the meaning and importance of scoping to identify important environmental components (IECs).
- Understand how to make spatial and temporal boundaries of the EIA study area.
- Understand the interdisciplinary nature of EIA in the project planning process.
- Develop study plan for collecting data for baseline development in EIA.
- Understand the need and procedure of preparing a socio-economic baseline for EIA.
- Understand the need and procedure for developing a water resource baseline for EIA.
- Understand land use survey for preparing a data base for developing land resource baseline for EIA.
- Understand the methodology for baseline development on forest and vegetation in the EIA process.

- Understand the need and procedure of preparing a wildlife baseline for EIA.
- Understand the importance of issues related to culture and capture fisheries.
- Understand the methodology for developing a fisheries baseline for EIA.
- Understand hazards and their associated risks and the methods used to develop baseline data.
- Understand the need and procedure of data analysis for EIA.
- Geographic Information Systems
    - Understand GIS
    - Understand the importance of GIS to the EIA process.
    - Understand basic cartography and how that helps us in EIA.
- Understand the approaches of interviewing people for collection of information.

Impact Assessment

- Understand how seasonal models can help in the EIA process.
- Understand the concept and method of trend analysis for EIA.
- Understand the methods of identifying and quantifying impacts on individual IECs.
- Assign appropriate scores to individual impacts.
- Assign appropriate weights and total impact value to individual impacts.
- Understand why it is necessary to assess alternatives in EIA.

Environment Management Plan

- Understand the components of EMP, and see how they relate to the EIA.
- Understand the need and importance of developing mitigation and enhancement plans to reduce adverse impacts, and to increase the overall benefits of the project.

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- Understand the meaning of compensation and learn about necessary compensatory programs in the context of FCD/I projects.

- Understand the plan of action that is needed to mitigate, reduce, or prevent the adverse effects of disasters on the environment.

- Understand the role and purpose of monitoring in the EMP.

- Know about existing legislation on environment in Bangladesh, understand the nature of the legislation.

- Understand the probable institutional mechanisms by which the EIA will be managed in Bangladesh.

Documentation and Communication

- Understand the importance of maintaining a good documentation system and appreciate the value of good spoken and written communication throughout the EIA process are significant.

- Know what needs to be incorporated in the EIA report and how to obtain feedback and incorporate it to improve the report.

EIA Review

- Understand the mechanism of EIA review and determine whether an EIA has been adequately performed.

SCHEDULE
EIA SKILLS WORKSHOP, 1995

Day	Time	Session
1	08:50 - 09:00	Registration
		MODULE 1: Workshop Introduction
	09:00 - 10:00	Inauguration
	10:00 - 10:30	Break
	10:30 - 12:15	Workshop Opening
	12:15 - 12:45	Break
		MODULE 2: Introduction to EIA in the Water Sector
	12:45 - 14:15	Need of EIA
	14:15 - 14:30	Break
	14:30 - 16:00	Habitat & Ecosystem
2	08:50 - 10:30	Place of EIA
	10:30 - 10:45	Break
	10:45 - 12:15	EIA Process
	12:15 - 12:45	Break
	12:45 - 14:45	Impacts of Structures Module Synthesis Journal
	14:45 - 15:00	Break
		MODULE 3: People's Participation (PP)
	15:00 - 16:30	Importance of PP
3	08:50 - 11:00	PP Methodology Module Synthesis Journal
	11:00 - 11:15	Break
		MODULE 4: Developing Environmental Baseline
	11:15 - 12:45	Scoping & IECs
	12:45 - 13:15	Break
	13:15 - 14:45	Bounding
	14:45 - 15:00	Break
	15:00 - 16:30	Interdisciplinary Nature of EIA

Contd...

Day	Time	Session
4	08:50 - 10:30	Field Data Planning
	10:30 - 10:45	Break
	10:45 - 12:15	Socio-Economic Baseline
	12:15 - 12:45	Break
	12:45 - 14:15	Water Resource Baseline
	14:15 - 14:30	Break
	14:30 - 16:00	Land-Use Baseline
5	08:50 - 10:30	Forest & Vegetation Baseline
	10:30 - 10:45	Break
	10:45 - 12:15	Wildlife Baseline
	12:15 - 12:45	Break
	12:45 - 14:15	Fisheries Issues
	14:15 - 14:30	Break
	14:30 - 16:00	Fisheries Baseline
6	08:50 - 10:30	Hazard & Risk Baseline
	10:30 - 10:45	Break
	10:45 - 12:15	Data Analysis
	12:15 - 12:45	Break
	12:45 - 14:15	GIS
	14:15 - 14:30	Break
	14:30 - 16:00	GIS
7	08:50 - 10:30	GIS
	10:30 - 10:45	Break
	10:45 - 12:15	GIS Debriefing
	12:15 - 12:35	Break
	12:35 - 14:05	Interviewing Skill Field Briefing
8	08:50 - 17:00	FIELD-I

Contd...

Day	Time	Session
9	08:50 - 10:30	Field Debriefing
	10:30 - 10:45	Break
	10:45 - 12:45	Field Debriefing Module Synthesis Journal
	12:45 - 13:15	Break
		MODULE 5: Impact Assessment
	13:15 - 14:45	Seasonality Model
	14:45 - 15:00	Break
	15:00 - 16:30	Trend Analysis
10	08:50 - 10:30	Identify & Assess Impacts
	10:30 - 10:45	Break
	10:45 - 12:15	Impact Evaluation
	12:15 - 12:45	Break
	12:45 - 14:15	Impact Evaluation
	14:15 - 14:30	Break
	14:30 - 16:00	Impact Evaluation
11	08:50 - 11:00	Assess Alternatives Module Synthesis Journal Mid-term Evaluation
	11:00 - 11:15	Break
		MODULE 6: Environmental Management Planning (EMP)
	11:15 - 12:45	Introduction to EMP
	12:45 - 13:15	Break
	13:15 - 14:45	Mitigation & Enhancement
	14:45 - 15:00	Break
	15:00 - 16:30	Compensation
12	08:50 - 10:30	Disaster Management
	10:30 - 10:45	Break
	10:45 - 12:15	Monitoring
	12:15 - 12:45	Break
	12:45 - 14:15	Legislation
	14:15 - 14:30	Break
	14:30 - 16:30	Institutional Setting Field Briefing

Contd...

Day	Time	Session
13	08:50 - 17:00	FIELD - II
14	08:50 - 10:30	Field Debriefing
	10:30 - 10:45	Break
	10:45 - 12:15	Field Debriefing Module Synthesis Journal
	12:15 - 12:45	Break
		MODULE 7: Documentation, Communication & Draft Report
	12:45 - 14:15	Documentation & Communication
	14:15 - 14:30	Break
	14:30 - 16:30	Draft Report Module Synthesis Journal
15		**MODULE 8: EIA Review**
	08:50 - 10:30	EIA Review Mechanism
	10:30 - 10:45	Break
	10:45 - 12:15	Introduction to Document
	12:15 - 12:45	Break
	12:45 - 14:15	Review of Document
	14:15 - 14:30	Break
	14:30 - 16:00	Review of Document
16	08:50 - 10:30	Review of Document
	10:30 - 10:45	Break
	10:45 - 12:15	Review of Document
	12:15 - 12:45	Break
	12:45 - 14:15	Review of Document
	14:15 - 14:30	Break
	14:30 - 16:00	Review of Document

Contd...

Day	Time	Session
17	08:50 - 10:30	Presentation & Discussion
	10:30 - 10:45	Break
	10:45 - 12:45	Presentation & Discussion Module Synthesis Journal
	12:45 - 13:15	Break
	13:15 - 14:45	Workshop Synthesis
	14:45 - 15:00	Break
	15:00 - 16:30	Post Test Evaluation
18	11:30 - 12:30	CLOSING
	12:30 - 14:00	Lunch

MODULE 2

SUPPLEMENTAL HANDOUTS

The materials on the following pages are intended for duplication and distribution to skills workshop participants. Exercises and other handouts for this module are located in Volume I of the EIA Skills Workshop Trainer's Manual.

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BANGLADESH
ACTION PLAN FOR FLOOD CONTROL

Guidelines for Environmental Impact Assessment
(EIA)

FLOOD PLAN COORDINATION ORGANIZATION
THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT
AND FLOOD CONTROL

October 1992

PREFACE

These Guidelines for Environmental Impact Assessment were prepared by the Irrigation Support Project for Asia and the Near East (ISPAN) with funding and support from the U.S. Agency for International Development towards the FAP16 Environmental Study component of the Bangladesh Flood Action Plan (FAP).

The Guidelines have been issued for use in ongoing and future FAP and similar flood control, drainage, Irrigation (FCD/I) and water management projects. ISPAN suggests, that the Guidelines document not be viewed as a static entity but should be modified and updated from time to time to incorporate the benefits of experience gained from actual environmental studies, EIAs and project construction and implementation as the FAP proceeds. EIA practitioners and other users of these guidelines are encouraged to communicate their experiences and problems to the Flood Plan Co-ordination Organization (FPCO) and also to the Department of Environment (DOE).

The Guidelines have been prepared by ISPAN in consultation with and with assistance from FPCO and DOE.

BANGLADESH FLOOD ACTION PLAN

GUIDELINES FOR ENVIRONMENTAL IMPACT ASSESSMENT

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Annex F
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Annex G
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Chapter 1

INTRODUCTION

1.1 Basis for Guideline Development

The following Guidelines for Environmental Impact Assessment (EIA) are intended for use in the study and environmental evaluation of regional plans and projects proposed under the Bangladesh Flood Action Plan (FAP). They were developed initially from similar guidelines used in industrialized and developing countries on a variety of water resource developments and by various government and donor agencies, but have been specifically tailored to:

- address proposed developments under the FAP;
- conform to the Environmental Policy (1992) adopted by the Government of Bangladesh (GOB), along with the subsequent Action Programme.

The Guidelines address types of interventions and projects likely to be included under future FAP programs, and may be used for other relevant water management and FCD/I projects and plans. The Guidelines specifically address EIA at the pre-feasibility (regional) and feasibility (project) levels but not programmes or policies. They are intended to be used in close conjunction with the Guidelines for Project Assessment (GPA) which provide guidance on the economic appraisal of regional and specific projects (Figure 1).

1.2 **Purpose and Scope**

The EIA Guidelines:

- provide a consistent and common basis for the application of EIA to FAP developments to protect environment by ensuring that only environmentally sound projects are designed and implemented;
- assist EIA practitioners in identifying, quantifying and evaluating potential environmental consequences of flood control, drainage and irrigation (FCD/I) and other FAP interventions so that the impacts of a project are highlighted and the project design can be altered or management measures can be developed to enhance positive impacts and lessen or alleviate negative impacts;
- provide a basis for GOB and assistance agency evaluation of the environmental consequences of proposed FAP projects;

- ensure that all FAP projects are developed with full consideration for economic and environmental optimization, and for a long-term sustainability and equitability of environmental resource conservation and use and become economic-cum-environmentally optimal and sound.

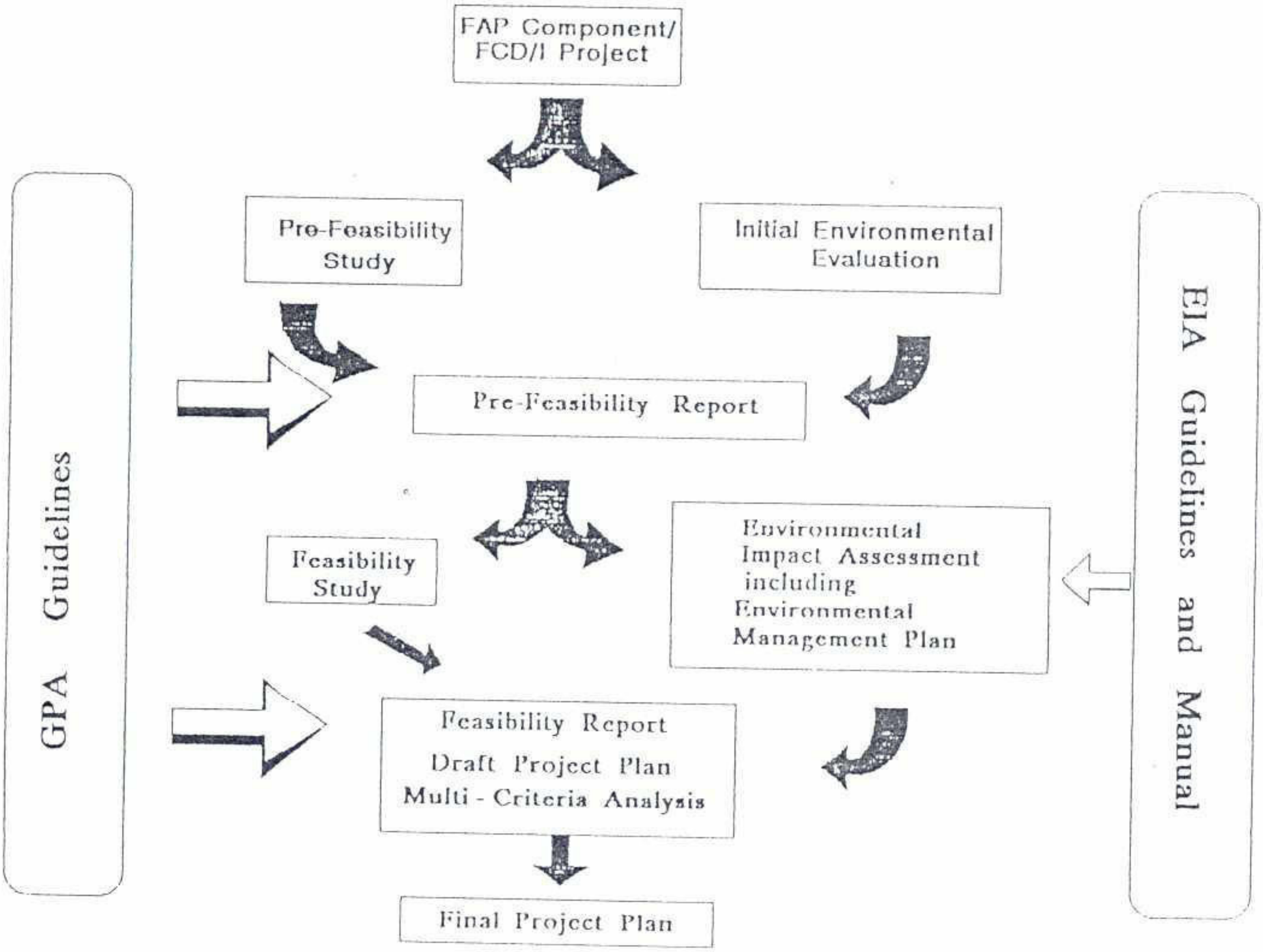

Figure 1 Role and Position of EIA Guidelines and EIA Manual in FAP Project Planning Process.

1.3 Intended Users

Intended users of the Guidelines include but not limited to :

- environmental and social scientists, planners, engineers and other practitioners concerned with the undertaking of EIAs and the preparation of EIA reports for FAP plans and projects, and other relevant water management and FCD/I developments;
- reviewers of EIAs;
- trainees in EIA.

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1.4 Organization of the EIA Guidelines

Chapter 2 briefly reviews the main types of environmental impacts to be expected from FAP-related developments. Chapter 3 describes the objectives of EIA as a procedure within the framework of environmental planning, outlines a 10-step approach and one other step - People's Participation to be pursued all throughout and as such not numbered to consistent EIA application, and describes the purpose of the environmental management plan (EPM). Chapter 5 is a broad outline of the principles and purposes of people's participation in the FAP planning and implementation process. Chapter 6 summarizes and main features of the review process to be used once an EIA has been completed. Eight appendices are attached. Annex A lists known potential environmental impacts of FAP-type FCD/I projects; Annex B lists the common components of FCD/I projects which should be examined for potential environmental impacts, and Annex C details the most common information requirements for FCD/I project EIA. Annexes D, E and F though short are very important part of the document dealing with weighted matrix, level of impacts to be considered and their required level of quantification respectively. Annex G presents a suggested outline for an EIA Table of Contents. Annex H gives a glossary of terms used in these guidelines.

1.5 EIA Manual

A two-volume EIA Manual is a companion document to these Guidelines and covers the technical aspects of EIA in more detail. The Manual includes a glossary of all EIA terminology used in these Guidelines.

CHAPTER 2

ENVIRONMENTAL IMPACTS OF THE FLOOD ACTION PLAN

2.1 The greater part of the surface area of Bangladesh is subject to permanent or seasonally occurring inundation. The resulting extensive wetlands result from complex and dynamic hydrologic and geomorphologic interrelationships between major rivers, tributaries and distributaries, channels, water bodies and seasonally flooded plains. Annual flooding represents an essential factor sustaining many biological communities and is the main medium for energy flow and nutrient and material transfer through the ecosystem. Where possible, retention of the essential features of these watlands through seasonal flooding is an objective of water management. Flood control should accordingly be aimed primarily at reduction of the impact of violent specific events associated with excessive water volumes and flow rates causing disruption and destruction of human lives and resources.

2.2 Proposed FAP projects and regional plans will be aimed primarily at the use of structural and no-structural means to provide protection from damaging floods, to improved drainage and in selected areas, provide irrigation. Structural flood control measures will include embankments, dikes, levees, floodways, drainage works, hydraulic structures and river channel modifications. Non-structural measures include regulation of floodplain uses, floodproofing of houses and infrastructure, regulation of land use in watershed areas, integrated wetland management, flood preparedness and disaster management.

2.3 Except for unusually severe flooding, ecosystems and rural human communities in Bangladesh are adapted to, and rely on, periodic inundation of the land. Flooding usually becomes a problem when natural events or human activities increase, flooding intensity or frequency, or man invades flood-prone areas with structures and developments that need to be protected.

2.4 The major potential environmental impacts of structural flood control measures arise from the modification of the natural patterns of flow, flooding and drainage. This may bring changes in water levels and flows on both sides, changes in siltation, erosion, flood protection, altered ground water levels, soil moisture and changes in water availability, socio-economics, fish availability, health status and property damage. Appendix A lists environmental impacts for past flood control, drainage and irrigation projects in Bangladesh.

2.5 Structural flood control measures such as embankments and channel modifications increase the capacity of a stream by increasing the volume of the channel and/or increasing the velocity of flow, but leads to increased bank and embankment erosion. Channel modification includes dredging, clearing it of vegetation and other debris, smoothing the channel bed and walls, or straightening the channel, all of which help increase the rate at which water is passed through the system, thus preventing flooding, straightening the channel by eliminating meanders also helps reduce the risk that water will breach the river bank on the outside of curves where the current is most rapid and water rises highest.

2.6 Floodways (high-flow diversions or spillways) are natural or artificial bypass channels or conduits that redirect waters around or away from urban centers or areas of high population density. Further downstream the water can be re-diverted into the river from which it originated.

2.7 Flood-control structures may impart a false sense of security in that the risk of flooding is not eliminated but only diminished. This may encourage development on the floodplain with disastrous results in the event of an unusually high flood or if control structures fail.

2.8 In addition to the impacts of flood control structures on the environment, the environmentally-related factors affecting flood control should be considered. Infrastructural or other developments on a floodplain expose themselves to risk, depending on their vulnerabilities, and also increase the risk of loss or damage to downstream communities Building can increase flood heights and velocities by obstructing the flood flow, reducing floodplain storage capacity, and increasing run-off.

2.9 Human activities in the watershed, such as cutting of trees or clearing for agriculture and settlements generally will increase run-off, as will hillside agriculture without adequate terracing or planting on the contour. Paving land in the watershed and on the floodplain will also increase run-off, and installing storm drainage systems will increase the quantity and rate at which rain water enters the river system.

2.10 Dredging operations, disposal of materials, shoreline development, increased traffic near the shoreline and other factors related to coastal zone and major bank protection can impact coastal and riverin biota and communities. Potential aquatic impacts include spills and discharges from construction and placement of new facilities near the waterline, contaminant release from sediment resuspension, surface run-off and point source discharges, habitat destruction, changes in water chemistry and circulation, contamination and habital loss from dredge spoil disposal, and erosion and sedimentation from changed flow and wave patterns.

2.11 As with any development, flood protection measures potentially produce a large number of beneficial and negative impacts on social well-being, health and safety (Annex. A). A major concern is usually the unequal distribution of benefits received from flood control measures.

CHAPTER 3

EIA IN PLANNING AND PROJECT APPRAISAL

3.1 Objectives of EIA

The main objectives of EIA are to identify environmental impacts of proposed plans, programs and projects (Figure 1), thereby:

> Assisting decision-makers and their constituents in making informed decisions on project developments and resource allocation;
>
> Providing where possible quantitative environmental information so that potential impacts can be avoided in project and program design; providing a basis of development of management measures to avoid or reduce negative impacts; and providing an Environmental Management Plan (EMP) for the project that will help promote sustainable development.

EIA is an integral part of multiple resource development planning and feasibility study of a project. It provides for a quantified assessment of the biophysical, economic and social impacts of proposed projects as well as the likelihood of such impacts occurring. It provides for the participation of local groups in identifying impacts, assessing their significance, and formulating strategies to manage negative impacts and enhance beneficial ones. EIA accomplishes its purpose by providing decision makers with the best quantitative information available regarding intended and unintended consequence of particular investments and alternatives, the means and costs to manage undesirable effects, and the consequences of taking no action.

A professionally carried out EIA has to quantify all major impacts in particular along with the possibility or chances of their occurring and all other impacts (if and where possible).

EIA is not intended to disrupt nor impede development but should enhance development by ensuring that projects are constructed and operated in an environmentally sound manner and do not negatively affect the functioning of essential environmental processes nor the long-term sustainability of resource conservation and human well being. In addition to identifying and describing environmental impacts which a proposed project would likely to cause if no environmental management measures were included, the EIA should:

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- specify the necessary environmental protection measures;
- ensure that these are included in the overall project feasibility study; and

- ensure that the project management will include an environmental management plan which will ensure that the prescribed protection measures are actually carried out in the follow up project stages of final design, construction and operation. It needs to be emphasized that Environmental protection measures mean more than mitigation i.e. offsetting unavoidable adverse effects and protection (measures for environmental enhancement when these can be feasibly included in the project.

3.2 Emphasis In EIA

Sound EIA should place emphasis on:

- reliable assessments of environmental disturbances likely to result from the proposed project;
- reliable field data on the background environment and on various environmental phenomena in the field;
- validated relationships between environmental components and resources and the predicted impacts, appropriate under local conditions;

- consideration of impacts on all targets considered sensitive or critical under the prevailing conditions and value systems;
- involving the affected communities at various stages of the assessment; and
- reliance on the judgement of local people and knowledgeable officials/professionals and other interested parties.

3.3 EIA In Project Planning

EIA is a planning tool which is to be used together with the project feasibility study to ensure that the project plan is the optimal Economic-cum-Environmental plan, that is the plan is environmentally as well as economically sound and thus represents the best approach to planning for development projects in order that continuing development will be sustainable. A project plan which is optimal from both environmental and economic perspectives will have a higher benefit/cost ratio than a plan which is not responsive to environmental needs, especially so when long term as well as short term effects are considered.

3.4 Stages of EIA

Within the context of the FAP, EIA will be applied at two main stages of detail pre-feasibility and feasibility.

a) Pre-feasibility level assessment (IEE) addresses regional planning options for water resource development. The main thrust at this stage is to assess regional resources and the effects of past interventions, examine the likely project - environmental linkages and interactions, establish the range and potential magnitude of impacts, identify the key regional environmental issues, compare the environmental consequences of project alternatives and develop an effective people's participation program. The same types of impacts as would be assessed during the feasibility stage are considered but at more general levels of detail and at larger scales of resolution. This assessment may also suggest whether or not a full scale EIA should be carried out at the feasibility level.

Following pre-feasibility studies, the decision-makers may choose to:

- proceed with feasibility studies and a detailed EIA where project impacts are indicated to be likely acceptable and or/ manageable; Once EIA is completed for the selected project;
- proceed with feasibility studies and a detailed EIA on a modified project to reduce unacceptably high levels of impacts; or
- reject the project because the nature and magnitude of the impacts are shown to be technically, environmentally, socially and /or economically unacceptable.

b) Feasibility level EIA provides a basis for:

- detailed impact assessments of selected project options;
- mitigation planning to reduce biophysical and social impacts;
- planning for adequate compensation for unavoidable impacts;
- planning project enhancements;
- establishing a monitoring program; and
- ongoing people's participation in project construction, operation and maintenance.

3.5 Relationship of EIA to Technical and Economic Feasibility: In comparative levels of study detail and decision-making, EIA should parallel the engineering studies and economic evaluations.

- Environmental and engineering evaluation should be closely linked so that effective project modifications and environmental management can be developed. Environmental and economic evaluations should be linked to ensure that both environmental benefits and losses of the project as well as the costs of environmental management are accounted for in the cost-benefit analyses.

3.6 Environmental Objectives in Regional Development for present and future FAP Projects

The main land and water management objectives for long term regional development should be identified and quantified in IEEs and EIAs as part of Regional Studies under present/future FAP interventions by Project Proponent. The development options should be identified, the main linkages to existing environmental conditions should be identified, and resource use and management systems appraised. The main environmental constraints to development, especially involving further flood control, drainage and irrigation should be identified. The environmental sustainability of present land and water resource management and further management with the projects in place and considering existing trends in population size growth, agricultural development, habitat destruction, soil degradation,pollution, and other relevant factors should be explicitly appraised.

3.7 Integrated Assessments:
An integrated engineering, economic-cum-environmental assessment of the alternative structural and non-structural options to attain the management objectives should be made and alternative ranked. Preferred options should be identified and justified on the basis of technical and economic soundness and long-term environmental resource sustainability. The assessment should clearly set out the criteria and methods used in the evaluation of alternatives. Preferred options hold be realistically appraised on the basis of past experience and performance of similar developments in the region.

3.8 Level of Efforts in EIA
EIA is an integral part of the planning process and should be undertaken by the planning team. The team should be in its or have access to a specialist on every major resources and environmental component expected to be affected by the proposed action. The team leader should preferably be a senior water resources expert with an overview of Bangladesh environment and skill in management and knowledge and capability in the preparation of comprehensive and accurate environmental impact assessments. The detailed skills that should be available on the team are described in the EIA manual.

Levels of effort required for assessment will vary according to:

- o whether the study is at the pre feasibility (regional planning) or feasibility (project) level
- o the size of the area being studied

- the complexity of the area under study
- the amount of background information available
- the experience of the study team members in undertaking EIAs
- the amount of study support available from other study components, especially the engineering studies.
- Availability of adequate budget and manmonth.
- A fair estimate of more or less 10% of fund allocated for feasibility study or 0.5 to 1% of total project cost (may be less in case of Regional study) which in all likelihood would correspond to man-months available is recommended to be earmarked for IEE/EIA studies.

CHAPTER 4

PROCEDURAL STEPS IN EIA

All EIAs should proceed through ten steps excluding peoples' participation which will continue through out the process as outlined in Figure 2. The levels of detail required will differ for pre-feasibility and feasibility EIA, as explained below:

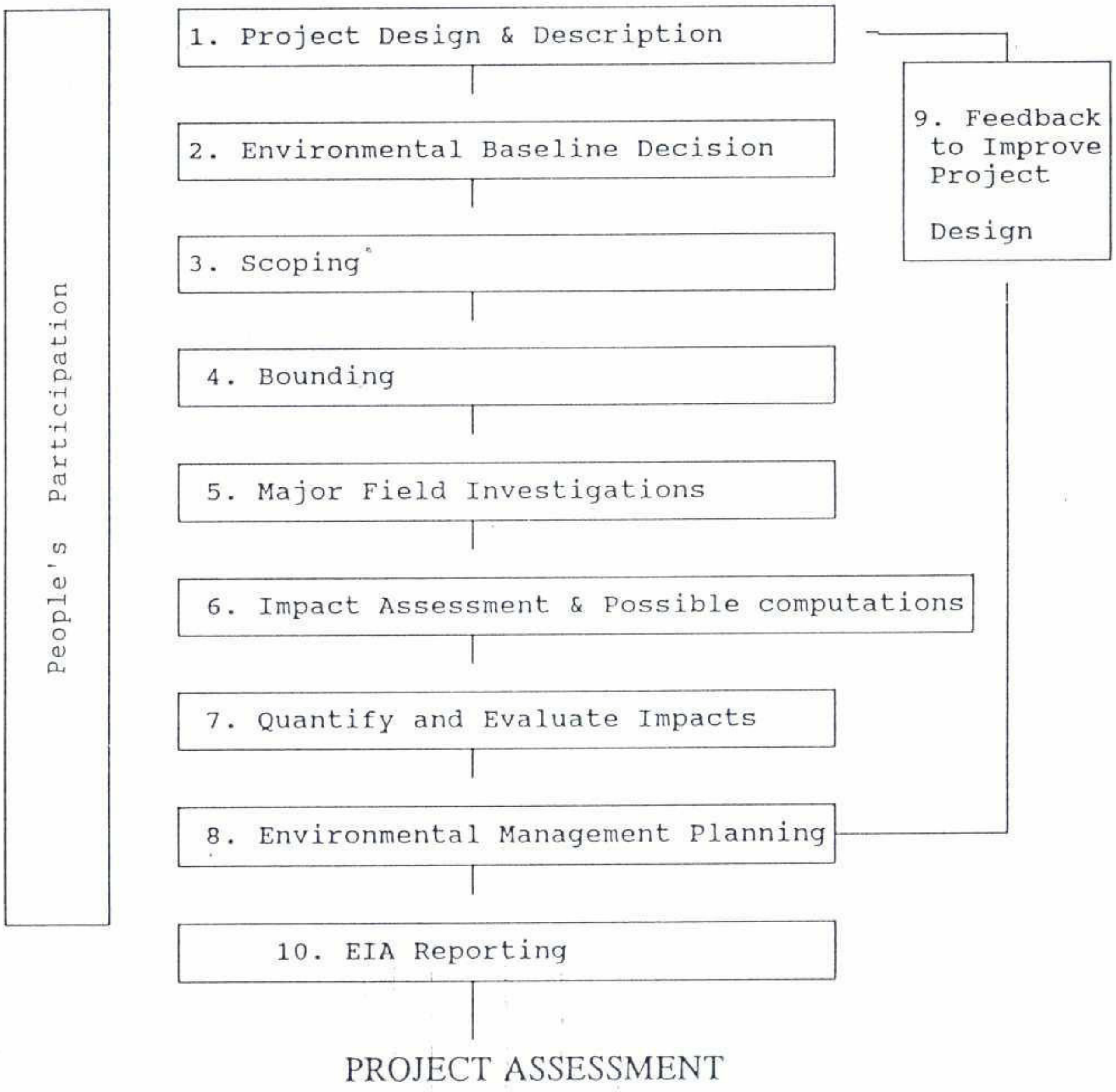

Figure 2. Recommended Steps in EIA.

Although not a numbered step in the EIA, active participation of local people should be sought in project study, appraisal, planning, implementation, operation and maintenance, This is described further in Chapter 5.

4.1 Project Design and Description (Step-1)

Describe the objectives, rationale and planned activities and potential interventions of the project and project alternatives, including the "without project" scenario. All proposed project activities both routine, and accidental events, having potential environmental significance should be ascertained and the principal disturbances likely to be inflicted on to the environment should be identified and quantified. Annex B lists the most common components of FAP projects. Distinction should be made between project components by project phase:

- preconstruction
- construction
- operation
- abandonment (if eventual project cessation or removal is likely)

The location, spatial extent, physical dimensions and temporal extent (for temporary facilities) should be identified, quantified, described and mapped in appropriately scaled maps.

4.2 Environmental Baseline Description (Step-2)

Describe the environment of the area likely to be impacted and identify important environmental components (IECs) and Indicators. The IECs should include components in water, land biological and human resources, including human aspirations.

A description of the project study area (see step 5 Bounding below) should be prepared, based on literature information and data, discussion with knowledgeable informants and a field reconnaissance of the area. The project study area should include all adjacent basins that may be influenced. Examples of components to be included in the description are:

- area and location
- climate and weather
- hydrological cycles
- physiography, landforms and soils
- surface and groundwater distribution
- land use patterns

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- terrestrial and aquatic habitats
- terrestrial and aquatic species including rare and endangered ones
- biodiversity/genetic pool
- vegetation
- historical environmental trends
- natural hazards
- major socio-economic features
- urban and rural settlements
- infrastructure
- archaeological/historical/cultural sites
- patterns of cumulative effects over the region

The EIA manual provides additional guidance on scales of data, quantification and levels of detail required.

4.3 Scoping (Step 3)

A scoping process should be used to identify the:

- main environmental issues of importance to all interested parties so that these concerns can be addressed in the assessment; and the
- Important Environmental components (IECs)

Scoping is best accomplished by integrating the knowledge available from as many sources as possible, including at least the following:

- archived information sources including literature survey and review reports on previous similar projects
- expert opinion from technical specialists, national, regional and local government officials, and Non-Governmental Organizations (NGOs); and
- knowledge gained from local communities, especially those using local land and water resources through direct communication with site reconnaissance

Scoping by technical specialists is best achieved through iterative technical meetings and workshop sessions where information sharing and simple quantitive analyses can identify the IECS to be considered further and to tentatively eliminate those components not requiring further attention. Scoping of local community concerns is addressed in Chapter 5. Scoping of issues for feasibility EIA should be more detailed than those for pre-feasibility level investigations.

Following identification IECS, should be evaluated in terms of:

- distribution (within the study area and elsewhere)
- quantity, quality and seasonality
- interaction with other resources and IECs (dependency or effect)

- socio-economic and/or ecological importance
- availability of substitutes
- economic value
- management responsibility and practices
- historical or cultural importance

4.4 Bounding (Step 4)

Spatial and temporal bounds to be used in assessing project impacts should be established. Selection of the appropriate time frame for the assessment of impacts as well as the appropriate spatial units for area-wise and community-wise impact assessment is a very important step in the EIA process. The spatial and temporal limits within which impacts will be assessed should be explicitly defined according to specified criteria. For FAP, FCD/I plans and projects within the FAP the following are recommended:

- physical factors, especially watershed boundaries;
- ecological boundaries, especially agroecological regions and sub-regions, which encompass the spatial and seasonal ranges occupied by biological populations being considered in the assessment; and

- social and administrative boundaries, including regions, districts and thana boundaries.

Watershed boundaries should include areas both up and downstream of the immediate project site within which project effects are likely to occur. Boundaries should also include areas within which off-site and cumulative impacts need be considered. Temporal bounds refer to the timing and duration of the proposed project phases (preconstruction, construction, operation and abandonment). For example, the operational life of an average FCD/I project in Bangladesh is taken as 30 years for which areal impact assessment (area and communitywise should be ensured.

4.5 **Major Field Investigations (Step 5)**

Field studies should be carried out to obtain data not available from existing sources and to update existing information, some of which may require verification and further detail. For regional plans and pre-feasibility level studies, rapid field assessment are recommended. For feasibility level EIA more detailed investigations entailing data collection and consideration of seasonal cycles should be undertaken. Annex C indicates the recommended feasibility-level information requirements for each major resource sector/ important environmental component. Sources of data and suggested methods of data acquisition are given in the EIA Manual.

4.5.1 Selection and validation of methods:

For feasibility level studies, a conceptual model of the environmental resources system is useful as a basis for identifying data needs, for planning and assigning priorities to data collection programs, and to delineate disturbance-background-impact interrelationships.

This should link the main environmental components and their associated processes and use by communities to the key features of the hydrological cycle and to the socio-economic systems within the area. Conceptual models can be in the form of biological calendars, networks or matrices. Both direct and indirect linkages between and among project components and IECs should be identified and evaluated. The EIA manual provides further detail on conceptual models. It is important to validate the concepts where possible by the time and study is over. Details of desired matrices/models have been discussed under 4.6.

4.5.2 Environmental Indicators

Indicators may be found useful as a basis for environmental description and assessment. Indicators are measurable features which relate to the essential functioning of the ecosystem, are sensitive to positive and negative project-induced changes, are looked to land and water-based livelihoods, and or are sensitive to seasonal changes.

4.5.3 Environmental Trends

It is of cardinal importance to distinguish significant trends in environmental baseline conditions and resource availability, demand, quality and or quality.

- Short-term trends are due to seasonal or periodic fluctuations in biophysical conditions or resource availability and use.
- Long-terms trends are due to changing baseline conditions on a local, regional, national or global scale.

4.6 Impacts Assessment and possible computations (Step 6)

Based on the nature of the project-environmental linkages, the baseline conditions within the receiving environment and the amounts of change expected in each case, the environmental impacts of the proposed project(s) should be identified and quantified as much as possible. Impacts should be evaluated with and without management measures.

At the regional planning level, impacts are best considered as potential constraints to project type, sitting and operation and may be evaluated without potential management measures. At the feasibility level, major impacts should be very seriously strived to be quantified and other important impact should at least be assessed according to each of the following criteria:

a. Role and importance of the IEC in the ecosystem:
   - o key links in the economic base of the nation, region, or locality (e.g. water);
   - o environmental components directly or indirectly oinked to human health or survival (e.g. animal protein);
   - o local key resources (e.g. fuel wood);
   - o irreplaceable cultural resources (e.g. archaeological sites, historic shrines);
   - o internationally recognized resources (e.g. Royal Bengal tiger);
   - o resources of importance to future generations(i.e. specific paddy germplasm);
   - o variable in abundance or quality over time (i.e. periods of critical availability e.g. supply of draught animals);
   - o important to ecosystem structure and function or as a surrogate to such a component;
   - o rare or endangered species/ or special habitats.

b. **Magnitude of the effect.**

   Impacts and the changes in the underlying processes should be assessed as quantitatively as data, information and understanding will permit. Quantification should be appropriately expressed, e.g.:
   - o percentage increase/decrease in volume, flow and composition;
   - o absolute change, e.g. frequencies and/ or durations (e.g. flood peaks, drought), size of at-risk populations (e.g. number of people potentially affected, economic losses/gains).

c. **Duration and type of impacts:**
   - o long or short-term
   - o reversible or irreversible
   - o cumulative or non-cumulative
   - o direct or indirect
   - o synergistic effects on the IECs by non-project related actions
   - o project-on-environment and environment-on-project

d. **Area:** environmental impacts are seldom uniformly distributed over the study area but are usually localized or unequally distributed. Evaluation of the quantified impacts as a single value representing the total aggregate impact over the entire study area would be inadequate for assessing environmental implications. Major impacts should be assessed for separate geographical units in the study area.

e. **Communities:** most socio-economic conflicts arise not from the total aggregate impacts but rather from differential impacts on different sections of the community. Various impacts should be assessed separately for each of the major sections of the community particularly for the poor and landless sections and quantified wherever possible.

Assessments should also be made for each viable project option and for each major component of the option where these are responsible for specific impacts.

The impact assessment should preferably be displayed in matrix fashion for ease of comparison and interpretation. There are many forms of impact matrices, however, standard procedure includes project activities entered as matrix rows and IECs listed as matrix columns. Elements of the matrix indicate which project activities and IECs interact to produce an environmental impact. These elements of the matrix may be scored and weighted in a large number of ways. The EIA manual describes some of these methods and provides references for obtaining additional information. The Government of Bangladesh (GOB) prefers that a weighted matrix be used which is illustrated in Annex-D. Whatever matrix representation is used, it should provide clear and concise results. All assumptions, terminology, and aspects of delineating matrix elements should be fully justified and explained. It is expected that the team will use an established matrix methodology that is documented in the literature.

Besides using a matrix approach for project on environment impacts, a separate analysis should be completed for cumulative impacts. In a heavily populated country, such as Bangladesh, the probability of non-project activities causing interactions with project ones is large. Often a cumulative impact can swamp a project impact (for example, the diversion of a large portion of the Ganges flow by India has considerable interaction potential with the smaller flow alterations associated with FAP projects in the downstream areas. Global climate change and regional riparian activities are also existing cumulative impacts that could be exacerbated by particular project activities).

As there are impacts of various nature and magnitude, those are of various levels. Five levels of impacts (from A to E) and their order of consideration while conducting an EIA have been elaborated in Appendix E.

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4.7 Quantify and Value Impacts (Step 7)

a. The main impacts identified in Step 6 should be quantified and valued using the methodology given in the EIA Manual and the guideline for projects assessment (GPA). Main features of quantification and valuation have been elaborated below for ready reference.

b. The type, magnitude, duration and other assessment criteria for impacts on specific resources and social areas should be summarized and listed in order of priority. Impacts and groups of impacts which threaten the long-term sustainability of resource systems or the social fabric of communities, and which cannot effectively be mitigated to acceptably low levels, should be identified for specific attention of reviewers and decision makers.

c. A system of multi-criteria analysis (MCA) has been adopted within the FAP for the valuation of beneficial and negative impacts for inclusion into overall project evaluations. Under the MCA system, impacts are evaluated in:

- o economic terms (taka or dollars) where costing is possible and acceptably accurate; or
- o Quantitative or numeric terms, where costing is not feasible (e.g. using impact scales as in step 6. or
- o descriptive terms where neither of the above is possible.

d. Environmental impacts will be costed at two levels in overall project accounting:

- o costs incurred by or through residual impacts (i.e. by impacts which cannot practically be mitigated);
- o cost of impact mitigation and environmental management.

e. Valuation of environmental impacts in economic terms is best accomplished by an integrated team of environmental scientists, project economists and design engineers to ensure consistency of methodologies and adequate identification of all relevant costs and benefits.

f. Benefits and costs accruing to different project components (especially flood protection, drainage and irrigation) and to different projects (if more than one are being developed contiguously and simultaneously) should be computed and reported separately to ensure adequate attention to mitigation and monitoring.

g. All costs of impact mitigation, compensation and enhancement should be included in evaluation (see section 4.8.1 for description of mitigation and enhancement). This includes costs of mitigation and management:

   o directly related to the project (e.g. specific control structures, access roads, embankment strengthening, maintenance, etc.);
   o externally related to the project through environmental management programs within the project impact area (e.g. agricultural extension, social, women's and educational programs, fisheries enhancement and extension, etc.).

h. Evaluation of impacts should take into consideration all likely future changes in resource abundance, availability and accessibility, brought about by:

   o the effects of the project itself (e.g. increases in agricultural yields, intensified cropping patterns, deterioration of habitat quality through local human population encroachment, etc.)
   o effect external to the project (e.g. changes in development policy, etc.).

i. Replacement costs and existing values should be fully costed in terms of resource losses, mitigation and compensation action needed to effect replacement, as well as the adequacy of such replacement (e.g. loss of natural fisheries, floodplain habitat which might have to be replaced by managed aquaculture ponds).

Required levels of quantification (which are to a varying degree) of various levels of impacts (from A to E elaborated in Annex E) have been added as Annex F.

4.7.1 Grade Impacts:

Grading of impacts for magnitude and significance should be carried out.

4.7.2 Mapping and presentation of impact magnitude

As many maps as possible should be included in the EIA report to make the contents more understandable. Once the Environmental Management Plan (EMP) is detailed out and dedicated steps should be taken to quantify most critical residual impacts. These impacts scaled down to manageable level be repeated in a maps for better understanding of the concerned people related to the project in the following steps (decision maker for the project for example).

Clarification of various impacts into high, medium and low criticality should be done first and then criticality values from 1 to 10 on a graded scale be assigned. The high criticality impacts are allotted weights of 8, 9 or 10; the low ones are allotted 1, 2 or 3 and the medium ones from 4. to 7.

An opinion assessment may be conducted at this stage among members representing the different affected communities.

The above opinion assessment be then used to modify and upgrade the criticality weight allocation for the particular project.

Major impact magnitudes be shown on separate maps of the area (including upper and lower reach effects if possible, and critical in the opinion of the EIA team) with different colours which could be dark green for significant positive, Red for significant negative, light green for moderate positive, orange for moderate negative, yellow for marginal positive and gray for marginal negative or suitable hatches for clear differentiations when presenting maps in black and white.

4.7.3 Evaluation of Trade offs between impacts:

Trade offs between impacts need very careful balancing using basic areal units. In case of socio-economic impacts which calls for more attention may be evaluated based on 3 income groups (for example Lower, Middle and High income groups). To arrive at a just conclusion it is suggested that the impacts on about 75/% lower income population be used to say completely while those on 20% middle income population be scaled down to one third. The 5% high income population based on criteria established during the process of EIA may be ignored.

The areas with positive and negative trade-offs may be shown in drawings using different hatches for clarity of understanding.

4.8 Environmental Management Planning (Step 8)

An environmental Management Plan (EMP) should be developed to deal with all follow-up activities during project construction, implementation, maintenance and (if required) abandonment. The main components of the EMP are:

- Mitigation and enhancement
- Compensation
- Monitoring
- Peoples' participation (described further in

Chapter 5).

- Disaster management plan (contingency planning)
- Description of the institutional implementation of the EMP.
- Description of all residual impacts
- Reporting and accountability framework
- Budget estimates for EMP implementation (for the detailed level EMP - see below).

The level of detail in the EMP will vary according to the stage of project study and development:

a. For the pre-feasibility EIA - identification of broad management options and major constraints.
a. For the feasibility EIA prior to review and decision on project development - identification of specific mitigation options, relative costs and expected residual impacts;
b. For the selected option to be developed - description of specific proposed mitigation, cost estimates, implementation schedules, mode of implementation, personnel requirements and training, and institutional arrangements.

For step 3 a detailed EMP report separate from the EIA is recommended to provide a working link to detailed engineering designs and contract documents.

Reviews and recommendations on the environmental management plan should be undertaken through consensus between the EIA practitioners, the project design and planning engineers, the regional government ministries responsible for project operation and maintenance, and local community representatives.

Budgeting for mitigation and or enhancement programs should be included in the project development and O&M budgets to ensure implementation. Effective budgetary support for mitigation programs may involve:

- one time financial grants to implementing agencies or bodies;
- continuing financial inputs as part of project management

Recovery of mitigation costs from project beneficiaries should be considered if FAP implementation policy is in accordance.

4.8.1 Mitigation and Enhancement

Mitigation and enhancement measures should be developed as the EIA proceeds to take full advantage of available information and engineering design possibilities.

a. Mitigation nd enhancement measures should be identified, fully described and evaluated for all severe impacts and for all other grades of impacts where the costs of such mitigation are in appropriate proportion to the effects in reducing impacts.

- Selection of alternatives (elevation, slopes, dimensions, site, size, sources of materials, placement of access roads, connections with existing systems, construction materials, energy, work force, scheduling of construction and or operation, etc.) that may not be optional on technical or economic grounds but are environmentally more benign;
- modification of a component to enhance a secondary benefit or reduce an impact;
- change in construction materials, methods, work force, etc;
- alternation in project operation (volume, flow, timing, etc.) or management;
- supplementary programs to counteract adverse effects (e.g. immunization);
- education or training to reduce risk or to allow more effective management of a diminished resource (e.g. fisheries training to avoid some existing poor management practices;

b. The feasibility of mitigation measures should be evaluated in terms of practicality, manageability and cost. All mitigation proposals should be costed and meet economic efficiency requirements (see Guidelines for Project Assessment).

c. Mitigation measures should be planned and implemented in parallel with project features to reduce environmental damage and to provide for more effective program development. Project modifications should preferably be designed into structures or operating procedures. After-the-fact changes tend to be costly and ineffective.

d. Mitigation and /or enhancement of some impacts may also affect the magnitude and significance of other impacts, and may introduce new side impacts which should be considered.

e. Environmental enhancement should be considered where significant gains in production, resource management and environmental protection can be achieved within the project area, through close collaboration with project development and operation and with financial support from the project. Potential enhancement to be considered includes:

- replacement or upgrading of affected resources;
- education and /or training to allow more effective

management of a diminished resource (e.g. fisheries training to avoid some existing poor management practices);
- introducing community management systems (e.g. water user associations).

f. All residual (non-and partially mitigable and adverse) impacts should be identified and quantified spatially and temporally. Such residual impacts should be classified and costed for inclusion in the Multi-criteria Analysis (see Guideline for Project Assessment). As the assessor passes from the first initial matrix to the final lists of residual impacts, increasing levels of quantification and analysis are required. Residual impacts and their severity are one of the most crucial parts of the EIA. These impacts must be delineated as significant or insignificant. Plans and projects with significant residual impacts should only proceed if they are justifiable in the circumstances. Clear statements on the effects of the residual impacts on the sustainability of the environment in question should be provided in the EIA and project feasibility reports.

4.8.2 Compensation Plan

Compensation measures should be developed as the EIA proceeds to take full advantage of available information and engineering design possibilities.

a. Compensation measures should be developed in all cases where significant residual impacts remain after implementation of practical mitigatory actions;
   - resettlement of displaced people requiring major social and infrastructural programs;
   - development of new wetland habitats;
   - development of alternative sources of fish supply to landless and poor communities deprived of common property fishery resources.

b. The feasibility of proposed compensation measures should be evaluated in terms of practicality, manageability and cost, and all proposed measures should meet economic efficiency requirements (see GPA), and be included as part of the cost of the EMP.

4.8.3 Environmental Monitoring

Environmental monitoring, as an integral part of EIA providing much useful base line data on actual environmental performance of FAP, FCD/I projects, is an essential part of the EMP. The EIA manual contains a great deal of valuable information on this component.

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a. Within the context of the FAP, monitoring is directed at the construction and implementation phases of projects already subjected to EIA. The objectives are to:

   - measure and extent of expected or poorly quantified impacts;
   - ensure early detection of unexpected impacts;
   - determine the efficacy of implemented mitigation measures in reducing impacts;
   - provide for periodic review and adjustment of mitigation programs.

   The type of monitoring is an integral part of environmental management.

b. Another form of environmental monitoring is directed at existing projects with the objective of:
   - acquiring knowledge of the type and magnitude of ongoing project-environmental interactions;
   - discovering, though analysis of the data and comparison with baseline conditions, any unforeseen secondary benefits or adverse impacts.

c. Establishment of environmental monitoring programs should be undertaken by the operational and maintenance agencies on the basis of expected severity of impacts and doubts as to the efficacy of proposed mitigation measures. Proposals for monitoring should be drawn up for review and approval by the Project Review Committee. Proposals should include:

   - the objective(s) of the monitoring program;
   - proposed sampling programs, including parameters to be measured, sampling strategies, location and times of sampling, personnel and equipment requirements and estimated costs;
   - indications as to how the monitoring data will be utilized technically and procedurally to improve mitigation and environmental management.

   Suggested sampling and implementation procedures for monitoring are given in the EIA Manual.

d. Responsibility for the environmental monitoring programs, including equipment, facilities, personnel and training should be assigned to the agencies having permanent responsibility for the resources in question.

4.8.4 Disaster Management Plan

The EIA should contain a full accounting of all hazards within the project area and assess how these would be affected by project development and implementation.

4.8.4.1 **Risk assessment and management**

Where significant risks are considered likely under post project conditions (e.g. sudden severe flooding from embankment breaching), an appropriate risk assessment methodology should be used. If after this further analysis, the risk is considered significant, the EMP should outline a contingency plan for containment and management of the hazard. Such plans should include:

- o identification of the agencies and /or community groups responsible and accountable for disaster management;
- o an outline of the specific steps to be take in the event of a disaster;
- o identification of any necessary early warning systems.

4.8.5 **Institutional Support**

The EMP should outline the institutional arrangements made to carry out the mitigation, enhancement, monitoring and other components of ongoing environmental management. At the present time the development of institutional support for FAP-related programs and projects is in an evolutionary phase. Institutional support should be assured at two major levels;

- o Local institutional support should be obtained through the activities of the Environmental Planning and Management Council(see chapter 5).

- o Central institutional support should be developed in close cooperation with the main proponent of the project which in most cases will be the Bangladesh Water Development Board.

4.8.6 **Reporting and Accountability Framework**

This details plans for regular and ongoing reporting of EMP activities to regulatory government agencies responsible for project operation and maintenance and to other concerned parties. It describes the required contents of reports when they should be completed, who is responsible for completing them and to whom the reports must be submitted.

4.9 Feedback to Improve Project Design (Step 9)

The results of the scoping, communication with interested/concerned parties, the impact assessment and the people's participation process should be fully utilized in ongoing fashion to improve and enhance the design of the project. Potential modifications to the project could include:

- selection of more environmentally benign structural alternatives (e.g. submersible rather than full flood embankments);
- selection of non-structural alternatives to reduce flood damage;
- modification of project design (e.g. setback distance, embankment heights);
- implementation of mitigation measures (e.g. provision of fish passage to permit fish access and/ or implementation of operating procedures to minimize specific impacts).
- Change in sitting of project.

4.10 EIA Reporting (Step 10)

Results of environmental assessments are reported at two levels:

- an initial environmental evaluation report for pre-feasibility (regional planning) level studies;
- a detailed EIA for feasibility-level studies

An Environmental Management Plan (EMP) should be an integral part of EIA when reviews are being carried out and a decision is being made to proceed with project implementation (see Chapter 6).

Standardized approaches to study and reporting procedures on methods and data collection are encouraged to facilitate reviews and to promote efficient implementation of project development and mitigation measures. EIA reports are the main medium of information exchange between EIA practitioners, project planners and engineers and decision makers. They should be detailed and analytical while presenting information, conclusions and recommendations clearly and unambiguously, and should include maps/overlays of impacts based on impact severity and should compare situations with and without project and with - and without recommended mitigation measures (area and community wise). A detailed outline of suggested EIA Table of contents is given in appendix G.

Chapter 5
PEOPLE'S PARTICIPATION

Active participation of local people in the entire project cycle, i.e. program identification, study, appraisal, planning and implementation, should be employed as the key to achieving long term sustainability and success of FAP water management programs. The overall aim of the participation process is to ensure that those social groups affected by a program have an opportunity to decide whether the program should be implemented. People's participation should be developed as a "bottom-up" planning process in which local people are fully involved in shaping their own future, rather than being objects in a "top down" planning approach.

5.1 Objectives of People's Participation

The primary objectives of people's participation in EIA are:

a. to enhance the sustainability of FAP projects by ensuring that these are relevant to the people of the area;

b. to have local people participate fully in plan or project scoping to identify Important Environmental Components and issues;

c. to give local people a decision-making role in the identification and exploration of environmental concerns of all FAP regional plans and projects;

d. to obtain local knowledge, information and ideas relating to the technical and hydrological development of the projects and plans;

e. to obtain local information about social conditions, land values, resources usage, informal and customary rights, so that an accurate appraisal of project impacts can be made and equitable standards for mitigation and compensation developed;

f. to ensure early detection of possible social conflicts arising from program interventions so that these can be minimized through negotiation and education;

g. to ensure that institutions and procedures are established that enable local people to participate in the construction, operation, and maintenance of FCD infrastructures;

h. to ensure that institutions and procedures are established that enable local people to participate in nonstructural FAP programs.

5.2 **Steps in People's Participation**

People's participation involves the following steps:

a. Identification and selection of programs for study after local needs and perceptions have been ascertained through an extensive dialogue with all social groups likely to be affected.

b. Use of participatory rural appraisal methods to ensure that;

  - all social groups likely to be affected by the program, both inside and outside the program area, are identified and consulted;

  - special attention is given to identifying the needs and interests of the rural poor, ethnic groups, minorities, women, and groups that depend on marginal or fragile resources;

  - all land and water resources used in the area are identified and placed in the local context in terms of their use, availability, role in maintaining family livelihoods, and vulnerability to program effects;

  - all informal rights to land and water resources and all customary usages are identified, understood, and recorded.

3. Development of an organizational context within which local people will be:

  - guaranteed representation (by resource user group);
  - Briefed and updated about information being developed about the social and economic effects of the program;
  - consulted about the engineering and design components of the program;
  - able to negotiate the environmental management plan especially compensation, mitigation, and enhancement packages; and
  - granted the right to decide whether or not a particular program will be implemented.

5.3 **Scope of People's Participation**

Scoping of community concerns can be accomplished by the following:

a. Presentation of the project or planning proposal by the EIA team in village level scoping sessions throughout the study area.

b. Provision of an organizational context within which local communities can formally respond to project designs.

c. Adherence to a requirement that EIA and engineering design specialists respond directly and in person to community concerns about the potential technical and social effects of the program.

d. Adherence to a requirement that program designers should integrate community recommendations into program components.

e. Consultation/negotiation with the affected communities about alternative programs and/or acceptable environmental management planning including: mitigation, compensation, and enhancement program packages.

f. In addition to local communities, public consultation should encompass the wider community of concerned government ministries, national and international NGOs, donor groups and agencies, and other interested parties.

Chapter 6
EIA REVIEW PROCEDURES

The purpose of the EIA review process is to assess the adequacy of the EIA for decision-making on regional or project proposals and to consider its conclusions and implications for project implementation.

EIA reports should normally be appended to the main project assessment report and should be accompanied by various technical annexes. Project reports should be submitted jointly and should be subjected to three separate reviews by:

- Local government agencies, community groups and NGOs operating in the project area;
- A Project Review Committee comprising representatives from the Ministry of Irrigation, Water Development and Flood Control (MIWDFC), concerned Ministries, knowledgeable NGOs working and selected professionals/academics and
- The Department of Environment (DOE) which is the final authority to review and approve EIAs and for giving environmental clearance to all projects in Bangladesh.

Key items from the EIA and project feasibility reports should be publicized among the communities in the project impact area(s) and provision made to meet these groups and discuss study findings and proposed plans (see chapter 5).

The Project Review Committee's review should address, but not be limited to, four main themes in the EIA:

1. Quality - whether the EIA is acceptable in terms of:
   - level of analysis;
   - data requirements (adequacy and reliability of baseline data);
   - clarity of presentation;
   - correct choice of study area, communities, boundaries and IECs;
   - the choice and development of the appropriate environmental impact model(s);

2. Content - whether the EIA satisfactorily addresses and adequately quantifies the relevant environmental issues:
   - linkages, interactions, magnitude of impacts, priority and casual sequences;
   - risk assessment and disaster management;
   - assessment of alternative actions and their relative effects;
   - comparison of benefits, adverse effects and trade-offs, including issues of equity, gender, biodiversity and sustainability;

- assessment of impacts on different sections of communities on different parts of the study area;
- tables and overlays that present the clearest overall impact picture.

3. Environmental Management Plan
   correct choice of components,

   - makes adequate provision for mitigation and compensation;
   - fully identifies all major residual impacts after EMP implementation;
   - has sufficient budget and manpower to accomplish the stated objectives.

4. Risk Assessment and Disaster Management - adequacy of the predictions and contingency plans.

5. Conclusions

   - clarity and conciseness of conclusions and recommendations;
   - adequacy of proposed management measures and their cost estimates;
   - adequacy of proposed monitoring programs;
   - the extent of acceptance of environmental recommendations into the project implementation phase;
   - the environmental significance of residual impacts;
   - Any other environmental implications of project approval.

6. EIA Report Acceptance or Rejection:
   The EIA review process concludes with one of two basic types of decisions:
   - the assessment is inadequate for decision making and requires additional study; or
   - the assessment is acceptable and adequate for decision-making.

In the case of an inadequate assessment the review report should indicate areas of deficiency and identify ways to obtain the required information or conduct the necessary analysis.

If the assessment is accepted, the review report should provide the rationale for a positive decision and should recommend either to:

- proceed with project assessment; or
- proceed with modifications to project design and/or the environmental management plan and specify which options to adopt; or
- cancel the project.

If a modified project is accepted which differs significantly from that assessed in the EIA and revised EIA should be prepared and submitted for review.

Chapter 7

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Annex A
POTENTIAL ENVIRONMENTAL IMPACTS OF FLOOD ACTION PLAN DEVELOPMENTS

1. Potentially Beneficial Effects

Beneficial effects of FAP projects include those which are primarily targeted in project design, e.g. flood protection, improved drainage, improved irrigation, higher agricultural yields, etc. as well as secondary benefits such as improved nutrition and effects of increased economic well-being.

1.1 Land/Land Use

- creation of more secure land for agriculture, settlement, industry and infrastructure

1.2 Agriculture

- net reduction of sand deposition on agricultural lands
- reduction in crop losses from floods
- more secure crop production in protected areas
- higher rice yields in both wet and dry seasons
- increased inducement to utilize HYVs
- reduced flood hazard to livestock
- increased tree crops
- increased species diversity
- decreased salinity in coastal agricultural areas protected from storm surges
- extended cropping periods and areas due to improved drainage
- increased fuel, fodder and feed.

1.3 Fisheries

- opportunity for creation of aquaculture ponds in borrow pits
- reduction in losses from pond aquaculture and impounded water bodies

1.4 Water Quality

- increased sanitary/pollution assimilation capacities in wet season
- reducation of saline contamination of shallow coastal aquifers by storm surges

1.5 Water Quantity

- reduced surpluses of water

1.6 Human Health

- nutrition gains from increased agricultural production
- reduced loss of life from flood hazard
- reduced incidence of post-flooding diarrhoeal disease
- improved sanitation

1.7 Social Benefits

- increased agricultural sector employment
- increase in incomes and general economic activities for some social sectors
- improved incentive for investment in capital stocks and efficiency of economy, encouraging development in general
- improved security for housing, industries and infrastructure
- increased employment opportunities for women

1.8 Hazards

- reduced hazards from extreme floods and tidal surges
- reduced vulnerability to flood-induced hazards.

2. Potentially Negative Impacts

Negative impacts of the various FAP interventions could include a very wide range of direct impacts on the biophysical and social resources of the project area, e.g. reduction in fish populations used as food source. They could also include secondary, indirect and cumulative impacts, both within the specific project area and over a wider area beyond or downstream of the actual project site. The extent of negative impacts would depend on the scope of the proposed project, the nature and value of the resources affected, and the extent to which mitigative measures could offset any negative effects. Not all the negative impacts listed would necessarily occur in any given project, but they would have to be considered and assessed during the EIA.

2.1 Land and Land Use

- increased pressure on available land resources from population increase as a result of higher agricultural yields and improved nutrition and economic status
- loss of riskier but seasonally productive land area and soils to embankments, roads and brick-making
- waterlogging within polders and compartments
- decreased security in downstream or peripheral areas
- inequalities in the distribution of benefits, disbenefits
- resettlement and dislocation

2.2 Agriculture

- deterioration of soil physical properties in waterlogged areas
- loss of natural flood-induced pest control
- trend to HYV monoculture reducing agricultural diversity
- reductions in agroecosystem resilience
- potentially greater losses of crops under conditions of extreme flooding and embankment failure

2.3 Fisheries

- loss of formerly flooded habitats for major capture fishery species
- reduction in allochthonous nutrient inputs
- loss of natural stock replenishment
- loss of access to fisheries for socially disadvantaged groups
- reduction in natural fishery production and harvests
- replacement of natural fisheries with potentially more expensive aquaculture
- potential long-term aquaculture productivity declines from bio-chemical accumulation in soils and ponds
- increased risk of production loss due to disease and lower bio-diversity
- net reduction in production despite aquaculture increases
- reduction in fishery resource diversity and resilience
- increased short-term turbidity at river dredging or construction sites
- loss of benthic fauna and flora at dredging or under-water excavation sites
- social costs of change from capture to culture fisheries
- increase threats to endangered species
- reduction in spawning and rearing areas

2.4 Water Quality

- decreased sanitary/pollution assimilation capacities in dry season
- increased agrochemical run-off, contamination of surface water
- increased turbidity at a river or coastal dredging and excavation sites
- local ecological toxicity in coastal and river areas from construction discharges and spills

2.5 Water Quantity

- restriction of water-borne transportation by physical structures and siltation
- reduced access to domestic water supplies and potential seasonal drinking water shortages in some regions
- drawdowns in tanks used for bathing and fishing
- water use conflicts, e.g. coastal agriculture, brackish versus freshwater aquaculture
- confinement effects (higher stages and discharges) in downstream areas

2.6 Human Health

- reduced access to drinking water from tubewell sources
- changes in epidemiology due to labor force aggregations

- increasing chemical toxicity to humans from agrochemicals
- nutritional declines due to reduction in fish protein food sources

2.7 Social Issues

- shift from common resource regimes (e.g. capture fisheries) to private property regimes (e.g. aquaculture)
- impacts to historical and cultural heritage sites

2.8 Wildlife and Biodiversity

- reduction in availability of wetland and terrestrial habitats
- estuarine ecological changes
- increased toxicity and decreased ecological resilience due to agrochemicals pollution
- increased threats to endangered species

2.9 Hazards

- increased depth of flooding, higher flood velocities, and erosion of char and other unprotected active floodplain lands
- build-up of river channels due to sedimentation, increasing risk of sudden embankment failure and overtopping
- water level and velocity increases in river channels
- increased depth of flooding when embankments breached
- increased embankment misuse and abuse
- risk of interactions between FAP interventions and natural disasters such as earthquakes.

Annex B

COMMON COMPONENTS OF FAP PROJECTS HAVING POTENTIAL ENVIRONMENTAL EFFECTS

1. **Preconstruction (Planning, Exploration and Study) Phase**

    1. Land, topographic and benchmark surveys
    2. Hydrological and climatic surveys and instrumentation
    3. Land use and natural resource inventories
    4. Socio-economic surveys
    5. Land acquisition
    6. Temporary access roads
    7. People's participation activities

2. **Construction Phase**
    1. Land acquisition
    2. Village and infrastructural resettlement and relocation
    3. Access:
        - road construction and maintenance
        - vehicular traffic pattern changes
        - pedestrian traffic pattern changes

    4. Temporary structures and land occupation:
        - storage and godowns
        - staff and labor camps
        - garages and parking sites
        - canteens and kitchens
        - waste and garbage disposal sides
        - water handling and storage facilities, including bathing facilities
    5. Excavation of canals:
        - drainage
        - irrigation
        - navigation
        - fisheries

    6. Embankment construction
        - labor mobilization
        - soil taking and borrow pit construction

    7. Installation of tube wells and associated electricity and energy supplies

    8. Construction of hydraulic structures:
        - sluice gates
        - regulators
        - culverts
        - fish ladders
        - navigation lock gates
        - pump houses
        - irrigation canals

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9. Operation and Maintenance Phase
    1. Operation and maintenance of:
        - sluice gates
        - regulators
        - fish ladders
        - navigation lock gates
        - pump houses
        - embankments
        - drainage channels
        - irrigation canals
        - cyclone and flood shelters

    2. Agricultural development:
        - institutional development
        - agricultural extension
        - credit inputs
        - seed acquisition and distribution
        - fertilizer storage and application
        - pesticide storage and application
        - irrigation
        - establishment and operation of cooperatives and resource user groups

    3. Development of infrastructure and supply services
    4. Initiation of project:
        - community educational programs
        - project support programs

4. **Abandonment (Post-Project) Phase**
    1. Land reclamation
    2. Monitoring and evaluation

Annex C
INFORMATION REQUIREMENTS

The information requirements are the same for both pre-feasibility and feasibility level investigations, however there are differences in the detail and scales of data and information used. Pre-feasibility investigations rely on existing information supplemented by rapid field reconnaissance methods. Feasibility studies require more specific investigations and longer-term data gathering programs. Much of the hydrology information and significant portions of the agricultural, sociological and possibly the fisheries data required for EIA will normally be available from the engineering and technical feasibility studies. Further details on methods and scales of study are given in the EIA Manual.

1. Climate

1.1 Describe the rainfall pattern for the study area. Indicate the maximum, minimum and mean monthly rainfall for the period of record, including variability in seasonal rainfall and the confidence limits. Relate the cropping seasons to the portability of rainfall (acceptable range, flooding range, drought range). Indicate the location of all recording stations for which data are presented.

1.2 Describe the general patterns of ambient temperatures and humidity and provide monthly means, maxima and minima for the period of record. Indicate the location of all recording stations for which data are presented.

1.3 Evaluate agroclimatic conditions in the study area, using a standard index of evapotranspiration.

1.4 For coastal areas describe the storm and cyclone patterns and antecedent weather conditions, the seasons of highest occurrence of destructive coastal weather patterns, and the historically recorded extent of cyclonic and flooding damage.

2. Land Resources

2.1 Topography

Describe and map the distribution of land types (F_0, F_1, F_2, F_3, and F_4) within the project area.

2.2 Land Use

1. Conduct semi-detailed land use surveys to map the distribution and uses of land within the area, geographically and by percentage of area. The suggested categories are:
   - agriculture
   - natural woodland and scrub
   - plantation forest, including orchards
   - grassland/pasture, including long-term fallow

- permanent water bodies
- temporary or seasonal water bodies
- coastal areas, including forests, beaches and polders.

2. Map and describe urban/village/settlements/other surface infrastructure.

3. Note all trends in land use patterns over the long term, up to the present, and their likely continuance or anticipated change. Map future land-use where feasible. Consider how land use patterns change seasonally, specifically in relation to:
   - flooding
   - agriculture
   - social factors
   - other factors (identify)

2.3 Soils

1. Describe and map the basic characteristics of the soil series and phases that affect land use, particularly:
   - chemical composition (fertility, acidity, etc.)
   - texture (topsails and subsoils)
   - permeability
   - drainage
   - soil moisture
   - soil salinity
   - soil consistency

2. Describe crop suitability of the major soils of the area based on land capability classifications.

3. Classify the uses of soil in the area, including:
   - agriculture
   - structures (embankments, roads, house, platforms, etc.)
   - bricks
   - industry (e.g. pottery)

   Consider how soil demands are met and the extent of conflicts.

4. Describe the extent of major soils that are subjected to irrigation. Note the effects of irrigation on water logging and seepage losses. Identify any nutrient deficiency problems (e.g. sulphur, zinc, etc.)

5. Describe the extent of soil erosion in the area, especially on:
   - agricultural land
   - embankments
   - other soil-based structures

Indicate how ;erosion is related to human activities (soil taking for embankments, house platforms, vehicular traffic, removal of vegetative cover, etc.) and natural factors (river bank erosion, etc.)

6. Describe and map areas where rivers and/or canals deposit sediments. Note if this has any effect on topsoil texture, land use and/or fertility.

2.4 Agriculture

1. Describe and map the major agricultural cropping patterns for each land type in the area

2. Describe the types of rice produced in the area in each of the three growing seasons. Specifically quantify:
    - the percentage of total rice production derived from the aus, aman and boro crops
    - the areas and percentages of cultivated land under different types of rice.

    Note the extent to which supplementary irrigation of aman is commonly practiced.

3. Describe the homestead vegetation in the project area. Characterize the species abundance and distribution of fruit, timber and fuel trees and their susceptibility to floods, drought and other factors.

4. Describe other crops are grown in the area:
    - food crops
    - cash crops
    - fodder crops

5. Note whether the study area is a net importer or exporter of food grains.

6. Quantify land types and seasons in which past crop damage has occurred due to:
    - floods
    - drainage congestion
    - drought
    - hail
    - other climatic and hydrological factors

7. Describe trends in cropping area, intensity, production, and strains in the above crops over the previous 10-20 years. Indicate any known causes for such changes, e.g.
    - flood management activities
    - surface irrigation

- groundwater irrigation
- improved agricultural technology

Note the extent to which:

- such changes have been distributed among different socio-economic groups
- local trends compared with national ones
- observed trends expected to continue over the next 10-20 years in the absence of major flood management activities.

8. Describe the use of the following agricultural inputs for major crops grown in the area:
   - seeds, seedlings and saplings
   - chemical fertilizers
   - organic manure
   - irrigation
   - pesticides

9. Provide estimates of the numbers of livestock kept by various social groups within the study area and their uses for:
   - draught power
   - food sources

Quantify the extent of pasture land available in the area. Describe the marketing procedures for livestock and livestock products.

Indicate any constraints on livestock maintenance and production, or trends in numbers and production, especially related to:

- feed and fodder availability
- disease and treatment facilities
- flood related factors

2.5 Renewable Energy Resources

1. Describe the major sources of biomass fuel in the study area in different seasons:
   - fuelwood, leaves and twigs
   - agricultural wastes, including residues, bagasse, etc.
   - manure

and indicate the major uses of such fuel for:

- cooking
- crop processing
- manufacturing (e.g. brickfields)

2. Identify any shortages or constraints on production and/or use of renewable energy in the area, including factors such as:
   - changes in land use patterns (e.g. conversion of forested land to croplands)

- reduction in land area available for fuel production, e.g. community forests

and any trends over time in such constraints related to factors such as population growth, etc.

Describe any programs to alleviate fuel shortages, e.g. community forests, agroforestry, homestead forests, etc.

3. Describe existing and planned electrical energy use and distribution in the area, and its use for:

   - domestic purposes
   - industrial uses (including cottage and rural industries)
   - irrigation and agricultural uses

3. Water Resources
   3.1 Surface Water

1. Describe and map the general pattern of surface water distribution and major drainage patterns, including rivers (Adjacent and within the area), small waterways, beels, haors and flooded areas. Indicate the:
   - natural and artificial drainage systems and their distribution
   - seasonal changes in water levels
   - seasonal changes in drainage
   - extent, periods of occurrence and causes of waterlogging
   - effects of existing infrastructure (roads, canals, building, platforms, etc.) on drainage
   - extent of interconnections

2. Describe and map river erosion hazards.

3. Provide analyses of river stages and discharges for standard return periods. Provide analyses of low flows for dry months for standard return periods. Indicate the availability of water for irrigation.

4. Provide a quantitative description of the hydrological cycle within the overall watershed encompassing the study area and within its component systems. Give mean, maximum and minimum discharges and water levels for all major lotic (flowing) water bodies, including main river and canal sources and water levels for lentic (standing) water bodies such as haors, baors and beels. Indicate the location of any gauging stations for which data are presented.

5. Quantitatively describe historic hydrological problems in the study area, including flooding, flash floods, waterlogging and inadequate drainage. As far as possible locate the types,

distribution and extent of such problems on maps and indicate their seasonally.

6. For coastal areas and shorelines of major rivers describe shoreline morphology and stability, and the major circulation patterns adjacent to any proposed structures.

3.2 Water Transportation

1. Describe the extent of navigational use of waterways (rivers, streams, beels, etc.):
   - geographic distribution and navigable lengths
   - ports or landings
   - infrastructural facilities
   - changes in relation to the annual flooding cycle
   - key linkages that affect navigation:
     - water flowing into the area from outside
     - sedimentation of channels
     - presence of embankments and regulators
     - aquatic vegetation (e.g. water hyacinth)

2. Describe any apparent trends in navigational use of waterways in the area from factors including erosion, sedimentation, flow reductions, FCD/I developments, etc. Evaluate the socio-economic responses to these trends, including factors such as increased use of road transportation, breaching of embankments and economic impacts.

3.3 Surface Water Quality

1. Characterize the major physical, chemical and biological properties of the surface waters of the area that determine how they are used for:
   - domestic purposes
   - irrigation
   - livestock
   - fisheries
   - village industries
   - wildlife
   - other uses

   Indicate the linkages within and to the outside which affect the water quality characteristics, e.g. seasonal flooding.

2. Describe any water pollution problems of the area and their sources, expressed in terms of types of pollutant, severity, and effect on water use. Indicate what is known about these water bodies in terms of flow rates, water quality characteristics, areas and volumes, and relationships to seasonal flooding patterns.

3. Describe the pollution assimilation capacities of these water bodies as determined through analysis of dispersion and seasonal variations.

4. List all human activities contributing to water pollution, specifically industrial discharges (including deliberate and accidental), urban/domestic runoff and agricultural drainage (especially pesticides, fertilizers). Note any evidence that these pollutants are reaching the groundwater. Consider potential toxicity of all industrial discharges. Describe actions being taken, individually, communally or institutionally, to diminish or avoid pollution problems.

5. Describe all major consumptive water users in the area that affect flow conditions in water bodies. Note ;any evidence that such flow reductions result in declining water quality by reducing dilution.

6. Evaluate any evidence that the water pollution situation has changed in the last 10-20 years. Specifically consider:
   - relationship to FCD/I activities, including upstream diversions
   - reduction in flow
   - reduced drainage
   - water quality changes casually related to land or water use (increased industrial discharges, urbanization, population growth in villages, increased use of agricultural chemicals)
   - any evidence for links between changes in water quality and changes in the public health situation.

   Evaluate whether water quality trends will continue for the foreseeable future, specifically considering increased industrialization, decreased or increased rate of population growth, non-FAP agricultural improvements, changes in national, regional, or local pollution control regulations and practices.

3.4 Salinity

For project areas located in coastal areas, consider the following:

1. Describe the effects of seasonal flooding cycles, amounts of inflowing fresh water, rainfall and cyclonic storm surges on water salinity in the area.
2. Note any evidence for salinity changes due to human activities, particularly deliberate breaching of embankments or poor operation of control structures. Describe ;all water uses in the area requiring certain levels of salinity (shrimp culture, salt extraction, etc.)
3. Consider the extent to which local resource ;uses have been adapted to salinity increases (e.g. changes in cropping

patterns, replacement of rice cropping with shrimp culture, etc.) and the economic effects of such changes.

4. Determine whether soil and/or water salinity has changed during the past 10-20 years. Any identifiable causes of such changes should be recorded as well as identifiable effects on fisheries, agriculture, wildlife, forests and afforestation, settlement patterns and infrastructure. Evaluate whether observed trends in salinity can be expected to continue over the next 10-20 years in the absence of FAP and FCD/I actions.

3.5 Ground Water

1. Describe the quantity and quality of the groundwater resource in a local and regional context. Specifically note whether the resource is part of a larger aquifer. Note any evidence for overuse (withdrawals exceeding recharge) or pollution.

2. Describe ground water recharge patterns in the area and their relationship to seasonal rainfall, river discharges and flooding.

3. Quantify the numbers and types of users of the groundwater resource:
   - numbers of wells by type (STWs, DTWs, HTWs)
   - uses for each type (domestic, industrial, agriculture)
   - volumes or percentages by well type

   Specifically indicate types of user dependency (casual use, required use, etc.) and the relationship of use to the hydrological cycle. Note any alternative water sources available to these users.

4. Analyze apparent trends in groundwater exploitation and use for the past 10-20 years and assumed trends into the future. Specifically indicate changes due to:
   - HYV agriculture and increasing use of STW and DTW irrigation
   - previous FCD/I schemes
   - changes in river discharges
   - reductions in dry season surface water flows
   - salt water intrusions

   Examine the linkages to these changes particularly in respect of socio-economic factors:
   - drinking water and public health
   - agriculture
   - industrial water use
   - replacement of STWs by DTWs or HTWs running dry
   - effects of on local and/or regional economics
   - avoidance of contaminated ground water supplies

4. Biological Resources

4.1 Open-Water Capture Fisheries

1. Describe and map, where possible, the various types of aquatic habitat, e.g.
    - beels (permanent or seasonal flood-plain depressions)
    - haors (bowl-shaped depressions between river levees)
    - baors (closed water bodies formed by oxbows of dead rivers)
    - floodplain
    - rivers (permanently flowing water bodies)
    - canals and drains
    - estuaries (mixing zones between fresh and salt water)
    - lakes and reservoirs

2. Describe and quantify habitat types according to their distribution, total area, range of areas of individual bodies, relationship to the seasonal hydrologic cycle, and physical, chemical and biological properties.
    - shore-line characteristics (vegetation, erosion, etc.)
    - water temperature
    - color
    - turbidity
    - total suspended and dissolved solids
    - conductivity
    - salinity
    - dissolved oxygen
    - biological oxygen demand
    - acidity and alkalinity
    - total inorganic and organic nitrogen
    - total phosphorous
    - chlorides and sulfates
    - heavy metals
    - phytoplankton
    - zooplankton
    - periphyton
    - macrophytes
    - macro-invertebrates

3. Describe general fish community structure and species diversity in each habitat type (including prawns and shrimp). Indicate how this changes in relation to the hydrologic cycle.

4. Define fish population structure, expressed in terms of:
    - dominant species
    - rare, threatened and/or endangered species
    - life stages (larvae, fry, juveniles, sub-adults, adults)
    - stages of maturation
    - spawning sites and seasons by species

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Relate population structural changes to changes in the hydrologic cycle.

5. Describe the migratory behavior of the species present and its dependence on the hydrologic cycle.

6. Describe and classify types of gear used by the various categories of fishermen, including:
   - nets (gill, net, lift, cast, push, etc.)
   - traps, crafts
   - harpoons and spears
   - hooks and lines

   Indicate how gear is used relative to habitat types and to the hydrologic cycle.

7. Quantify the seasonal intensity of fishing in the various habitat types by numbers of capture (gear) units for each category of fishermen and/or numbers of fishermen per unit of habitat and time. Desirable statistics include catch per unit effort (CPUE) expressed as weight (kg) of fish caught (by species if possible) per category of fishermen per unit of fishing time.

8. Compute the total production (including shellfish) in the area, preferably on a monthly basis, for each habitat type. Indicate the distribution by species, category of fishermen, types of gear and hydrologic seasons.

9. Describe fisheries management in the area, including:
   - practice of old short-term leasing system
   - practice of New Fisheries Management Policy (NFMP)
   - enforcement of fishing regulations
   - management practices, including fish stocking programs

10. Describe fish landing and marketing practices in the area, specifically identifying buyers (middlemen), landing sites, trading localities, fish processing plants and distribution routes.

4.2 Closed Water Culture Fisheries

1. Describe the status of fish culture in the area, including average pond size (and limits) for various types of impounded water bodies:
   - aquaculture types
   - cultured (actively stocked and harvested)
   - potentially cultured (suitable for culture but not actively stocked)
   - derelict (not suitable for aquaculture in present condition due to flooding or structural deficiencies)

2. Describe the type of culture practiced:
   - species stocked
   - stocking rates and ratios
   - seed sources (river or hatchery)
   - pond fertilization and/or fish feeding practiced

3. Describe the production (by various pond types):
   - total production (kg/ha)
   - by species (kg/ha)

4. Describe the extent of fish culture extension services.

4.3 Wildlife

1. identify and map all major terrestrial wildlife habitat types in the project area:
   - open fallow land
   - agroforst
   - plantation forest
   - roadside vegetation/community forest
   - homestead vegetation
   - deciduous forest
   - evergreen forest

   Characterize and quantify each habitat type according to plant species composition, canopy cover, amount of edge, ecotones, ecological requirements of vegetation, and problem vegetation.

2. Quantify the habitats in the project area according to:
   - areas of habitat within different land types (relating to area elevation curve and flood levels)
   - changes in habitat quality (loss, improved protection, etc.)
   - seasonality of availability and use

3. Prepare a terrestrial wildlife profile for the study area based on:
   - species (by mammals, reptiles, amphibians and birds, dominant, residents and migratory species)
   - distribution, relative abundance and status of populations

   Compare local species numbers and distribution and the local quality of habitats with regional and national levels.

4. Identify and map all major aquatic wildlife habitat types in the project area:
   - permanent wetlands (rivers, canals, beels, pits, ponds, lakes, mangroves, etc.)
   - seasonal wetlands

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Characterize and quantify each habitat type according to surface area, water depth, flow, direction, tidal influence, vegetation cover (macro-phytes, algae, etc.), edge vegetation, ecotones, ecological requirements of vegetation, and problem vegetation.

5. Characterize the physical and chemical characteristics of waters in representative wetlands (turbidity, odor, pH, dissolved oxygen, CO_2, chloride, nitrate, iron, alkalinity, total hardness, ammonia, salinity, pollutants and organic matter.

6. Prepare an aquatic wildlife profile for the study area based on species and trophic levels - plankton, benthos, fish, reptiles, amphibians, birds, mammals, dominant, migratory species, and residents. Compare local species numbers and distribution and the local quality of habitats with regional and national levels.

7. Identify and quantify all critical wildlife habitants, according to:
   - habitat type
   - location and area
   - land type
   - vegetation
   - causes of habitat conversion (changes in previous 10-20 years, deforestation, afforestation)

8. Describe any commercially important wildlife resources by
   - species and population
   - extent of trade (local consumption, export, etc.)
   - hunting and trapping (legal and/or illegal)
   - recreational value of wildlife (local and foreign visitors)
9. Describe any rare, threatened and/or endangered wildlife species by:
   - species
   - critical habitat
   - status and distribution
   - causes of decline
   - possibilities of enhancement

10. Describe wildlife pests in the study area:
    - species and populations
    - damage extent and seasonality
    - present control measures (effectiveness ;and cost)
    - possible biological control
    - identification of pesticides (including insecticides) used and any known effects on the ecosystem
    - identification of pest predators and the possibility enhancement through habitat improvement

5. Human Resources

5.1 Socio-Demographic Conditions

1. Quantify and describe the total population of the project area, growth rates, densities, male-female ratio and the distribution of population by religion and ethnic groups.

2. Note the percentage of population affected by flooding, waterlogging, drainage congestion, erosion and other water-related management problems and the extent of each of these conditions. List the areas (by unions, mouzas and villages) affected and the present responses of communities to floods and various flood related conditions.

3. Describe settlement patterns, house types, family types, size of family, numbers of households, location of urban-industrial centers, numbers of markets/central places, historical and cultural sites, transportation and communication facilities.

4. Map the following on a base map showing land types, water bodies and major infrastructure:
    - habitation sites (paras)
    - village boundaries (mouzas)
    - common access areas
    - social services (schools, hospitals/dispensaries, government offices, banks)
    - cultural sites (mosques, temples, churches, shrines, sacred streets, archeological and historical sites, fairgrounds)
    - markets (hats and bazaars)
    - rural industries (e.g. cottage industries, handicraft and boat building centers)
    - transportation routes (rivers, roads and railways)

5. Describe the annual cycles of activity. These should include the:
    - seasonal and hydrological calendar
    - agrarian calendar (including cropping patterns)
    - fishing calendar (including fish breeding cycle)

    Note interrelationships and dependencies between the various cycles.

5.2 Socio-Economic Conditions

1. Describe the main economic activities (agriculture, fisheries, business etc.) and calculate the percentage of households in various occupations. Describe the basis of livelihood of the

poor, with special emphasis on fishermen, boatman, landless laborers and women that may be affected by project interventions and land acquisition.

2. Quantify and describe all the socio-economic groups in the project area:
   - landowning farmers (separate by absentee/resident landowners and by farm size
   - landless farmers (separate by lessors, sharecroppers and seasonal agricultural laborers)
   - professional and subsistence fishermen
   - boat owners/operators and boat builders
   - village artisan groups
   - petty traders/shopkeepers and merchants
   - workers in rural industries and support sectors (e.g. transportation)
   - teachers
   - religious leaders
   - government officials
   - NGOs
   - women from each of the above groups (including female-headed households), their contribution to family income and food security, and their status within the household and the community.

3. Indicate the socio-economic condition of each group in terms of:
   - land tenure and ownership distribution of land
   - household income and assets
   - level of literacy, attendance and drop-out rates
   - nutritional level and seasonal variations
   - opportunities for employment and income generation, wage rates and seasonal variations
   - demand for and use of government and non-government services (e.g. education, health and credit facilities)
   - demand for and use of natural resources
   - access to common areas or informal access rights to land and water resources
   - access to tenancy and credit markets
   - access to safe water supply and sanitation
   - access to markets and infrastructures
   - nature and type of internal social organization and or community organization.

4. Identify formal and informal social groups and leaders, leadership structure, resource and credit user groups, farmers organization and conflicts (if any) over water sharing.

5. Describe the "patron-client" system of "leader-follower" dependency relationship in the area. Assess the effects of such socio-political networks on resource/benefit distribution

and social participation of people in flood management projects. Note that actions would be required enhance project success, particularly through public participation.

6. Describe land tenure and ownership in the study area. Categorize land ownership and occupancy in the area:
   - in terms of land types
   - in terms of geographical distribution
   - privately owned by residents and absentees
   - publicly owned (government at all levels)

7. Categorize land occupancy and use by:
   - land type categories
   - owner
   - lessee
   - squatters
   - common property resources

8. Describe fishery management in the area in terms of:
   - leasing arrangements (e.g. leasing of the resource to private individuals and cooperatives)
   - traditional fishing rights and problems
   - licensing of fishermen for fish-catching
   - enforcement of regulations and leasing rules
   - conflicts

   Indicate:
   - how management system affects the fishery and fishing community
   - who controls the open water capture fishery resources in the area
   - how the benefits of leased fishery resources are distributed among lessor, lessee and the fishermen
   - the socio-economic structure of the culture fishery in the area and how it is managed or controlled.

9. Describe the fish marketing in the area (both capture and culture fishery), specifically identifying marketing channels, intermediaries/middlemen, buyers, trading spots/localities and marketing facilities.

10. Describe the marketing procedures for livestock and livestock products.

11. Evaluate the socio-economic importance of the navigation system in terms of:
    - numbers of people depending directly on the use of waterways for transport
    - classes of users
      - boat owners and operators
      - shippers of goods
      - passengers

- extent of dependence of local and regional economies on river transportation
    - movement of goods (tonne-kms, category of goods)
    - movement of people (passenger-kms)
    - income to the sector

12. Identify any socio-economic and technological changes in the area during the previous 10-20 years, especially those related to trends and changes in the natural resource base. Comment on the role of population growth in such change and the role of FCD or FCD/I projects in the area. Identify any trends observed up to the present which could continue or even worsen during the next few decades in the absence of appropriate flood management actions.

5.3 Public Health

1. Indicate the sources of domestic water in the area (drinking/cooking, bathing and laundry) and the seasonal changes in such sources.

2. Describe and map the distribution of tubewells and other protected water sources in the study area. Compute the number and proportion of households having access to tubewells for drinking water and the seasonal variability in such numbers and proportions.

3. Describe present conditions of disposal of domestic sanitary waste in isolated homesteads, villages and urban areas, and any relationships to the seasonal hydrologic cycle. Present and evaluate any data on the quality of receiving waters, especially with regard to faecal coliform bacteria.

4. Outline the seasonal distribution of diarrhoeal and other vector borne diseases in the area.

5. Describe the nutritional status of members of the various social groups in the area if possible using rapid rural appraisal sort of technique.

5.4 Hazards

1. Describe the flooding history of the area in recent decades. Use land types a measure of flooding depth. For dry, normal and wet years show:
    - area
    - duration
    - numbers of affected homesteads
    - numbers of affected people

2. Quantify the amount of land in the area protected by embankments. Describe the origins of these embankments.

3. Give a brief history of flood-related problems in the area, including reference to embankment failures, breaching and erosion.

4. Identify non-flood related risks to crops in the area, e.g.
   - pests and crop diseases
   - drought
   - failure of irrigation systems
   - failure to obtain necessary inputs (e.g. fertilizers, pesticides)
   - sand deposition
   - others

5. Note the extent to which the area is subject to other natural hazards, including earthquakes, cyclones, tornados, hail storms, tidal surges, etc. Describe their known occurrence, severity, and impact.

6. Determine whether the frequency or severity of flooding has increased over the last 10-20 years. If sao, note whether damage and loss of life have been related to the magnitude of the event or to other factors, such as increased population density, shifts in population, increased value of infrastructure, etc.

7. Given continuance of present climatic and hydrologic conditions, decide if the trends seen to date can be expected to continue in the absence of FCD/I activities. Describe any new hazards being added to the region through development activities not directly related to the flood cycle.

5.5 **Cumulative Impacts**

1. Possible implications of regional and global environmental changes including greenhouse effect changes.

2. Consider regional and transboundary patterns of land use and other human activities which may affect flow, siltation, erosion, water quality etc.

Annex - D
Weighted Matrix

In the weighted matrices, when preparing the impact matrix, one indicates the relative magnitudes by numbers e.g. on a scale of 1 to 10, rather than by symbols or letters. Also one assigns a weigh or relative importance to such impact, again by numbers on a numerical scale of 1 to 10 and mentions these two indicative measures in each of the relevant boxes as M/I. Of course both the magnitude and importance of the likely impact are dependent entirely on the judgement of the assessing team. Simple calculations have been suggested to asses the total environmental impact of a particular project component or activity (and hence to help planning mitigation measures) or even the overall weighted relative impact of a total project (to help compare alternative projects).

Thus the total impact of ith component/Activity:

$$Pi = \sum_{j = 1}^{j = m} (Iij. Mij)$$

Where Mij and Iij are respectively the relative magnitude and relative importance (on scales of 1 to 10) for the likely impact of ith component/activity on jth environmental attribute and m is the total number of environmental attributes relevant.

Also the overall relative impact of the project:

$$I = \sum_{i = 1}^{i = n} Pi$$

Where n is the total number of Project Components/Activities.

Annex - E

Order of Consideration of Environmental Impacts of FAP, FCD/I Projects while conducting an EIA

A. First Level Impacts

1. Changes in topography directly brought about by construction activity (including borrow pits and waste dumps). Show by detailed controur maps/engineering drawings.
2. Changes in landuse and vegetal cover (to give specific and locationwise trees and other vegetation lost) directly brought about by project activity (land acquisition, township, storage of materials, roads, land clearing, post-project plantations etc.)
3. Changes in water levels and flows at different points in the river caused by the project.
4. Changes in water levels and flows at different points in the protected area.
5. Changes in water levels and flows at different points in the non-protected area, e.g. opposite bank.

B. Second Level Impacts

1. Siltation/erosion at different points in (a) river, (b) protected area, (c) outside protected areas like opposite bank, upstream/downstream areas etc.
2. Changes in ground water recharge, ground water flows and ground water levels at various points inside and outside the protection area.
3. Changes in water availability and consequent changes in cropping patterns and yields at various points ;inside and outside protected areas.
4. Changes in natural flora and fauna and general ecology at different points inside and outside protected area.
5. Changes in nutrient/food material availability, spawning and stocking areas and patterns and of fish-availability.

C. Third Level Impacts

1. Longterm changes in river course or character (even as small a change as a ten percent reduction in width may trigger significant changes in character or course or both.

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2. Long term changes in bed-levels and hence in flood levels and their consequence e.g. need to raise or retire embankments.

3. Long term changes in flooding patterns.

4. Long term changes in surface and ground water availability and water levels.

5. Longterm changes in soil and water quality.

6. Long term changes in landuse patterns, agriculture and fisheries.

7. Long term changes in habitational patterns.

D. Fourth Level Impacts

1. Reduction in loss of life
2. Impact on overall agriculture crop production, horticulture, etc. evaluated in Taka.
3. Impact on fish production evaluated in Taka.
4. Protection of property and assets evaluated in Taka.
5. Impacts on livestock and wildlife/endangered species evaluated in Taka.
6. Impacts on human health and health care evaluated in Taka.
7. Impacts on transport, communication, severance, resettlement evaluated in Taka.
8. Impacts on other economic activities including tourism, evaluated in Taka.
9. Impacts on employment, living standards and incomes of different sections of communities inside and outside the protected areas evaluated in Taka.

E. Fifth Level Impacts

1. Impacts on structures/locations/activities of historical, social or cultural value.
2. Impacts on social and cultural strains and patterns of different sections of community inside/outside the protected area.
3. Psychological impacts and reaction of people.
4. Impacts on regional/global environmental issues.

Annex - F

Required Levels of Quantification

A. Level Impacts - Complete quantification if possible 100%.

B. Level Impacts - High level quantifiaction may be between 60-80%.

C. Level Impacts - Quantification to the level possible may be between 20-30%

D. Level Impacts - As far as possible impacts to be converted to Taka values.

E. Level Impacts - All impacts stated reflected as size of communities worried/concerned about alongwith judgement of the EIA Team.

Annex - G

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(IEE or EIA REPORT)

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GLOSSARY

Biophysical is that part of the natural environment which includes physical, chemical and biological components such as air, soil, water quality, plants and animals.

Bounding is the process to determine spatial and temporal boundaries that an environmental impact assessment will include based upon physical, chemical, biological, social, economic, jurisdictional, and administrative factors.

Compensation is the provision for enhancement, replacement, restoration, and restitution to recipients of unavoidable negative residual impacts. Often there is payment in funds or replacement in-kind for losses attributed to a development. Funds may also be used to recreate lost habitat or other valued resources.

Compensation plan is the portion of the Environmental Management Plan that describes the compensation measures that will be undertaken and committed to if a project proceeds. It includes how much compensation will be paid to whom, by whom, and under what conditions.

Cumulative impacts are those environmental impacts that are recognizable in regional patterns of environmental change (usually deterioration) caused by:

(a) multiple human activities ;and or
(b) natural events:

which are either repeated or occur in combination. Examples include lowering of the groundwater in a large regional aquifer or water pollution in the large river such as the Ganges. Global climate change is a type of cumulative effect involving the total planet.

Ecosystem is a marine, freshwater or terrestrial system or combination of systems that include some or all of the living and non-living components. Boundaries of an ecosystem are often specified for a particular application.

Environment is the totality of the natural and human environments on which the project will exhibit influence, and includes:

(a) all biophysical components of the natural environment of land, water and air including all layers of the atmosphere, biological resources, and all inorganic and organic matter both living and dead:

(b) all socio-economic components of the human environment including, but not limited to, social, economic development, human resources, quality of life, administrative, cultural, historical, archeological, architectural, structures, sites and things, land and resource usage, and human health, nutrition and safety.

Environmental assessment is the process for making environmentally-sound decisions in regard to ensuring the concept of sustainable development is achieved in respect to projects and the plans leading to projects. It has four components:

(a) early planning to avoid environmental impacts,
(b) identification of environmental impacts,
(c) Environmental Management Plan to determine residual environmental impacts and their management, and
(d) public participation.

Environmental Enhancement is an intentional change which amplifies the anticipated positive impact of the project on one or more environmental components.

Environmental impact is, in respect to a project,

(a) any change that the project may cause to an environmental component;
(b) any change to the project that may be caused by the environment which then leads to changes in environmental components;
(c) any cumulative effect caused or exacerbated by the project.

[Note: environmental impact and environmental effect are considered as synonymous].

Environmental Impact Assessment (EIA) Report is the environmental assessment report prepared at the feasibility level which is the systematic study, quantified assessment and reporting of the impacts of a proposed plan or project.

Environmental Management Plan (EMP) is a plan to undertake an array of follow-up activities which provide for the sound environmental management of a project so that adverse environmental impacts are minimized and mitigated; beneficial environmental effects are maximized and sustainable development is ensured.

Environmental Effects Monitoring (EEM) is the taking of repetitive measurements over time of environmental components to detect changes caused by external influences directly or indirectly attributable to a specific anthropogenic activity or development. It is undertaken for many reasons such as:

(a) to improve environmental understanding of cause-effect relationships,

(b) to provide an early warning of undesirable change in the environment,
(c) to verify earlier EIA predictions,
(d) to evaluate uncertainty, and
(e) to check on the effectiveness of the Environmental Management Plan.

Environmental Protection Plan (EPP) is a plan that describes specific mitigation actions that will be undertaken during project preconstruction, construction, operation, rehabilitation and abandonment to lessen the effects of the project on the environment usually with specific instructions for personnel involved in project activities. It is a key component of the Environmental Management Plan that integrates existing legislation, codes of good engineering practice, proponent commitment, and designated mitigation measures.

Evaluation is the assignment of monetary, importance, priority or other values to the estimated impacts. Monetary or economic evaluation is often termed valuation.

Follow-up activities constitute the set of specific actions described in the Environmental Management Plan for project implementation.

Impact matrix is a square or rectangular array of rows (project activities) and columns (important environmental components) used for organizing the analysis of positive and negative environmental impacts of a project.

Important Environmental Component (IEC) are environmental components of biophysical or socio-economic importance to one or more interested parties. The use of important environmental components helps to focus the environmental assessment.

Initial Environmental Evaluation (IEE) is the initial environmental assessment report prepared for a regional or prefeasibility level study for identifying and assessing possible environmental impacts.

Insignificant environmental impact is a residual environmental effect that is not considered significant regardless of level of associated mitigation.

Interested Party include: residents of the plan or project area, elected bangladesh representatives, Government of Bangladesh officials in various departments, Bangladesh professionals, non governmental organizations (NGOs), the general public in Bangladesh, and donor organizations and international agencies. Intervention is the specific action caused by a project which creates an environmental impact.

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Justified in the circumstances occurs when circumstances occur, which when balanced against the public interest, public health and safety, and the protection of natural resources, constitute the best alternative for ensuring sustainable development.

Magnitude is the degree of change in a important environmental component that results from a project activity.

Mitigation is the elimination, reduction or control of the adverse environmental impacts of a project. Mitigation measures are specified in the Environmental Protection Plan portion of the Environmental Management Plan.

Project includes:

(a) a physical work such as proposed construction, operation, modification, decommissioning, rehabilitation, abandonment or other undertaking in relation to that physical work, and

(b) a regional, prefeasibility, feasibility, design or conceptual plan or study undertaken to ascertain the desirability of proceeding with physical works and associated activities such as flood proofing, sector development, etc. for eliminating the negative impacts of floods and such activities that are under the purview of the Flood Action Plan.

Project Phase refers to the main categories of project activities expressed sequentially including: preconstruction, construction, operation and abandonment.

Project Stage refers to the main stage of project planning including: prefeasibility (regional study) and feasibility.

Proponent in respect to a project, means the person, body, authority, government or donor that proposes the project, or who is responsible for the environmental assessment or implementation of the project.

Residual environmental impact is any environmental impact that remain after a reasonable and practical environmental management plan is or would be implemented.

Scoping is the process by which the important environmental issues, project alternatives and important environmental components are identified by the interested parties.

Significant environmental impact is an adverse residual environmental impact that is not justified in the circumstances.

Socio-economic refers to the human environment which includes social and economic components that are not termed biophysical.

Sustainable development is development that ensures preservation and enhancement of environmental quality, and sound and sustainable use of natural resources thereby providing for economic growth which meets the needs of the present without compromising the ability of future generations to meet their own needs (adapted from the Brundtland Commission, 1987).

C:EIA:tc

BANGLADESH FLOOD ACTION PLAN

Ministry of Water Resources
Flood Plan Coordination Organization (FPCO)

Annotated Bibliography on Environment

April 1995

Prepared by

Environmental Study

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ISPAN

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PREFACE

Although extensive study of the natural resources has been carried out, bibliographic documentation of that work has not been compiled in an annotated form. There is, therefore, a need to have such an abstract available for environmental researchers, practioners, planners, development agencies, donors, and decision-makers.

This annotated bibliography on environment and development in Bangladesh has been prepared by FAP 16 (Environmental Study). It groups the environmental works under the following resource components:

- environmental policy and issues;
- water resources and environmental assessment;
- climate change and disaster management;
- soil and agriculture;
- forest and vegetation;
- biomass energy;
- fisheries and wetlands;
- wildlife;
- socioeconomics;
- women and environment; and
- environmental training.

The volume includes abstracts of published research works, papers, books, and reports on the environment. This compendium has been designed to serve the information/data requirements of scientists, researchers, planners, policy-and decision-makers and many other people associated with environmental activities in Bangladesh. It covers a wide range of materials which would be of interest and use to all involved in environmental studies and resource management.
It is particularly useful for EIA reviewers and practitioners, and was designed to be used as an insturctional aid during EIA training.

The successful completion of this document is the result of the time and effort given by the team members of FAP 16 in collecting necessary information from individuals, organizations, and institutions involved in environmental studies and resource management. The team was limited by time and there will of course be many important references left out.

This document should be treated as the baseline compilation of environmental information in Bangladesh. But, like the Training Manual and EIA Guidelines prepared by FAP 16, it is a living document. It will be necessary to regularly update it in order to include future works on the environment of Bangladesh.

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ENVIRONMENTAL POLICY AND ISSUES

1 **Asian Development Bank (ADB). 1988. Environmental guidelines for selected industrial and power development projects. ADB, Dhaka.**

In Part A (Environmental Guidelines for the Project) of the two-part document, a complete set of guidelines for selected industrial and power development projects is presented. The need for such guidelines and the methods needed to prepare them are discussed. Part B (Supplemental Information) includes information on selected references of environmental agencies in developing member countries, and trial application of the guidelines to particular projects.

2 **Canadian International Development Agency (CIDA). 1989. The environment and development in Bangladesh: An overview and strategy for the future. CIDA, Canadian High Commission, Dhaka, Bangladesh.**

This report provides an analytical basis for the CIDA Country Program Review process. Literature on environment and development in Bangladesh is reviewed and strategies for sustainable development in the future are suggested. The report identifies the major natural and human resource features, as well as the major ecological concerns within the different sectors related to the environment.

3 **Danish International Development Assistance (DANIDA). 1989. Environmental profile: Bangladesh. DANIDA, Department of International Development Cooperation, Ministry of Foreign Affairs, Denmark.**

This report highlights major sectoral issues, cross-sectoral issues, and operational guidelines on environment and development in Bangladesh. The document provides a comprehensive list of organizations involved in environmental and resource management, national policy on environment, Bangladesh national environmental legislation, and institutions for data collection and research.

4 **FAP 2 (Flood Action Plan). 1991. Interim report. North West Regional Study. Mott-Macdonald, Nippon Koe, Hydraulic Res. (HOC). Dhaka.**

Regional flooding and drainage systems, options and scenarios for development, impact analysis, and regional planning and development priorities are highlighted in this report.

5 **FAP 2. 1992. The regional plan—initial environmental evaluation. North West Regional Study Draft Final Report. Mott-Macdonald, Nippon Koe, Hydraulic Res. (HOC). Dhaka.**

The North West Regional study area includes the total catchment of three rivers systems namely the Ganges, the Atrai and the Brahmaputra. This report identifies and prioritizes the environmental impacts of the water development proposal for the study area, quantifying and valuing these whenever feasible. Detailed proposals for mitigation, resource management planning, monitoring, and plans for further investigation also are discussed.

6 **FAP 5. 1991. South East Regional Study. Initial environmental evaluation. Draft. Mott-Macdonald, Nippon Koei, HOC, Resource Development. Desh Upadesh, Dhaka.**

This initial environmental examination evaluates the environmental impacts of water resource development proposals in the South East Region of the country. This report discusses the existing environment and its influence on regional and project planning, regional assessment of environmental impacts, management and mitigation, and monitoring, training and future studies. Extensive appendices address legislation relating to environment, and flora and fauna of Bangladesh, including threatened and endangered species. Appendices also include lists of common birds and mammals; economically important trees; and historically, archaeologically, and ecologically important sites in the southeast region.

7 **FAP 12. 1992. Flood Control Drainage/Irrigation (FCD/I) agricultural study. Final report. Vol. 3, appendices E-J. FCD/I Agricultural Study, Dhaka.**

This report discusses the impacts of various FCD/I projects on agriculture, fisheries, water-logging, and socio-economics. The report also addresses operational maintenance in existing FCD\I projects.

8 **FAP 12. 1992. Project impact evaluation of Chalan Beel Polder-D. FCD/I Agricultural Study. Hunting Technical Services, Sanyu, Bangladesh Institute of Development Studies (BIDS) and Technoconsult, Dhaka.**

This study assessed the impacts of the Chalan Beel Polder-D Project on agriculture, fisheries, livestock, infrastructure, communication, and socio-economics. It considers environmental and economic appraisals and makes recommendations for the future.

9 **FAP 12. 1992. Project impact evaluation of Meghna-Dhanagoda Irrigation Project. FCD/I Agricultural Study, Hunting Technical Services, Sanyu, BIDS, Technoconsult, Dhaka.**

This study assessed the impacts of the Meghna-Dhanagoda Irrigation Project on agricultural production, crop diversity, fisheries, and socio-economic issues of the project area. The report highlighted the adverse impact of the project on capture fisheries production and species diversity within the project area. A brief history of the project highlighting its weaknesses are also presented in the document.

10 **FAP 16/FAP 19. 1992. Compartmentalization pilot project: Environmental impact assessment case study. ISPAN, Dhaka.**

The study determined that the proposed project would aid agriculture, culture fisheries, homestead security, household income, and cereal-based nutrition. In contrast, it found that the proposed project would reduce agricultural crop diversity, capture fisheries production, subsistence fishing income, fish-based nutrition, while increasing environmental contamination with more agrochemical use. They study also recommends an Environmental Management Plan (EMP) to reduce or eliminate the adverse impacts of the project.

11 **FAP 16/FAP 19. 1993. Bhelumia-Bheduria Project, environmental impact assessment case study. ISPAN, Dhaka.**

The study addresses a small coastal project under consideration by the Early Implementation Project (EIP) of the Bangladesh Water Development Board (BWDB). Although potentially severe impacts for resources such as fisheries and for certain social groups (fishermen) were pointed out. The study suggested an environmental management plan (EMP) to reduce or eliminate the adverse impacts of the project on various resource components.

12 **Flood Plan Coordination Organization (FPCO). 1993. Guidelines for people's participation. FPCO. Dhaka.**

This Guidelines suggest a flexible approach to the integration of knowledge, experience, and insights of local people. It suggests that this cross-fertilization will strengthen the process of decision-making with regard to local needs assessment, project formulation and implementation, and long-term operation and maintenance. The process also will help minimize the negative effects of conflict of interest.

13 **Government of Bangladesh. 1991. Report of the task force on Bangladesh development strategies for the 1990s. Environment policy. Vol. 4: 265 p. University Press Limited, Dhaka, Bangladesh.**

This volume looks at environmental policy and critically evaluates development issues facing Bangladesh. It provides qualitative and quantitative information about the people and the economy, physical resources and environment, natural hazards, agriculture, and pollution. It examines the existing policies and suggests policy changes to achieve sustainable development.

14 **Ministry of Environment and Forests. 1992. Towards sustainable development: The national conservation strategy of Bangladesh. Ministry of Environment and Forests, Dhaka.**

This report analyzes the status of 20 sectors of environmental components such as soil, water, fisheries, forest, minerals, and other such resources with thier conservancy issues. Formulated strategies and plans for sustaining development of the country's renewable and nonrenewable resources also is addressed.

15 **Ministry of Environment and Forests. 1993. National environmental management action plan (NEMAP). Environmental Resources Limited, London, U.K.**

This document constitutes the national Environmental Management Action Plan of Bangladesh. Because the Ministry of Environment and Forests played a major role in preparing the document, it reflects the environmental views of the Bangladesh government. The report proposes a plan to reduce the rate of environmental degradation, conserve habitats and biodiversity, promote sustainable development, and improve the quality of human life.

16 **Rahman, A.A., Haider, R., Haq, S. and Jansen, E.G. (eds.). 1994. Environment and development in Bangladesh. 2 vols. University Press Limited, Dhaka.**

In two volumes, the authors explore some of the connections between poverty, population, environment, and development in Bangladesh. Discussion on land, water, nutrition, fisheries, biodiversity, industrial pollution, energy and mineral resources, sea-level rise, natural disaster, women-poverty-environment interaction, environmental awareness, and environmental activity are presented in 31 articles. The articles point out multifaceted problems, both man-made and natural, that exist in Bangladesh, and suggest inte-rating environmental concerns in all development activities.

17 **Rashid, H.E. 1991. Geography of Bangladesh. University Press Limited, Dhaka.**

This book, first published in 1977 and revised in 1991, covers all facets of the geography of Bangladesh. It provides more details on physiography, hydrography, climate, soil conditions and land use, agriculture, natural resources and industry, trade and commerce, history and economic development than any other regional book written about Bangladesh. The latest revision includes a new chapter on environmental issues.

18 **Research and Advisory Services (RAS). 1992. People's participation, NGOs and the Flood Action Plan: An independent review. RAS, Dhaka.**

This report attempted to cover a set of interrelated issues such as alternative approaches to people's participation, lessons from the experince of earlier flood protection projects, people's participation and the actual nature of effectiveness of people's invovement in the FAP implementation processes. The document also covers approaches to involve NGOs to take the strategic lead in certain activities which are aimed at supporting the views and interests of the affected people.

19 **Shamsuddin, S.D. 1992. An outline of policies and legislation related to environment in Bangladesh. ISPAN/FAP 16, Dhaka.**

This document compiles existing rules and legislations for conservation and sustainable management of various environmental resources such as fisheries, wildlife, forests, livestock, soils, and others. The aims of and major provisions of the policies and legislation which appeared to be relevant to EIA work have been briefly mentioned in the document.

20 **United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). 1990. Environmental impact assessment guidelines for agricultural development. ESCAP Environment and Development Series. United Nations, New York.**

The objectives of these guidelines were to: a) summarize general assessment methods presented in pertinent references, b) identify data collection and evaluation methods for assessing the quality of key parameters, and c) present the typical im-pacts related to agricultural development projects based on secondary literature and special case studies. A number of reference documents were used in preparing the guidelines.

21 **U.S. Agency for International Development (USAID). 1990. Environmental assessment of the USAID/Bangladesh integrated food for development program. USAID, Dhaka.**

This USAID-requested environmental assessment of its food-for-work program in Bangladesh coincided with the joint USAID/CARE design of the new Integrated Food for Development program. An environmental assessment field review of the project was done by a joint team from KBN Engineering and Applied Sciences, Florida, USA-based Tropical Research and Development in association with House of Consultants, Dhaka. Team members included expatriate and host-country counterparts specializing in ecology and tropical forestry, agronomy, soil science, fish biology, land use planning, water resource engineering, human ecology, and sociology. The report suggested that the project implementing agency should conduct field research to quantify appropriate design strategies and labour and infrastructure requirements for a wide range of diversified component schemes. Special attention should be given to pond and wetland construction; tree nurseries and plantation; brick field construction; renewable facility construction (biogas digester); and canal and river channel desilting.

22 **World Resource Institute (WRI). 1990. Bangladesh environment and natural resource assessment. Draft. WRI, Center for International Development, Washington, D.C., USA.**

This report summarizes the findings and recommendations of a preliminary analysis made of current environmental and natural resource management issues in Bangladesh and their relation to the country's economic growth and development. The document presents an overview of the context of the country's economic development, environmental and natural resource management issues, institutional and policy framework, and recommended strategy and priority actions.

23 **Ahmed, Q.K., Warrick, R. A., Ericksen, N.J. and Mirja, M.Q. 1994. The implications of climate change for Bangladesh: A Synthesis. 17 p. Bangladesh Unnayan Parishad (BUP), Dhaka.**

This report is the seventh in a set of seven briefing documents that address the various effects of climate change on Bangladesh. A synthesis of what is known, and what needs to be known, about possible effects of climate and sea-level change on Bangladesh are presented in this paper.

24 **Brammer, H., Asaduzzaman, M. and Sultan, P. 1994. Effects of climate and sea-level changes on the natural resources of Bangladesh. 31 p. BUP, Dhaka.**

This document is the third in the set of seven briefing documents about climate change implications. It considers the possible impacts of global warming and sea level rise on Bangladesh's water, agricultural, forests, fisheries, and livestock resources.

25 **Ericksen, N.J., Ahmed, Q.K. and Chowdhury, A.R. 1994. Socio-economic implications of climate change for Bangladesh. 37 p. BUP, Dhaka.**

This report is the fourth in the set of seven briefing documents. The authors developed a model of the process that affects the green house phenomenon and suggests that the mean global temperature of Bangladesh may rise by 1.5 to 1.8 degrees celsius by the year 2050. He also suggests that these changes would increase annual rainfall in Bangladesh. Climate changes such as these would affect plant and animal growth in Bangladesh. The socioeconomic implications of such climate changes are also discussed in this report.

26 **Freestone, D., Farooque, M., Jahan, S. R. 1994. Legal implications of global climate change for Bangladesh. 21 p. BUP, Dhaka.**

The fifth in a series of seven briefing documents, this report looks at the framework provided by both national and international law within which Bangladesh must develop strategies and policies to respond to likely environmental impacts precipitated by climate change. Legal issues have a bearing not only on the matter of responsibility for climate changes, but also on response strategies.

27 **Kausher, A., Kay, R. C., Asaduzzaman, M. and Paul, S. 1994. Climate change and sea-level rise: the case of the coast. 36 p. BUP, Dhaka.**

The sixth in the set of seven briefing documents, this book reviews the sensitivity, vulnerability, and resilience of Bangladesh's coastal zone to future climatic changes and rise in sea level. The implications for managing the coastal zone and the need for further research are discussed.

28 **Rahman, M.M. and Haque, M. 1992. A study on global warming and environmental issues related to Bangladesh. Center for Human Development, Dhaka.**

After describing the methodology and conceptual framework of this study concerning the impact of global warming on Bangladesh, the document reviews existing theories and views on the sub-ject. International concerns about global warming, environmental degradation, and other issues related to sustainable development are highlighted. The current trends affecting development in Bangladesh are discussed. The views, resolutions, and recommendations discussed in various regional and international forums are included in the report.

29 **Warrick, R.A., Bhuiya, A. H. and Mirza, M. Q. 1994. The greenhouse effect and the climate change. 31 p. BUP, Dhaka.**

This report is the first in a seven-part briefing document series that addresses various climate change issues in Bangladesh. Based on the review of literature concerning global warming and its possible affects, major areas for research in Bangladesh are suggested.

30 **Warrick, R.A., , Bhuiya, A. H., Mitchell, W. M., Murty, T. S., Rasheed, K. B. S. 1994. Sea level changes in the Bay of bengal. 24 P. BUP, Dhaka.**

The second in the set of seven briefing documents, this book is concerned about the future possibility of sea level rise in Bangladesh. The authors look at the causes of sea level change, and discuss current changes and future trends in global sea level rise. Sea level changes in the Bay of Bengal and the ways to address such changes are also discussed.

LAND AND WATER RESOURCES

31 **FAO/UNDP. 1988. Land resources appraisal of Bangladesh for agricultural development. Report 2: Agro-ecological regions of Bangladesh. Rome, Italy.**

This is one of a series of seven documents. It reports the results of a study on appraisal of land resources of Bangladesh. It is good reference material on agro-ecological conditions in Bangladesh and is designed to be used by specialists and nonspecialists alike. It provides information on agriculture, soils, forests, geography, and the effects of environmental factors on agriculture.

32 **Organization for Economic Cooperation and Development (OECD). 1985. Management of water projects: Decision-making and investment appraisal. Oxford and IBH Publishing Co., India.**

This publication analyses decision-making and appraisal in large-scale water management investment projects. It also examines the effects of such projects on the environment and society. The result of work undertaken by national teams nominated in most OECD member countries and an international team of multidisciplinary experts, the book lists various alternatives to problems, but does not provide any "ideal" solution. Instead, the book is a resource for policy makers and members of multi-disciplinary teams responsible for appraising projects. It provides the viewpoints of various scientific disciplines involved in the appraisal process, and guides the reader through the decision-making process involved in project appraisal. The book covers a broad range of situations and problems observed in various countries. It identifies project impacts, and develops global, long-term planning strategies. These are put in the context of institutional relations between government organizations and the various interests of the populations.

33 **Rashid, H.E. 1989. Land use in Bangladesh: Selected topics. Bangladesh Agriculture Sector Review, Vol. III. United Nations Development Programme (UNDP), project BGD/87/023, Dhaka.**

This working paper for the agriculture sector review discusses the major issues in land use and identifies the main geographical areas of concern with relevant tables and graphics. Statistics of land use are critically examined and new light is thrown on land use pattern in the villages, particularly on areas used for horticulture, and in the Hill Tracts. The second part of the paper examines environmental issues with regard to land use.

34 **Weber, Fred R. 1989. Rapid low-cost assessment of biophysical impacts of agricultural and rural development projects. AID Occasional Paper No. XX. U.S. Agency for International Development (USAID), Dhaka.**

This report describes 10 simple, practical indicators for assessing the biophysical impacts of development projects and suggests ways in which these indicators can assist USAID field personnel to monitor both the positive and negative impacts of project interventions on natural resources (soils, water, natural vegetation, and wildlife). It also discusses methods for collecting and using the indicators, while emphasizing reliance on locally available information and use of simple techniques. The paper briefly discusses using indicators for measuring impacts on areas of historical, religious, cultural, and scientific significance.

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FORESTS AND VEGETATION

35 **Alam, M.K. 1992. Some potential multipurpose trees for homesteads in Bangladesh. Winrock International/Bangladesh Agriculture Research Council (BARC), Farmgate, Dhaka.**

Homesteads in Bangladesh are integrated production systems and stable ecosystems. This publication recognizes the importance of the homestead vegetation and proposes homestead development through multi-layered plantations with species diversity. The author discusses the socioeconomic, ecological, and biological criteria for tree species selection as well as management practices and wood properties. The document also lists timber trees and details their uses, propagation, and properties.

36 **Bangladesh Agriculture Research Council (BARC)/International Council for Research in Agroforestry (ICRAF). 1991. Agroforestry technologies for an encroached forest area in Dhaka division, Bangladesh. 95 p. BARC, Dhaka/ICRAF, Nairobi, Kenya.**

This study was a collaboration between BARC and ICRAF to strengthen agroforestry research and development in Bangladesh. A diagnosis and design survey was carried out in Kaliakoir, Dhaka Division, a site selected for thana agroforestry practice and nursery project by the Forest Department. Historically, the site was a *sal (Shorea robusta)* forest, which has now become entirely denuded because most of the area has been settled by landless people. The Forest Department placed about 60 ha under its forestry development program and secured the participation of 50 to 60 landless households in the program. The BARC/ICRAF study then surveyed, diagnosed and designed an effective agroforestry development module for the area.

37 **Champion, Sir Harry G. and Seth, S.K. 1968. A revised survey of the forest types of India. Forest Research Institute, Delhi.**

Although this is an old document, it is the pioneer survey that ecologically classifies forests and vegetation in the sub-continent.

38 **Choudhury, A.M. 1981. Wood and wood products. Forest Department, Banobhavan, Mohakhali, Dhaka.**

This Bangladesh country paper on government policies and procedures for joint venture industries was prepared for the Economic, Social Commission for Asia and the Pacific (ESCAP) trade cooperation group venture. The main focus of the document is administrative classification of forests.

39 **Das, U.K. and Gouranga, 1994. Beeldakatia: Farmers turn fishermen. Dhaka Courier Vol. 10: pp. 35.**

According to the Bangladesh Water Development Board, Beeldakatia covers about 30,000 acres of permanently waterlogged land. The article pointed out that due to continous water logging, the farmers have been compelled to change their profession from crop farming to fishing, and most of the plant species are effected in the area.

40 **Hassan, M.M. and Mazumdar, M.H. March-April, 1990. An exploratory survey of trees on homesteads and waste land of Bangladesh. ADAB News Vol. 17, No. 2: pp. 26-32.**

This document presents the findings of an exploratory survey of homestead trees conducted in different parts of Bangladesh. It reports on a range of variables including climatic, hydrological, edaphic, and sanitary conditions. It also makes recommendations for increased homestead afforestation in Bangladesh.

41 Hooker, J.D. 1872-1896 (rev. 1973 and 1975). Flora of British India. 7 vols. Bishen Singh & Mahendra Pal Singh, Dhera Dun, India/L. Reeve & Co. Kent, U.K.

This historical document identifies the characteristics and importance of India's flora. Although the orginial survey was conducted over 100 years ago, the 1970's revision has updated the information. The book is considered as an important tool for plant scientists in the sub-continent.

42 Huq, A.M. 1986. Plant names of Bangladesh. Bangladesh National Herbarium/BARC, Farmgate, Dhaka.

This document lists the local and scientific names of Bangladesh plants and exotics. The local names of plants have been arranged alphabetically along with thier scientific names.

43 Kamaluddin, M. 1984. Forest ecology. Khanjan Maha, Chittagong University, Chittagong.

This document describes the forest types of Bangladesh and species combinations of each type of forests. It also describes the biological characteristics and socio-economic and ecological importance of trees, shrubs, and other plants. The habitats of the different species of plants are discussed.

44 Katebi, M.N.A. 1992. Forest resources of Bangladesh, present and future development activities. In Training Manual on Environmental management in Bangladesh (written in Ban-gla). pp. 52-73. Department of Environment, Dhaka.

This article provies up-to-date information about the forest resources in the country and about the Forest Department's development activities in forest resources management. The paper reports that 17 percent, or 5.92 million acres, of Bangladesh land is under forest. Of the 5.92 million acres, about 3.61 million acres are under the control of the Forest Department, 1.64 million acres are under the control of the District Commissioner, and the rest is homestead forest. The report classifies the Forest Department's acreages as reserve, protected, acquired, or unclassified. It also classifies forest types, such as hill, mangrove, plains, or homestead. It highlights current and future development activities of thana afforestation programs, plans for wildlife survey and conservation of projects.

45 Khaleque, K. 1986. The importance and prospects of homestead forests in Bangladesh. ADAB News Vol. 13, No. 2: pp. 10-13.

This article states that by the year 2000 there will be a shortage of 185 million cubic feet of fuel wood and 60 million cubic feet of timber in Bangladesh. It identies research needs for the development of homestead forestry in Bangladesh. It also mentions that homestead forest provides 70% of the total needs of the country's fuel wood and timber.

46 Khandakar, K. 1991. Homestead agroforestry in Bangladesh and its development. Bangladesh Forest Research Institute (BFRI), Chittagong.

This document describes the systems, patterns, benefits, and limitations of homestead agroforestry. It also discusses the status of agroforestry development, research, education, and training. It identifies and prioritizes a number of research areas for agroforestry in general and for homestead forestry in particular.

47 **Prain, David. 1903 (rev. 1963 and 1981). Bengal plants. 2 vols. Bishen Singh & Mahendra Pal Singh, Dhera Dun, India/L. Reeve & Co. Kent, U.K.**

This twice-revised book classifies all the plants of Bengal and lists their identifying characteristics. The book is being used as an important tool by the plant scientists in the sub-continent.

48 **Rahaman, M.A.; Khandakar, K.; Ahmed, F.U.; Ali, M.O. (eds.). 1990. Proceedings of the seminar on top dying of Sundri (Heritiera fomes) trees, 96 p. BARC, Farmgate, Dhaka.**

The *sundri (Heritiera fomes)* is the most important tree species in the Sunderbans, contributing to over 60 percent of total marketable timber. This speices, however, has been affected by top dying, a disease that kills the foliage and twigs of one or more branches, including the main stem, then moves back down the tree to eventually cause its death. The document reports that about 45 million trees, or 18 percent of the total Sundri stand, are affected by top dying, and, of those, at least 20 million are seriously affected. The possible causes of top dying include: increased salinity due to reduced fresh water flows through the Sunderbans, alteration in the depth and duration of flooding, increased siltation, and an outbreak of pathogenic gall cankers on tree branches. The document recommends further research on possible causes of top dying.

49 **Timm, R.W. 1981. Forestry development and its impact on environment. Proceedings of the Third National Zoological Conference, March 15-17. 315 p. Dhaka.**

This document identifies forest areas in Bangladesh and points out that deforestation is causing the temperature to rise in summer, and is causing atmospheric humidity and soil moisture to decrease. Hill forests have been denuded, resulting in siltation and other problems. The paper concludes that political decisions and commitments to halt deforestation are crucial. The author suggests a massive afforestation program to combat the situation.

50 **Tiwari, K.M. and Singh, R.V. 1984. Social forestry plantations. Oxford Publishers Co., New Delhi.**

The principles and techniques of social forestry development are discussed in this document. The characteristics of trees, shrubs, and other plants are included in this document. This document can be used as a manual for the development of social forestry plantation.

51 **Winrock International. 1990. Homestead plantation and agro-forestry in Bangladesh. Winrock International/-BARC, Dhaka.**

This document presents summary proceedings of a workshop on "Homestead Plantation and Agroforestry in Bangladesh". The workshop, attended by representatives from 17 national and international organizations and the first of its kind in Bangladesh, assessed existing homestead plantations and agro-forestry practices. It identified research needs and directions on homestead plantation and agro-forestry development in Bangladesh. This document is a useful guide for researchers, policy makers, development workers, and politicians who set national development priorities.

ENERGY USE

52 **Ahmad, A.J.M.U.; Hossain, Md.; Mian, M.H.U.; and Hossain, Md. Alamgir. 1986. Energy crisis in a Bangladesh village. Rural Development Academy, Bogra, Bangladesh.**

This document focusses on the fuel problems of rural areas and their impact on various social classes. It reports that the rate at which trees are cut exceeds the rate of tree planting. The paper suggests that by changing cropping patterns it would be possible to increase fuel supply. *Dhaincha* could be grown to meet the fuel shortage and to improve soil fertility.

53 **Chowdury, N. 1985. Agricultural residues as sources of biomass and their utilization through bioconversion. Proceedings of the Seminar on Biomass Production, 15-18 April 1986, Dhaka, Bangladesh.**

Since agricultural and agro-industrial residues which constitute potential sources of biomass cannot be used as food directly, they can be effectively utilized through bioconversion to fuel, feed, and food. While starchy residues can easily be converted into useful products, the lignocellulosic residues constituting the majority of agricultural and agro-industrial residues are recalcitrant to normal utilization modes. Cellulose, hemicellulose, and lignin, the major components of residual biomass can be separately and collectively converted into useful products through bioconversion. The paper summarizes the seminar proceedings and explains the steps involved in such processes as pretreatment, enzyme production, saccharification, and fermentation.

54 **Das, S.; Davidson, J.; Khan, S.A.; Latif, M.A.; Jashimuddin, M. 1986. Research on biomass production in Bangladesh with special reference to tree crops. Proceedings of the seminar on biomass production.pp. 64-73. Ministry of Energy resources, Dhaka.**

The document presents the summary proceeding of biomass production in Bangladesh. Biomass of individual trees, annual yield of biomand ratio of stem weight to weight of leaves and branches are determined. Comparison of biomass production between the best and worst provenances (seed sources) were made to show the differences due to origin of genetic material. Among these exotic species, Eucalyptus Camaldulensis has the highest production of biomass when it is cultivated in suitable sites as in Charaljani.

55 **Government of Bangladesh. 1991. Physical Resources and Environment: Energy use and resources, In: report of the task force on Bangladesh development strategies for the 1990's, Vol. Four, Part II, pp: 52-60. The University Press Limited, Dhaka. Bangladesh.**

The article discusses the energy balance for the year 1990 and shows that per capita energy consumption was 5.98 GJ (140 Kg OE) of which commercial energy was 1.61 GJ (37.71Kg OE) or 29.9 percent of total per capita energy consumption. The remaining 73.1 percent came from traditional biomass fuel. With these figures Bangladesh is one of the lowest users of energy, (commercial energy in particular) in the world. Even among the 40 countries classified as low income countries (other than China and India) by World Bank, Bangladesh's commercial energy use stands less than 31 percent of the average of these countries (122 Kg OE).

56 **Haq, Lutful. 1986. The role of biomass in Bangladesh economy. Proceedings of**

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the seminar on biomass production.pp. 51-61. Ministry of Energy resources, Dhaka.

This paper reports that biomass production has gained newer and greater significance in ensuring human welfare. The traditional sources of fuel such as fire, cowdung, bagasse, jutestick and the like account for more than two thirds of the fuel consumed annually in Bangladesh. Fast growing indigenous and exotic plant species hold a promising future for fuel wood supply.

57 **Islam, M.N. 1992. Energy crisis-dimension of the problem and its bearing on sustainability of environment quality. In: Training manual on environmental management in Bangladesh, pp.105-131. Department of Environment, Dhaka.**

The paper gives an overview of (a) the energy situation in Bangladesh and the various issues and options related to the energy development program; (b) environmental issues related to energy crises have been discussed; (c) institutional management of environmentally sound sustainable energy development programs in Bangladesh; (d) investment in energy development program in the Fourth Five Year plan. Some observations were made on the national technological capability in planning, development and management of energy sector.

58 **Kamaluddin, M. and Bhuiyan, M.K. 1986. Growth and fuelwood yield of Petford provenance *Eucalyptus camaldulensis Dehan* grown in rural marginal land in Bangladesh. Paper presented at the Seminar on Biomass Production, 15-18 April 1986, Dhaka, Bangladesh.**

Petford provenance of *Eucalyptus camaldulensis Dehan* was planted on the banks of rural ponds with a spacing of 1.6m x 1.6m to assess its growth and fuel wood yield under rural site conditions. The plant survival rate was 96 percent. At 5 years of age the plants attained an average height of 11.54m and an average diameter (dbh) of 11.64-cm. The yield of fuel wood, including bark and branches, was 139.1 t/ha at 12 percent moisture content. The results show good prospects for increasing fuel wood plantation of the provenance in rural waste and marginal lands.

FISHERIES AND WETLANDS

59 Aguero, M., S. Haq., A.K.A. Rahman and M. Ahmed, eds. 1989. Inland fisheries management in Bangladesh. Department of Fisheries, Bangladesh; Bangladesh Center for Advanced Studies (BCAS), Dhaka; International Center for Living Aquatic Resource Management (ICLARM), Manila, Philippines.

This book is a compilation of articles presented in the Workshop on Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh held in Dhaka in January 1989. The articles deal with various issues related to fishing activities in Bangladesh, including fisheries ecosystems and fishing communities. It discusses the biological, ecological, social, and economic factors of fishing activities.

60 Ahmed, A.T.A. 1994. Biodiversity and the role of Zoologists. Souvenir, 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.

This paper defines biological diversity in the context of habitat and ecosystem and highlights the state of biodiversity in Bangladesh, emphasizing the aquatic resources. It points out some impacts of Farraka Barrage on the agricultural and fisheries resources in the context of surface water flow and salinity intrusion. It also suggests research needs and covers management aspects of biodiversity.

61 Ahmed, R.; Hirst, Stanley M.; Livingston, Ron D.; and Pooley, Michael R. 1993. Considerations for a national wetland inventory. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 245-253

This paper discusses how land and water resource development activities have caused significant reductions in Bangladesh's wetlands. It suggests that conservation of the remaining wetlands and their sustainable management requires accurate and updated inventory information. It also discusses the need for a national inventory to establish and monitor the conservation and management status of wetlands. It suggests that a national inventory would require the establishment of a group with the full capability for remote sensing, image analysis, a geographic information system to manage the database, a number of field survey teams to collect relevant ecological and land use data, a national committee to coordinate and review the progress and products of the inventory, and sufficient budget to maintain the activities for an initial period of at least one year. The paper recommends the need for a pilot study to develop appropriate methodologies and institutions for the main inventory.

62 Akhtaruzzaman, M. 1988. A Study on the production of kio-fish (*Anabus testudineus*) under semi-intensive culture system. Journal of Zoology, 3:39-43.

The study discussed the monoculture of *Anabus testudineus* (Bloch) under semi-intensive culture system. Fingerlings (average wt. 8-9g) were stocked at a density of 16,000/ha in three 0.028ha ponds. They were fed six days per week with a mixture of rice bran, mustard oil cake, and fish meal at a ratio of 3:1:1. Feed was given daily at the rate of 5-6% of the estimated body weight of the stocked fish. The study found that after five months the average yield was 450 kg/ha and average survival was 78%.

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63 **Akhter, J.N.; Halder, G.C.; and Majid, M.A. 1994. Development of pen culture technology in irrigation canals. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.**

This paper presents the result of the trials of pen culture of carps in canals of Chandpur Irrigation Project (CIP). The stocked species were *rui, mrigel, catla*, silver carp, and common carp at a ratio of 30, 20, 10, 10, and 30%, respectively, with densities of 10,000 (970kg), 15,000 (100kg), 20,000 (140kg) per ha. The results of three treatments after six months of rearing were 1.27, 1.69, and 2.68 tons/ha. In the authors' opinion there are prospects for fish production in irrigation canals within FCD/I projects.

64 **Ali, M.L. 1989. Survey and data collection in rural fishing communities for fisheries resources management in Bangladesh. In Inland fisheries management in Bangladesh, M. Agiiero, S. Huq, A.K.A. Rahman and M. Ahmed, eds. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Center for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. pp. 61-70.**

This paper describes the existing survey and data collection system in the fisheries sector of Bangladesh. It reports that a frame survey followed by regular catch assessment survey are being carried out by the Department of Fisheries (DOF) through the FAO/UNDP-supported Bangladesh Fisheries Resources Survey System Project initiated in 1979. The paper adds that more detailed environmental, technological, biological, and socioeconomic data are being collected in 12 sites through the project "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh" since 1986 . The paper makes recommendations for improveing and strengthening of the fisheries statistical system in Bangladesh.

65 **Ali, M.Y. 1989. Environment, conservation and fishery resources in Bangladesh. In Inland fisheries management in Bangladesh, M. Agiiero, S. Huq, A.K.A. Rahman, and M. Ahmed, eds. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Center Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. pp. 36-52.**

This paper highlights the importance of the floodplains during the monsoon season in the continuation and sustenance of the stocks of a large variety of fish species as the inland fishery production system, consisting of rivers, floodplains, beels, and estuaries, is a single integrated system. It discusses the impacts of some flood control, drainage and irrigation (FCD\I) projects on the fish production system. The impacts of submersible embankments on the aquatic production system and species diversity in *haor* areas are discussed. It also discusses the withdrawal of irrigation water from large water bodies such as the oxbow lakes of the Jessore area and perennial *beels*. The effects of this on the fishery production system are indicated. The fish and prawn resources of the inland water fishery are discussed. The paper also addresses the possible industrial and chemical pollution impacts on fisheries, particularly those caused by agricultural pesticides. It also discusses conservation measures to sustain the populations and stocks of various fish species, as well as the enforcement of those measures.

66 **Ali, M.Y. 1994. Fisheries and Environment. Environment and Development in Bangladesh, vol. 2. A.A. Rahman, S. Haq, R. Haider, and E.G. Jansen, eds. University Press Limited.**

This section of the book has elaborate description of fisheries resources (capture and culture), constraints, potentials, and some aspects of the biology of floodplain species in Bangladesh.

67 **Ali, S. 1984. Marine Resources of Bangladesh. Proceedings of the 4th National Zoological Conference, Bangladesh. Dhaka. p. 121.**

This paper gives an overview of fin fish, shell fish, and turtle and plant communities in the Bay of Bengal. It recommends carrying out intensive investigation of marine resources of Bangladesh.

68 **Bangladesh Center for Advanced Studies (BCAS). 1991. Floodplain Production Monitoring Initial Study Report. Third Fisheries Project. Department of Fisheries, Government of Bangladesh.**

The methods and techniques monitoring floodplain capture fisheries are described in this report. The methods cover both the households and gear-dependent monitoring systems for estimating production. The socioeconomic survey method for fishing households is also described.

69 **Bennett, S.L., Anisuzzaman, K., and S.M.A. Rashid. 1993. Potential initiatives for wetland management in the north eastern region of Bangladesh. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh.PP 255-261.**

This paper documents the initiatives that have been formulated for inclusion in the regional water management plan (presently under preparation) covering the northeastern region of Bangladesh. It is suggested that development of a regional water management plan requires an understanding of all water-related aspects of regional development including hydrology, sedimentation, agriculture, fisheries, and wetland ecosystem. The initiatives recommended include community-based management of rotating bird sanctuaries, community-based resource management for wetland sites, afforestation of economically important swamps, monitoring of wetland sites of ecological importance, farming of highly valued wildlife, restoration of endangered plant species, water quality management, and strengthening institutional support. It also recommends potential initiatives in agriculture and fisheries.

70 **Chowdhury, Z.A.; Sada, N.M.; and Khan, M.G. 1994. Exploitation of fish and shrimp by beach seine fishery at Teknaf, Cox's Bazar. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.**

The paper reports the major research findings of a year-long study conducted from March 1988 to February 1989 in two stations where high concentrations of beach seine nets were operated. The study recorded a total of 78 species of fin fish and shell fish of which seven were penaeids, four carideans, sergestid, Alphid shrimp, crab, squilla and 32 species/groups of fin fishes. The dominant species at sampling station-I (Teknaf seacoast) were *Hilsha filigera*, other clupeids, engaulids, *Johnius dussumerii*, *Lepturacanthus savala*, and other fish and shrimp. At sampling station-II (Naf river estuary), the predominant species were *Johnius bengeerii*, *Otolithoides pama*, engraulids, and clupeids. These were followed by *Metapenaeus brevicornis*, *Acetes indicus*, *Liza tade*, *Pomadasys hasta*, *Palaemon styliferus*, *Lepturacanthus savala*, *Parapenaeopsis stylifera*, *Penaeus indicus*, *Metapenaeus monoceros*, and other organisms.

71 **Cooper, G.P. 1977. Development of Fisheries in the Chandpur, Muhuri and Karnaphuli (Halda and Ichamati) Irrigation and Flood Control Projects. W-orking Document no. 4. Directorate of Fisheries. Snell Environmental group INC., Michigan, USA.**

This document highlights the results of the socio-economics and catch assessment data in the Chandpur, Muhuri, Halda and Ichamati project areas.

72 **Department of Fisheries (DOF), Bangladesh. 1983-84, 1984-85, 1985-86, 1986-87, 1987-88, 1988-89. Fish Catch Statistics of Bangladesh. Dhaka.**

These annual publications of the DOF include fish catch data (yield) by habitat, species group, fishermen, area (district) in Bangladesh. They also include data on carp spawn production in hatcheries and the natural spawn collected from river sources.

73 **De Silva, S.S. 1987. Reservoir Fish Management and Development in Asia. Proceedings of a workshop held in Kathmandu, Nepal, 23-28 November, 1987.**

This publication covers the state of reservoir fisheries research in Asian countries, including Bangladesh. The topics covered include: existing state of fisheries, limnological, biological, and management aspects of reservoir management in Asian countries.

74 **Doha, S. 1973. Fisheries of the districts of Mymensingh and Tangail. Bangladesh Journal of Zoology 1(1):1-10.**

This paper provides a detailed checklist of 106 species of fish belonging to 68 genera and 34 families observed in the rivers and swamps of Mymensingh and Tangail districts.

75 **Dugan, Patrick J. 1993. Wetland management: An international perspective. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh.pp 263-273.**

Throughout the world, wetlands have been degraded by draining, dredging, and filling as dams have been built and water diverted, and as wetlands have been converted into agricultural land. This paper briefly reviews the areas of major wetland loss all over the globe. In recognition of the importance of wetlands and the environmental, social, and economic consequences of wetland loss, a growing number of countries have initiated national programs to address wetland conservation needs. National programs are being developed in many countries. This paper reviews the approaches taken by Canada, Uganda, and Vietnam. It also presents an overview of international conventions and efforts discussing the provisions of the Ramsar Convention, World Heritage Convention, Bonn Convention, and Biological Diversity Convention. It summarizes international experiences, initiatives, and lessons learned upon which a wetland management approach for Bangladesh may be built. The salient points of these are recognition of their economic value and preparation of a national program based on a national policy that ensures that inter-sectoral concerns will be addressed and rural communities will be consulted.

76 **FAO. 1996. Aspects of the Management of Inland Water for Fisheries. FAO Fisheries Technical paper no. 161. FIRS/T 161.**

This document outlines the effects of changes in water quality on fisheries as well as impacts of various types of water management/control structures on fisheries.

77 **FAP 2. 1992. Agriculture and fisheries. North West Regional Study Draft Final Report, Vol. 12. Bangladesh Flood Plan Coordination Orgaization, Dhaka.**

This report outlines the present status of agriculture and fisheries resources and practices in the area by water depth, land and wetland types, project options, and impacts on resources components.

78 **FAP 3.1. 1993. Final Feasibility Report: Main Report. Jamalpur Priority Project Study. Bangladesh Flood Plan Coordination Organization, Dhaka.**

This report has a section on fisheries that includes a fisheries assessment methodology, the present state of culture and capture fisheries resources in the project area (habitats, production, and management). It also analyzes the impact of the proposed project on fisheries and suggests a fisheries development plan.

79 **FAP 6. 1993. Fisheries specialist study. Northeast Regional Water Management Project Draft Final Report. Bangladesh Flood Plan Coordination Organization, Dhaka.**

This report has detailed descriptions of fisheries resources (habitats, biodiversity, production, some aspects of biology of floodplain species), flood control projects, fisheries mitigation measures, etc. in the Northeast Region of Bangladesh.

80 **FAP 6. July 1994. Northeast regional water management project: Fishpass Pilot Project implementation plan, final draft. Report prepared by Shawinigan Lavalin Inc., Northwest Hydraulic Consultants, CIDA.**

This document describes the loss of floodplain fisheries production and species diversity within the Manu river flood control project in Moulvibazar district. A detailed design of an appropriate fish pass is described in the paper and a feasibility of installing the fish pass on experimental basis in the Manu river project is also discussed.

81 **FAP 17. 1992. Inception report: Phase 1. Fisheries Study, Bangladesh Flood Plan Coordination Organization, Dhaka.**

This report outlines the project background, scope of work, study approach, and the basic principals of fish population dynamics in floodplain ecosystems. It also predicts the impacts of flood control structures will have on capture fisheries and on the different communities of people.

82 **FAP 17. 1994. Final report (Draft): Main volume. Fisheries Study, Bangladesh Flood Plan Coordination Organization, Dhaka.**

This report summarized the findings of fisheries studies and socio-economic studies conducted in different regions of the country over 18 months. The fisheries studies include catch monitoring in the primary (Ganges-Padma and Jamuna-Brahmaputra), secondary and tertiary rivers, floodplains, and canals. The report compares fish production in the wetlands inside and outside of some FCD/I projects. The socio-economic studies cover the issues like impact of flood control projects on fisheries production and ichthyodiversity, fisheries access, professional fishing communities, part-time and subsistence fishing families. Information on fish consumption was collected and fisheries impact and economics of flood control were assessed.

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83 FAP 17. 1994. Final report (Draft): Supporting volume 1. Fisheries Study, Tangail Compartmentalization Pilot Project. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report presents the major research findings of an 18-month long study on monitoring fish catch in rivers, beels, canals and floodlands both inside and outside of the proposed Compartmentalization Pilot Project in Tangail. Comparative analyses of catch effort, species diversity and production inside and outside the project is made.

84 FAP 17. 1994. Final report (Draft): Supporting volume 2. Fisheries Study, Satla-Bagda Poder 1. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report presents findings of an 18-month long fisheries monitoring program conducted within the Satla-Bagda FCDI project located in the south west in between Gopalgonj and Madaripur. The study monitored fish catch in various wetlands within the project and made comparisons with that outside the project. It found that the catch effort and catch rate are higher outside than inside the FCDI project. The study found lesser number of species within the project with greater dominance of floodplain species over the migratory species.

85 FAP 17. 1994. Final report (Draft): Supporting volume 3. Fisheries Study, Chatla-Fukurhati Project. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report documents the findings of an 18-month long study on monitoring fish catch in rivers, beels, canals and floodlands both inside and outside of Chatla-Pukurhati FCD project located in the south west in between Faridpur and Madaripur. Comparative analyses is made of catch effort, species diversity, production, water quality inside and outside the project. The study identified *kua* fishing as an important fisheries activity in the area.

86 FAP 17. 1994. Final report (Draft): Supporting volume 12. Village Study, Pabna Irrigation and Rural Development Project. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report presents the findings of village studies conducted in Chalan Beel Polder B located in Natore and Bogra districts. It describes the impacts of FCDI projects on fishing communities, distribution of fisheries benefits, seasonal variation of fisheries activity, access regulation and the agriculture-fisheries controversy. The study also dealt with livelihood in general within the project.

87 FAP 17. 1994. Final report (Draft): Supporting volume 13. Village Study, Pabna Irrigation and Rural Development Project. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report documents the results of village studies conducted within the Pabna Irrigation and Rural Development Project. The study produced the site specific output on issues like impacts of FCDI projects on fishing communities, distribution of fisheries benefits, seasonal variation of fisheries activity, access regulation, and the controversy between agriculture and fisheries.

88 FAP 17. 1994. Final report (Draft): Supporting volume 14. Village Study, The Kai Project and Dekker Haor. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report discusses the findings of socio-economic studies conducted in haor area in Sunamgonj district. Data and information on impacts of submersible embankments on fisheries resources were collected for study. Impacts of submersible embankment on both the professional and subsistence fishing communities, fishing pattern, livelihood and dependence on fisheries resources, and access rights were assessed. The agriculture-fisheries controversy was discussed.

89 FAP 17. 1994. Final report (Draft): Supporting volume 15. Village Study, Chatla-Fukurhati Scheme. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report discusses the findings of village studies conducted in Chatla-Fukurhati Beel Drainage scheme of BWDB located in Bhanga thana under Faridpur district. Data and information were collected on the impacts of beel drainage scheme on fisheries resources, traditional fishing communities, changes in fishing pattern, dependence on fisheries, access rights and agriculture.

90 FAP 17. 1994. Final report (Draft): Supporting volume 16. Village Study, Satla-Bagda Polder 1. Bangladesh Flood Plan Coordination Organization, Dhaka.

This report documents the results of a village study conducted inside and outside the Satla-Bagda Polder 1: an FCDI project of BWDB located in Gopalgonj and Barisal districts. Data and information were collected on the impacts of the project on fisheries resources. Changes in fishing profession, access rights, and dependence on fisheries for livelihood were assessed..

91 FAP 17. 1994. Final report (Draft): Supporting volume 23. The use of passes and water regulators to allow movements of fish through FDC/I structures. Overseas Development Adminstration, U.K. Bangladesh Flood Action Plan. Dhaka.

This report discusses losses of fish due to water control structures in the typical FCD projects in Bangladesh and suggested for installation of fish friendly structures in order to facilitate fish migration through structures. The report also described some suitable fish-friendly structures with detail design.

92 FAP 17. 1994. Final report (Draft): Supporting volume 24. Investigation of Pesticide residue levels in Floodplain fish in Bangladesh. Overseas Development Adminstration, U.K. Bangladesh Flood Action Plan. Dhaka.

This report presents the findings of the investigation on the pesticide residue in fish tissue. The sample fish were collected from beels in Tangail in March and April 1992. The study revealed low levels of DDD and DDE, metabolites of DDT, and also dieldrin in fish tissue. The result indicated slight organochlorine pesticide pollution in floodplain ecosystem.

93 FAP 17. 1994. Final report (Draft): Supporting volume 25. Nature and extent of NGOs participation in Fisheries Resource Development in Bangladesh. Overseas Development Adminstration, U.K. Bangladesh Flood Action Plan. Dhaka.

This report presents the findings of the investigation on the Non-Governmental Organizations (NGOs) who are working in the fields of aquaculture and fisheries development in Bangladesh. A comprehensive list of NGOs is provided. Their area of actvities, nature and types of aquaculture, fisheries program and projects, skilled and non-skilled man power in fisheries sector, and program coverage in terms of area and benefiary groups, program cost, etc. have been given in the report.

94 **FAP 17. 1994. Final report (Draft): Supporting volume 26. An Annotated Bibliography (1940-92) on the River and Floodplain Fisheries Biology and Production in Bangladesh and South Asia. Overseas Development Adminstration, U.K. Bangladesh Flood Action Plan. Dhaka.**

This bibliography includes published and unpublished information on fish and prawns. Most refernces listed in the biliography concern studies undertaken in Bangladesh. The bibligraphy is indexed using document numbers by species and by subject to facilitate reference to the relevant literature.

95 **FAP 17. 1994. Final report (Draft): Supporting volume 27. Review and Bibliography of Nutrition in Bangladesh. Overseas Development Adminstration, U.K. Bangladesh Flood Action Plan. Dhaka.**

This report presents the findings of the review of literature on nutrition by the project team. Also included is an annotated bibliography of nutrition in Bangladesh. The report also discusses the issues associated with nutritional status of people in rural Bangladesh, impact of FCDI projects on nutrition, impacts of fish consumption, dietary diversity and household food security.

96 **FAP 17. 1994. Final report (Draft): Supporting volume 28. An Annotated Bibliography of the Quality and Limnology of Inland Freshwaters in Bangladesh. Overseas Development Adminstration, U.K. Bangladesh Flood Action Plan. Dhaka.**

This document presents 185 annotated citations on the quality and limnology of inland freshwaters in Bangladesh. The bibligraphy is indexed using document numbers by subject to facilitate reference to the relevant literature.

97 **FAP 20. 1992. Interim report (Draft), Annex 3: Fisheries and aquaculture. Compartmentalization Pilot Project, Tangail. Bangladesh Flood Plan Coordination Organization, Dhaka.**

This report highlights the biological characteristics of the fish community in Bangladesh, the present status of capture fisheries resources in the project area, and the possible impacts of different project options on capture fisheries in the project area.

98 **FAP 20. November 1993. Hatchling migration in the Lohajong River: Preliminary results of the special fisheries study (draft). Compartmentalization Pilot Project, Tangail. Working paper CPPWP-93/04. Bangladesh Flood Plan Coordination Organization, Dhaka.**

This report discusses fish hatchling migration pattern in the Lohajong river and describes migration timing, daily abundance, diurnal/nocturnal variation, variation at different depths, etc. The study results are based on daily sampling at selected points along the Lohajong River from June to October 1992 and June to October 1993.

99 **Farooque, M. 1993. Laws on wetlands in Bangladesh: A complex legal regime. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 231-237**

This paper briefly reviews the present legal status of wetlands in Bangladesh and highlights the serious legal limitations to their conservation. There is a need to revise the existing legal frame-

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work and pertinent rules and regulations. The policy and legislative or regulatory issues that are responsible for destruction or degradation of wetlands should be identified first. Wetlands for conservation should be selected on the basis of an inventory, and all wetlands may not be targeted for such action. Sustainable development should be the aim for those not targeted. The legal status (including ownership, possession, and record of right status) and institutional authority of the wetlands need to be ascertained and existing provisions may then be reviewed. Legislative measures should be under a single regulatory framework, which must be effective and workable. The paper also presents a brief historical overview of the regulatory framework of wetland management.

100 Karim, M. 1994. Shrimp seed resources exploitation and utilization. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh, held at the Department of Zoology, Dhaka University, 26-28 January, 1994.

This paper analyzes the seed demands of the country's 115,000 hectares of shrimp farms and finds that most of them are collected from natural sources by poor people living in the coastal area. Due to a lack of technical knowledge and awareness, huge quantities of seed are wasted every year. The author suggests in-depth study of this issue to reduce damage and to sustain the natural population of shrimp.

101 Master Plan Organization (MPO). 1985. Fisheries and flood control, drainage and irrigation development, technical report no. 17. Dhaka.

This report discusses some biological aspects of selected floodplain fishes and highlights the impacts of flood control, drainage and irrigation (FCD/I) projects on capture fisheries production and species diversity in the inland open waters of Bangladesh.

102 Government of Bangladesh. 1991. Task force report on Bangladesh development strategies for the 1990's. Environment policy, vol. 4. University Press Limited. pp. 91-107.

This report contains a fisheries section which discusses fisheries resources, living aquatic resources, and production of fish by species, by habitat, and by location. It also assesses the impacts of various anthropogenic interventions on aquatic habitats and capture fisheries production and biodiversity, water quality degradation, and pollution.

103 Habib, M.A.B.; Ahmed, M.; Islam, M.A.; and Haque, A.K.M.A. 1984. Seasonal variations in benthic fauna in relation to chemical condition of bottom soil in two selected ponds. Proceedings of the 4th National Zoological Conference, Bangladesh. Dhaka. 121 p.

This paper reports on the considerable monthly and seasonal variations observed in the chemical characteristics of soil and its effect on the growth and abundance of bottom fauna in ponds. Fluctuations of benthic fauna were found to be partially related to pH, organic carbon, total nitrogen, exchangeable K, Mg, and Na and inversely related to nitrate-nitrogen in ponds.

104 Hamidur, Rahman Khan. 1993. Water development activities and their impacts on wetlands. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 23-31

This paper presents an overview of water development activities in Bangladesh and their impact on wetlands. The development imperatives of the recent past have guided the activities and investments in the water sector toward the objective of increased food grain production. Consequently, improvements in water resources management have taken place in water level control in the monsoon season and in expanding water supply for irrigation in the dry season. Flood control and drainage projects have been built consisting of embankments, river closures, excavation of drainage channels, and the construction of drainage control structures. Embankments stop overbank flooding from rivers and the control structures prevent back flow from high river levels into low-lying areas. This results in the reduction of wetland areas. Such lowering of flood water levels is intended to increase the intensity of agricultural activities in lands which used to be subjected to medium and deep flooding. The irrigation consists mainly of small manual and power pumps to lift surface or groundwater with earthen distribution systems constructed by the farmers. The exploitation of surface water by low-lift pumps during dry season dried up small rivers and natural water bodies (*beels, haors,* and *baors*). Large groundwater withdrawals also lowers groundwater levels in the dry season which reduces the availability of dry-season surface water in wetlands. In other words, large-scale utilization of surface and groundwater has greatly reduced wetland areas.

105 Haque, A.K.M.A. 1989. Environment, conservation and management of fishery resources in Bangladesh. In Inland fisheries management in Bangladesh, M. Agiiero, S. Huq, A.K.A. Rahman and M. Ahmed, eds. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Center for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. pp. 24-35.

This paper points out the key requisite for the efficient management of fishery resources is management of the environment, which contributes to the sustainability of fish populations. Pollution of the aquatic environment of Bangladesh is already causing concern among fisheries people. This paper suggest an urgent need to know the nature and effects on fish stocks of all industrial, agricultural, and medical chemicals. There is also a need to understand the physiology and nature of responses fish have to various environmental stimuli.

Mere enactment of legislation is not enough; there has to be an effective mechanism to enforce legislation. The estuarine area and Kaptai Lake call for special treatment so as to reap the maximum benefit from their vast potential. There should be a system for easy flow of information and experience, and easy interaction among government agencies, NGOs, scientists, fish culturists, and the fishing population. The latest satellite imagery technology may be of help in tacking many fish management problems.

106 Hossain, S.M. Altaf; Ali, M.M.; Dewan, Somen; and Islam, M.S. 1988. Rice-fish culture: An adoptable technology for Bangladesh. Bangladesh Journal of Extension Education, 3(1): pp 39-45.

Experiments on rice-fish culture were carried out in farmers' fields in the of village Kazirshimla (Trishal Upazila, Mymensingh District) and at the Agronomy Field Laboratory, Bangladesh Agricultural University, during 1985-1987. In this study, fish fingerlings of *rui* (*Labeo rohita*), *catla* (*Catla catla*), *mrigal* (*Cirrhina mrigala*), silver carp (*Hypophthalmichthys molitrix*), *bagna* (*Cirrhina reba*), mirror carp (*Cyprinus carpio*), and Thai *sarputi* (*Puntius gonionotus*) were stocked in different combinations, compositions, and densities. Of all these species, mirror carp showed the highest average growth at the Agronomy Field Laboratory, followed by Thai *sarputi*. In the farmers' fields, Thai *sarputi* showed the highest average growth.

The net income obtained at the Agronomy Field Laboratory and farmers' fields in 1987 were Tk.4,094/ha and Tk.2,672/ha, respectively.

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Mirror carp and Thai *sarputi* were found the best for rice fish culture in the country's existing environmental conditions.

107 **Huq, Md. Fazlul. 1993. Institutional aspects of wetland management in Bangladesh. In Freshwater wetlands in Bangladesh: Issues and approaches for management. A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 213-229.**

This paper reviews the existing institutional arrangements and capabilities for wetland management in Bangladesh. Discussion on the adminstrative resources including institutions, policies, laws, research organizations and NGOs have been included to highlight the present status of management capabilities. Management issues have been identified and alternative strategies suggested for sustainable management. Basic steps for drawing up a management plan for wetlands in Bangladesh have been discussed in brief. An action plan recommendation have been suggested with proposed outlines for an integrated and improved institutionalized approach to wetland management.

108 **Huq, S.M. Imamul and Kamal, Golam Monowar. 1993. Characteristics and dynamics of wetlands soils. In Freshwater wetlands in Bangladesh: Issues and approaches for management. A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 33-59.**

This paper discussed wetland soils types in Bangladesh. Out of a total 483 soil series, around 416 have developed under aquic moisture regime. Most of Bangladesh's mineral soils contain less than 3% organic matter which is the standard for wetland soils of tropical Asia. The pH of mineral wetland soils is around 7.0 becoming acidic or alkaline on drying depending upon parent material while the organic wetland soils are acidic. The CEC of mineral wetland soils ranged between 10 and 20 meq %, while that of organic wetland soils, because of the presence of high clay content, is relatively higher. The organic wetland soils are deficient in some micro nutrients. A substantial change occurs in the influx and afflux of various nutrients including the organic matter turn over in the wetland soils which is mostly controlled by the source of water, the positional situation of the wetlands and the parent materials. The nutrient dynamics of a few wetland soils and water of Bangladesh are also discussed.

109 **Islam, A.K.M. Nazrul. 1993. Ecological characteristics of freshwater wetlands. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 65-73**

This paper presents a conceptual framework for the role of hydrology in wetland ecosystems and classifies wetland systems based on a hydrodynamic energy gradient. The physical parameters of three freshwater wetland ecosystems (marshes, *baors* and *haors)* are evaluated.

110 **Islam, A.K.M. Nurul, 1993. Limnology and pollution of wetlands. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 123-145.**

This paper discusses the limnological characteristics of freshwater wetlands of Bangladesh. Reviewing the historical transformation of these wetlands, it shows that a complex interaction of man and natural processes—river bed evolution, extensive flood control and irrigation works, and excessive pollutants—have caused changes in wetland features and rendered them ecologically fragile. The productivity and trophic status of freshwater wetlands in Bangladesh and their adjacent areas is discussed using various case studies. Phytoplankton productivity in some *beels* was found to convert only 5-21% (or 15-30%) of energy and a major contributor was found to be macrophytes. Major pollution sources, both point and non-point, that cause environmental hazards in the wetlands are identified. These are mainly chemical and biological in nature. These pollutants have caused as many as 32 waterborne diseases, including cholera, dysentery, diarrhoea, typhoid, and shigellosis. Many diseases of fish, waterfowl, cattle, and other animals are related to eutrophication and pollution of the wetlands. Freshwater wetlands of Bangladesh exceed the limit of natural purification. a number of recommendations are made to mitigate eutrophication and pollution problems. Population, poverty, pollution, productivity (biological), politics, progress,and prejudices constrain the conservation of the wetlands.

111 **Jyotirmoy, Talukder. 1993. Socio-economic issues in management of freshwater wetlands in Bangladesh. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 187-197.**

This article examines the socioeconomic and administrative issues related to the management of *jalmahals* to develop an understanding of present-day conflicts in land use management. Social conflicts resulting from *jalmahal* management are also highlighted. The paper reviews human settlement patterns and the process of resource tapping from the *haors*. It proposes an approach for sustainable management of *haors* through effective involvement of local people on a "community-based management" methodology. This paper is based on two monographs—one on Kaliagota Haor and the other on Shanir Haor—produced by the Socio-Anthropological Team of FAP 6.

112 **Karim, A. 1993. Plant diversity and their conservation in freshwater wetlands. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh pp. 75-104.**

This paper discusses the conservation of plant diversity in freshwater wetlands in Bangladesh. It documents and discusses the different life forms and communities in the wetlands and describes their distribution in six ecological zones. About 158 species belonging to 49 families are identified. The changing condition of the landscape due to geotectonic change within a very short period of time and increasing human intervention disrupt the patterns and processes of vegetation development in wetlands. *Aldrovanda vesiculosa* and *Rosa involucrata* have been identified as locally threatened species, and freshwater swamp forest consisting of *Barringtonia acutangula*, *Pongamia glabra* and *Crataeva nurvala* is the most threatened vegetation due to over-exploitation and sedimentation. The paper points out that deep tillage for cultivating HYV in the wetlands disturbs the natural seed bank and that leads to loss of plant diversity. Conservation of wetland plants is recommended. Immediate protection measures for the Tanguar Haor system and Bara Haor in the northeast region is also recommended. Adoption of a policy and legal framework, integrated conservation management, and research are identified as essential for the restoration of threatened plants communities.

113 **Khan, A. Ali. 1993. Freshwater wetlands in Bangladesh: Opportunities and options. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim. IUCN—The World Conservation Union, Bangladesh. pp.1-8.**

This paper contains an account of the state of wetlands in Bangladesh. While recent rapid expansion of physical infrastructure in the floodplains and wetlands yielded two beneficial effects—increased food production and improved road communication—their adverse effects on fisheries, wildlife, and the ecosystem have had far-reaching consequences. The paper recommends urgent action to arrest further degradation of wetlands due to human interference. It suggests three distinct, though not mutually exclusive, strategies for preserving the wetlands of Bangladesh. These are: a moratorium on development in at least a few ecologically sensitive wetlands, inclusion of environmental mitigation components in all development projects in the wetlands and rehabilitation of critically essential degraded wetlands. The success of such an approach is contingent on continuous research and monitoring of wetlands.

114 **Khan, Y.S.A. 1984. Marine fisheries resources of Bangladesh. Paper presented at the 4th Zoological Conference of the Zoological Society of Bangladesh, March 15-17 1984. Dhaka**

This article discusses the territorial area (1 million ha) of the Bay of Bengal and the richness of its aquatic life. It also reviews the work of surveys done on different aspects of the bay ecology. Some examples of demarsal and pelagic fish and shrimps are given. Causes of pollution and environmental alteration in the coastline are also discussed.

115 **Molla, Atiar Rahman and Islam, S.M. Fakrul. 1986. Development of fisheries in Bangladesh. Bangladesh Journal of Aquaculture, 8(1):25-35.**

This paper points out that there exits a tremendous potential for increasing fish production in Bangladesh. It also discusses the broad objectives of fisheries development, natural endowments of fisheries resources, socio-economic constraints on fish production, trends of fish consumption, and future demand. The document also points out the fisheries consequences of grain-biased food production strategies in Bangladesh. On the basis of available data, the authors have recommended some policies and strategies for the development of fisheries resources in Bangladesh.

116 **Mustafa, M.G. and Dey, M.P. 1994. The effects of environmental factors in the ecosystem of the Bay of Bengal, Bangladesh. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.**

This paper describes the results of an oceanographic survey during a long-term systematic program of bottom and shrimp trawling in the territorial waters of Bangladesh. The Bay of Bengal is characterized by river discharge from the mainland. This dynamic character involves changes in the ecosystem, stability of depth, and water quality. This study reveals the responses of the bay to seasonal variations in temperature, salinity, and turbidity.

117 **Nishat, A. 1993. Freshwater wetlands in Bangladesh: Status and issues. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 9-21.**

This paper examines the definition of wetlands adopted at the RAMSAR convention and the classification of wetlands as developed by IUCN. The paper argues that *haor* areas, which offer a complex ecological, hydrological, and geo-morphological landscape system, contain all the elements of freshwater marshes, floodplains, swamp forests and lakes. The study covers all issues related to the conservation and sustainable management of freshwater wetlands. The paper describes the characteristics of wetlands in Bangladesh and identifies various causes of their degradation. Present-day development activities in *haors* are directly linked with agricultural practices and cropping seasons. There are two distinct approaches. One provides protection against early monsoon flood with the help of submersible dikes to save *boro* crops. The other protects against the main monsoon flood and requires high embankments. The paper evaluates the negative and positive impacts of these activities and finds that submersible dikes are more acceptable to local people.

118 Nuruzzaman, A.K.M. 1991. Effects of environmental modifications on riverine fisheries in Bangladesh. Paper presented at World Fisheries Congress held in Athens, Greece, 14-19 April 1991.

This paper highlights the effects of various human actions, flood control and drainage projects, and pollution and sedimentation on fisheries resources.

119 Patra, R.W.R and Azadi, M.A. 1985. Hydrological conditions influencing the spawning of major carps in the Halda River, Chittagong, Bangladesh. Bangladesh Journal of Zoology 13(2):63-72.

This study concludes that the spawning of major carps is favored by a combination of some environmental factors that stimulate the biological process. The following possible environmental factors are described in the paper: 1. abrupt rise of water level due to monsoon flooding; 2. increasing current velocity and turbidity; 3. decreasing water temperature, DO, and conductivity; 4. slight acidic water. Interactions of all these factors trigger carp spawning in the Halda River.

120 Rahman, A.K.A. 1993. Wetlands and fisheries. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 147-161.

The paper highlights causes of disappearing wetlands in Bangladesh. It also documents that the Inland fisheries cover an area of 4.3 million ha, 94% of which is open-water capture fisheries supporting about 260 species of freshwater fish. The paper identifies a host of man-made stresses, such as large-scale water abstraction for irrigation; construction of embankments for flood control; siltation and soil erosion resulting f.rom deforestation in the catchment zones; water pollution from industrial, agricultural, and municipal wastes; and over-exploitation and destructive fishing practices. It evaluates the potential of fisheries in paddy field wetlands and recommends its introduction in Bangladesh. It outlines an integrated management approach for inland open-water fisheries.

121 Rahman, A.A., et al., eds. 1994. Environmental aspects of surface water systems of Bangladesh. University Press Limited, Dhaka.

This book is a compilation of articles on water resources issues from different disciplines. The articles covers such diverse disciplines as the natural and biological sciences, engineering, health, and social sciences.

122 Rahman, A.K.A. 1989. Freshwater fishes of Bangladesh. Zoological Society of Bangladesh, Dhaka.

This book is the outcome of research on freshwater fish species diversity in Bangladesh. The book provides scientific descriptions (diagnostic characteristics with some aspects of biology) of 260 species under 145 genera and 55 families. It can be used as a guide to work on fish taxonomy and biology.

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123 Rahman, M. Mokhlesur. 1994. Community-based management of wetland resources in Bangladesh. Paper presented at the 15th Annual Meeting of the Society of Wetland Scientists, May 30-June 3, 1994, Portland, Oregon, USA.

The paper points out the richness of wetland resources in Bangladesh which cover an area of 4.3 million hectares, providing habitats for 400 vertebrate species, 300 plant species, and a wide variety of invertebrates. It discusses people's interactions with wetlands. More than 1.1 million people are estimated to be involved in commercial fishing and 73% of rural families are engaged in part-time subsistence fishing. In addition, wetlands provide water for irrigation, navigation, and other household uses. Millions of rural people depend for their livelihood on wetlands. The paper highlights the declining trend of wetland resources in Bangladesh and outlines a long-term environmental management plan for sustaining wetlands and their biodiversity. It focuses on the importance of a community-based resource management approach for the restoration, conservation, and management of wetlands. It also highlights the possible ways of educating and involving community people in management processes, giving due consideration to their perceptions and traditional beliefs.

124 Rahman, S.M. 1989. Fishing activity and distribution of benefits in Bangladesh. In Inland fisheries management in Bangladesh, M. Augero, S. Huq, A.K.A. Rahman, and M. Ahmed, eds. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Center for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. p. 102-117.

This study analyzes the economics of fishing activities in four river sites in Bangladesh. The analytical framework provides a basis for computing the costs and returns of various types of fishing gear used by fishing units in these sites. Also provided are estimates of the catch per unit of effort (CPUE) and catch rate for all four fishery sites. The economic analysis reveals significant economic rents and profits in all four sites. The profitability of fishing is higher in the two sites under the management of the Department of Fisheries (DOF) compared to the other two fisheries, which are under traditional management. The study does not provide a causal explanation of these differences. From implicit wage rate computations the study finds that fishing is relatively more remunerative than alternative income-generating opportunities in and around the fishery site.

125 Rasid, H. and Mallik, A. 1993. Poldering vs. compartmentalization: The choice of flood control techniques in Bangladesh. Environmental Management 17, No. 1:59-71.

This paper is based on a case study of the impact of the Dhaka-Narayanganj-Demra (DND) project. The study found that the project alleviated flooding but induced considerable environmental degradation due to stagnation of water, structural instability of embankments, etc.

126 Reza, R. 1993. Wetland policies rules and regulations in Bangladesh. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 199-211.

This paper recognizes that wise application of sustainable development principles to wetland conservation will bring about multifarious benefits to any country that has wetlands. The present thrust of development activities in the wetland areas of Bangladesh, has mainly aimed to meet demands emanating from increasing demographic pressure, and there is a lack of concern for manag-

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ing them in an ecologically sound manner. To ensure the sustainable use and management of this country's wetlands and promote development of their ecological and socioeconomic functions and for the long-term benefit of the people, the paper proposes effective enforcement of existing rules and regulations.

127 **Sada, N.M. and Chowdhury, Z.A. 1994. Seasonal abundance and diversification of species in the estuary at Kumira, Chittagong. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.**

This paper presents the results of a year-long study (December 1989-November 1990) of the estuarine fauna of Kumira, Chittagong. A total of 35 species were recorded, of which the dominant were gobbies followed by crab, bombay duck, jaw fish and other carideans. The catches peaked in March.

128 **Sarker, A.L. 1994. Fish species diversity for sustainable aquatic environment. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.**

This paper discusses the various ways in which the environment is being degraded, and altering natural fish production both in terms of quantity and species diversity. Steps need to be taken to ensure a sustainable environment for the sustained development of the fisheries resources. Mitigation measures as well as the prospects for the compensation of fisheries losses and enhancement of fisheries resources are also suggested.

129 **Sarker, S.U.; Roy, P.C.; and Sarker, N.J. 1994. Biodiversity in the resources of Hail Haor and their environmental impact and conservation. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University, 26-28 January, 1994.**

This paper documents the results of a study on biodiversity of Hail *haor* (wetland) during the period from June 1992 to December 1993. The authors identified 98 species of birds, 54 species of fishes, 11 species of mammals, 5 species of amphibians, 9 species of reptiles, 16 species of invertebrates, and 37 species of aquatic vegetation. About 22 species of animals and plants in the wetland are found to be endangered. The author suggests that the *haor* resources should be protected and be included on the Ramsar Convention list as a wetland of international significance.

130 **Sarker, S. Uddin. 1993. Faunal diversity and their conservation in freshwater wetlands. In Freshwater wetlands in Bangladesh: Issues and approaches for management. A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 105-122.**

This paper discusses the status, distribution, and conservation of wetland fauna in Bangladesh. Of the avifauna listed, 78 species are migratory and 129 are resident water birds that frequent the wetlands. Among them ducks, lapwings, plovers, cormorants, herons, gulls and terns are important. Twenty-five species of resident and migratory water birds are endangered and threatened and the rest are vulnerable. The number of ducks in each roosting site ranges from 2,000 to 5,000, and there are about a hundred such sites in and near the wetlands. Thousands of waders and other waterfowl also visit the wetlands every winter. Seasonal distribution shows that migrants begin to arrive between mid-August and mid-November, reach optimum in December-January, and begin to return between February and May. Resident waterfowl breed in wetlands and nearby woodlands in small groups. Large breeding colonies are rare even in the Sundarbans. Breeding success is very low owing to human disturbances and habitat destruction. Ever-increasing human population, hunting, trapping, lack of awareness, and absence of wetland sanctuary and agro-chemical residues are the main problems in conserving wetlands and waterfowl in Bangladesh. In spite of a ban on the trapping and hunting of waterfowl, such activities happen frequently due to a lack of agencies to enforce the law. The paper suggests undertaking a detailed survey of wetland fauna and a the development of a conservation and management plan for the ecologically significant wetlands. It suggests that Hakaluki, Hail, and Tanguar haors and some suitable areas of the Jamuna River be declared wetland sanctuaries for the protection of wetland fauna.

131 **Sharafuddin, A.M. 1993. Awareness and public participation in wetland management. In Freshwater wetlands in Bangladesh: Issues and approaches for management, A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 239-243.**

For sustainable wetland management, the participation of local communities and creation of awareness among all concerned is essential. This paper stresses the need for making full use of all the channels of formal and informal education in the country to raising public awareness of wetland management. Key actors in the conservation of wetlands are the rural poor living in and around the wetlands whose cooperation is of crucial importance. Special attention therefore must be given to raising awareness among the rural poor. The paper recommends the inclusion of conservational issues in school curricula, effective utilization of media, and arranging of social debates. It also suggests the involvement of NGOs, utilization of religious institutions in developing environmental ethics, and the involvement of women in community programs.

132 **Tsai, Chu-fa; Ali, L.M.; Hasan, S.O.; and Kasem, S.H.M.B. 1985. Carp spawn fishery and implementation of fishery regulation. <u>Fisheries Information Bulletin</u> FRSS/Vol. BGD/79/015.**

This document describes the state of the carp spawn fishery in the Ganges, Brahmaputra, and Meghna rivers in Bangladesh. It describes natural spawn collection methods, gears used, type of people involved, costs and income, collection points, etc.

133 **Zafar, M. 1994. On the occurrence of milk fish *Chanos chanos* larvae in the mangrove ecosystem of Kutubdia Channel, Bangladesh. Paper presented at the 9th Zoological Conference of the Zoological Society of Bangladesh held at the Department of Zoology, Dhaka University. 26-28 January, 1994.**

This study records the occurrence of milk fish larvae in Bangladesh costal waters during the rainy season (June to September) and found a positive correlation between larval density and rainfall and an inverse relation to salinity.

134 **Zahir, Sadeque S. and Islam, M. Aminul. 1993. Socio-economic characteristics of freshwater wetlands in Bangladesh. In Freshwater wetlands in Bangladesh: Issues and approaches for management. A. Nishat, Z. Hussain, M.K. Roy, and A. Karim, eds. IUCN—The World Conservation Union, Bangladesh. pp. 179-186.**

The unique socioeconomic features of the wetlands of Bangladesh pose challenging issues for their sustainable management and conservation. This

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paper attempts to understand the interaction between the social and physical dynamics of freshwater wetlands. All wetlands are flood-prone; hence, agricultural practices have been adjusted to minimize the risk of flooding. Human settlements are of two types: densely populated clustered settlements on high ground, which remain above water during the monsoon, and elongated linear ones along natural levees. The social organization of these areas is unique as the geo-social units are clearly demarcated in the wet months. These areas have a larger than national average of Hindu population (17%); the rest are Muslims. Occupational patterns follow religious lines: Muslims are farmers and Hindus are in fishing and services (teaching, medical, and legal professions). The resolution of social disputes and the leadership hierarchy transcend these occupational patterns. Management practices of *jalmahals*, which often lead to conflicts, are discussed. The paper recommends mass education in the wetland areas.

WILDLIFE

135 Ahsan, M.F. 1989. Occurrence of crab-eating mongoose (*Hetpestes urva*) in Sylhet, Bangladesh. <u>Bangladesh Journal of Zoology</u> 17(1):pp. 87-88.

This scientific note indicates the presence of three species of mongoose in Bangladesh. It includes a detailed description of the morphology, food habits, and distribution of these animals in Bangladesh as well as in the region.

136 Ali, S. and Ripley , S.D. 1983. A pictorial guide to the birds the Indian Subcontinent. Bombay Natural History Society. Oxford University press, Bombay, India.

This is one of the best pictorial guidebooks for identifying the birds of Bangladesh. It helps to indentify almost all the birds of the country. It also contains taxonomic information and some biological details.

137 Ali, S. 1992. The Book of Indian Birds. Bombay Natural History Society. Bombay, India. 187 p.

This book since its first publication in 1941, has been a close companion of the bird watching enthusists as well as of the seasoned ornithologists in South Asia. It illustrates in colour and tersely describes the habits and habitats of 296 of the commoner birds of the plains and foothills, and of the wetlands and sea coast. It also contains taxonomic information of birds. This is an indespensible field guide.

138 Asmat, G.S.M.; Ahmed, B.; and Rahman, M.M. 1985. Avifauna of the Chittagong University campus. <u>Bangladesh Journal of Zoology</u> 13(2):23-29.

This study found 79 species of birds belonging to 32 families on the campus of Chittagong University from April 1982 to November 1984. Of these, 48 were passerine species and 31 were non-passerines. Sixteen birds were migratory and 63 were resident. The paper also outlines and provides reasons for the regular and irregular occurrences of birds in the area.

139 Azadi, M.A. and Hossain, M. 1984. Studies on the biology of the tree frog, *Rhacophorus maculatus* with special reference to the limnology of the rearing grounds and the rearing aquarium. Proceedings of the 4th National Zoological Conference, March 15-17. Dhaka. 121 pp.

This paper discusses the biology of tree frogs in the context of selected limnological parameters including temperature, DO, free CO_2, pH, and conductivity of the rearing ground and rearing aquarium. The study finds that high pH values had a detrimental effect on the rearing of tree frog larvae. The tree frogs lay eggs on trees on or near water. The paper also discusses the breeding biology of tree frogs which has a strong association with rainfall.

140 Bhuiyan, M.H.R. and Khan, M.A.R. 1981. Population and breeding activities of pariah kite *Milvus migrans* (Boddaert) in greater Dacca, Bangladesh. Paper presented at the 3rd National Zoological Conference, March 15-17, 1981. Dhaka.

This paper reports the findings of a year-long study of pariah kites in Dhaka. The study revealed that more than 80% of the pariah kites in Dhaka are migratory and the resident population breeds from September to April when migratory birds are present. Both sexes took part in nest building,

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incubation, and parental care and breeding success was 57.1%. The immigration of pariah kites peaked in November and the population size remained unchanged until mid-February. Emigration started the last week of February and all birds were completely gone by the last week of April. The paper concludes that Dhaka supports both the resident and migratory populations, having 880-950 pariah kites over an area of 31 square kilometers. The resident population was eight times higher than the migratory population. The migratory kites mostly feed on slaughterhouse refuse, while the resident birds prefer kitchen refuse waste from roadside dustbins.

141 Daniels, J.C. 1983. The book of Indian reptiles. Bombay Natural History Society.

This handbook is very useful for the field identification of reptiles. It consists of color and B&W photographs of reptiles, taxonomic information, and some biological details.

142 Fugler, C.M. 1984. The commercially exploited chelonia of Bangladesh: Taxonomy, ecology, reproductive biology and ontogeny. Fisheries Information Bulletin 2(1):52 p.

This paper is based on a comprehensive study of the chelonia of Bangladesh. It includes biological descriptions, assesses the commercially important species, and recommends sustainable exploitation of the population. The paper evaluates the feasibility of establishing hatcheries for artificial reproduction and stocking in places where the species is depleted.

143 Harvey, W.G. 1990. Birds in Bangladesh. University Press Limited, Dhaka.

This is one of the best lists of the birds of Bangladesh, covering almost all the birds of the country. It also contains taxonomic information and some status and distribution information, including sighting reports by bird-watchers.

144 Hiremath, I.G. and Hiremath, G.G. 1986. Catching of wild frogs vis-a-vis ecological imbalance—some considerations. Proceedings of the First World Conference on Trade in Frog Legs vis-a-vis Environmental Considerations. Calcutta, April 10-11. Vol(1). pp. 53-56.

This paper discusses the pros and cons of catching wild frogs and makes suggestions for the systematic survey of the status of frogs. It emphasizes frog culture for sustaining the frog leg industry in India.

145 Huq, A.M. and Mia, M.K. 1991. Madhupur National Park: A survey report. Bangladesh POUSH, Dhaka.

This report discusses the geographical location and area of the Madhupur National Forest, its topography, human population, and makes some general observations about its plant resources and wildlife.

146 Husain, K.Z. 1981. Development activities and their impacts on the terrestrial fauna of Bangladesh. Paper presented at the 3rd National Zoological Conference, March 15-17, 1981. Dhaka.

The paper emphasizes the impacts of agriculture, industry, embankment, roads, etc. on terrestrial fauna in an underdeveloped country like Bangladesh and compares them to developed countries. It investigates the environmental impacts of development projects. Among the losses indicated are: rhinoceros, wild buffalo, peafowl, pinkheaded duck, gaur, etc. The paper also discusses the country's most threatened species.

147 Hussain, K.Z. 1991. Report on the survey of the diversity of wildlife and its habitat in the Cox's Bazar-Teknaf area. Bangladesh POUSH, Dhaka.

This document, based on an exploratory survey of the Cox's Bazar-Teknaf area, reports that at least 19 forest species have become extinct in Bangladesh within this century. More than 70 species are endangered or threatened and the ranges of other forest and wetland species have declined considerably, mainly due to the shrinking of their natural habitats. The decrease of biodiversity is closely correlated with the increase in monoculture plantation. Exotic species like eucalyptus, as well as indigenous species like garjan, jam, and jarul are used as monoculture plantation. The document found that it is vital to protect the remaining natural forest to sustain biodiversity and also to maintain indigenous original genetic material for posterity. One species of a plant may support more than one animal species in a given area, but not all species. The greater the diversity in the floral composition of an area the larger the number of animal species there.

148 Islam, M.A. and Husain, K.Z. 1981. Activities of age-sex groups of the capped langur *Presbytis pileatus* of the Madhupur National Park. Paper presented at the 3rd National Zoological Conference, March 15-17. Dhaka.

This paper presents the findings of a study, conducted from December 1977 to July 1987, on the behavioral patterns of the capped langur. The paper discusses the time spent by different age and sex groups of capped langur on sitting, resting, moving, playing, and grooming. The paper also defines and explains each of the activities studied.

149 IUCN. 1990, et seq. 1990 IUCN red list of threatened animals. IUCN—The World Conservation Union. Gland, Switzerland.

This book contains the global list of endangered and threatened animal species. It also contains the criteria for categories.

150 Khan, M.A.R. 1982. Wildlife of Bangladesh: A checklist. Dhaka University, Dhaka.

This book reports that Bangladesh has one of the richest wildlife fauna of the Indian sub-continent. The country has 119 species of mammals, while the sub-continent has 500 species; 578 species of birds against 1200 for the region. Likewise 124 species of reptiles and 19 species of amphibians are present in the country. This book is a checklist of wildlife from amphibian to mammal.

151 Khan, M.A.R. and Ahsan, M.F. 1981. The group structure, composition and age-sex relationship of primates of Bangladesh. Paper presented at the 3rd National Zoological Conference, March 15-17. Dhaka.

The paper discusses a survey of primates, conducted from December 1970 to March 1971, in the forested and non-forested areas of Bangladesh. It describes the group structures, group composition, and age-sex relationships of different species of primates.

152 Khan, M.A.R. and Saha, S.N. 1981. Birds of the natural and artificial vegetation of the Botanical Garden, Mirpur, Dhaka: A case study. Paper presented at the 3rd National Zoological Conference, March 15-17. Dhaka.

A 12-month study, conducted in 1979-80, found 128 species of birds belonging to 37 families. Of these, 60 (46.8%) species were found only in natural vegetation, 8 (6.4%) in artificial vegetation, and 60 (46.8%) in both. Of the species found in natural and artificial vegetation, 39 were common in natural vegetation and 21 were common in artificial vegetation. The paper also discusses the reasons birds were found in particular types of vegetation.

153 **Pandian, T.J. and Marian, M.P. 1986. Production and export of frogs: An ecological view. Proceedings of the First World Conference on Trade in Frog Legs vis-a-vis Environmental Considerations. Calcutta, April 10-11. Vol(1). pp. 33-48.**

This paper discusses the harvesting of frogs in India and evaluates the issue relative to pest control by frogs, ban on frog leg export, and emphasized culture of frogs.

154 **Paranjape and Ghate, H.V. 1986. Frogs and frog legs: Socioeconomic and ecological perspective. Proceedings of the First World Conference on Trade in Frog Legs vis-a-vis Environmental Considerations. Calcutta, April 10-11. Vol(1). pp. 59-64.**

This paper discusses the socioeconomic status of the people involved in the frog leg industry. It emphasizes regulation of the industry so that the primary catchers are not exploited by traders. The paper also highlights the ecological importance of frogs and their role in the natural food chain. The overuse of frogs for research work is also discussed and some recommendations are made toward improving the sustainability of frog species in nature.

155 **Pillai, R.S. 1986. Diagnosis, distribution and bionomics of the edible frogs of India. Proceedings of the First World Conference on Trade in Frog Legs vis-a-vis Environmental Considerations. Calcutta, April 10-11. Vol(1). pp. 49-52.**

This paper discusses the abundance and distribution of Indian frog species. It describes the diagnostic characteristics and some biological details (i.e., habits and breeding).

156 **Prashad, B. 1986. Role of frogs and toads in environment with special reference to agriculture. Proceedings of the First World Conference on Trade in Frog Legs vis-a-vis Environmental Considerations. Calcutta, April 10-11. Vol(1). pp. 57-58.**

This is an overview of the role of toads and frogs in controlling agricultural insects. The paper emphasizes frog culture for sustaining population balance.

157 **Prater, S.H. 1980. The book of Indian mammals. Bombay Natural History Society. Bombay. India.**

This is one of the best pictorial guidebooks to the mammals of Bangladesh. It helps to identify almost all the country's mammals and also contains taxonomic information and some biological details.

158 **Raana, H. (ed) 1992. A follow-up study, cyclone '91 revisited. Bangladesh Center for Advanced Studies. Dhaka. p 144.**

This book is based on a study of the coastal area of Bangladesh after the cyclone of April 1991. It briefly discusses the situation of wildlife fauna in the cyclone-prone area and the condition of the population and community following the 1991 cyclone.

159 **Sarker, N. and Parveen, M. 1986. Food habit of whitetailed shrew. Bangladesh Journal of Zoology 14(1):97-100.**

This paper on a study of the eating habits of whitetailed shrews (*Suncus muriuns*) reports on the food contents of the stomachs of 40 study animals. The contents consisted of animal food (62%), plant food (29%), and miscellaneous food items (9%). Insects were consumed in higher numbers during the monsoons.

SOCIO-ECONOMICS

160 **Ahmed, B. and M. Rahman. 1990. Local organizations and adaptations of irrigation technology. In Saleemul Huq *et al*. (eds.), Environmental aspects of agricultural development in Bangladesh. The University Press Limited (UPL). Dhaka. pp. 159-171.**

The paper discusses the role of local organizations and bureaucracy in water resource management in Bangladesh. The author uses examples of community based irrigation programs involving small scale tubewell irrigation as well as canal irrigation to explain how the government and local organizations manage the relevant activities.

161 **Ahmed, N. 1990. Temporal changes in agricultural land use in Bangladesh. In Saleemul Huq *et al*. (eds.), Environmental aspects of agricultural development in Bangladesh. The University Press Limited (UPL). Dhaka. pp. 87-95.**

Using Agricultural Census Reports and other Bangladesh Bureau of Statistics (BBS) data, this paper describes the present agricultural land-use in Bangladesh and the changes that have occurred over time. The paper also presents some case studies indicating the nature of changes which have occurred in spatial land use within the country.

162 **Barbier, E. B. 1993. Valuation of environmental resources and impacts in developing countries. In R. Kerry Turner (ed.), Sustainable environmental economics and management: principles and practices. Belhaven Press. London. pp. 319-337.**

This paper shows the crucial role of natural resource management for the developing countries of the world by citing examples from the real life. In understanding the contribution of natural resource management to development, it indicates the importance of valuation of welfare gains and losses. The paper emphasizes that natural resource management in the developing world need not be viewed as counter to development efforts; in fact there is a complementarity between natural resource management and sustainable development.

163 **Bateman, I. J. 1993. Valuation of the environment, methods and techniques: Revealed Preference Methods. In R. Kerry Turner (ed.), Sustainable environmental economics and management: principles and practices. Belhaven Press. London. pp. 192-265.**

This paper is based on the premise that the evaluations of individuals of environmental goods can in certain cases be revealed by what these individuals purchase from the basket of the marketed goods associated with the consumption of those environmental goods. The author shows how the Travel Cost Method (TCM) attempts to estimate the recreational value of a site by analyzing the travel costs incurred by visitors to that site. The Hedonic Pricing Method (HPM), as explained in the paper, attempts to put a price on an environmental good by analyzing the effects that the presence of such a good may have on a relevant market priced good. The author, however, cautions that since both the techniques capture only 'use values', there is a chance of under-estimation of the economic values of the environmental goods to the extent that these have 'non-use values' as well.

164 **Bateman, I. J. and R. K. Turner. 1993. Valuation of the environment, methods and techniques: the Contingent Valuation Method. In R. Kerry Turner (ed.), Sustainable environmental economics and management: principles and prac-**

tices. Belhaven Press. London. pp. 120-191.

The Contingent Valuation Method (CVM), as explained in this paper, is an expressed-preference survey technique. While the authors feel that this technique can be applied to a wide range of environmental goods, they at the same time recognize that it may be subjected to biases. Thus, CVM has not been proposed as a 'non-expert technique'. The paper has suggested various means of avoiding pitfalls in the empirical application of CVM.

165 Chadha, S. 1989. Managing projects in Bangladesh. The University Press Limited (UPL). Dhaka.

In discussing the institutional environment of development projects in Bangladesh, this book analyzes the factors affecting project schedules, costs and success. It discusses the costs of delay, ways of calculating such costs, and their effect on decision-making. The book presents ten case studies of projects covering different sectors of the economy.

166 Conway, G. R. 1990. Agriculture and the environment: concepts and issues. In Saleemul Huq *et al.* (eds.), Environmental aspects of agricultural development in Bangladesh. The University Press Limited (UPL). Dhaka. pp. 9-26.

The paper discusses modern agriculture against the backdrop of how it originated at the first place. It dwells on agricultural productivity and its sustainability. The paper also discusses certain equity issues in agriculture and puts forward the concept of agro-ecosystem.

167 FAP 14. 1992. Flood response study. Flood Plan Coordination Organization (FPCO). Ministry of Irrigation, Water Development and Flood Control. Government of Bangladesh. Dhaka.

This report discusses flood response at the household and institutional levels in different 'flood environments'. Using primary data collected from fifteen *thanas*, it explains how people in different flood environments try to prepare for floods, face floods and rehabilitate themselves after flood waters recede. The problems faced by people at each of these stages are documented. Attention has been devoted to point out gender-specificity of some of the issues. Part of the report is devoted to an exposition of how farming is adjusted to different flooding environments and what the lingering problems are. The report also discusses the roles of different government and non-government institutions in assisting the people to respond better to flooding events so that disruptions and damages are minimized.

168 Government of Bangladesh. 1991. Making changes toward sustainability. In Report of the Task Forces on Bangladesh Development Strategies for the 1990's. Vol. Four. Environmental Policy. Part VI. The University Press Limited (UPL). Dhaka. pp. 187-250.

This part of the report discusses the sustainability of the food production system. It traces the nature and extent of malnutrition, food requirements, crop agriculture potential, fish production potential and livestock as it relates to food supply. It also discusses sustainable forestry development, emphasizing the importance of the sector, its development potential, relevant technology, and certain constraints. In discussing conservation of biodiversity, emphasis is put on both education/ information dissemination and action programs. Energy issues (including conservation) and sustainability of water supply are also discussed. A number of recommendations are put together at the end.

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169 Government of Bangladesh. 1991. Physical resources and environment. In Report of the Task Forces on Bangladesh Development Strategies for the 1990's. Vol. Four. Environmental Policy. Part II. The University Press Limited (UPL). Dhaka. pp. 28-60.

This part of the report discusses the land resources and agro-ecological zones of Bangladesh. Basic information is provided on physiography, soil, land levels (in relation to flooding), climate and crop cycles. The dynamic nature of the river system and the sedimentation and land build-up potential are also discussed. The water resources of the country are assessed in terms of surface water availability, ground water development potential and gross water requirement. Energy resources and their use are also discussed.

170 Islam, M. A. 1990. Environmental perceptions and agriculture. In Saleemul Huq *et al*. (eds.), Environmental aspects of agricultural development in Bangladesh. The University Press Limited (UPL). Dhaka. pp. 154-158.

This paper takes up the incidence of flooding as a major environmental factor, and discusses the choices of farming practices open to the farmers of Bangladesh. In pursuing the analysis, the author uses the perceptions of the farmers themselves. The nature of environmental risks which affect agriculture are discussed at some length.

171 Jalal, K.F. December 1993. Sustainable Development, environment and poverty nexus. Occasional Papers. Number 7. Asian Development Bank. Economics and Development Resource Center. Manila.

The working paper discusses the depletion of natural resources, the poverty situation that exerts extra stress on existing natural resources and the failings of many development projects in paying proper attention to environmental considerations in the Asia-Pacific region. By using tools like the Environmental Kuznets Curve, the paper argues for alleviating poverty to resolve environmental problems that can lead to sustainable development.

172 Kafiluddin, A.K.M. 1991. Disaster preparedness for Bangladesh floods and other natural calamities. Padma Printers and Colour Ltd. Dhaka.

The author in this book suggests certain measures for the protection of human lives, livestock and crops in the face of natural disasters like floods. Issues concerning public health during such disasters are also discussed. The study points out the need for coordination among local, bilateral and international agencies.

173 Masum, M. 1994. Population-environment interaction: a case study of Bangladesh. In A. Atiq Rahman *et al*. (eds.), Environment and development in Bangladesh. Vol. I. The University Press Limited (UPL). Dhaka. pp. 259-275.

The paper contends that the current population of the world exceeds its optimal carrying capacity, resulting in ecologically unsound exploitation of resources. The population-environment interaction is first discussed at the general level, and then followed up with an analysis of the situation in Bangladesh. The author points out the strain on environmental resources resulting from population growth in Bangladesh. However, the paper also stresses that erroneous public policies have contributed to the problem. In this context, deforestation caused by making forestry products available to industries at rather low prices and degradation of fisheries resources caused by implementing Flood Control, Drainage and Irrigation (FCDI) projects without proper environmental impact assessment are discussed.

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174 Pearce, D. 1993. Sustainable development and developing country economies. In R. Kerry Turner (ed.), Sustainable environmental economics and management: principles and practices. Belhaven Press. London. pp. 70-105.

The paper recognizes the importance of analyzing the conditions under which optimal growth is also sustainable growth. It argues for decoupling growth from its environmental impacts which requires that the amount of waste per unit of economic activity is reduced. The paper shows the importance of attempts to value environmental functions. In terms of priority areas the problems of deforestation, soil erosion and pollution impacts are identified. The paper discusses the role of price incentives and various fiscal measures in protecting the environment from degradation.

175 Rahman, A.A. and S. Huq. 1994. Environment and Development Linkages in Bangladesh. In A. Atiq Rahman *et al.* (eds.), Environment and development in Bangladesh. Vol. I. The University Press Limited (UPL). Dhaka. pp. 1-37.

The paper discusses the problems posed to environment by mass poverty, poor resource availability, institutional weakness, poor information base etc. It describes the main environmental issues and problems in the context of population growth, natural hazards, land issues (including agricultural land), forestry, fishery and industry. The linkages among population, development and environment are analyzed. The paper emphasizes the need for public and community awareness. It also points out the urgent need for an institutional set up that can embrace relevant efforts of government agencies, non-government organizations, the private sector, academic institutions and community groups.

176 Redclift, M. 1993. Environmental economics, policy consensus and political empowerment. In R. Kerry Turner (ed.), Sustainable environmental economics and management: principles and practices. Belhaven Press. London. pp. 106-119.

This paper emphasizes the role of social commitment in extending and refining the work in environmental economics. It argues for an appreciation of cultural differences among communities, and against a search for universal models for addressing diverse environmental problems. Besides, the cumulative social impact of individual choices has been highlighted in the paper. It also stresses the need for the developing countries of the world to take into account the links between environmental knowledge and power.

177 UNDP and UNFPA. 1990. Proceedings of the seminar on people and environment of Bangladesh. Dhaka.

This volume contains six different papers highlighting policies and programs necessary for protecting the environment of Bangladesh from further degradation. A discussion on the threats posed to Bangladesh due to its geographical location is undertaken in the proceedings. Natural calamities like floods, cyclones, riverbank erosions and droughts, and the consequent environmental problems are discussed. Besides, the possible effects of anticipated sea level rise are discussed. An attempt has also been made to relate the environmental problems of Bangladesh to population pressure and mass poverty.

WOMEN AND ENVIRONMENT

178 Khurshida-Khandakar. 1992. Women in resource management. In Training manual on environmental management in Bangladesh,pp.309-322. Department of Environment, Dhaka.

This document describes the role of women in the management of land, water, animal, and forest resources. These resources are used to generate production, and women play a crucial role in the process. The article discusses the effect of illiteracy on resource management. It points out that the literacy rate of women is (12%) lower than that of men. This has an important impact in efficient management of resources. The paper suggests the formulation of an integrated program for the management of resources and the development of conservation strategies for uneducated women.

179 Khurshida-Khandakar. 1991. Role of women in the advancement of science. Science and Women. No. 5: 11-14, Bangladesh Association of Women Scientists (BAWS), Dhaka.

This paper discusses that women constitute approximately 50 percent of the country's population. Although 50 percent of what is published in education, basic and applied research, health and hygiene, food habit, and communication is contributed by women, little is known about women's contribution to science. This paper recommends that women should be actively involved in communication, in the media, in the writing of books, journals, and papers which should be published at national and international levels.

180 Khurshida-Khandakar and Nilufer Hye Karim. 1991. Women and Environment. Proceedings of the workshop on Women and Environment. Women in Science and technology in South Asia Region (WISTER) - Bangladesh, Dhaka.

The document highlights the relationship among women and environmental components and identifies constraints and opportunities for the development of women, and to the development of the environment. The paper suggests that provisions should be made so that rural women receive better education and training, extended health care and family planning services. and a greater share of parental property.

181 Women for Women. 1978. Women and education. Women for Women, 148pp, Dhaka.

This book is the first ever published exclusively about women in education in Bangladesh. The book is broadly divided into three parts. Part I deals with the social attitudes towards women's roles and status and the resultant types of formal and informal education received by Bangladeshi women. Part II deals with the various stages of formal education and the participation of women in these stages both as students and teachers. Part III discusses on women and non-formal education.

182 Najmir Nur Begum. 1987. Pay or Pudah: Women and income earning in rural Bangladesh, pp.172. Winrock International / BARC, Farm gate, Dhaka.

This document reports that poor and destitute women in Bangladesh have always worked to maintain themselves and their dependent children. They are mostly engaged in rice processing, handicraft making or in rich landowner's households as domestic servants. A few work as agricultural laborers, but are hardly seen working alongside

men outside their homes or villages. The book discusses that the employment of women as wage earners is a relatively new phenomenon in rural Bangladesh. Women constitute about 48 percent of the total population of Bangladesh. 90 percent live in rural areas. Their economic, political, social and cultural conditions present a gloomy picture. Their lives are dominated by men to a great extent.
Irrespective of their religious beliefs, Buddhist, Christian, Hindu and Muslim women are subject to patriarchal control.

183 United Nations Development Program (UNDP). 1989. Bangladesh agriculture sector review: Women's role in agriculture—present trends and potential for growth. UNDP, Dhaka.

One of the six major themes of the Bangladesh Agricultural Sector Review completed in 1988 was "Women in Agriculture". The monograph consists of four chapters which discuss women's role in food production, the institutional bases of rural women and their access to credit, the implication of this in agricultural research, and programs.

184 Department of Environment (DOE). 1992. Training manual on environmental management in Bangladesh. Department of Environment, Dhaka.

This document is a compilation of lectures by distinguished and well-known resource persons of environmentally concerned disciplines. Their subjects include natural calamities and the greenhouse effect, natural resources management, pollution control, and population explosion. The lectures stress that development today must discard the older model of resource exploitation, which discounted the ultimate cost in terms of pollution, depletion of biodiversity, and exhaustion of non-renewable resources. The lectures give an overview of the principal environmental problems and some suggestions for solving them.

185 FPCO/ISPAN 1994. Environmental Impact Assessment Skills Training Workshop. Trainers Manual. Vol.1: Training Procedures. FPCO/ISPAN. Dhaka.

This trainer's manual is to assist those who will be engaged as trainers in EIA skills training workshop designed to improve the skills of engineers, social scientists, environmental scientists, and other specialists working in the field of natural resources who perform and/or review environmental impact assessments. It accompanies the EIA Guidelines developed by the Irrigation Support Project for the Asia and the Near East (ISPAN) as part of the USAID-funded Eastern Water Initiative (EWI) in collaboration with the Flood Plan Coordination Organization(FPCO) and the Department of Environment(DoE).The trainers manual is designed for a four-week long workshop. The workshop focuses on the process outlined in the EIA Guidelines. The subject matter is divided into 8 modules, each module reflecting a stage in the process, plus an introduction to the workshop and introduction to the methodology.

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ENVIRONMENT, DEVELOPMENT AND EIA IN BANGLADESH

Environment

The word "environment" has been defined in many ways. The World Commission on Environment and Development, for example, defined it simply as "Where we all live". An alternative definition might be "the resource capital of a country" (Figure 1). In other words, **environment is the totality of the natural and human surroundings** and includes:

- **Biophysical** components of the natural environment of land, water, and air, including all layers of the atmosphere and all inorganic and organic matter both living and dead; and
- **Socioeconomic** components of the human environment, including social, economic, administrative, cultural, historical, archeological, land and associated resource usage, structures, sites, human health, nutrition, and safety.

The environment we live in is polluted and degraded by human activities, as well as technological and other development. Moreover, natural disasters such as repeated floods, storms, cyclones, tidal surges, and riverbank erosion threaten the human environment. The resources of a country can sustain only a certain size of population. The population of Bangladesh is increasing at a pace faster than the production rate of most of its essential commodities. The over-exploitation of resources is accelerating depletion of such important resources as water, soil, forests, and fisheries.

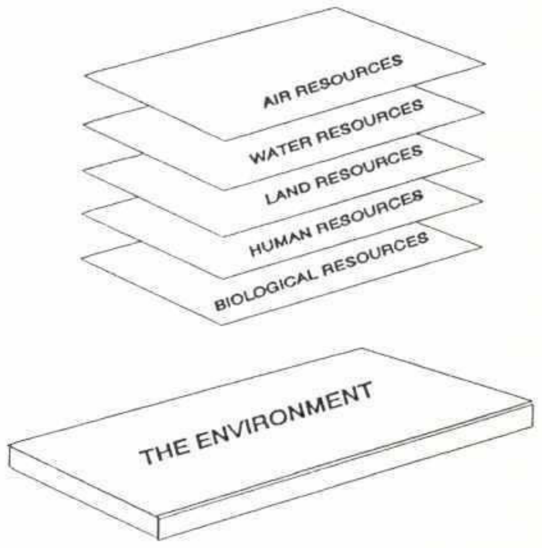

Figure 1 **Diagrammatic Representation of the Environment**

Symptoms of serious environmental degradation exist in many parts of the country. For instance, in some areas of the northern region, the use of deep

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tubewells combined with the effects of the Farakka Barrage on the Ganges River have lowered the water table. Similarly, withdrawal of Ganges water combined with siltation at the Gorai River off-take have greatly increased salinity in the south-western part of the country. Indiscriminate use of pesticides and release of industrial effluents, unplanned development of urban infrastructure and rural road networks, and construction of brickfields in agricultural land are further examples of negative impacts on resources.

Natural disasters may also lead to environmental degradation. For instance, the floods of 1987 and 1988 caused considerable loss of human and animal life and damage to property, crops, and plants. Similarly, the devastating cyclone of 29 April 1991 and its accompanying tidal surge killed nearly 139,000 people in the coastal areas. About one million people are estimated to be displaced annually due to riverbank erosion. To highlight the importance of conserving land, water, forests, and fisheries resources in Bangladesh, POUSH has published a series of fact sheets.

In view of Bangladesh's limited resources, it is essential to slow down human population growth and stop depletion of forests, soil fertility, and water and land resources. There is an urgent need to understand key factors needed for environmental assessment and sustainable development. **Sustainable management needs sustainable planning and sustainable planning needs the feedback from the environmental impact assessment (EIA) of developmental interventions.**

Development of Environmental Policy

In the past national- and institutional-level environmental management was confined to the Department of Environment Pollution Control (DEPC) under the Ministry of Local Government, Rural Development and Cooperatives (MLGRDC). The DEPC was mandated to deal mainly with the issue of pollution control. Then, in 1989, a separate Ministry of Environment & Forest (MOEF) was created, and in August 1990, the DEPC was renamed the Department of Environment (DOE) and placed under the newly created ministry with broader objectives and mandates for environmental management. The Government of Bangladesh (GOB) considers environmental protection to be a part of development, since development cannot be properly attained without sustainable environmental management.

Given the importance of environmental management, the **International Centre for Science, Technology and Environment** for densely populated regions, is being set up in Dhaka with the cooperation of Nobel Laureate Professor Abdus Salam and his Third World Academy of Science.

The GOB has also approved an **Environmental Policy**, and developed the **National Conservation Strategy (NCS)** and the **National Environmental Management Action Plan (NEMAP).** These documents have identified national issues and formulated action plans for the implementing agencies. Some environmental laws have also been revised and additional ones passed.

On the international level, Bangladesh is a member of such international organizations as the South Asian Cooperation of Environment Program (SACEP), the International Board of Plant Genetic Resources (IBPGR) and the United Nations Environment Program (UNEP). During the Rio Earth Summit held in June 1992 in Brazil, the GOB prepared a country report for the United Nations Conference on Environment and Development (UNCED). During the conference the GOB signed three international documents on environmental development. These are:

- **Agenda 21** - an action plan for all governments;
- **Convention on Climatic Changes** - aimed at reducing greenhouse effects; and
- **Convention on Biodiversity** - for protecting plant and animal species.

Bangladesh has also participated in numerous other environmental forums and signed many treaties, conventions, and agreements dealing with environmental issues (Table 1).

Table 1 Titles of Treaties, Conventions, and Agreements of Environmental Concern and Dates of Signing by the GOB

Feb. 1992	Convention on International Important Wetland as Waterfowl Habitat
18.2.1992	Convention on International Trade in Endangered Species of Wild Fauna and Flora
30.11.1990	International Convention on Oil Pollution Preparedness, Response and Cooperation.
18.9.1990	Convention of the Phycotropic Substances.
31.5.1990	Montreal Protocol on Substances that Deplete the Ozone Layer.
27.6.1990	Montreux Conference.
31.5.1990	Vienna Convention for the Protection of the Ozone Layer.
14.4.1990	Agreement on the Network of Aquaculture Centers in Asia and the Pacific (NACA).
7.2.1988	Convention on Early Notification of a Nuclear Accident.
14.1.1986	Treaty on Principles Governing the Activities of States in the Exploration and use of the outer space including the Moon and other Celestial Bodies.
13.3.1985	Convention on the Prohibition of the Development and Stockpiling of Bacteriological (Biological) and Toxic Weapons, and on their Distribution.
13.3.1985	Treaty Banning Nuclear Weapon Tests in the Atmosphere, in outer space and under water.
10.12.1982	United Nations Convention on the Law of the Sea.
4.2.1982	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties.
28.12.1981	International Convention for the Prevention of Pollution of the Sea by Oil (as amended on 11 April 1962 and 21 October 1969).
3.10.1979	Convention Concerning the Protection of the World Cultural and Natural Heritage.
3.10.1979	Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques.
23.8.1979	Treaty on Non-Proliferation of Nuclear Weapons.
4.12.1974	Plant Protection Agreement for the South East Asia and Pacific Region.

The above agreements bind the GOB to implementing the projects and proposals therein. It also became imperative for the GOB to implement the national environmental policy and the recommended action plans in the NCS and NEMAP. The national documents particularly recognized environmental impact assessment (EIA) as an important tool for the sustainability of major development projects.

Environmental Impact Assessment (EIA)

EIA is a formal study process that predicts the environmental consequences of development projects, such as flood control, drainage and irrigation (FCD/I), mining for energy and minerals, hydropower generation, and industrial development.

An excellent description of the EIA process is given in the booklet "Environmental Impact Assessment--Basic Procedures for Developing countries," which was produced by the United Nations Environment Program (UNEP).

Development of EIA in Bangladesh

Most national documents have emphasized the environmental changes that occurred during the past few decades because of the introduction of flood control, drainage and irrigation (FCD/I) structures, sinking of deep tubewells (DTWs) and shallow tubewells (STWs) and the extensive use of low lift pumps (LLPs). For instance, adverse environmental impacts have occurred because of the lowering of the ground water table, blocking of the natural drainage system and fish migration routes, and creation of a narrow gene pool for rice species.

Given these problems, emphasis has to be given to projects and programs that promote economic development and enhance the sustainability of the ecosystem. Thus, EIA needs to be incorporated in all development projects that may result in environmental degradation.

EIA Practice in Bangladesh

Only a few agencies in Bangladesh have so far taken initiatives for implementing EIA in development projects. World Bank included EIA in its Third Chittagong Water and Sanitation Authority (WASA) Project. The DOE carried out rapid EIA for its Hatiya-Sandwip Cross Dam Project and for two cement factories, Messrs Elias Brothers PVT. Ltd. at Rangadia and Confidence Cement Factory at Sitakundu of Chittagong. In addition, some consultancy firms such as Bangladesh Consultants Ltd. (BCL), Aqua Consultants Ltd., House of Consultants (HOC), Resource Control Company (RCC), Envirocare, Environment Associates, and Bureau of Research, Testing and Consultation of Bangladesh University of Engineering & Technology (BRTC/BUET) have also undertaken EIA studies for various development projects. Follow-up studies are being undertaken as per recommendations of the EIA (as a part of feasibility study) for the Jamuna Multipurpose Bridge.

The Irrigation Support Project for Asia and the Near East (ISPAN), in collaboration with the Flood Plan Coordination Organization (FPCO) and Department of Environment (DOE) have developed EIA Guidelines (Figure 2) and a corresponding EIA Manual for the use of water development projects. The guidelines and manual were field tested with three case studies of proposed water development projects, Surma Kushiyara, Tangail Compartmentalization Pilot Project (CPP), and Bhola Bhelumia-Bheduria Early Implementation Project (EIP). The case studies were undertaken by a multidisciplinary environmental study team from the Flood Action Plan Environmental Study (FAP 16). The guidelines have been approved by DOE and the revised version is now available for use. All FAP components are required to do EIA as part of project feasibility studies.

Between 1992 and 1994, the Environmental Study component of the Flood Action Plan (FAP 16) has conducted five EIA skills workshops, and has trained 78 EIA practitioners and reviewers from

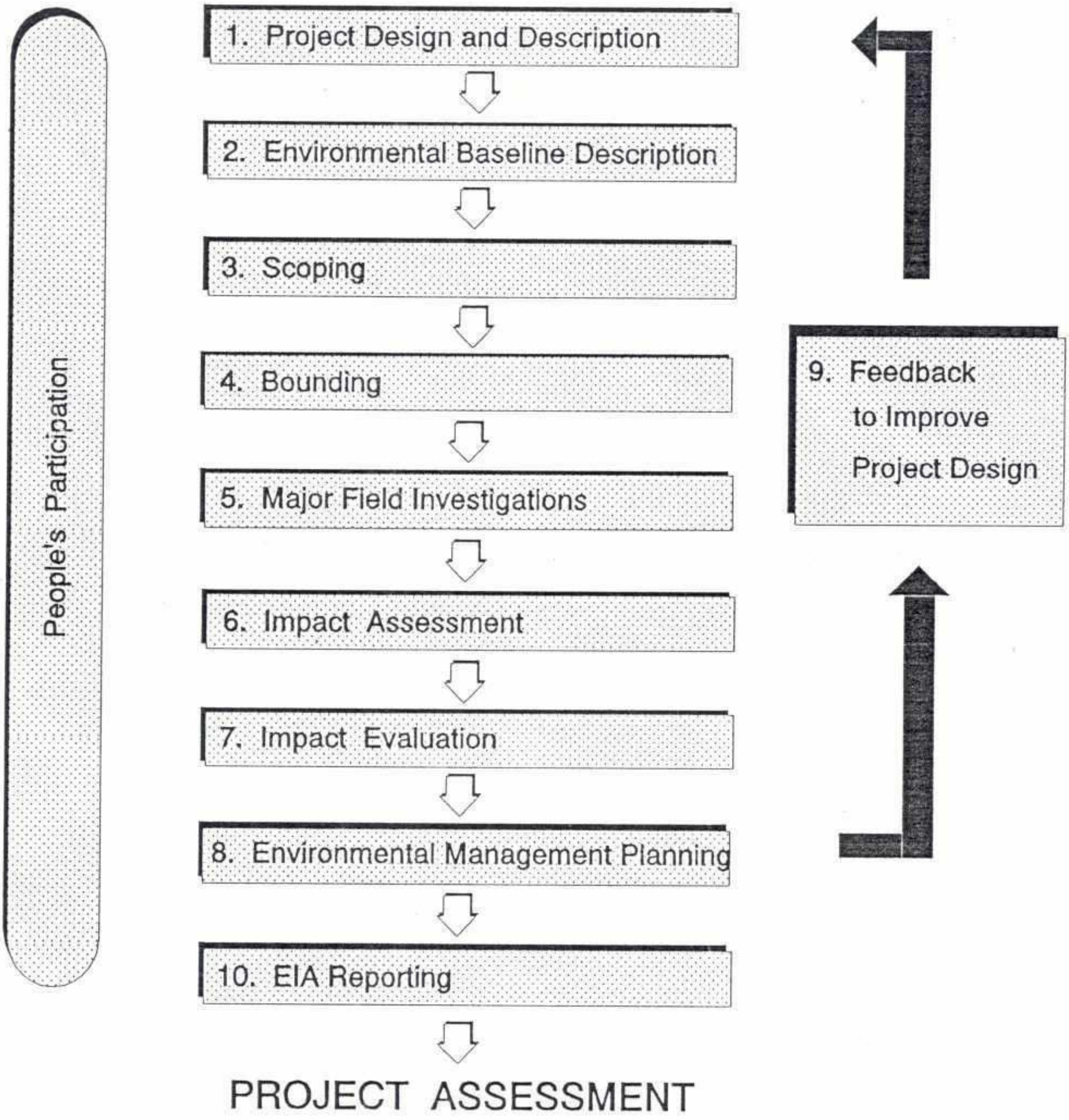

Figure 2 Procedural Steps in Environmental Impact Assessment (EIA) for the Bangladesh Flood Action Plan

the public and private sectors. It has also conducted a Training of Trainer's Workshop to develop a core group of EIA trainers who can train successive batches of EIA professionals. It is the largest EIA training program held in Bangladesh.

The workshops were financed by the United States Agency for International Development (USAID), with the Irrigation Support Project for Asia and the Near East (ISPAN) acting as the executing agency. ISPAN worked closely with the Flood Plan Coordination Organization (FPCO) and the Department of Environment (DOE).

Other training programs on environmental management that included an EIA component have been conducted by DOE, DANIDA, and UNDP. In May 1993 Winrock International organized a two-week training program on environment and economic assessment. The objective of the workshop was to develop EIA skill in mid-level and senior scientists and technocrats.

The above overview of the environment, environmental development, and EIA practice in Bangladesh would lead to the following conclusions:

- The sustainability of a development project depends upon the extent to which its adverse consequences on the surroundings can be reduced.
- The EIA study process concentrates on resources, the livelihood of the people and their homestead, and other potential problems and conflicts that may affect the viability of the project.
- An EIA study process usually ends with necessary mitigation measures for the modification of the project.
- It is essential to institutionalize EIA in Bangladesh. It is imperative for the GOB to make EIA mandatory through executive order or by Act of Parliament.

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Bangladesh Factsheet

1 LAND

Extent of Land

The total continental area of Bangladesh is 14.79 million hectares, of which approximately 13.70 million hectares is land and the rest is inland waterbodies. In addition there is over 10 million hectares of marine area, which is comprised of the territorial waters and the Exclusive Economic Zone. Despite its relatively small size, Bangladesh has a surprisingly high number of complex agro-ecological regions. This is due to the interaction of temperature and rainfall gradients with topography and normal flood levels. Of the total area 12 percent is hilly or mountainous, 8 percent consists of raddish soil uplands and 80 percent is floodplains[1]. Only one-fourth of the floodplains is normally flooded every rainy season, and another one-fourth is liable to experience floods once every five years.

From north to south (Langalbandha to Jinjiradwip) the distance (in a straight line) is 790 kilometers, and from west to east (the maximum distance) is 500 kilometers. The coastline along the Bay of Bengal is 1200 kilometers long including the coastlines of numerous islands, but not measuring minor indentations. A large area in the south is therefore in the Coastal Zone, which has its own dynamics and deserves special attention as a very distinctive area.

Land Use in Bangladesh (1986-87)

		Area (mha)	Percent of total
1.	Net cropped land	8.85	59.8
2.	Current Fallow	0.39	2.6
3.	Culturable Waste	0.27	1.8
4.	Forest Land	1.99	13.5
5.	Not available for cultivation	3.29	22.2
6.	Total area	14.79	100.0

Land Use

In Bangladesh land is generally classed into five categories (shown in the table)[2]. Of the total area 60 percent is forest land (but not necessarily forested), less than 2 percent is culturable waste land, nearly 3 percent is current fallow and over 22 percent is not available for cultivation. Due to favourable climate conditions and the development of irrigation ever fifty percent of the land is cultivated twice a year and ten percent is cultivated three or more times. Gross cultivated area is therefore more than 15 million hectares[3]. Current fallow is land that is cultivable but not cultivated during the year of enumeration. On the other hand culturable waste is land that lies fallow at least one year.

Forest land is that land which is designated for forests but necessarily under tree cover. The area not available for cultivation includes land in urban areas, under rural housing, rivers and other water bodies, uncultivable sandy chars etc. About one-third of the area classed as "not available for cultivation" is under permanent waterbodies.

Inundation Level Land Types

		Area (000 ha)	Percentage	Net Cultivable area (mha)	Percentage
1.	Highland	4,200	29.9	3.04	36
2.	Medium Highland	4,567	32.6	3.15	35
3.	Medium Lowland	1,771	12.6	1.43	16
4.	Lowland	1,102	7.9	1.10	12
5.	Very Lowland	193	1.4	0.08	1
6.	Settlements, Waterbodies etc.	2,178	15.5	-	-
		14,011	100.0	8.80	100

Land Types

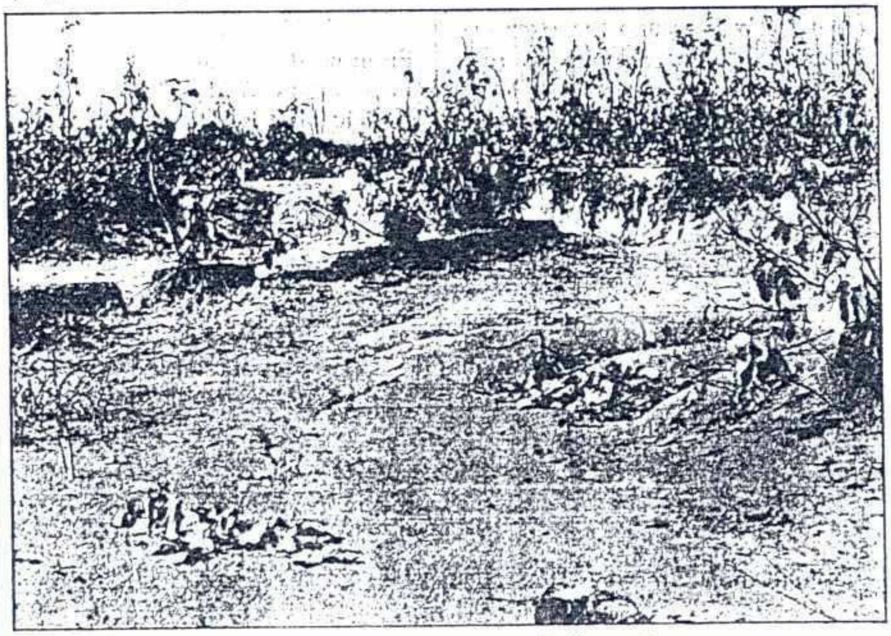
Every rainy season it is normal for the lower parts of the country to be inundated for periods of up to four months[4]. On the higher areas rain water is impounded by field bunds ("ails") to conserve water for rice cultivation. One way of classifying land is by reference to the depths to which they are normally inundated. Land which is normally not inundated is classed as Highland. Medium Highland is that which is normally shallowly inundated but may have as much as 90 cm. of water for short periods. Medium Lowland is normally inundated from 90 to 180 cm.. Lowland is inundated to between 180 to 300 cm.. and Very Lowland is inundated deeper than 300 cm. during the main rainy period (July to September). As much as 29 percent of the country is therefore normally inundated by river flows and 35 percent is shallowly inundated by impeded drainage (often man made) during three to six months of the year. During rest of the year even this land is mostly dry. The remaining 36 percent of the land consists of well-drained plains, red soil tracts at levels well above the floodplains and hilly areas.

Cultivated Land

Nearly 60 percent of the total land area of Bangladesh is cultivated. This is a high proportion in comparison with most countries of the world. It is made possible by the abundance of water, the fertility of the delta soils and the skill of the farmer in utilizing land which in other circumstances would have been either forest or swamp. An Agriculture Cencus was held in 1983-84. After analyzing its findings it was seen that 46 percent of the cultivated land is cropped only once, forty seven percent is cropped twice and seven percent is cropped three times in a year[5]. The Gross Cultivated Area of the country was therefore 61 percent more than the Net Cultivated Area. Irrigated area has increased several fold in the past twenty years, but this has not increased the Gross Cultivated Area proportionately because in many areas the second crop of rice has replaced a crop of one of the pulses or oilseeds. If this trend continues it could lead to adverse nutritional effect. Crop diversification particularly with horticultural crops is desirable.

Current Fallow

This refers to cultivated land that is kept fallow for one or two seasons formerly a fairly high proportion of the land used to be under current fallow, but with growing demand for land there is no land under this category in many areas, particularly



Denuded and Eroded Land in the Madhupur Tract in these which have fertile soils. Most of the current fallow is found now a days in upland areas of the Barind and Madhupur tracts, and in the eastern Hills.

Cultivable Waste

This is another category of land which has been reduced rapidly in the past two decades. Whatever remains is concentrated mainly in the Barind and Madhupur tracts. The large area of Unclassed State Forest (USF) in the Hill areas could be classified in this category if the definition is changed to include timber and fuelwood trees as crops.

Urban Land

Urbanization has increased fairly rapidly in the past two decades and much good agricultural land has been converted to urban/industrial use. It is estimated that about 0.15 mha. is under urban and industrial use. This is one percent of the total land area. This is relatively a small percentage but has already affected horticulture adversely because urban expansion is usually on scarce highland, which is obviously the best horticultural land. In future urban growth may accelerate, and if so, it is likely to negatively affect horticulture, field crops and even forests, unless Land Use Plans are prepared and zoning is enforced[6].

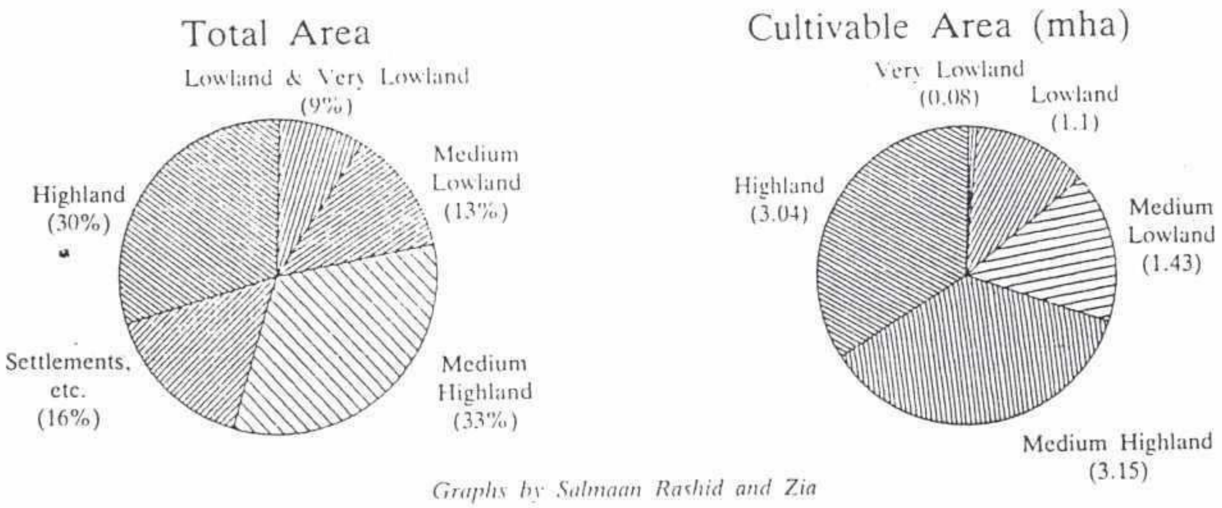
Forest Lands

Even though 2.1 million hectare are said to be under forest only 57 percent of it is under tree cover[7]. Half of the forest land is in the Hill Tracts districts where the Unclassed State Forests (USF) have very few trees. A large part of the Sal forests in the Madhupur Tract has also been lost to encroachers and illegal feeling. The only remaining substantial forests are now in the Sunderban, Kassalong and the Teknaf peninsula.

Land Degradation

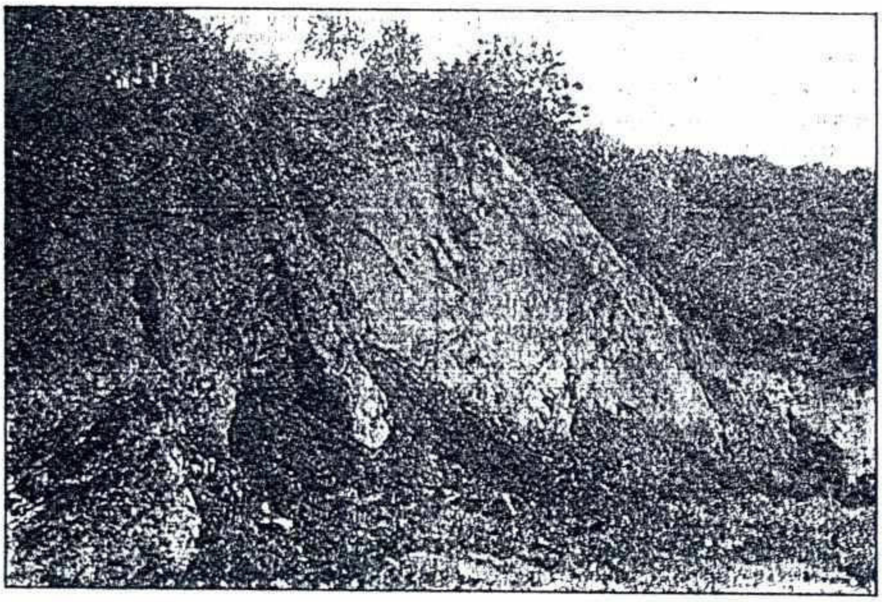
Deforestation, hill-cutting, cultivation on steep slopes and drying up of wetlands are causing widespread land degradation. Deforestation is the major cause of land degradation in Bangladesh. The Madhupur Tract, virtually in the centre of the country, used to be well forested just thirty years ago, but now only five percent of it is under forest. Large areas are now denuded, exposing the sloping land to increased leaching and erosion. The floodplains of all four sides of this important watershed are being increasingly affected by rapid run-off and excessive sediment load. The foot of the Garo Hills have also been largely denuded and this has also led to the choking of the network of streams in the piedmont from heavy sediment load in the run-off. These problems are also encountered all along the east, from Tamabil to Teknaf because of the same problem of deforestation, leading to increased erosion and consequent degradation of both the watershed and the river basins[8]. Hill-cutting is an increasing problem, although the Government has banned it. Hillsides are cut away for material to fill lowland for building sites or for making bricks. This not only destroys flood-free land which is very suitable for horticulture and settlements but also contributes sharply increased amounts of sediments to the waterways, whose beds are then raised up, leading to more frequent floods. Cultivation of sloping land is yet another major cause

INUNDATION LEVEL LAND TYPES



Graphs by Salmaan Rashid and Zia

of land degradation. Large numbers of settlers have moved into the hill areas in recent years due to population pressure, but they are not aware of hill cultivation practices. By cultivating steep slopes, removing trees and shrubs, not paying attention to contour lines, and leaving loose soil at the beginning of the monsoon rains, they are causing immense loss of top soils in these hill areas. This is rapidly degrading the hill land and also creating conditions for recurring floods in the floodplains below. Drying-up of wetlands for rice cultivation is also causing degradation, by reducing soil moisture, changing the microclimate reducing the fish catch and affecting biodiversity. Some compromise has to be found between the need to grow more cereal food and the need to increase fish production and preserve the wetlands for environmental reasons[10]. The future of agriculture in Bangladesh is in large measure tied up with the manner in which the wetlands will be treated by development projects.



Forest and Hill Land Destroyed by Hill cutting

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Bangladesh Factsheet

2

INDUSTRY

Status of Industrial Growth

Bangladesh is not an industrialised country but one which is in the early stages of industrialisation. The share of industrial sector in the national GDP is 10.8%. From 1985 to 1990, the sector achieved an average annual growth rate of about 4%[1], but the sector remains small in terms of both value added and employment.

Though the first modern textile mill was set up as early as 1908, the beginnings of an industrialization initiative was first felt in the early fifties. The first two decades since then saw the contribution of industry to GDP rise to about eight percent. However, since 1970 the increase in contribution has been very modest[2].

It has been estimated that presently there are about thirty thousand industrial units in the country, out of which 24 thousand are small and cottage industries and the rest are medium and large[3].

In recent years the major source of industrial growth has been primarily in textiles. Garment manufacture expanded from insignificant levels in the 1970s to the leading export earner today. Leather exports have also grown quickly and are likely to continue to do so in future. Frozen food industries (particularly shrimp), have grown quickly. It is, however, apprehended that brackish water shrimp farming may have already harmed agriculture, coastal forests and drinking water supplies[4].

Large-scale industries produce jute goods, sugar, cement, paper, newsprint, TSP and urea fertilizer. There is a large steel mill, several thermal power plants and a petroleum refinery plant.

Whatever industrial growth has been achieved so far, has generally been made without seriously taking environmental considerations into account. In most of the industries health and safety measures for workers are non-existent. Nor do they exist for the communities that adjoin such industrial units.

Types of Industries

Majority of the industrial units are of small and cottage level. These include weaving factories, rice mills, fabrication and repair workshops, plastic industries, etc. Large and medium industries and the number of units in each category are as follows: Sugar (16), Food (193), Paper and pulp (5), Cement (2), Fertilizer (6), Textile Hosiary (140), Jute (114), Distillery (5), Garments (704), Pharmaceuticals (185), Leather Products (31), Beverage (7), Tobacco (18), Industrial Chemicals (21), Petroleum refining (1), Pottery and China ware (8), Plastic Board mill (14), Rubber (65), Glass (34), Matches (19), Iron and Steel fabricated metal products (108), Edible Oil mills (210), and Tanneries (119), Textile (Cotton) factories (63), Drydock and Shipbuilding (18)[5]. Major part of the industrial sector is still agro-based.

Employment in Industry

The share of employment in industries sector increased from 3.9% in 1950-51 to 10.8% in 1989-90. The

Industrial Production (1988-90)

Products	Total Production[6]	
Sugar	185,844	metric tons
Tabacco	11,221	million cigarettes
Cottonyarn	12,289	thousand pounds
Paper Products	65,791	metric tons
Fertilizer	4,707	metric tons
Matches	10,633	thousand gross boxes
Pharmaceutical	10,112	thousand Taka worth
Petroleum Products	982	thousand metric tons
Cement	337,359	metric tons
Steel ingot	75,029	metric tons
Glass sheet	14,261	thousand sq. ft.
Jute goods	235,106	metric tons

rise was gradual but steady[2]. Whereas small and cottage industries employ atleast 1,400,000 persons[7], medium and large industries employ only about 467,000 persons[8].

Resource Use in Industries

Most of Bangladesh industries are still agro-based including jute, tea, textile, tobacco, sugarcane etc. Nearly 10% (0.79-1.12 million ha) of the total cropped area is devoted to production of agricultural resources for industrial use[9].

Both renewable and non-renewable resource based industries exist in the country. Renewable resource based industries include pulp, paper and board, safety match (using all together about 343,985 m^3 of wood, 590,000 tons of bamboo and reed and 66,000 tons of agricultural residues annually), leather (annual processing of 10 million cow, goat, sheep and buffalo hides), sugarcane, jute, tobacco, cotton etc[2].

Among non-renewable resource based industries, there are five existing urea fertilizer and two more under construction (using natural gas amounting to 50,965 million cft. in 1987-88), thermal power plants (using natural gas amounting to 61,959 million cft. in 1987-88 and fuel oil), ceramic, steel, petroleum refinery, pharmaceutical etc. are important[6].

Most of the older industries are based on inefficient technology with little regard to economy of energy and raw materials. It is apprehended that even the industries based on renewable resources may be overexploiting local resources in some places.

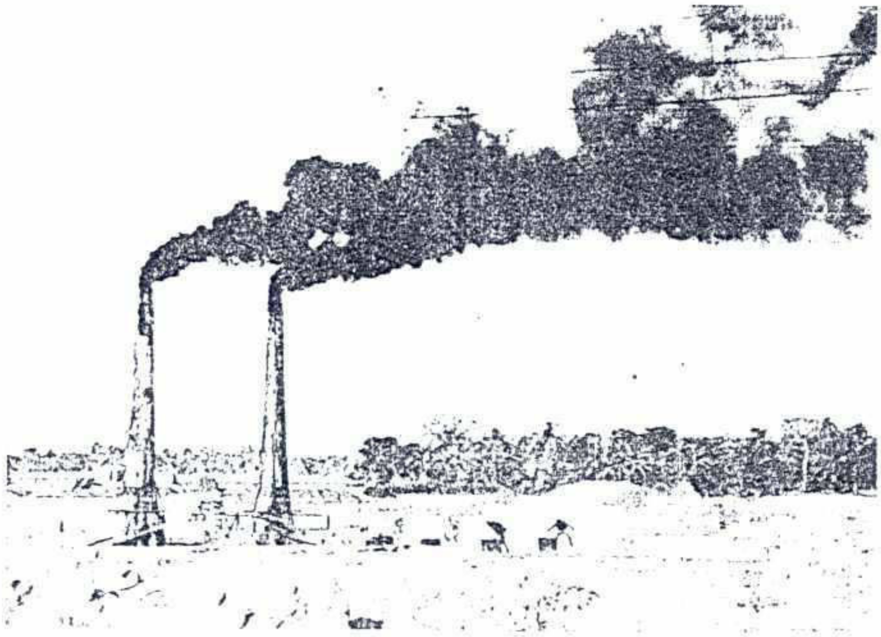
Locational Patterns

There is no 'National Industrial Siting Plan' and there exists only a few designated industrial areas in the country. These include a large number of BSCIC developed industrial estates for small and cottage industrial units, which are scattered throughout the country.

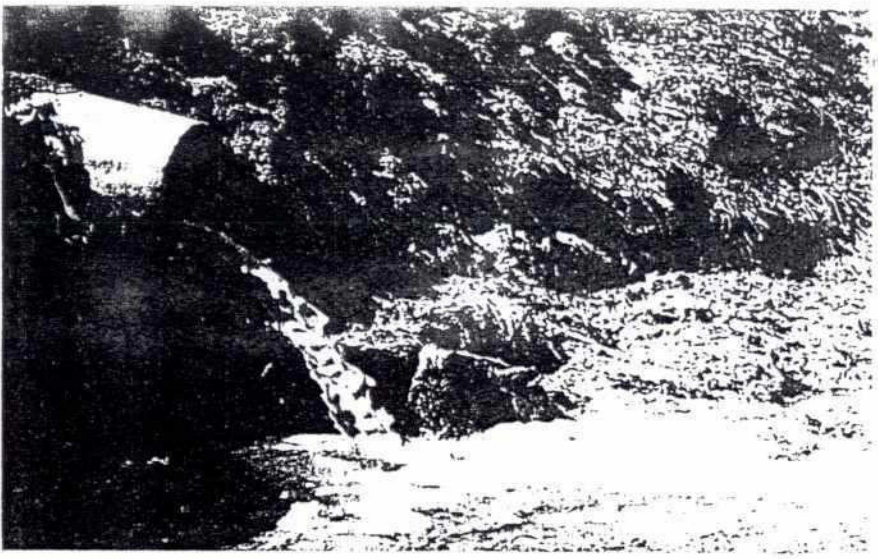
Industrial growth is currently limited mainly to urban areas. The major industrial locations are – Dhaka (Tejgaon, Hazaribagh, Demra, Tongi, Gazipur), Chittagong (Kalurghat, Nasirabad, Patenga, Sholashar), Khulna (Shiromoni, Khalishpur, Rupsha), Narayanganj, Ghorashal, Narshingdi, Tarabo, Fenchuganj and Bogra. Of late fiscal (tax) incentives have been provided to encourage the spread of industries to other areas of the country. Two export promotion zones have also been created.

It is common to find industrial units located intermingled with human settlements. Many polluting industries have been located near and even within thickly populated urban areas without provision for treatment of polluting wastes.

Industries with large effluent load or water intake requirement often locate themselves on the bank of major waterbodies, generally discharging untreated effluent into these water bodies.



Brickfields can cause serious air pollution.



Industrial effluents are discharged into rivers.

Industrial Pollution

Industrial pollution is caused by untreated effluent, emission, solid wastes and noise. Though the level of overall industrial pollution in the country is not alarming as yet, it is still quite significant, on the increase and disturbing in some areas.

In Bangladesh industrial wastes contain mostly organic degradables, but the problem of hazardous/toxic wastes from chemical industries, tanneries, electroplating and other non-primary industries is on the increase. In many areas brickfields not only degrade the land but also cause serious air pollution.

With increasing industrialisation, it is almost certain that there will be serious industrial pollution problems in the very near future.

Location Hazards

Location hazards caused by industries are significant. There is overall lack of zoning facilities even within an industrial zone, including BSCIC industrial estates.

The location pattern of various industrial units is very often not environmentally acceptable. Among other extremely hazardous units located close to habitations are the high-voltage electrical (transformer) sub-stations and high-voltage electric cables whose electro-magnetic influence have long term effects on health.

Industrial units in residential urban areas are common. Sometimes an industrial unit or workshop will occupy the ground floor, while the first floor is a residential unit. There are noisy units working 18-20 hours a day and still located in residential or mixed use area. There are moulding workshop, saw mill, oil mill etc. just next to residential blocks or engineering workshop close to educational institutions.

Legislation

The existing Environment Pollution Control Ordinance 1977 has been found inadequate to control industrial pollution in respect to coverage of polluting activities. Its enforcement is also weak. The proposed Environment Preservation Ordinance 1991 provide for improved and pragmatic provisions for control and enforcement, but it still awaits final approval and promulgation.

Factories Act 1965 basically deals with the shopfloor environment and occupational health hazards, but fails to make provisions, for industrial pollution control. It does not also specify the need for environmentally sound location of a particular manufacturing unit[10].

Institutions

Permission to set up an industry is provided by various agencies including the Board of Investment, Bangladesh Small and Cottage Industries Corporation (BSCIC), Department of Textiles, Export Processing Zone Authority, Local Government authorities. There is lack of coordination among agencies involved in industrial development of the country.

Cottage Industries, 1981

Items	Number of Enterprises	Number of Workers
1. Carpets, Rugs, Rope Bags & Nets	25,659	73,531
2. Food Drink and Tobacco processing	84,749	232,414
3. Glass & Ceramics	17,294	80,899
4. Jewellery & Ornaments	12,265	26,600
5. Leather Work	2,219	5,394
6. Metal Work	23,191	60,148
7. Miscellaneous	9,775	55,953
8. Salt	28,544	66,702
9. Tailoring	46,340	103,184
10. Wood, Cane & Bamboo Works	70,787	215,449
11. Yarn & Textile Fabrics	198,200	853,532

Other agencies involved include Inspectorate of Factories and Establishment, Department of Environment, Commercial Banks, and the Development Finance Institutions such as SABINCO, IDLC, BSB, BSRS and ICB.

Industries identified by DOE as highly polluting ones have not been compelled to take mitigating measures, due to weakness in enforcement of existing laws.

Standards

Bangladesh has Environmental Quality Standards prepared by Department of Environment and approved by an Expert Committee formed by the Government. Standards have been set for industrial effluent discharge and emissions[11]. It is hoped that these standards will now be strictly enforced.

Industrial Policy

The Industrial Policy (1991)[12] provides incentives to the private sector but does not adequately safeguard environmental concerns. The National Conservation Strategy (NCS) and The National Environment Management Plan (NEMAP), both of which were drafted in 1990, have suggested several ways in which the industrial sector can be both more productive and at the same time environmentally compatible, so that the cost of managing a depleted and destroyed environment is not passed on to future generations.

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Bangladesh Factsheet

3 FOREST

Extent

Bangladesh has 2.46 million ha of forest land according to an official estimate, covering about 17 per cent area of the country[1]. Actually forested land is much less as this official estimate includes all land recorded as forest land irrespective of tree cover. Except for 0.27 million ha of village forests, all forest land is state owned and more than 90 per cent of the state owned forest land is concentrated in 12 districts in the eastern and south western region of the country. Out of 64 districts, 28 districts have no state owned forest at all. Village forests, spread all over the country on homestead lands, consist of groves and orchards around rural homesteads.

Hill Forests

The hill forests of Chittagong, Cox's Bazar, Rangamati, Bandarban and Khagrachari Hill Tracts, Sylhet, Moulovibazar and Habiganj districts cover approximately 1.40 million ha, of which 0.67 million ha is under the control of the Forest Department and the remaining 0.73 million ha is under the control of the hill district councils. In high forests, activities of the Forest Department are mainly confined to raising of single-species plantations to convert so called low value natural semi- evergreen and evergreen high forest into high valued plantations by practising a silvicultural system of clearfelling followed by artificial regeneration. So far over 100,000 ha of high forest has been converted into plantations, mostly of Teak mixed with other hardwood species. Inventory shows most of these plantation will not give desired yield since the plantation programme sufferes from certain technical, social and administrative problems. Most of the remaining high forests are in the inaccessible areas of hill districts which are subjected to shifting cultivation by hill tribes. Forest lands under the control of the three Hill Tracts districts councils (amounting to about 0.73 million ha) are termed as Unclassed State Forests (USF) and the hill tribes are entitled to practice shifting cultivation there. This has resulted in the total destruction of these tropical evergreen forests. The USF, now, is a forest only in name and comprises mostly of scrub forest[2, 3].

Mangrove Forests

The mangrove forests of Bangladesh fall under two broad categories : namely natural managrove forests known as Sundarban and the plantations of mangrove species which have been established all along the coast and along off-shore islands in the Bay of Bengal.

The Sundarban, extending over 0.57 million ha, in the districts of Khulna, Bagerhat and Satkhira, is the largest single mangrove forest in the world[5]. Out of 0.57 million ha, 0.17 million ha is occupied by rivers, channels and other watercourses. The Sundarban has been exploited since time immemorial but has been managed by the Forest Department for the last 100 years. Silvicultural system followed for Sundarban is selection felling followed by natural regeneration. Sundarban is the natural habitat for a large number of wild animals including the Royal Bengal

Tiger and the Spotted Deer and is considered as one of the richest natural wildlife habitat in this part of the world. It may be the last viable Tiger reserve in the world[2].

Plantation of mangrove species along the coast and in the offshore islands is a very imaginative and progressive undertaking by the Forest Department. It was initiated with indigenous technology to accelerate accretion of land deposits, stabilize the ecosystem and also produce logs and fuelwood. Forest Department has so far planted an area of about 100,000 ha. in the coastal area.

Plainland Forests

Plainland forests, which is more commonly known as Sal forest, is spread out in small patches over Gazipur, Tangail, Mymensingh, Jamalpur, Dinajpur and Rangpur districts and covers an area of 120,000 ha. These are generally very degraded forests of very low productivity. There is considerable evidence to suggest that as much as 50 per cent of this land may have been cleared and settled under temporary agriculture.[6] Felling of trees in these forests were suspended (at least officially), since 1972.

Village Forests

These are tree groves grown in and around the homestead land by rural people and usually composed of multipurpose fast growing trees, fruit trees, bamboo, clumps of rattans and shrubs. Even though the quantity of wood supply from village forests is not accurately known, it is certain that a major share of fuelwood and timber consumed in the country comes from these forests.

Information on growing stock in different forests have become available after the recent inventories. Official estimate of area, tree coverage and growing stock of different forests are shown in table 1.

Table 1 : Forest : Area and Growing Stock

Forest Type	Area in Million Ha	Tree Coverage in Per cent of area	Growing Stock in Million m³
a) Hill Forests (Tropical Moist) Evergreen)			
1. Forests under the control of FD	0.67	54	28.32[7]
2. Unclassed State Forests	0.73	Not known (Mostly Scrub Forest)	Not known
b) Mangrove (Tropical Evergreen)			
1. Sundarban	0.57	70	13.19[8]
2. Coastal Plantations	0.10	70	5.05[9]
c) Plainland Sal Forests	0.12	30	1.13[6]
d) Village Forests	0.27	100	54.68[10]

Bamboo Resources

Bamboo, grown both in state owned and homestead forest, is a very important resource since it is the poor man's timber. Bamboos occur in individual patches and also as an undergrowth in forests. The growing stock was estimated in 1984 as 0.78 million air-dried (AD) tons in state forests and 1.8 million AD tons in privately owned land[11]. Recent study by BBS reported about 21.49 million bamboo clumps of eight different varieties in villages. The total number of bamboos in these clumps was estimated at 2,047 million pieces[12].

Trend in Resource Use

The gap between demand and supply is widening continuously and there will be a net deficit of 5.96 million m³ of logs by the year 2000 assuming no change in the present demand/supply trend[13]. The consequence of a widening demand/supply gap are (1) un-authorized felling of trees from state owned forests, (2) over-cutting of village forests, (3) increased use of non-traditional energy sources and (4) raw material scarcity for wood based industries.

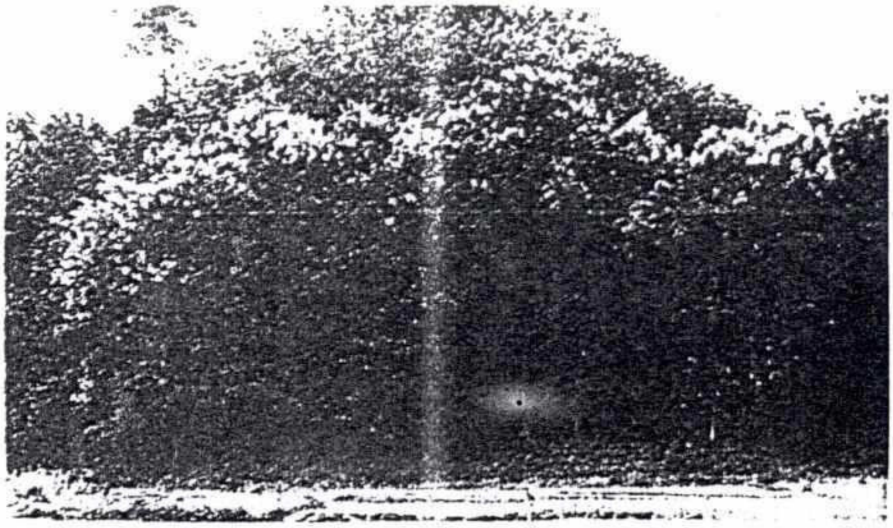
State forests contribute only 26 and 10 percent of total timber and fuelwood supply; whereas homestead forests contribute 74 and 90 percents of total supply of timber and fuelwood respectively.[14]

The per capita consumption of fuelwood and timber is estimated at 0.07 m³ and 0.01 m³ respectively[15]. These figures are quite low when compared to those of the neighbouring countries (Table 2). If trees continue to be depleted at current rate, annual fuelwood availability in rural areas will further decline to 0.02 m³ [2]. This low figure is mainly due to a shift in use pattern from tree biomass to agricultural residues (60 per cent of consumption) and cowdung (20 per cent)[16].

Paper, pulp, board and match industries at present use 343,985 m³ of wood and 90,000 metric tons of bamboo and reed per annum as raw materials[17]. The wood and bamboo for industrial use comes mostly from Sundarban and Hill Forests, and it is apperehended that the raw material supply source is being depleted.

Shifting Cultivation

Shifting cultivation, based on the



A teak Plantation in flower

traditional practice of slash and burn agriculture by tribes of the hill districts, mainly in the unclassified state forests, was a stable and self sustaining system only three decades ago with a fallow period of 10-15 years enabling adequate restoration of soil fertility. But increased population pressure has reduced the fallow period to about three years, resulting in irreversible impacts on the natural ecosystems. Demand for forested land for shifting cultivation has become so acute that reserve forests of hill districts are being encroached. In Kassalong and Rankhiang reserves, shifting cultivation had destroyed an area of approaximately 65,000 ha by 1985[18]. This process of shifting cultivation is the single greatest threat to the remaining natural forests of the hill districts.

Resource Degradation

Inventories show that there has been an overall depletion in forest resources in all major state owned forests. The growing stock in the Sundarban has been depleted from 20.3 million m^3 in 1960[19] to 13.2 million m^3 in 1984[19].

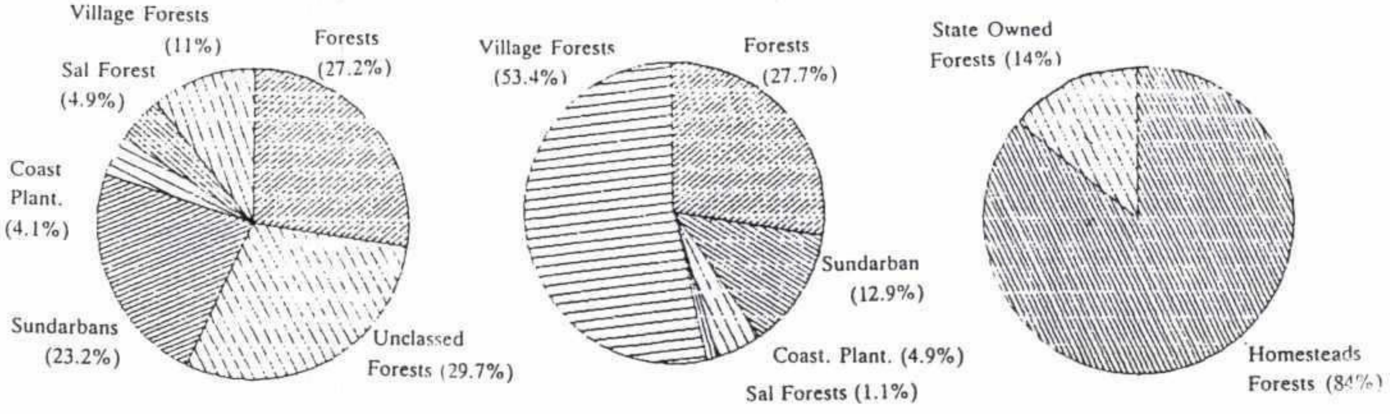
Table 2 : Per Capita Fuelwood and Timber Consumption in Different Countries.

Country	Fuelwood (m^3)	Timber (m^3)
Nepal	0.69	0.04
Burma	0.63	0.07
Thailand	0.25	0.13
India	0.20	0.02
Bangladesh	0.07	0.01

In the hill forests of hill tract districts, the growing stock has depleted from 23.8 million m^3 in 1964[20] to less than 19.8 million m^3 in 1985.

Since 1960, two major approaches regarding the role of forestry in development have been reflected in the forestry sector of Bangladesh. Bangladesh as a part of Pakistan in the 1960s and then as an independent nation has followed an "industrialization approach" consonant with the international conventional wisdom of that time. As a result, Forest Department raised large scale industrial plantations which were seen as conversion of low yielding natural forest into artificial plantation of species

Forest by area, growing stock and supply of wood



Graph by Zia

(mostly Teak) of high economic importance. This conversion of evergreen and semi-evergreen forest into deciduous Teak plantation was largely concentrated in Kassalong Reserve Forest, the only important catchment area of the Karnafuli River falling within the political boundary of this country. During plantation raising, local people were generally not consulted, and often they did not derive any benefit from these plantations. The lack of support by the local people in combination with lack of silvicultural knowledge and lack of proper maintenance contributed to widespred failure of the plantations. In the name of plantation raising genetic resources of the evergreen and semi-evergreen forests were lost.

In the 1980s, following a change in thinking regarding the role of forestry in development, peoples' participation in forestry activity was encouraged, and a tendency for spending of development resources for rural forestry was observed. In many cases early attempts to implement people oriented forestry programmes failed since the Forest Department, with whom responsibility of implementing such programmes lies, was out of touch with what the people wanted. In the past two years interaction between the Forest Department and people has improved due to implementation of the Upazilla Banayan Prakalpa and WFP- supported Peoples Participatory Forestry by NGOs. The Upazila Banayan Prakalpa has created widespread awareness of the need to systematically plant and protect trees. This project is carrying out a successful training programme for both Government officials and the staff of NGO's involved in forestry. The numbers of NGO's involved in tree-planting has increased in the past three years and the World Food Programme is assisting many of them by providing wheat grants for nurseries, planting work and maintenance workers.

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Bangladesh Factsheet

4

WATER RESOURCES DEVELOPMENT

Introduction

A rhythm in the annual water cycle dominates life in Bangladesh : excessive water during the monsoon causing flood and insufficient water during the dry season creating drought like situation. These two extremes influence the planning for water resources development in Bangladesh requiring effective measures in flood control, irrigation and drainage. Development in irrigation sector together with flood control and drainage infrastructures, in areas where it has already been completed, has created a regime when other agricultural inputs may be effectively utilized to enhance the yield rate. But this trend in water resources development with single objective of increasing production level in agriculture has led to neglect to other water sectors such as fisheries, navigation, control of salinity level in the coastal area, etc. Concerns are being expressed about the various adverse aspects of present day water development activities specially the decline in open water fisheries due to construction of embankments and drainage projects. It is expected that environment will be made integrate part of all future project planning in Bangladesh though it is yet to be reflected at implementation stage (Nishat 1990, BARC 1991).

Need of Irrigation and Flood Mitigation

Fig. 1 shows a generalised cropping pattern on a flood prone area in Bangladesh along with time and duration of occurance of floods and need for irrigation water. Thus for improvement of Kharif I and Kharif II crops efforts in flood protection is necessary. For Boro and Rabi crops irrigation water supply is the main input (together with HYV seed and fertilizer). In areas where there is risk of early monsoon flood protection from flooding is essential. Land type F0, F1 and F2 (see Table 1 for details) representing high land, medium high land and medium low land constitute 36%, 35% and 16% (87% in total) of cultivable area respectively. Rest of the land belongs to F3 (i.e. low land) and F4 (very low land) types (MPO 1991). Thus if low and very low land are left out to remain under flooding condition, the probable flood depth for the rest of the area is less than 2m and it should be possible to bring these areas under flood protection. However, total elimination of flood may not be possible and desirable. Provision of adequate regulatory structures should be ensured in the embankment system that would allow controlled flooding (World Bank 1989). There is need of irrigation facilities round the year; for HYV Aman, the need is for supplimentary irrigation in flood-free as well as in flood protected areas, and in dry months primary irrigation is a prerequisite.

Trends in Resource Use

The predominantly agrarian society evolved in the then East Bengal, now Bangladesh, over the centuries with full dependence on climate and weather. Excepting for lifting water from ponds and streams, by indigenous methods no major effort in water development was there. The importance of water management was realised after the successive floods of 1954 and 1955. In 1957 an inter-

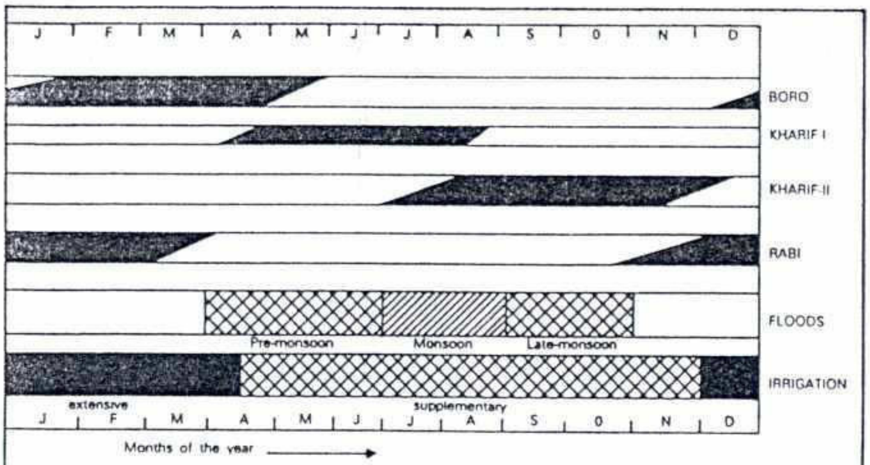


FIGURE 1 RELATION OF CROP SEASONS WITH FLOOD AND IRRIGATION
[Source : Nishat 1989]

national mission concluded that protection against flooding was the key element of all future agriculture development plans.

In 1959, the erstwhile, EPWAPDA (now Bangladesh Water Development Board, BWDB) was established and assigned the responsibility for planning design, construction, and operation and maintenance of water development schemes. A Water Master Plan was prepared in 1964. The broad strategy of the Plan was to reduce damage to crops first by providing flood protection and then boosting production through introduction of modern agricultural techniques including use of fertilizers. Irrigation was to be introduced at a later stage. Such a strategy required large and massive flood-protection schemes and was never taken up for implementation in a coordinated way. However BWDB implemented many of the projects recommended in the Master Plan.

Meanwhile, EPADC (now Bangladesh Agriculture Development Corporation, BADC) had been set up in 1961 and entrusted with the task of procuring and distributing tractors, low lift pumps (LLPs), tubewells (TWs) and other inputs like seeds, fertilizers and pesticides and succeeded in bringing in very fast growth in food grain production.

In the Land and Water Resources Sector Study, 1972, completed by IBRD, the strategy of attaching high priority to small and medium sized, quick yielding, low cost, labor-intensive projects with long term projects to be formulated at a later date was recommended. This strategy constituted a major ingredient in the programs formulated by BWDB and BADC, and was manifested in all the Five Year Plans of the country, formulated so far. The National Water Plan (MPO 1991) prepared by Master Plan Organisation (MPO) has also been based on this strategy, but with main emphasis on development in agriculture sector (Nishat 1990).

Flood Mitigation

Flood is a recurring phenomena in Bangladesh. The various factors that singly or in combination create flood in Bangladesh are the huge monsoon inflows of water that come from upstream catchment areas coinciding

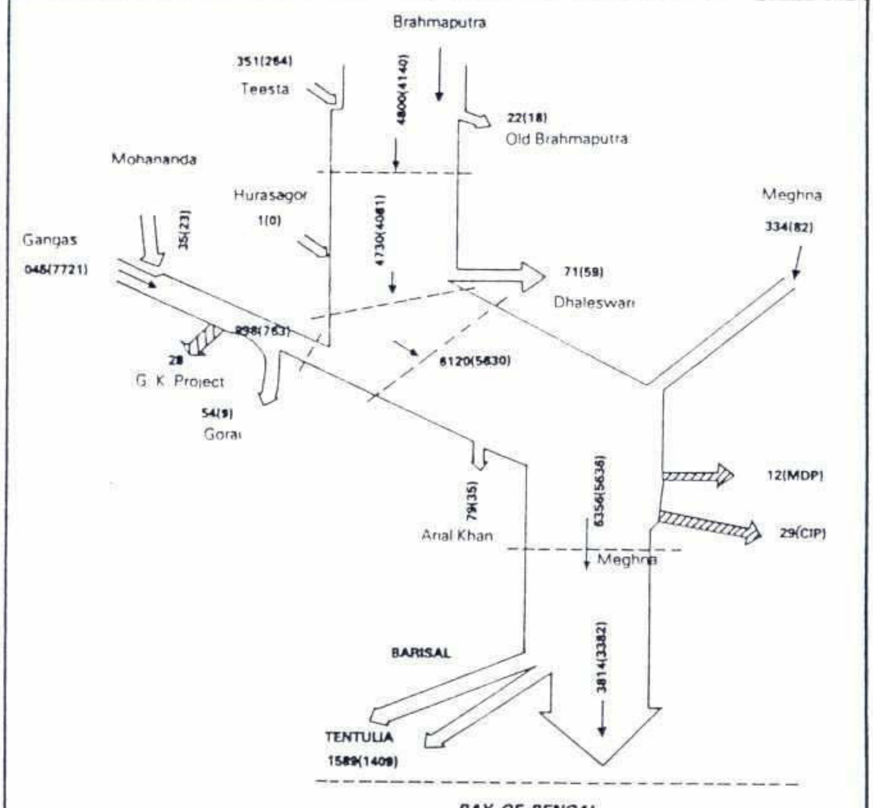


FIG 2 : STREAMFLOW DISTRIBUTION, MARCH 1990 [SOURCE, MPO 1991]

NOTE :

1. FIGURES ARE MEAN MONTHLY STREAMFLOW IN CUBIC METRES/SECOND
2. FIGURES IN THE PARENTHESIS ARE FIVE-YEARS, ONE-MONTH LOW FLOW IN CUBIC METRE/SECOND
3. STREAMFLOW FIGURES SHOWN FOR THE GANGES RIVER AND THE PADMA RIVER ARE POST-FARAKKA CONDITION (WATER YEAR 1975-89)

with heavy monsoon rainfall over Bangladesh, low floodplain gradient, congested drainage channels, and the influence of tides and storm surges. Only 8% of the 1.72 million square kilometers of the catchments of the Ganges, the Brahmaputra and the Meghna lie inside country. In Bangladesh four major types of flood occur, viz :

- monsoon floods from major river;
- local flooding due to heavy rainfall and drainage congestion;
- flash floods in the eastern and northern rivers; and
- floods due to high tides and storm surges in the coastal areas.

In recent times in 1987 and 1988, Bangladesh experienced two of the most severe floods on record. These floods were a major setback to the country's economy and stimulated the Government to undertake a comprehensive review of the planning approach. A flood policy study and a flood preparedness study were carried out and a set of eleven guiding principles (Table 2) was developed. Studies were also carried out by professionals from Japan, France and U.S.A. Based on these studies the World Bank recommended an integrated approach for flood mitigation based on the concept of "controlled flooding" and "compartmentalisation" for management. Under the "Flood Action Plan" six regional plans for water development and management are presently under preparation.

Table 2

The Eleven Guiding **Principles of the** Flood Action Plan (source, World Bank 1989)

- Phased implementation of a comprehensive Flood Plan aimed at protecting infrastructure and controlling flooding to meet the needs of rural activities and the environment.
- Effective land and water management in protected and unprotected areas.
- Strengthening disaster preparedness and management.
- Improvement of flood forecasting and early warning.
- Safe conveyance of large cross border flood flows through the major river systems to the sea.
- River training to protect embankments and urban centres.
- Flood flow reductions in the major rivers by diversions into major distributaries and flood relief channels.
- Channel improvements and structures to ensure efficient drainage.
- Flood plain zoning where feasible and appropriate.
- Coordinated planning and construction of road and railway embankments with provision for unimpeded drainage.
- Encourage popular support by involving beneficiaries in the planning, design and operation of flood control and drainage works.

Irrigation

Irrigation has been the leading factor in agricultural development. The development of irrigation started in the 1950's with the exploitation of surface water using low lift pumps which irrigate, on average, about 15 hectares. By mid-1970's, 600,000 hectares were irrigated with surface water and most of the easily accessible resources had been developed. Groundwater development started with deep tubewells (irrigating on average 25 hectares) in the 1960s and continues today. The further exploitation of groundwater with farmer-owned shallow tubewells (irrigating on average 4 hectares each) started in the late 1970s and is now a major form of groundwater irrigation.

Through the 1970s and 1980s there was a rapid spread of minor irrigation and of high-yielding rice varieties and fertilizers. The total area

Table 1

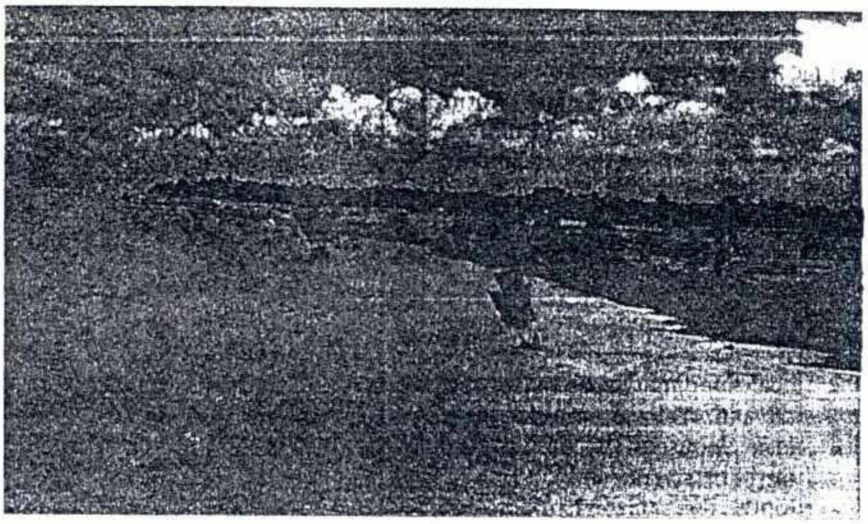
MPO Land Types Based on Flood Depth and Cropping Patterns (source, MPO 1991)

Land Type	Description	Flood Depth (cm.)	Nature of Flooding	Identifying Crop
F0	Highland	less than 30	Intermittent	Land suited to HYV rice in the wet season.
F1	Medium-high	30-90	Seasonal	Land suited to local varieties of Aus and transplanted Aman.
F2	Medium-low	90-180	Seasonal	Land suited to broadcast Aus and broadcast Aman in the wet season.
F3	Lowland	Greater than 180	Seasonal	Land on which only broadcast Aman can be grown in the wet season.
F4	Low to Very-low	Greater than 180	Seasonal/ Personnel	Land on which either the depth, or rate, or timing, of flooding does not permit growing of broadcast Aman, but does support local Boro in the dry season.

under irrigation has increased from 1.2 million hectares in 1973 to 2.6 million hectares in 1990.

Surface Water Resources

The river system that flows through Bangladesh comprises the third largest source of fresh water discharge to the oceans. Only the Amazon in Brazil, and the Congo in Africa, have larger discharges that the Ganges-Brahmaputra-Meghna river system (MPO 1991). The annual volume of flow past Baruria just below the confluence of the Brahmaputra and Ganges in 795,000 million cubic metre which is equivalent to 5.52 metres of depth over the 14.4 million hectare of land area of Bangladesh. In contrast the average annual rainfall for the country is 2.32 metre. Figure 2 shows the distribution of flows of the main rivers for a typical dry month.



Ground Water Resources

Bangladesh lies over a subsiding basin of tectonic origin with a huge thickness of sedimentary stata. This quatenary alluvium constitutes a huge aquifes, mainly with good to reasonable transmission and storage properties. Because of high rainfall and wide spread annual flooding, this aquifes has good recharge characteristics and is normally saturated almost to the ground level. The ground water is of good quality except in the estuarine south, where under the influence of tidal condition, most of the shallow aquifer are saline.

In recent years exploitation of ground water for irrigation has increased in a very fast pace. Table 3 shows the volume of existing ground water use, together with potential recharge (MPO 1991).

Table 3
Groundwater Recharge (MPO 1991)

Region	Annual Net Recharge	Existing Irrigation	Available For New Use	Potential New Area Irrigated
	—(Billion cubic meters)—			—MHa—
NW	9.5	2.1	6.1	0.9
NE	9.6	1.8	7.4	1.1
SE	1.5	0.3	1.1	0.2
SC	1.8	0.1	1.2	0.2
SW	2.0	0.6	1.2	0.2
AFP	1.3	0.3	0.9	0.1
Total	25.7	5.2	17.9	2.6

Concluding Remarks

Water resources development including flood management has been and will continue to be a key factor in the economic development of Bangladesh. Failure to utilize the water resources in an integrated, balanced and comprehensive manner will not only cause stagnation in growth, specially in agriculture sector but also will give rise to many environmental problems.

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5

FISHERIES

Fisheries play a major role in nutrition, employment, exports and domestic economy of the country. There are extensive fisheries in the country due to the nature of the country. Bangladesh covers a total continental area of 14.79 million hectares, of which approximately 1.09 million hectares are inland water bodies. In addition there is over 10 million hactares of marine area, which is comprised of the territorial waters and Exclusive Economic Zone[1]. Of the total area, 80% is flood plains. One fourth of the flood plains is normally flooded every rainy season and another one fourth is liable to experience floods once every year.

The flood plains include fisheries in rivers, haors, beels, baors, lakes and irrigation reservoirs. However, the fisheries in different water bodies have been categorised broadly into capture and culture, inland and marine.

Management

Almost all water bodies are government owned and as such the Public Sector has a major role in their management though exploitation mainly rests with the private sector. NGOs are increasingly active in this sector.

Key Institutions

Ministry of Fisheries and Livestock heads this sector's management and gives policy guidelines and decisions. The Director of Fisheries, Bangladesh Fisheries Development Corporation and Bangladesh Forest Research Institute and Upazilas are the implementation bodies in respect of their own share of responsibilities. The Ministry of Environment and Forest, the Ministry of Land and the Ministry of Irrigation, Flood Control and Water Resources, the Ministry of Local Government Rural Development and Cooperation and the Bangladesh Water Development Board are also involved when they own or manage water bodies. The Ministry of Environment and Forest is particularly interested in the preservation of wetlands, which will of course be beneficial for the protection of fisheries.

Contribution of Fisheries

The total fish catch in 1986-87 was about 815,000 tons. Of this 597,000 tons were from inland waters and 218,000 tons from the sea[2]. Total demand is expected to rise to 1.6 million tons by the year 2005[3].

Fish is an integral part of traditional Bengali diet, and the main source of animal protein particularly for the low income group. It contributes 7% to argiculture and 3.5 to the total GDP and provides 80% of the animal protein requirements. Export of fisheries products, particularly shrimp, earns over US$ 10 million in foreign exchange.

Fisheries sector employs about 1.5 million full-time fishermen in addition to about 11 million part timers. In recent year rapid expansion in shrimp cultivation in the saline and semi-saline belts in the coastal area have led to development of a major exportable commodity.

The Table below reflects the contribution of different categories of fishery water bodies to fish produca

Annual Total Catch and Area Productivity of Fisheries (in 1988-89)

Sectors of Fisheries	Total catch (M.tons)	Water area hec.	Catch/Area Kg/hec.
A. Inland fisheries			
a) Capture			
1. Rivers including estuaries	181,140	1,031,563	176
2. Sundarban	6,416	—	—
3. Beels	47,019	114,161	412
4. Kaptai lake	3,439	68,800	50
5. Flood lands	186,126	28,32,792	66
Capture total	424,140	40,47,316	—
b) Culture			
1. Ponds	155,012	146,890	1,055
2. Baors	1,321	5,488	241
3. Shrimp farms	27,172	108,280	251
Culture total	1,83,505	2,60,658	—
Inland total	6,07,645	43,07,974	—
B. Marine fisheries			
a) Industrial fisheries (trawl)	10,353	—	—
b) Artisanal fisheries	222,928	—	—
Marine total	233,281	—	—
Country total catch	840,926	—	—

Source :

1) Fisheries Resources Survey system of the Directorate of Fisheries
2) Marine Fisheries Deptt.

tion during 1985/86. The predominance of capture fisheries is noticeable.

Fish Production Trend

Open water capture fisheries contribute most of fisheries production (61% in 1985) followed by closed water culture fisheries (16%) and marine fisheries (23%). The productivity of all these fisheries is in decline and specifically that of inland fisheries. During the 80's there was a declining trend in production and it is apprehended that by the year 2000 this may seriously affect the nutritional status of the lower income groups.

Fish Species

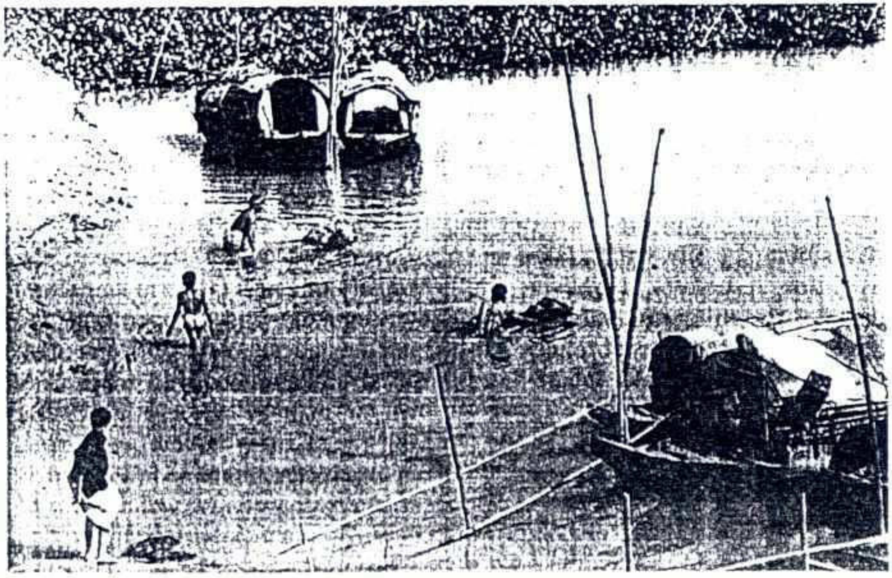
A total of 260 species of fresh water fish belonging to about 55 families have been reported. About 56 species of prawn occur in the country. The species of tortoise and turtle number about 25 and in marine water the species of fin fish recorded so far are 475. A total of 13 exotic species have been introduced in the country for augmenting production.

Types of Fishery

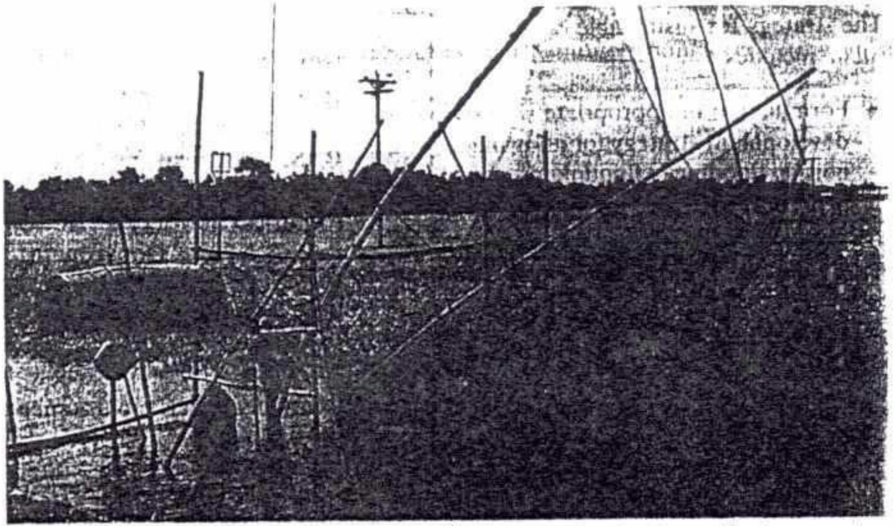
Fish production system is based on open inland water capture fishery, colsed water culture fishery and marine capture fishery. The inundated floodplains are central to the sustenance of the open inland water fishery production system, which is fast declining. On the other hand closed water fisheries in ponds and reservoirs are expanding rapidly. Brackish water aquaculture in coastal area is expanding both in area and application of technology: however, the cultural practices are still basic. Marine fishery sector is also threatened due to over exploitation.

Pond Fishery

A special aspect of fisheries in Bangladesh is the importance of pond fishery, which supplies 15% of the



total fish catch. There are nearly 1.3 million ponds, covering an area of 147,000 hectares, which are used as a source of domestic water supply and also for raising fish. A large number of ponds are lying virtually uncared for, and in most of the remaining ones fish rearing is somewhat casual. Average yield is therefore only 1,050 kg. per hectare per year, whereas it could be raised to 2,500 kg./ha., or more. Pond fishery has the potential to be the fastest growing element in the fishery sector.



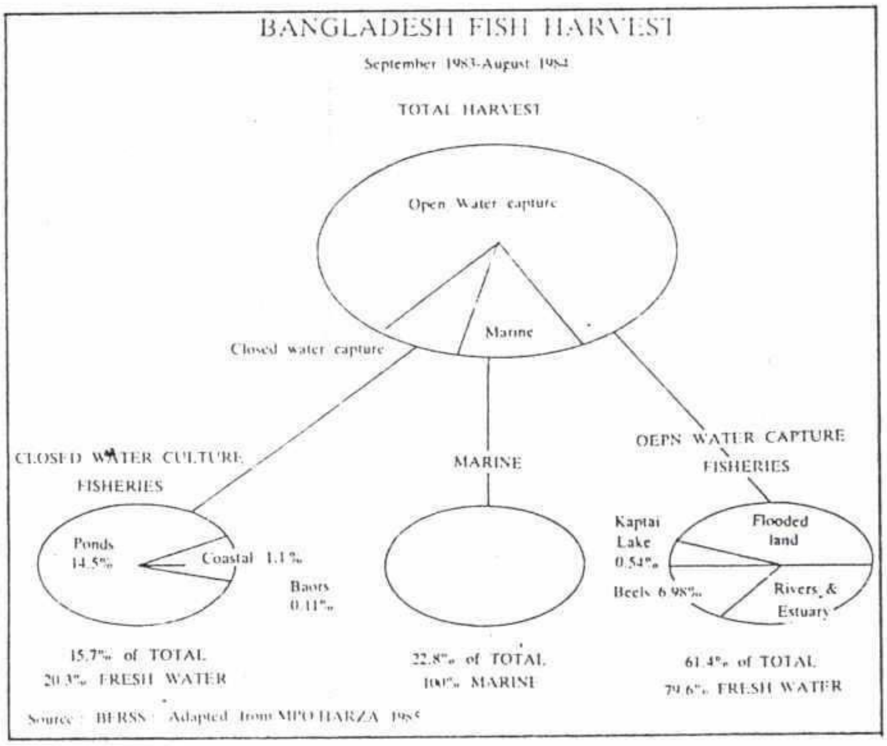
Constraints to fishery

Fisheries sector is at a corss-road now. Over exploitation of water bodies, mainly due to the existing leasing mechanism of "Jalmahals", and conversion of fish migration and nursery grounds due to flood control embankments are major factors leading to a decline in open water fisheries. Other causes of decline are modification in aquatic environment due to human interventions such as cut off, siltation and shoaling of rivers, degradation in water quality due to industrial effluents, destruction of mangroves and aquatic biosystem, fish harvesting timing and method, and prevalence of fish diseases. While in the fresh water zone water bodies have been drained off for enhancing agricultural productivity, in the coastal belt shrimp cultivation is in conflict with rice growers and mangrove forestry. In order to enhance productivity and at the same time ensure equity a New Fisheries Management Policy was introduced in 1986. This policy has the following objectives:

- To Gradually eliminate the short-term leasing system in near future;
- To save the fishermen from exploitation by influential middle-men;
- To increase fish production through introduction of production-oriented biological management systems in public inland water bodies by replacing the existing revenue-oriented lease system;
- To ameliorate the socio-economic condition of fishermen by librating them from exploitation by intermediary beneficiaries like lease holders and money lenders. Under this policy, only the bonafide fishermen, living permanently around a selected fishery resource, are entitled to harvest the resources, either individually or in groups, on the strength of renewable annual licenses issued to them by the Department of Fisheries (DOF).

Sustainable Development

The National Conservation Strategy has suggested several means by which the Fisheries sector can be revived and further development can be on a sustainable basis.



BANGLADESH FISH HARVEST

September 1983-August 1984

Source : BERSS : Adapted from MPO HARZA 1985

The strategy for sustainable development includes :

- Formulation of appropriate water development strategy for allowing normal flooding in floodplains and prevention of over drainage;
- Allocation of permanent water bodies such as beels, haors etc. for fish production and enhancing their productivity by stocking;
- Control over fish harvesting timing and technique and reivew leasing mechanism for "jalmahals";
- Control over introduction of exotic varieties of fishes specially in floodplains and beels;
- Institutional strengthening and improved management including stocking of open water fisheries and remedial measures against prevailing diseases;
- Preservation of spawning grounds.

In order to achieve this strategy it has been suggested, inter alia, that the following measures be taken":

- Recognition of Openwater Fishery Resource as "Common Property Renewable Natural Resource";
- Due recognition to Fisheries needs in Water Resources developement;
- Change in current land and water use policy which currently favours agricultural crops balanced development with due towards more emphasis on wetlands;
- Action to fully implement the New Fisheries Management Policy;
- Reduction of water pollution;
- Study of the biology of all fish and prawn in different openwater habitats.

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GLOSSARY OF ENVIRONMENTAL TERMS

Adverse impact:

An impact that is harmful to human interests over either the short or long term.

Aman:

Rice grown during *kharif 2* season (with the exception of broadcast aman, which is sown in the *kharif 1* season and harvested in the *kharif 2* season).

Aus:

Rice grown during the *kharif 1* season.

Baseline studies:

Work done to collect and interpret information on the status and trends of the environment that are likely to be affected by a development action.

Beneficial impact:

Impacts that improve resources, the economy, and/or quality of life for a population and improve resources.

Biodiversity:

The variety of species within a given area or region. Areas of high diversity are characterized by a great variety of species, with relatively few individuals or domination by any one species. Areas with low diversity are characterized by a few species with often relatively large numbers of individuals of each species.

Biophysical:

The part of the natural environment that includes physical, chemical, and biological components such as air, soil, water, plants, and animals.

Bounding:

A process for determining spatial and temporal boundaries within which an environmental impact assessment will be conducted. Such boundaries are based upon physical, chemical, biological, social, economic, jurisdictional, and administrative factors.

Broadcast aman:

A type of rice grown in deeply flooded areas during the *kharif* season.

Char:

An alluvial island that periodically emerges from the riverbed as a result of accretion. Chars can be seasonal or can remain in existence for several decades.

Coliform:

A group of bacteria used as an indicator of faecal contamination in water.

Community:

All animals that live in the same locality under the influence of similar environmental factors and affect the existence of one another through their activities. Communities are usually named after their dominant species.

Compensation:

Compensation is the provision for enhancement, replacement, restoration, and restitution to recipients of unavoidable negative residual impacts. Often there is payment in funds or replacement in-kind for losses attributed to a development. Funds may also be used to recreate lost habitat or other valued resources.

Compensation plan:

The portion of the environmental management plan that describes the compensation measures that will be undertaken and committed to if a project proceeds. It includes how much compensation will be paid to whom, by whom, and under what conditions.

Conservation:

The preservation of natural resources so as to maintain supplies and qualities at levels sufficient to meet present and anticipated needs.

Cost-benefit analysis:

A technique used to compare the ratio of costs to benefits for a development activity. Comparison is made by converting costs and benefits to monetary units (e.g., taka value). It has not yet been successfully used to incorporate all environmental, social, and health impacts of concern.

Critical habitat:

The area of land, water, and air required for the normal needs and survival of a plant or animal species.

Cropping pattern:

The arrangement of crops (including crop varieties) on a plot of land within a year (or sometimes more than one year if one crop or a complete cropping cycle occupies the plot for more than one year). Examples are: mixed Aus and Aman followed by *rabi* crops, BR3 boro followed by BR4 transplanted Aman, pineapples (2 years) followed by 5 years natural fallow.

Cumulative impact:

The environmental impact that results from actions that are added to others of the past, present, and the foreseeable future. Cumulative impacts are caused by multiple human activities and/or natural events, which are either repeated or occur in combination. Examples include lowering of the groundwater in a large regional aquifer or water pollution in a large river such as the Ganges. Global climate change is a type of cumulative effect involving the whole planet.

Dike or dyke:

A natural or man-made structure to impound or curtail the flow of water from one place to another. Synonymous with embankment or levee.

Ecological niche:

The physical space an organism occupies in a habitat; its functional role in the community (e.g., its trophic position); and its position in environmental gradients of temperature, moisture, pH, soil, and other conditions of existence.

Ecosystem:

An ecosystem is a sustainable marine, freshwater, or terrestrial system or combination of systems that includes some or all of the associated living and non-living components. The boundaries of an ecosystem are often specified for a particular application.

Embankment:

See Dike.

Environment:

Environment can be defined in many ways. A common definition is "the sum total of all the physical and biological components and processes which make up the surroundings of man". The term includes:

a. biophysical components and resources such as agricultural land and crops, fisheries, wetlands and wildlife, and the physical and biological factors and processes that support these resources; and
b. social components made up of the human communities and populations that utilize the various resources.

Environmental effects monitoring plan (EEMP):

An EEMP takes repetitive measurements of environmental components over time in order to detect changes directly or indirectly caused by external influences attributable to a specific man-made activity or development. It is undertaken for such reasons as:

a. improving environment understanding of cause-effect relationships;
b. providing an early warning of undesirable change in the environment;
c. verifying earlier EIA predictions;
d. evaluating uncertainty; and
e. checking the effectiveness of the Environmental Management Plan.

Environmental enhancement:

Improvement of the resource base or amplification of the anticipated positive impact of the project on an environmental component.

Environmental impact:

a. any change that a project may cause to an environmental component;
b. any change to the project that may be caused by the environment, which then leads to change in environmental components;
c. any cumulative effects caused or exacerbated by the project.

Environmental impact assessment (EIA):

An environmental planning procedure whereby the potential effects of a proposed project on the environment are studied and predicted before the project is undertaken, and whereby a plan for avoiding or dealing with the negative impacts is formulated.

Environmental management plan (EMP):

An EMP is a plan to undertake an array of follow-up activities that provide for the sound environmental management of a project so that adverse environmental impacts are minimized and mitigated, beneficial environmental effects are maximized, and sustainable development is ensured.

Environmental protection plan (EPP):

An EPP describes specific actions that will be undertaken during project preconstruction, construction, operation, rehabilitation, and abandonment to lessen the effects of the project on the environment. It usually includes specific instructions for personnel involved in project activities. It is a key component of the Environmental Management Plan, and it integrates existing legislation, codes of good engineering practice, proponent commitment, and designated mitigation measures.

Eutrophication:

The process by which the enrichment of *beel* waters by surface runoff containing nitrogen and phosphorus causes an increase in aquatic plant biomass.

Floodplain:

A belt of low, flat ground, that is subject to flooding on one or both sides of a stream channel.

Ground-truth (remote sensing):

A process by which remotely sensed data can be verified in the field.

Groundwater:

Subsurface water, moving under the force of gravity, that accumulates in the pores and cracks of rocks and soil.

Habitat:

A subdivision of the plant environment having a certain combination of slope, drainage, soil type, and other controlling physical factors. Also, a place where one lives, including the surroundings needed for sustenance.

Haor:

A water body formed during the monsoon season by the inundation of several *beels* to form a continuous water body in a large geological depression.

Hazard:

A chance event in the bio-physical environment that has consequences harmful to humans.

Hundred-year flood:

A flood of a size that, on average, recurs once in every 100 years as estimated on the basis of past records of flood stages.

Impact matrix:

A square or rectangular array of rows (project activities) and columns (important environmental components) used for organizing the analysis of the positive and negative environmental impacts of a project.

Important environmental component (IEC):

The environmental components of biophysical or socioeconomic importance to one or more interested parties. The use of IECs helps to focus the environmental assessment.

Indicator species:

Any organism that by its presence or absence, its frequency, or its vigor indicates a particular property of its surrounding environment. For example, a particular plant may indicate a soil type or the presence or absence of an air or water pollutant, or a particular fish species that indicates water quality.

Initial environmental evaluation (IEE):

The initial environmental assessment report prepared for a regional or pre-feasibility study for identifying and assessing possible environmental impacts.

Interested party:

Residents of a regional or project area, elected representatives, government officials in various departments, Bangladesh professionals, non-governmental organizations (NGOs), the general public, and donor organizations and international agencies.

Intervention:

The specific action caused by a project that creates an environmental impact (e.g., obstruction of a drainage canal by an embankment).

Kharif 1:

Early summer (March through June).

Kharif 2:

Late summer and fall (July through October).

Land use plan:

A coordinated composite of information, ideas, policies, programs, and activities related to existing and potential uses of land within a given area. A land use plan is frequently the key element in a comprehensive plan for an area under development for public and private land uses, such as residential, commercial, industrial, recreational, and agricultural activities.

Levee:

see Dike, Natural levee.

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Magnitude:

The degree of change in an important environmental component that results from a project activity.

Mitigation:

Elimination, reduction, or control of the adverse environmental impacts of a project. Mitigation measures are specified in the Environmental Management Plan.

Natural levee:

A belt of higher ground paralleling a meandering alluvial river on both sides of the stream channel and built up by deposition of fine sediment during periods of overbank flooding.

People's participation:

A process to ensure that the right problems and all available resources are identified and that the ensuing programs or projects are understood, accepted, and brought to full effectiveness.

Plankton:

A general term for micro-organisms in water; it includes plants (phytoplankton) and animals (zooplankton).

Pollution:

The introduction into the biosphere of materials that, because of their quantity, chemical nature, temperature, or difficulty of disposal by natural recycling process, have a negative impact on the ecosystem.

Project:

A project includes:

a. a physical work such as proposed construction, operation, modification, decommissioning, rehabilitation, abandonment, or other undertaking in relation to that work; and

b. a regional, pre-feasibility, feasibility, design, or conceptual plan or study undertaken to ascertain the desirability of proceeding with physical works and associated activities such as flood proofing, sector development, etc.

Project area:

The actual project location provided by project officials.

Project phase:

The main categories of project activities expressed sequentially including preconstruction, construction, operation, and abandonment.

Project stage:

The main stage of project planning including pre-feasibility (regional study) and feasibility.

Rabi:

Winter season and associated crops (November through February).

Reconnaissance survey:

A preliminary survey, usually executed rapidly and at relatively low cost, in which information obtained is recorded in written form or as reconnaissance maps or sketches.

Remote sensing:

The collection of spatial information through a system of sensors mounted on an airplane or satellite.

Residual impacts:

Environmental impacts that remain after application of mitigation measures and that cannot practically be overcome.

Reversible impact:

An environmental impact that recovers either through natural processes or with human assistance.

Salinity:

The content of salts in sea water, soil, or brackish water.

Scoping:

The process by which the environmental issues, project alternatives, and important environmental components are identified by the interested parties.

Significant environmental impact:

An adverse residual environmental impact that is not justified in the circumstances.

Socioeconomic:

Refers to the human environment, which includes social and economic components that are not biophysical.

Study area:

The total area affected by a proposed project and its impact considered for EIA field study and data collection.

Sustainable development:

Development that ensures preservation and enhancement of environmental quality, as well as sound and sustainable use of natural resources, thereby providing for economic growth that meets the needs of the present without compromising the ability of future generations to meet their own needs (adapted from the Brundtland Commission, 1987).

Thana:

The main rural administrative unit in Bangladesh consisting of several unions with an average population of around 200,000.

Union:

Smallest administrative unit of the local government (usually consisting of 12 to 15 villages).

Water-logging:

The condition of soil saturation due to the rise of a groundwater table, which may happen due to various factors, such as excessive irrigation, seepage from adjoining highlands, seepage of water through canals, impervious obstruction, excessive rains, flood, etc.

HABITAT AND ECOSYSTEM

1. Habitat

> **A <u>habitat</u> is the natural home or dwelling place of a living organism, and includes all features of the environment where that organism lives. Habitats are almost as varied as the Earth's surface. They are occupied by countless numbers and kinds of organisms, including both free-living and parasitic forms ranging in size from sub-microscopic viruses to the largest trees and mammals.**

Organisms and their habitats comprise an almost infinite series of self-regulating communities. Each of the smallest sub-divisions of these communities may be thought of as a large habitat, and each holds a great many smaller habitats. For example, Khondker, et al. (1994) reported that the characteristic duckweed (*Lemna perpusilla*) habitat is a small ditch with slowly flowing drains. This habitat is commonly found in places where direct contamination by organic waste materials are present.

A plankton study (Zaman, et al., 1994) in three ponds of Jahangirnagar University Campus reported that the ponds were dominated by chlorophycean phytoplankton and crustacean zooplankton. Seasonal changes in the zooplankton population, the study found, followed the seasonal changes noted for phytoplankton in the ponds. It appears that chlorophycean phytoplankton and crustacean zooplankton need a habitat of similar limnological conditions but of a different size and limnology than that required for *Lemna*.

It appears from the above information, therefore, that *Lemna* spp. requires the specific habitat of a small ditch with slowly flowing drains, and chlorophycean phytoplankton and crustacean zooplankton mainly need habitats of similar limnological conditions.

1.1 Habitat Characteristics

Every habitat has distinct characteristics made up of the following:

1. **Physiographic characteristics:** The precise location of the area. This embraces the general topography of the area, its altitude, slope of the land, drainage conditions, mobility of the soil due to tidal action, erosion, silting, and tidal frequency and depth, where applicable.

2. **Climatic characteristics:** These include general climatic conditions, e.g., temperature, rainfall, prevailing wind, light intensity variations, and evaporating power of the air.

3. **Edaphic characteristics:** These include physical and chemical properties of the soil such as soil texture, water content and availability, organic content, and acidity or alkalinity.

4. **Biotic characteristics:** These are the influences one living thing has over another, e.g., plant-on-plant influences (shade of one over another) and plant-on-animal influences such as pollination and competition between species for space within the habitat.

1.2 Causes of Habitat Loss

Habitat loss can occur as the result of natural processes or human activities. Among the natural processes that can cause habitat loss are floods, storms, and cyclones. The causes of habitat loss attributable to humans include population pressure and a wide variety of human interventions, such as:

- **overexploitation**
- **development projects**
- **encroachment**
- **monoculture (tea, rubber, teak)**
- **shrimp farming**
- **natural hazards (flood, storm, cyclone)**
- **oil spills**
- **industrial pollution**

The effects of natural hazards can be indirectly caused by human activities or amplified by them.

2. Ecosystem

An organizational unit that includes a community of living organisms and non-living substances interacting to produce an exchange of materials between those organisms and substances. No organism in the Earth's ecosystem is totally isolated; herbivores need plants, and carnivores must have access to prey. Foods are built up (anabolism) or broken down (catabolism) in cycles dominated by plants using photosynthesis or bacterial regeneration. This results in a pyramidal food chain where larger organisms feed on smaller ones. Thus, the organisms naturally assembled in a given area are interdependent.

The study of the interdependence of natural communities began in the 1930s, and the term "ecosystem" was coined to describe their complex biological relationships. The biological process is continuously at work as all organisms react to their habitats. Ecosystems can be self-sustaining, undergo cyclical changes, have constant energy, and transmit productivity. The overall environment and human activities can influence these processes. As an ecosystem evolves a pioneer community seeks a state of natural equilibrium. This eventually stabilizes into a climax community. The survival of a community depends on a variety of factors, including geography, climate, heredity, and the distribution of organisms.

2.1 Components of an Ecosystem

1. Nonliving or *abiotic* substances, e.g., water and all that may be dissolved in it.

2. The *producer* component of the living organisms found in the system, namely the photoautotrophes (green plants).

3. The *consumer* element, mostly animals.

4. The *decomposers,* e.g., fungi and bacteria.

The components of a typical pond ecosystem are shown in Figure 1.

3. Habitats and Ecosystems in Bangladesh

The important habitats and ecosystems of Bangladesh are listed in Table 1, and the locations of some of them are shown in Figure 2. A few of these habitats and ecosystems are briefly described below.

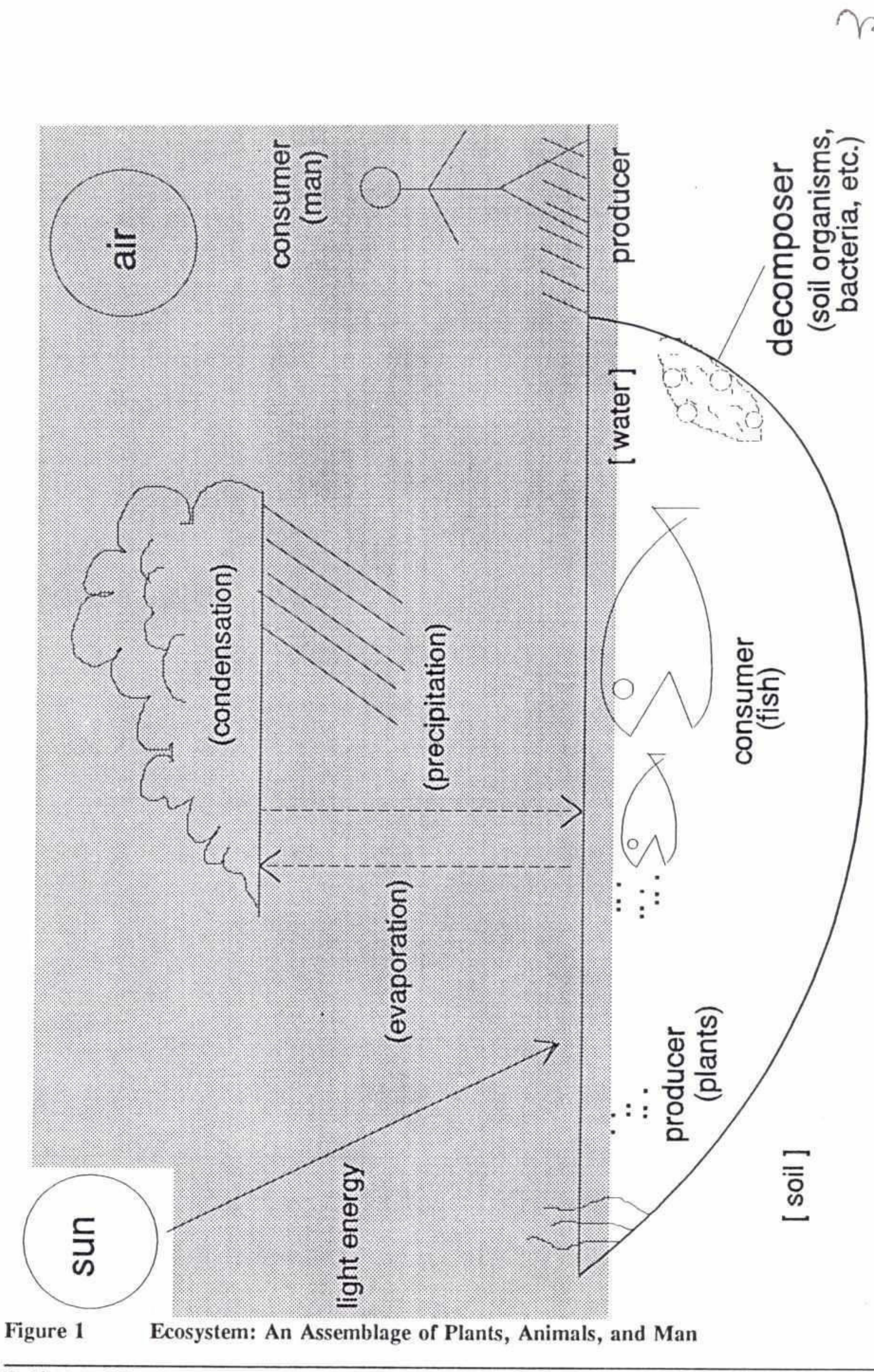


Figure 1 Ecosystem: An Assemblage of Plants, Animals, and Man

Table 1 Some Representative Habitats and Ecosystems in Bangladesh

Habitat/Ecosystem	Location
Mangrove ecosystem	Sundarban
Hill forest ecosystem	Chittagong Hill Tracts, Sylhet
Madhupur Tract ecosystem	Dhaka, Tangail, Mymensingh
Barind Tract	Rajshahi
Coral island ecosystem	Jinjira Dwip (St. Martin's Island)
Estuarine ecosystem	Lower Meghna
Sand beach	Cox's Bazar
Wetlands ecosystems:	
Hakaluki Haor/Oxbow lakes (baor)	Sylhet
Chalan Beel	Natore
Arial Beel	Dhaka

3.1 Mangrove Ecosystem

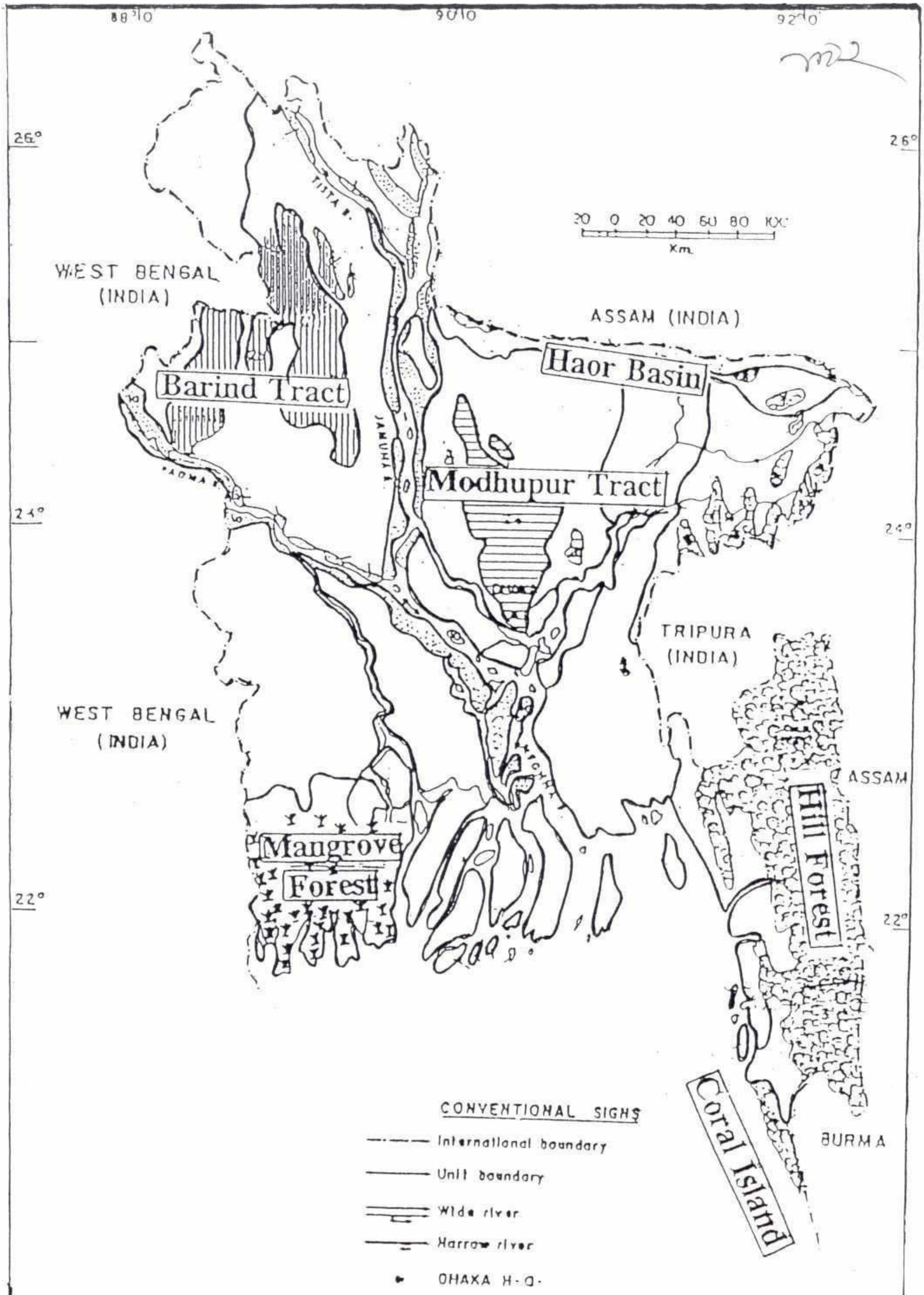
The Sundarban, which extends over 0.57 million ha in the districts of Khulna, Bagerhat, and Satkhira, is the largest mangrove forest in the world. It is dominated by high mangrove forest cover mainly consisting of *sundari* (*Heritiera fomes*), *keora* (*Sonnernatia apetala*), and *golpatta* (*Nipa fruiticans*). Understory species commonly found beneath the *sundari* are *singra* (*Cynometra ramiflora*), on comparatively dry soil, and *amoor* (*Amoora cuculta*) on relatively moist soil. In more saline areas, *goran* (*Ceriops roxburghiana*) becomes the principal understory species.

The Sundarban supports a very rich and diverse fauna, including 120 commercially important fish species. It also has more than 270 species of birds and 42 species of mammals, including the royal Bengal tiger, leopard, jungle cat, fishing cat, spotted deer, and wild boar. The Bangladesh Sundarban, together with adjacent Indian Sundarban, are the largest remaining tract of habitat for the royal Bengal tiger and the last refuge in the region for a variety of mammals that are rare elsewhere in the country.

A significant ecological change is occurring in the Sundarban due to the spread of diseases, such as top-dying of *sundari*, and pests, such as stem borer attacks on *keora*. This change is mainly due to the eastward shift of the Ganges, withdrawal of 40 percent of the dry season flow of the Ganges, abandonment of some distributaries, diversion of water for irrigation, abnormal reduction of water flows during the dry season, rise of salinity, and groundwater abstraction. Oil spills in Mongla Port on the northern edge of Sundarban are also a threat and could cause immense damage to the aquatic fauna and seabirds of the Sundarban.

3.2 Hill Forests

The hill forests of Sylhet and the Chittagong Hill Tracts are the most important watershed areas in Bangladesh. They are composed of tropical evergreen and semi-evergreen forests. These forests have a large diversity of tree, bamboo, and shrub species of ecological significance. The tropical evergreen and semi-evergreen forests are not very distinct and often intermingle and merge into one another. The majority of the small understory species are evergreens, while a majority of the dominant trees are deciduous. Some of these deciduous trees shed their leaves during the winter season and some during the monsoon, so the forests always appear green.



Major Eco-Systems In Bangladesh

Tropical evergreen forests: The predominant species in this type of forest are *garjon* (*Dipterocarpus* spp.), *chapalish* (*Artocarpus chaplasha*), and *telsur* (*Hopea odorata*). The lower canopy consists of such important species as *pitraj* (*Amoora wallichi*), *buno am* (*Mangifera sylvatica*), and *jam* (*Syzygium* spp.). The forest undergrowth is usually a tangle of herbs and shrubs where cane, *patipata, buno tal* (*Licuala peltata*), bamboo, and banana are prominent.

Tropical semi-evergreen forests: The principal characteristic is the presence of a large number of deciduous species that usually remain leafless during the winter season. *Garjon* (*Dipterocarpus* spp.) is usually found in the upper canopy, along with other deciduous species such as *koroi* (*Albizzia* spp.) and *bandarhola* (*Duabanga grandiflora*).

Loss of species diversity and wildlife habitat is the result of shrinkage and degradation of hill forests mainly due to shifting cultivation, encroachment, and overexploitation. In view of the hydrological importance of the forest cover, and the need to maintain genetic diversity and wildlife habitat, sustainable development of the hill forests is urgently needed.

4. Biodiversity

Biodiversity is the totality of *genes, species, and ecosystems* in a region (WRI 1992). It can be divided into three hierarchical categories: genes, species, and ecosystems and used to describe different aspects of living systems.

- *Genes/genetic diversity*: The variation of genes within species (e.g., thousands of rice varieties cover distinct populations of the same species, while genetic variation is very low in cheetahs).
- *Species/species diversity*: The variety of species within a region (e.g., species diversity is high in an area with two species of birds and one species of lizard but low where there are three species of birds but no lizards).
- *Ecosystem diversity*: This encompasses a number of factors including the relative abundance of species, the age structures of populations, the pattern of communities in a region, changes in community composition, and such ecological processes as predation, parasitism, and mutualism.

For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes, as well as their relative abundance.

According to Arroyo, et al. (1992) the species of a few groups of organisms, including vertebrate animals and butterflies, have been enumerated reasonably well. Of the estimated 10 million species of organism in the world, however, only 1.4 million have been named. Even less is known about the function of these species in ecosystems.

The extinction of major proportion of species of plants, animals, fungi, and microorganisms, which could amount to 20 percent or more of the total within the next 30 years, constitutes a very serious problem. The tendency toward extinction is moving rapidly and is completely irreversible.

The current extinction event is estimated to be proceeding at a rate 1,000 to 10,000 times greater than the natural background rate (Wilson 1988a). In view of this, the Rio Conference recommended that each country establish a National Biological Resource Center for the conservation and sustainable development of biological resources.

4.1 Biodiversity in Bangladesh

The biological resources of Bangladesh are part of the Earth's biodiversity. The paleontological evidence, geographical location, geomorphological features, and climatological status of Bangladesh indicate that before the early Cretaceous Period (130 million years

Table 2 **Wildlife Species Diversity in Bangladesh**

Species	Number
Reptiles	123
Turtle/Tortoises	25
Lizards and Snakes	18
Snakes	78
Gharial	1
Crocodile	1
Amphibians	19
Mammals	113
Birds (local/migratory)	574
Resident	375
Migrant	199
Extinct Species*	19
Endangered Species*	39
Threatened Species*	27

Source: (Khan 1994, MOEF * 1991)

ago), when the Subcontinent separated from the combined area of Australia and Antarctica, the region was one of the world's major faunal and floral genetic exchange grounds (Khan 1994).

The anthropological history and current multiracial human population of Bangladesh have placed heavy demands on the country's biological resources. But there is great potential for biodiversity-based development in Bangladesh. The country supports 123 species of reptiles (including 25 species of turtles and terrapins), 18 species of lizards and snakes, 78 species of snakes, 2 species of crocodiles, 574 species of both resident and migratory birds, and 113 species of mammals (Table 2). Approximately 900 wildlife species have been reported in Bangladesh. Among them, 19 species which had a wide distribution in the forests and freshwater and mangrove swamps have become extinct in the present century due to misuse. The extinct species include three species of rhinoceros, wild buffalo, Indian bison (gaur), banteng, hisped hare, pink-headed duck, two species of peafowl, Bengal florican, greater adjutant, king vulture, and freshwater crocodile (*muggar*). The International Union for the Conservation of Nature and Natural Resources (IUCN) lists 23 Bangladesh species as endangered in its Red Data Book. The major ones among them are the royal Bengal tiger, leopard, clouded leopard, Asian wild elephant, white-winged wood duck, python, estuarine crocodile, and gharial. Many other species may soon find places in the Red Data Book. The National Conservation Study (MOEF 1992) reported that there are 27 threatened and 39 endangered wildlife species in Bangladesh (Table 2). The very survival of the rural community and long-term sustainable development of the society and rural economy are fully dependent on biodiversity. Over-exploitation of some of the renewable biological resources without due consideration of the ecological consequences is fast depleting these resources.

All plants contribute to a balanced environment as well as being a unique part of the diversity of nature (Table 3). Plants constitute a reservoir of genetic resources that provide essential human needs such as food, shelter, clothing, and medicines. The Bangladesh National Herbarium has reported 55 families of flowering plants in Bangladesh, which is roughly a quarter of the estimated 190 families in the country. These families include 5,000 angiosperm species 400 of which have

Table 3 **Plant Species Diversity in Bangladesh**

Species	Number
Angiosperm	5,000
Medicinal (recorded)	400
Fibre species	130
Timber species	224
Endangered	25

Source: (IUCN 1991)

potential medicinal use, 130 of which yield fibers for diverse uses, 224 of which provide timber, while twenty-five species were reported as endangered. A vast number of plants have been classified as food resources for man and wildlife. Bangladesh also provides habitats for a number of wild relatives of cultivated crops such as jute, mango, and banana. According to a recent report by Rahman 1994 (Table 4) the number of endangered plant species increased to thirty-seven from twenty-five.

Table 4 Tentative list of threatened and endangered plant species

Serial No.	Scientific name	Local Name	Probable causes
1.	*Acanthophippium sylhetense*	-	Homestead Damage
2.	*Aeschynanthus parasiticus*	Alok Jhar	Homestead Damage
3.	*Aglaonema clarkey*	-	Homestead Damage
4.	*Aldrovanda vesiculosa*	Balanka Jhangi	Homestead Damage
5.	*Aquillaria agalocha*	Agor Gus	Deforestation
6.	*Centrantherum anthalminticum*	Shomraj	Over exploitation
7.	*Cirrhopetalum roxburghii*	-	Deforestation
8.	*Cycas pectinata*	Moniraj	Over exploitation and Deforestation
9.	*Cymbopogon osmastonii*	Gondhi Ghus	Homestead Damage
10.	*Dehaasia kurzii*	Modon Mosto	Over exploitation
11.	*Dendrobium formosum*	Bokphul Orchid	Homestead Damage
12.	*D. chrysotaxum*	-	Over exploitation
13.	*Elaeocarpus lucidus*	Bamun	Deforestation
14.	*Eulophia mackinnonii*	Bhumi Orchid	Homestead Damage
15.	*Gloriosa superba*	Olot Chandal	Over exploitation
16.	*Gynocardia odorata*	Chal Mugra	Over exploitation
17.	*Hipporcardia macrantha*	-	Rare Existence
18.	*Homalium schlichtii*	-	Rare Existence
19.	*Justicia orephylla*	Choto Arusa	-
20.	*Knema bengalensis*	-	Deforestation
21.	*Limnophila cana*	-	Homestead Damage
22.	*Mangifera sylvatica*	Jongili Aam	Deforestation and Homestead Damage

Serial No.	Scientific name	Local Name	Probable causes
23.	*Mantisia saltatoria*	Nritta Rata Ramoni	Deforestation
24.	*M. spanthulata*	-	Deforestation
25.	*Marsdenia tinctoria*	Roiongo	Over exploitation
26.	*Phajus trancarvaillae*	-	Homestead Damage
27.	*Phrynium imbricatum*	Pitul Pata	Rare Existence
28.	*Quercus acuminata*	Kanta/Kali Batna	Deforestation
29.	*Rotala simpliciuscula*	-	Homestead Damage
30.	*Sageraea listeri*	Dhamon	Rare Existence
31.	*Semicarpus subpanduriformis*	-	Deforestation
32.	*Sonneratia griffithii*	-	Deforestation
33.	*Spatholobus listeri*	-	Rare Existence
34.	*Strophanthus wallichii*	Stropen Gus	Deforestation
35.	*Vanilla parishii*	-	Rare Existence
36.	*Vatics scaphula*	-	Deforestation
37.	*Vernonia thomsoni*	-	Homestead Damage

Source: (Rahman 1994)

5. Ecosystem and Development

> **Development is an increase in resource use that produces useful products required to meet the needs of the people of a given area.**

Development projects that change land use and alter river flows have severe impacts on habitats, food sources, and the reproduction of fish populations. Swamps and marshes associated with the shorelines of river floodplains and lakes merit special attention as a development issue. In every case it has been demonstrated that these areas are critical to habitats and water quality. It is therefore necessary to justify the modification of these ecosystems and/or their disconnection from the rivers and lakes that support them. *Therefore, project planning, construction, and follow-up activities should allow sufficient time and resources for the full incorporation of ecological considerations, data, and findings.*

Fish are highly mobile, and many species must migrate long distances to complete their life cycles. Some species spend most of their adult lives at sea or in lakes, only migrating up rivers to spawn. Fishing for these species is adjusted to these migratory patterns and their survival depends upon having corridors for migration that are free of barriers. These corridors may be blocked by obstructions such as dams, as well as waste discharges that fish avoid. Fish migration appears to be linked to favorable habitats for specific life stages of the species, especially those stages when they are young and vulnerable. For example, species that spawn in the upstream portions of rivers usually encounter a habitat with more abundant food, greater protection from predators, and suitable physical and chemical water characteristics. Thus, protection of habitat and water quality is essential.

People who depend upon fisheries are often deprived of an essential and inexpensive source of protein when aquatic resources deteriorate due to the construction of dams and drainage projects, conversion of forest to agriculture, pollution of water, and other such activities.

Causes of Deterioration in the Fish Ecosystem

The productive capacity of fisheries and forests is the result of natural energy sources such as sun, wind, and rain. When fish and forests are harvested and converted to products, little or nothing of them is returned to the ecosystem from which they came. The ecosystem is thus susceptible to overexploitation, which can occur in three basic ways:

1. Overfishing and water development programs can deplete fish stocks so severely that production is insufficient for harvest.
2. The aquatic environment can be degraded by waste water discharge, hydropower generation, agricultural production, and other kinds of development.
3. The construction of water development structures such as dams, levees can make the floodplain unavailable to fish, even when forests and vegetation are left intact as a potential food source.

Figure 3 shows the aquatic ecosystem and the factors that influence it. These factors fall into three categories:

1. Inputs of energy and materials from either natural or artificial sources;
2. Outputs, which usually represent products that are valued by society; and
3. Stresses, which are either blockages of inputs or losses that compete with useful products (outputs) from the ecosystem.

The stresses shown in the figure represent losses from the aquatic ecosystem caused by:

1. Obstructions that block or divert natural inputs such as water flow and the mixing and migrating of organisms;
2. Overexploitation that depletes fish stocks either to extinction or to the point that the capacity for the stocks to sustain yield is severely limited; and
3. Alterations of internal cycles and dynamics within the aquatic ecosystem, such as those caused by pollution with toxic organic compounds and metals or by nutrients that change the structure of the food web.

The simple principle is that the sustained production of a given area of land or water has limits; the more intensively the area is managed for the high yield of one product, the less it will support the yield of a broader spectrum of products.

6. Proposed Environmental and Ecological Guidelines

- The national development plan should consider the environmental consequences of development in and around the forests, wetlands, hills, coastal and estuarine areas, islands, oxbow lakes, unforested lands, floodplain, mangrove swamp, evergreen and deciduous forests, Barind Tract, Hill Tract, and other ecosystems of Bangladesh.
- Ecological impacts that may create damage outside of the immediate project area (such as downstream flooding and loss of estuarine spawning habitat) should be considered.
- Water quality and fishery issues should be systematically coordinated with large-scale river basin development.

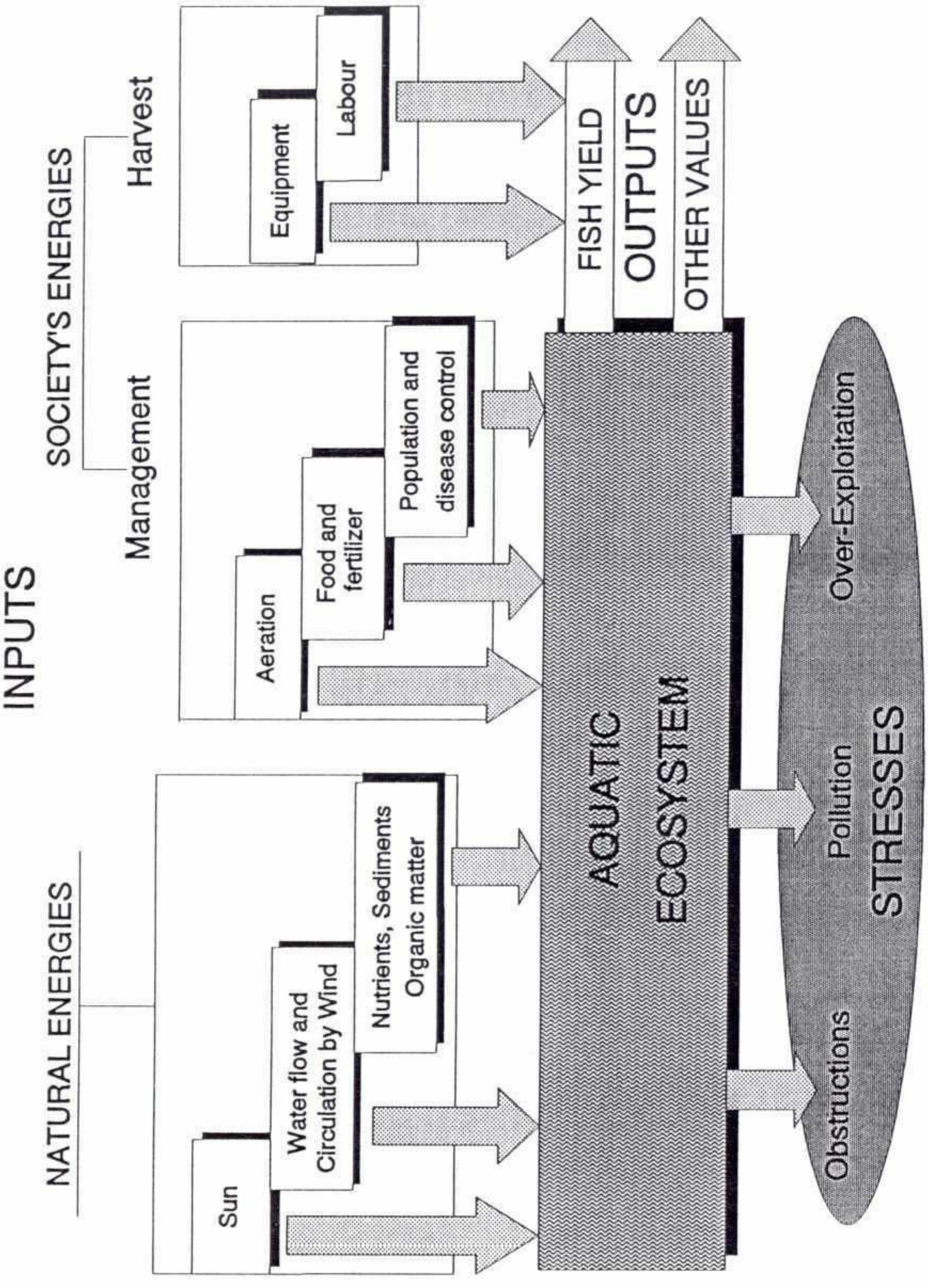


Figure 3 **Factors Affecting the Aquatic Ecosystem**

- The benefit analysis of development projects should include estimates of all the ecological costs and benefits of the project (including alternatives).

- Final project funding should adequately provide for training, management, and extension services to support ecological objectives. Where necessary, funding should be made available to local agencies that are responsible for development.

- In the planning stages, water development projects of all kinds can be assessed in terms of the new habitats that will be created.

- Habitats for aquatic invertebrates that are important in aquatic food webs, but which also may be vectors for human parasites (mosquitoes/malaria, black flies/onchocerciasis, snails/schistosomiasis), should be a part of the evaluation.

- Urban and industrial waste water should be treated to the highest possible level in order to adequately protect water quality.

- Preventive measures should be taken against excessive erosion, wasteful fertilizer application, inappropriate pesticide use, and other practices that may degrade habitats and, thus, the ecosystem.

- The advantages and disadvantages of species introduction should be comprehensively evaluated. Certain introductions may cause extensive changes in the structure of native species communities. The advantages of introduction to improve yields should be weighted against the impacts of possible species extinction. However, the following key points should be kept in mind during the development plan for a sustainable project.

- Define critical biophysical factors.

- Design with nature (strengthen natural mechanisms that regulate ecosystem functioning).

- Explore sustainable options for intensifying the production of existing resources (e.g., integrated pest management).

- Design development activities to prevent avoidable damage to the resource system.

- Maintain the productivity of the natural system.

- Plan project objectives to ensure that development activities are sustained beyond the life of individual project activities.

7. Conclusion

Without sufficient baseline information on biological diversity, development practices in Bangladesh have serious depleted both its store of species and its ecosystem. The asymmetrical overexploitation of some very common species has put these species in a vulnerable state. The best example is the freshwater crocodile (*muggar*), whose habitat, while still available, is threatened. This is due to lack of a bi-symmetrical approach to development that allows sustainable utilization while also providing strict protection measures.

The basic ecological work required may include an understanding of nutrient cycling, soil biology, plant competition and succession, groundwater hydrology and soil microclimate, survival requirements of important plant protection, and impacts on the physical environment.

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MODULE 3

SUPPLEMENTAL HANDOUTS

The materials on the following pages are intended for duplication and distribution to skills workshop participants, Exercises and other handouts for this module are located in Volume I of the EIA Skills Workshop Trainer's Manual.

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BANGLADESH
ACTION PLAN FOR FLOOD CONTROL

GUIDELINES FOR PEOPLE'S PARTICIPATION

FLOOD PLAN COORDINATION ORGANIZATION
MINISTRY OF IRRIGATION, WATER DEVELOPMENT
AND FLOOD CONTROL

March, 1993

ACTION PLAN FOR FLOOD CONTROL
GUIDELINES FOR PEOPLE'S PARTICIPATION

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PREFACE

The Guidelines for **People's Participation** in the Flood Action Plan (FAP) are addressed to a diverse, multi-disciplinary audience including the people who would be affected by any future FAP activities, GOB policy makers and the FAP planning teams. Evaluations of a cross-section of FCD/I projects completed in the past show that the agricultural and socio-economic benefits resulting from these projects can be greatly enhanced, their sustainability assured, by **integrating local people and their representatives in all stages of project activities.**

Indeed, it is now accepted by everyone concerned with development policies and practices that **people's participation is the key** not only **to sustainable** flood control, mitigation and water management activities, but overall **economic development and growth.** These Guidelines suggest a flexible approach to the integration of considerable local knowledge, experience and insights of people living in a given area with professional expertise, resources and efforts. This cross-fertilization will strengthen the process of decision making with regard to local needs assessment, project formulation and implementation, long-term operation and maintenance. The process will also help address fully the **needs of diverse local groups** - fishermen, boatmen, the destitute entrapped in poverty, disadvantaged women and children, those living outside the embankments, for instance - and minimize the negative effects stemming from conflict of interests.

The Guidelines for People's Participation (GPP) form a part of a series of guidelines that incldue the Guidelines for General Project Assessmetn (GPA) and the Guidelines for Environmental Impact Assessment. Other guidelines to be developed in the future would bear on Land Acquisition and Resettlement, Project Implementation, Operation and Maintenance, Monitoring and Evaluation. Interlinked, these guidelines would form the corpus of the Guidelines for Project Planning (Development) in the Flood Action Plan.

The Guidelines stipulate not merely a commitment to a methodology, but a whole hearted adherence to a process that will translate this commitment to **a rigorous and invariable practice of all development activities.** It therefore follows that these Guidelines will be modified and improved as regional and local experience is accumulated from implementing them in Bangladesh.

ACTION PLAN FOR FLOOD CONTROL
GUIDELINES FOR PEOPLE'S PARTICIPATION

1. INTRODUCTION

1.1 Flood Action Plan (1990-95)

The Flood Action Plan (FAP) issues from a comprehensive review of flood policy in Bangladesh in the aftermath of the devastating floods of 1987 and 1988. The FAP marks the initial phase in the development of a long-term phased programme of flood control, drainage and water management activities in Bangladesh. The development imperatives of Bangladesh stipulate that comprehensive technically, economically, environmentally and socially sound solutions to the problem of recurrent flooding be found urgently. This principle is reinforced by all FAP supporting studies and strongly endorsed by both the Government of Bangladesh and the World Bank.

1.2 Objective

The **objective of the FAP is to bring about an environment secure enough to stimulate intensive agriculture, fisheries and integrated rural and urban development.** FAP would seek to achieve this by a combination of controlled flooding and drainage measures and a much enhanced state of flood forecasting and early warning, flood proofing, flood preparedness and other related actions. This would facilitate **sustained economic and social growth, welfare and security and to ensure a higher quality of life for the people dwelling on the floodplain.**

1.3 People's Participation

In the light of considerable field experience gathered over the years and recent FAP evaluations, it is evident that to ensure sustainable flood control, drainage, water development planning and management, diverse socioeconomic groups of people affected by recurrent flooding must have the opportunity to articulate their needs, identify problems and work out solutions. Experience gained from the process of development planning in Bangladesh demonstrates clearly that due to a lack of an appreciable measure of people's participation, programmed activities in social and economic development have had only limited success in achieving the stated objectives and ensuring sustained delivery of project benefits. In keeping with the new development perspective of the Government to align participatory democracy with the need for accelerated and sustainable economic development of the country, **it is essential that local people participate in full range of programmed activities** including needs assessment, project identification, pre-feasibility, feasibility, design and construction, operation and maintenance, monitoring and evaluation. This is intended to **replace the traditional approach** limiting decision making to a remote centre dominated by professionals and specialists. This **alternative development strategy** is expected to stimulate the evolution of the process of decentralization in development planning and implementation. The most notable gain would be commitment of the people to generating and sustaining socio-economic development relevant to their needs.

1.4 Perspective Plan

The FAP's central concern relates closely to GOB policies embodied in the Fourth Five Year Plan (1990-95), which clearly recognizes the crucial importance of people's participation in the process of planning and development, and the necessity to give policy and institutional support in order to direct increasing degrees of that effort to accelerate the pace of economic growth. The FAP would seek to derive as much benefit as it can from people's participation augmented by human resources development, defined in the Perspective Plan (1990-2010) as **"the ability of the people, particularly in the rural areas, to identify their problems and plan and implement these plans by themselves in areas which concern them most."**

2. PEOPLE'S PARTICIPATION IN PLANNING

2.1 Overview

People's participation in planning is a vital process which will enable different socio-economic interest groups in an area develop their capabilities to play a dynamic role in development initiatives. It will also strengthen the commitment to development of a wide cross-section of affected people, elected representatives, government employees, professional groups, voluntary groups including NGOs, development practitioners and others **by giving them an opportunity to share responsibility for key decisions.**

2.2 Parameters

People's Participation involves:

- **assessment** of local perception/needs assessment through extensive dialogue with all social groups likely to be affected;
- **identification** of and consultation with groups likely to be affected both inside and outside the programme area and analysis of conflicting interests likely to affect the project;
- **attention** to in particular marginal groups, including
  - rural poor
  - ethnic groups
  - minorities
  - women
  - fishermen
  - boatmen
  - other disadvantaged people dependent on fragile resources
- **identification** of all land and water resources
- **development** of an organizational structure for
  - guaranteed representation
  - briefing
  - consultation about technical components
  - negotiations for mitigation, compensation, etc.

2.3 Salient Features

The process can identify **local issues** that conventional socio-economic surveys do not fully estimate or clearly bring to light. Close and active participation of people is the device to ensure that these are taken into account in **project formulation and planning.**

2.3.1 People's participation will ensure that projects take fully into account essential local data on environment, land and water regimes, informal and customary rights, resource usage, and the most directly affected social groups among others, in order to assure that projects do **minimum damage to habitats, livelihoods of the people and natural resources.** It will also help develop **equitable standards for compensation and mitigation.**

2.3.2 The process will facilitate identification of diverse beneficiary/disbeneficiary socio-economic interest groups and their leaders, traditional organizations and institutions. This will ensure that their collective views are reflected in project development and its management.

2.3.3 Early forging of **partnership between the Planning Team and the local people** is the key to their effective **participation in the subsequent stages** of construction, operation and maintenance, monitoring and evaluation.

2.3.4 It also sharpens the focus on the **needs of the poor and disadvantaged** with a view to ensuring that their interests are taken into consideration **in assessing project impacts** and to target short - and long - term benefits to them.

2.4 Linkages

People's participation is not an isolated activity; rather **complements** information gathering techniques such as RRA, PRA, sample surveys and key informant interviewing, etc. It involves activities and institution building at different levels of society and administration. The institutional development will involve Ministries, NGOs and other interest groups and help establish extensive **inter-organizational linkages,** with well-defined accountability at all administrative levels. The objective at the project level is to achieve **effective co-ordination.**

3. PROJECT CYCLE

3.1 Project Scale Factor

This intensive participatory planning process might not be equally practicable for water management projects of different sizes. Some FAP efforts have a distinctly local focus, for example, compartmentalization, flood response, flood proofing, small scale FCD and irrigation structures. Other FAP projects are much larger in scope. The scale of the project will largely determine the approach used.

a. Small: Local Area Development

For small projects restricted to a village, union or thana, it should be possible to optimize the active involvement of the people in all project stages through local level groups.

b. Large: Larger Area Development

Large scale projects covering larger areas are common in the FAP and pose special problems of their own in terms of people's participation. Methods of organizing the project development process are of necessity quite different from those appropriate in smaller localities. It is especially difficult to conduct large area feasibility studies in a participatory manner. Planning teams, however, must still foster participation by organizing extensive consultation sessions in selected locations to elicit predominant development issues and concerns of the people. Multidisciplinary teams of ecologists, social scientists, engineers and other appropriate specialists could assess needs, describe development alternatives, likely benefits/disbenefits, environmental effects and socioeconomic benefits of each. These projectwide consultation programmes for needs assessment and appraisal of environmental and social effects would suffice provided that all concerned parties receive essential information and opportunities for consultation.

Note: Details of composition of the Planning Team and expected inputs are at Annexure-A.

3.2 Stages

People's participation in the FAP projects and programmes should effectively begin at the inception or the **prefeasibility** stage with preliminary survey of an area for needs assessment, and continue throughout the life of any given project. Broadly speaking, at least the following **six stages of people's participation can be identified:**

3.2.1 **Prefeasibility study:** local people, their elected representatives and local officials are to be involved in **needs assessment. This includes technical, environmental and social appraisal** of an area's problems, **analysis of alternative project options, and possible selection of project or programme. The results may be used to adjust any existing project concept in accordance with the findings.**

3.2.2 **Feasibility study:** As a project takes shape local people are involved in more **detailed technical, environmental, social and economic appraisal.** Also, at this stage the representatives of diverse local socio-economic groups and the local councils can interact, discuss and concur in project concept including mitigation and land compensation measures. This process will help develop methods of **people's involvement in project design, construction, management, operation and maintenance, monitoring and evaluation.**

3.2.3 Detailed design: **once a project is deemed feasible,** there must be **ongoing interaction between local people and technical planners in developing criteria and specifications** for many vital project or programme considerations, e.g., the location, size, and distribution of project works, land acquisition, relocation plans and mitigation measures. **A Project Co-ordination Committee (PCC)** should be set up at this stage to ensure that these issues are satisfactorily resolved. PCC will continue.

3.2.4 Implementation/Construction: PCC will monitor implementation in order to ensure that design standards and implementation are carried out as agreed. Both formal and informal communications with local people should be as open as possible. The plan itself and any modifications should be explained to them and their views taken into account. **The monitoring group would identify and analyze unforeseen problems and offer suggestions to resolve them.** It may also seek expert advice if problems are severe or threaten the projects.

3.2.5 **Operation and Maintenance:** the operation and maintenance stage should directly involve the local population. However, **the degree of direct local control and management will vary according to the nature of the infrastructural** works to be built and operated. Operational manuals must be drawn up with this in mind including the legal responsibilities for ownership, labour and financial resource provision, day to day operation, routine and emergency maintenance and repair work. The **criteria for deciding operational procedures must be drawn up with the consensus of local people.**

3.2.6 **Monitoring and Evaluation:** In order to learn from experience of a project and influence future development, the PCC should constantly monitor performance, and initiate remedial actions as necessary. This will require intensive liaison with local people both directly in the area and those affected outside it. It will need to **address both the positive and negative ways in which people are affected at all stages of project development.**

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4. PEOPLE'S PARTICIPATION IN PREFEASIBILITY PLANNING

4.1 Rationale

The FAP will seek to enhance the economic security and quality of life of the floodplains population by means of improved water management techniques. Sustained and extensive consultation with the people in particular areas and their active participation in the process is essential to assess local needs, highlight topographic, hydrographic and other geophysical characteristics, potential opportunities and constraints as well as the associated socioeconomic conditions that will crucially affect the probability of success in planning and implementing projects.

4.2 Techniques

The following techniques may be useful in gaining a multidisciplinary perspective:

i. Village scoping sessions in which Planning Team **presents** these priority development choices. **This consultative/iterative process** should include relevant levels of all concerned GOB departments, elected officials, GOB specialists, and most importantly, the people of the proposed programme, and adjacent areas.

ii. **Consults** various socioeconomic groups and their representatives in a series of meetings, or public hearings, Official representatives of these interest groups also may be consulted;

iii. **Questionnaire surveys** of sampled households to elicit views of a truly representative cross-section of the affected population;

iv. **Discuss with local people and their representatives positive and negative environmental, social, economic implications.** If any or all are unacceptable to any interest group, this should be noted.

The prefeasibility study must show that any proposed development alternative is:

- consonant with the expressed needs and wishes of the local peoples including social and environmental imperatives
- likely to be institutionally, administratively practicable.
- capable of being implemented without creating major social disruption or irretrievable damage to any social group, particularly the poor.

5. PEOPLE'S PARTICIPATION IN FEASIBILITY PLANNING

At the Feasibility Planning Stage which involves indepth examination of the technical, economic, financial, environmental and social viability of a programme or project concept in a particular area, planning and engineering study groups would move to detailed baseline studies of environmental and social effects (FAP Manual for Environmental Impact Assessment), **local surveys** and **overall blueprint designs. All study and design groups must interact with each other and with the local community or communities during the Feasibility Study stage.**

5.1 Needs Assessment

Inputs for the feasibility study would accrue from

i. crucial identification of the needs of various interest groups and the potential of a proposed project area is the most crucial activity at the feasibility stage. In a departure from the traditional dependence on assessment performed by professionals or specialists in a **detached, "top down" fashion**, the **emphasis now is** on the people belonging to different social groups voicing their own perceptions of the existing problems, potential solutions, including ideas about technical solutions, their implications and probable impact. Projects conceived, designed and implemented on the basis of complementary needs of the people or an appreciation and/or reconciliation of the competitive interests of the various socioeconomic groups in the area have better than average possibility of yielding sustained FCD/I benefits over time.

ii. **Interviews** a wide range of **concerned groups** of people and individuals to solicit the **views and comments** of:

- landholders
- assetless/landless people
- farmers, fishermen, artisans
- women
- transporters, shopkekepers etc.
- those who manage or operate existing projects, to learn from their successes and failures
- elected officials or existing multi-agency task forces
- NGOs or others in a position to represent large interest groups;

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iii. **Data collection** by a multi-disciplinary team, cross-checking data by triangulation, carrying out a diagnostic RRA prior to a PIE to assess probable

  - o direct impact on hydrological conditions.

  - o changes in fisheries, livestock, agriculture, ecological, social and economic parameters

  - o combined impact of several factors, such as, physical, biological, human and environmental, especially potential negative impacts;

iv. The needs assessment should **elicit from the various interest groups their perception of:**

  - o present water management regime;
  - o main flood control and drainage problems and trends; and
  - o preferred solution to any problems identified.

v. The needs assessment survey also should **include communities living outside** the proposed programme area, who are likely to be affected by any interventions under consideration.

vi. The **needs of poor and marginal groups** must be given special attention during feasibility planning. Special efforts would be required to

  - o consider the several technical possibilities available to bring about a change in their circumstances

  - o enable marginal groups voice their interests, consider the several technical possibilities available to bring about a change in their circumstances.

  - o offer their own suggestions

  - o choose leaders to represent them in various deliberations

vii. **Formation** of consultative groups in wards, thanas, districts, and creation of regular forums for regional planning deliberations in which discussions of specific issues, even negotiations between competing groups, can occur.

Direct Planning Team efforts, contract with government rural development agencies or suitable NGOs are some of the ways to perform local organizing functions. Experience also confirms that development of existing potentials might be thwarted by numerous factors. A multidisciplinary approach leavened by wide participation of people is therefore essential not only to acquire detailed information about the prospective command area, but also develop appropriate solutions and programmes.

5.2 Environmental and Social Considerations

Planning Team specialists should seek to understand people and their perceptions, detail basic data on local environmental and social conditions, and enumerate:

- all socioeconomic groups in order to identify, analyze and understand the livelihood strategies of diverse groups and conflict of interests. Special efforts would be necessary to identify and involve the poor and marginal groups -landless, poor fishermen, destitute men and women, groups depending on scant resources etc. in any intervention planned;
- all land and water resources, local assessment of these resources and interdependencies and importance of livelihood strategies;
- all customary and formal/informal rights to use particular natural resources;
- major cultural properties;
- local leaders and officeholders, organizations and associations including traditional groups, cooperatives, development organizations e.g., Grameen Bank, etc., and
- government institutions and agencies.

5.3 Development Alternatives

The information gathered from each of the interest groups should be combined into **need assessments "pictures"**, in which all natural and social elements are integrated into a coherent whole. The Planning Team should add to these assessments other development targets based on national priorities and the judgements of team specialists. These various needs would then be translated into development alternatives, and grouped into major types of interventions and evaluated both generally as well as by a simplified version of the multicriteria analysis specified in the Guidelines for Project Assessment (GPA). Once prioritized, the two or three major options should be developed in more detail, describing each in terms of:

- **needs** addressed
- expected **positive effects**
- expected **negative impacts**, and
- the **structural** and **institutional measures** needed to implement them.

5.4 Consultation Process

Feasibility planning would require the planning team to play an energetic role. It would be required to initiate a series of relatively structured consultations in multiple locales.

All comments and suggestions gained in this **consultation process should be recorded.** Sectoral specialists should then review all the issues that emerge from the consultative exercise, and **note key questions, comments, and areas of conflict.**

5.5 Recommendation

The Planning Team should evaluate the feedback gained in the consultation exercise and revise each development alternative as necessary and/or possible. Finally, the Planning Team should recommend one development alternative to be taken on to the Feasibility Study stage. Before making this recommendation it is essential that actual or potential conflicts e.g., outsiders vs. insiders, large vs. small farmers etc. are identified, their implications assessed, and the possibilities for compensating those adversely affected are worked out. It would be futile, even counter-productive, to allow a project to proceed without addressing such conflicts and attempting to resolve them.

6. PEOPLE'S PARTICIPATION IN DETAILED DESIGN

There is now a wide recognition that despite the dominance of the technical construction aspects, water management activities are no less social than they are technical processes. Indeed, one broad reason for the failure of many such schemes is the insufficient attention given to social aspects of project design. Many of the problems could have been avoided if local people had been closely consulted. Projects are distinctly shaped by their respective contexts, objectives, approach, anticipated achievements, financial basis and so forth. Hence, it is essential that the PCC (3.2.3) is formed at this stage and carefully briefed on issues that emerge during detailed design. The main task of the PCC during this stage is to **prepare for a role in the implementation of the project.** Depending on the project, PCC will perform specific roles in construction, operation, and maintenance. In projects with a substantial irrigation component, beneficiary groups might form **Water Users Associations** either independently or as subcommittees of the original PCC. These latter **Water Users Association** should be configured in such a way that they eventually can take over ownership of small scale irrigation systems.

6.1 Interest Group Organization

In this phase **people's participation ought to grow from the individual and unorganized level to that of formal organized interest group representation.** It may be noted here that at the interest group level large landholders, shopkeepers and businessmen, transporters and transport workers, leasehold fishermen, NGOs and Cooperatives already will be well organized. On the other hand, landless labour, women especially destitute women (single heads of households), capture fishermen, brick kiln workers, marginal groups depending on foraging for grass or wood, etc. may not be organized at all. This has two major aspects:

i. **Encourage** specific socioeconomic interest groups and resource users, especially this second collection of social groups, **to organize themselves** sufficiently to ensure that their interests are taken into consideration in project planning. This denotes choosing leaders to represent them on the **Project Coordination Committee (PCC) to** define interests, determine positions, and decide on acceptable compensation and mitigation measures.

ii. Organize a Project Coordination Committee (PCC) at the project level.

6.2 Composition of Project Coordination Committee (PCC)

i. **The responsibility for organizing the committee should be that of** the Ministry of Irrigation, Water Development and Flood Control. In the case of distinct and identifiable FAP components, relevant ministries/agencies, such as Local Government and Co-operatives Division, BRDB etc., would have to take the initiative to form PCC to help implement programmed activities.

ii. Once a development alternative has been selected, chosen representatives of the likely affected social groups should be organized into a **Project Coordination Committee (PCC).** In **addition to area socioeconomic interest groups**, including women, this Committee should include representatives of government technical departments, local NGOs, those responsible for project design, as well as **members of the former Planning** Team. It should be **chaired** by the **elected officeholder** closest in the governing hierarchy to the project level.

iii. Interest groups should be encouraged to get organized at the **appropriate project level - village, ward, union, district, multidistrict** with membership clearly reflecting the size and complexity of the project. Despite the size of the project area, all social and resource user groups must have representation on the committee. This **includes the poor, marginal groups, and women.**

iv. **The Project Coordination Committee** exists primarily to represent the interests of the affected social groups at the detailed design, implementation and O&M stages. Specifically, the committee will

- discuss with the Design Team all aspects of programme or project design;
- resolve conflicts between social groups over aspects of project design;
- develop acceptable compensation and mitigation plans as necessary.

6.3 Sub-Committees

Sub-Committees of the PCC may be formed depending on project needs.

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7. PEOPLE'S PARTICIPATION IN IMPLEMENTATION

The emphasis in these guidelines is on participation of the people in comprehensive decision-making on the

- definition and articulation of key issues
- formulation of viable solutions
- initiation of project implementation activities

This is based on the recognition that goals of development interventions can not be reached without the understanding and support of local communities, whose knowledge of local conditions and resources, ideas and cooperation are crucial to the technical success of a project.

7.1 Role of Project Coordination Committee (PCC)

Resolution of issues of implementation, operation and maintenance (O&M) would depend on several factors such as the **goals of each intervention, the sources and terms of funding,** and most importantly, the **broad direction given by national policy makers.** The PCC would provide the all-purpose vehicle for the participation of individuals and groups of people directly in the activities of the project, enabling them to gain better understanding of its objectives and likely impacts, and develop pride in the work carried out. PCC's efforts would be best directed to help

- develop human resources and promote active participation
- design and adjust a flexible implementation schedule as the requirements and constraints of the people become more clearly understood
- review implementation to agreed schedule and standards
- develop and adjust recommendations for operation and maintainance (O&M) of any assets created by the project, togethern with continuous monitoring and evaluation (M&E)
- equitably distribute project benefits.

Further,

i. a strong indication that planning and design are based on the needs of local people would be their participation by contributing in cash or labour during the construction of tertiary structures and other works, particularly the re-excavation of khals and the (re)building of embankments

ii. Where appropriate to the specifications earth works should be contracted to the maximum possible extent to Landless Contracting Societies (LCS) in order to benefit landless people. If LCSs do not exist in the project area, they should be encouraged to be formed with the assistance of BRDB or local NGOs. At least half of the earth work should be reserved for female LCSs

iii. these LCSs should be made up of disadvantaged groups both within and outside the protected area. Providing opportunities to participate through LCSs in the implementation/construction of the project should be a major concern of the **PCC**.

8. PEOPLE'S PARTICIPATION IN OPERATION AND MAINTENANCE

8.1 Operation

The operation of FCD/I structures varies from making or cutting open temporary closures of tertiary and secondary channels, to opening and closing multi-vent regulators along major rivers and the operation of pump houses. In consequence

I. **operating manuals** nust be produced in simple Bangla for all projects and for all levels at which operation takes place within projects. These manuals will present technical, operationally useful information in language that even those who are not highly educated can understand. There must be a procedure for training people in their use and updating them regularly in the light of experience gained and changing field requirements;

II. the operating manuals will have to cover the operating options at all levels, given the whole range of possible external parameters. This **range will have to include** a number of **possible disaster scenarios including** structural failure, sabotage, flood levels surpassing design levels, etc.;

III. the **PCC will** have the freedom to operate the system as needed in accordance with rules and, of course, within the operating options and external parameters as determined by the BWDB; PCC will be also responsible for setting up training programmes.

IV. facilitate sustainable water management, i.e. acceptable to all concerned (conflicting interests), Relevant GOB department officials may advise and assist the committee members, or any other affected person who might wish to duscuss aspects of a given project.

8.2 Maintenance

i. **Yearly maintenance needs** for a local system can **be assessed by the PCC** after each flood seaon. The relevant **GOB officials** will be charged with **preparing a detailed proposal, including a budget**, for the maintenance of all works under the authority of the committee. The budget should include financial **provisions** for **contingencies** that might arise from time to time.

ii. Upon verification and adjustments as necessary, the committee **will formally approve the maintenance proposal.** In the case of self-governing irrigation systems that can levy users fees to fund maintenance, the Committee should be able to do all of this themselves.

iii. **Regular maintenance of roads and road and embankments may be awarded to local group including women's groups.** In all cases employment of women's groups should be encouraged. Experiments may be conducted to find ways of combining such maintenance with the use by these women of roadside, embankments, borrow pit, etc. for productive purposes.

iv. **Earthwork and turfing wherever appropriate to the specification will be done by LCSs.**

8.3 Funding of O&M

Funding of O&M must be seen in the wider context of project sustainability and resource generation at the grassroots level. No easy solutions are expected, and **experimentation together with ongoing monitoring and evaluation will be needed for workable arrangement.** Planning and Design Teams should investigate the following in particular and suggest ways and means:

i. Local resource commitment for income - producing FCD/I projects is most likely where resources generated are directly ploughed back into the project. Tertiary committees would need some freedom to decide on a fair way to levy charges.

ii. The larger the area covered by a project (i.e., secondary and primary level committees), the more difficult it will be to generate local resources for O&M. Possible sources are:

  o market/sales tax
  o land taxes
  o property tax
  o licence fees
  o service fees etc.

iii. **A system of government subsidies perhaps in the form of a matching grant**, may be needed to stimulate local resource generation.

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ANNEXURE: "A"

FEASIBILITY PLANNING TEAM COMPOSITION AND INPUTS

1. Composition

a. The Feasibility Planning Team, part and parcel of the overall project planning team, is drawn in the main from the staff of the project. Its composition should reflect the principle features of the socioeconomic setting of the prospective programme or project area.

In general the Participatory Planning Team would include at least:

- a male sociologist or social anthropologist,
- a female sociologist or social anthropologist,
- a water and land use specialist (or drainage/irrigation engineer),
- a fisheries specialist (riverine or marine),
- an agronomist (in most cases rice),
- an institutional specialist,
- an ecologist, and
- male and female village organizers (to serve as a bridge to poor and marginal groups),
- co-opt local body representative.

b. The **Planning Team Leader** should be a senior specialist with experience in conducting Rapid Rural Appraisals (RRA), possibly including Particularly Rural Appraisals (PRA), which is an emerging RRA methodology and should be increasingly tested and employed in Bangladesh. His or her main assignment is leading the team. This means in leading the team the team leader would be responsible inter alia for framing and scheduling the general approach, organizing logistics, overseeing reporting schedules, mediating disputes among team members, and taking responsibility for the quality of work performed.

c. **The Planning Team members be:**

- **willing and able to conduct extensive field** work and **learn from people** (i.e., experts who are too sure of what they know or will find before they go into the field may not be suitable for this kind work);

- **trained** and preferably **have experience in** RRA methodologies;

- **have experience of FCD/I** projects; and
- **able to report** their findings in written English and Bangla.

Specialists covering such areas as infrastructure, communications (river and road transport), marketing, wildlife, forests, urbanization, industrialization, etc. should **be added as needed.**

4. Flexible Timing and Schedules

Planning for the appropriate water management project or nonstructural program in an area is a time consuming process. Although theoretically project phases are timed linearly e.g. needs assessment, tentative development alternatives, consultation about alternatives, etc., in practice each phase may reveal issues that are as yet unclear and for which part of the pervious phase(s) may have to be repeated. Depending on the complexity of the situation, the extent to conflicts of interest, and the experience of the Planning Team, the planning process may take more time than originally planned.

5. Needs Assessment and Project Formulation

A careful preliminary survey of the area should precede actual needs assessment in the field. The following information should be collected and analyzed:

- contour and other maps (4" and 8" to the mile);
- satellite and aerial photography;
- district gazetteers (relevant for historical data and long term trends);
- national, regional and unionwise socioeconomic statistical data;
- the social and political history of the area, with reference to national, regional and local politics;
- national, regional and local water management projects completed, being implemented, or planned in the proposed programme area, or which are or may affect the area;
- all other GOB projects at all phases that have a bearing on the environment, or could affect fisheries and agricultural development in the proposed programme area;

- NGOs and their programmes in the area
- women in development programmes/projects

RRA/PRA methods should be used to conduct fieldwork for the needs assessment. The **needs assessment must spring from the likely affected socioeconomic groups passed over** by the specialists conducting the assessment. It is **most important to listen and learn from the people,** instead of pressing one's own insights and views on local people. The ability to ask non-leading but probing questions during needs assessment interviews will determine the quality of the work during this phase. Pre-fieldwork training and seminars should specially focus on this. **Only those Specialists should be included** on RRA/PRA teams **who respect the knowledge that local people** have about the land and water resources upon which they depend. To this end, **Specialists should use Participatory Rural Appraisal methods** wherever appropriate, thus **allowing local people to assemble their own information and devise their own simple scales to prioritize needs and measure effects.** This includes hydraulic charts, social mapping, resource and resource usage mapping, work diagramming, local calendars (agrarian, fishing, social), listing and diagramming customary and informal rights, etc.

6. Logistics

i. The Planning Team may need a variety of means of transport (including one or more small 4WD vehicles) to move from area to area. Once in the area, local transport - rickshaw, vans, boats, etc. may be used. Care should be taken by the team to **keep as low a profile** as possible. In practice, this often will mean walking into and around the area where interviews/consultations are to be held.

ii. Team **interaction is of great importance.** This would help verify the importance and trustworthiness of information gathered by the different specialists. If gaps or discrepancies are found, it would still be relatively easy to return to the area to collect more information. It would **also help all team members gain an integrated view of the area. Very often potential social and environmental effects can only** be **identified and understood when specialists combine their knowledge and data.**

iii. To facilitate such intensive team interaction, common lodging facilities for the whole team are necessary, preferably in or as close as possible to the proposed project area.

7. Reporting

i. Team members should **use their own notebooks** and diaries, and their **own methods**, to record data collected in the field. However, team members should **have prior agreement on the checklist** to be used by each of the team members.

ii. At appropriate times during the study, each specialist should **report his/her information to the Planning** Team **in a predetermined form.** This report should include the following:

- agreed-upon chapter headings, subheadings, tables, etc. (use FPCO standardization);
- a chapter entitled: "Own Views and Observations" to record his/her own perceptions/observations/ recommendations. Separate **sections on the views expressed by local people will thus remain free of the specialist's judgements;**
- a chapter containing issues that need to be followed up, either because;
  - there was not sufficient time to get the information, or
  - the information collected from different people or interest groups is conflicting; or
  - the information collected differs from the generally accepted opinion in the relevant field of specialization, or
  - the information collected was found to be unique to that specific locality or interest group.

iii. **Planning Teams need secretarial** support to ensure that reporting requirements are met. Given the complexity of the research and interaction among specialists, portable computer, printing and photocopying **facilities should be available at the field office.**

C:MA:PEOPLE:tc

MODULE 4

SUPPLEMENTAL HANDOUTS

The materials on the following pages are intended for duplication and distribution to skills workshop participants. Exercises and other handouts for this module are located in Volume I of the EIA Skills Workshop Trainer's Manual.

HUMAN RESOURCES DATA SOURCES

Useful data on relevant issues regarding human resources can be obtained from a variety of sources including government departments and ministries, donor agencies, NGOs, and consulting firms. The Government of Bangladesh publishes a wide variety of official data, much of it in serial publications of the Bangladesh Bureau of Statistics (BBS). These include:

- Statistical Yearbook of Bangladesh (current volume): a compendium of data on all natural, social, and economic sectors.
- Final Report of Bangladesh Population Census, 1981: useful for EIA studies are the District Series and the Thana/Community Series. The latter series has socio-demographic data down to the mauza level.
- *The 1991 Population Census.*
- Bangladesh Census of Agriculture and Livestock, 1983-1984: the Thana Series is the most useful for EIA work. It carries landholding (by type and size) and livestock data down to the mauza level.
- The Yearbook of Agricultural Statistics of Bangladesh: publishes cropping and yield data. It is useful for general reference and standards.
- Report on the Bangladesh Livestock Survey,1983-84, (March 1986): resolved data down to the District level. The volume may be useful for historic reference.
- Bangladesh Census of Non-farm Economic Activities, 1986, (March 1990): provides district volumes on commercial, artisan, industrial, and professional activities/occupations. Data are resolved down to the mauza level.

Other BBS publications that might provide useful information are:

- Thana Statistics, Vols. I to III (land utilization and irrigation, agricultural output, minor crops, community level social data).
- Survey of Ponds, 1982.
- Final Report on the Census of WAQF Estates, 1986.
- Socio-economic Indicators of Bangladesh, (Second Edition), 1986.
- Rural Credit Survey of Bangladesh, 1987.
- Mauza Based Study of Rural Facilities, 1989: has data by mauza for police stations, *tahsil* office, hospitals/dispensaries, family planning clinics, veterinary clinics, schools, colleges, *hats/bazaars*, banks, post offices, and metalled roads. Data are given as distance in km from the mauza to the nearest such facility.
- Report on the Survey of Farm Forestry, 1988
- Report on Bangladesh Handloom Census, 1990
- Selected Statistics and Indicators on Demographic and Socio-economic Situation of Women in Bangladesh. Proceedings of a National Workshop, Dhaka, May 29-30, 1989.
- Survey of Bangladesh: the Survey has topographical maps in fairly large scales: 1:7,000 ft., 1:15,000;, and 1: 50,000. Other maps are available with the Revenue Department (mauza and district maps), the BWDB (1:15,690 and 1:7,845 with 1 foot elevation contours), and the BIWTA. For other maps and series, and for sets of Bangladesh aerial photography, see: GIS Resources in Bangladesh, Draft Technical Report, Flood Action Plan, FAP-19 (June 1991).

Other sources of information:

- Floods and flood damage: check locally with the BWDB Executive Engineer at the district, or the Sub-divisional Engineer at the Thana level to obtain reports on flood damage. Another source on flood damage and social disruption is the affected Union Parishad Office.
- General, fish and livestock marketing: the records kept by market franchise holders and their toll collectors provide information on both the wholesale and retail movement of products through local markets.
- Fisheries management: for *jalmahals* above 20 acres, see ADC (Revenue) at the District level. For *jalmahals* between 3 and 20 acres, see the Thana Fisheries Officer, and for *jalmahals* below 3 acres, see the Union Chairman. The Bangladesh Rural Development Board (BRDB) has a program to develop fisheries cooperatives. Check with BRDB for cooperatives in the program area.
- Navigation system: check with the Bangladesh Inland Water Transport Authority (BIWTA) for passenger and freight data on large ferries. The BWDB also collects data on the use of rivers for transportation.

It is also worthwhile to check with local NGOs in the program area. Most NGOs do a socio-economic baseline survey at the start of their program and update their information in subsequent periods.

Some of the libraries that can provide relevant information are:

- United States Agency for International Development (USAID)
- World Bank (WB)
- Food and Agriculture Organization (FAO)
- Centre on Integrated Rural Development for Asia And the Pacific (CIRDAP)
- Association of Development Agencies in Bangladesh (ADAB)
- Bangladesh Institute for Development Studies (BIDS)
- Water Resources Planning Organization (WARPO)
- Early Implementation Projects (EIP)
- Bangladesh Agricultural Research Institute (BARI)
- Bangladesh Rural Advancement Committee (BRAC)
- Bangladesh Academy of Rural Development, Comilla (BARD)
- Institute of Post Graduate Studies in Agriculture (IPSA)

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WATER RESOURCES DATA SOURCES

1. Climate

The Water Resources Planning Organization (WARPO) maintains a large computerized database of basic climatological data. They will perform numerous types of statistical data analysis upon request, and will also provide computer files of the raw data. The Bangladesh Agricultural Research Council (BARC) also can provide data obtained from the Bangladesh Meteorological Department (BMD) in MS-DOS format disks.

2. Rainfall

The major source of rainfall data specific to the project area should be the rainfall database prepared by the project planning team. Much of the rainfall data listed above are essential components of agricultural and engineering design of typical FCD and FCD/I projects. If the required data are not available from project planners, rainfall data may be obtained from other sources shown in Table 1. WARPO can also perform extreme value (log Pearson) rainfall frequency analyses on daily rainfall records on request, and will provide the results as a computer disk file.

Table 1. Sources of Rainfall Data

		Output Medium	
Agency	Format	Hard Copy	Disk File
Bangladesh Meteorological Department[1]	Daily/Hourly	Yes	Yes
Bangladesh Water Development Board	Daily	Yes	Yes
Bangladesh Rice Research Institute	Daily	Yes	No
Bangladesh Agricultural Research Institute	Daily	Yes	No
Bangladesh Agricultural Research Council[2]	Daily/Hourly	Yes	Yes
Master Planning Organization	Daily	Yes	Yes

[1] BMD's floppy disks are in 8" Tandy TRS-80 format. May be converted to MS-DOS at the Bangladesh University for Engineering and Technology (BUET).

[2] The BARC database is obtained from BMD, but is available in MS-DOS format.

Display the locations of the adopted rainfall stations on a map and comment on the length and reliability of the records.

3. Temperature and Relative Humidity

Ten-day mean, maximum, and minimum temperatures measured at the data station during the crop calendar of critical crops may be presented in tabular form to support the agronomists on the EIA team. This information is available in regional form in the UNDP/FAO AEZ reports.

If the temperature and relative humidity data are not available from the project planners, other potential sources of such data are listed in Table 2. Display the temperature measurement locations on a map, and comment on the length and reliability of the temperature records.

Table 2. Sources of Temperature and Relative Humidity Data

		Output Medium	
Agency	Format	Hard Copy	Disk File
Bangladesh Meteorological Department[1]	Daily/3-hr	Yes	Yes
Bangladesh Water Development Board	Daily	Yes	Yes
Bangladesh Rice Research Institute	Daily	Yes	No
Bangladesh Agricultural Research Institute[2]	Daily	Yes	No
Bangladesh Agricultural Research Council[3]	Daily/3-hr	Yes	Yes
Master Planning Organization	Daily	Yes	Yes

[1] BMD's floppy disks are in 8" Tandy TRS-80 format. They can be converted to MS-DOS at the Bangladesh University for Engineering and Technology (BUET).

[2] BARI does not record relative humidity measurements.

[3] The BARC database is obtained from BMD, but is available in MS-DOS format.

The UNDP/FAO AEZ reports show the regional thermal regimes of Bangladesh relative to the growing seasons of the major cropping systems. If daily mean temperatures for the temperature station(s) are readily available, and project budget and time constraints permit, a table of 10-day mean, maximum, and minimum temperatures that match the 10-day rainfall totals may be useful for EIA purposes.

4. Surface Water

Existing Data Sources

Table 3 lists the major items of water resource and related data collected in Bangladesh, as well as the primary data collecting agencies. Secondary sources of data would be some of the major data users, such as BARC, RRI, WARPO (MPO), and organizations conducting project studies. In particular, WARPO, during the conduct of the NWPP - I & II, established a large water resource planning database. It computerized and processed all of the precipitation, streamflow, water level, and groundwater data collected from BWDB and others. One of WARPO's mandated functions is to continually update its database and make it accessible to all agencies.

Data can normally be obtained from an agency by submitting a formal written request stating the purpose of the request and the type of data wanted. The agency will charge a fee for providing data in any type of format.

Table 3. Type and Source of Water Resources and Related Data

	Data Collecting Agencies*										
Type of Data	BWDB	BADC	BMD	DPHE	WASA	SOB	SPARRSO	DOE	SRDI	BIWTA	Port
Precipitation	✓		✓								
Streamflow	✓										
River WL	✓									✓	
GW Table	✓	✓		✓	✓						
Aquifer Test	✓			✓							
Drilling Test	✓	✓		✓	✓						
Sediment Load	✓										✓
Salinity Level	✓							✓	✓		
River X Section	✓									✓	✓
Water Use	✓	✓		✓	✓		✓				
Land Elevation						✓					
SW Quality				✓	✓			✓			
GW Quality	✓	✓		✓	✓			✓			
Evaporation	✓		✓								
Climatic Data	✓		✓								
Satellite Photo							✓				
Maps (Topo)						✓					
Soils Data									✓		
Cloud Picture							✓				
Morphological Change	✓									✓	
Flooded Area	✓						✓				

Source: Interagency Committee Report on Data Improvement (1991)

* Acronyms explained in glossary

Surface Water Modelling Center (SWMC)

The SWMC is developing a suite of mathematical river models at two different scales based on the generalized MIKE 11 software package. The models include a single general model, embracing almost the whole of Bangladesh, and six regional models, which operate at a greater level of detail. The model is also planned for use in detailed area flood control design, as compartmental models. The boundary conditions are hierarchal; conditions for each submodel are provided from the model higher up in which the submodel is embedded.

Model inputs are rainfall and evaporation, flows from across borders, terrain and river channel geometries, and land factors. Outputs are water levels and flows in river channels and flooded areas on a daily basis throughout the year. In addition, groundwater levels are predicted and estimates of sediment movement and salinity intrusion can be made.

5 Groundwater

There are four agencies in Bangladesh that collect primary data on groundwater, i.e., BWDB, BADC, DPHE, and the WASAs (Dhaka and Chittagong). They collect data on the groundwater table, aquifer tests, and drilling tests.

A list of BWDB, BADC, and DPHE groundwater observation stations is given in Appendix 2 along with maps showing the location of the stations and examples of station records. The listing of each agency's observation stations indicates the period of record of each station as well as the frequency and units of measurement.

The WASAs supply domestic water and monitor groundwater levels in the Dhaka and Chittagong areas. They also make predictions of water levels for different time periods and with different growth patterns.

6. Aquifer Tests

The BWDB has conducted more than 200 well tests at production wells installed by the BADC. The wells are pumped at a constant discharge for 72 to 96 hours, and the water levels in a series of observation wells are observed, both during pumping and recovery. Some step pumping tests have also been performed. The collected data are then processed and the aquifer characteristics of transmissibility and specific yield determined.

7. Well Logs and Boring Data

The BWDB records the logs of their wells and has more than 400 wells on file. Above 500 feet, the materials are sampled with a split spoon sampler. Below 500 feet, the wash material is examined and logged. The sample material is analyzed in the laboratory. The BWDB has also undertaken an investigation of the potential of shallow tubewells by sinking a few wells and evaluating their performance.

8. Water Quality

Water quality data are used to assess the suitability of water to meet a specified need such as potable water supply, agricultural or other uses. As shown in Table 5.4, there are only four agencies who collect data to determine water quality. They are DOE, DPHE, the WASAs, and BWDB. DPHE and the WASAs are primarily concerned with potable water supplies and monitor mostly groundwater quality. BWDB monitors both surface water and groundwater quality; however, surface water monitoring is limited to salinity only. DOE, in its role as Bangladesh's primary environmental agency, is concerned with all aspects of water quality monitoring. However, since they are a newly established agency, there is no well-established monitoring program.

9. Salinity

Streamflow salinity has been measured by BWDB since 1965. The measurements are reported as both electrical conductivity in micromhos and chloride concentration in milligrams per liter (mg/l). There have been three types of salinity measuring stations in Bangladesh: (1) monitoring stations, (2) static stations and, (3) dynamic stations. All of these stations are located in the Southwest and South Central Regions. There are also extremely limited salinity data available from several industries in the Southeast Region.

Salinity is also measured at monitoring stations where samples are taken from the riverbank at high and low flows during the period from November through June. There were 80 monitoring stations operating in 1988. The period of sampling is fortnightly. Samples are sent to the laboratory where electro-conductivity and chlorides are measured. Laboratory processing of the samples is slow, with delays ranging from 18 months to 2 years. The data are kept by BWDB in non-computerized format. Photocopies of the data are made available to government approved users.

10. Water Transportation

The Bangladesh Inland Water Transport Authority (BIWTA) has responsibility for maintenance and conservation of the inland waterways. They are the primary source of data on the extent and condition of the navigation system. Their 1988 Bangladesh Inland Water Transport Master Plan (BIWTMAS) is the most recent and complete source of information.

Other important sources of existing information and data on Bangladesh's inland water transport system are the various studies and sectoral reports conducted by GOB, donor agencies, and consultants during recent years. A list is included in the bibliography.

LAND RESOURCES DATA SOURCES

1. Land Types

Over a period of some 20 years the Soil Resources Development Institute (SRDI) developed a system of 11 land types for use in their Soils Data Processing System (SODAPS). The agroecological zoning (AEZ) system devised by FAO (1988) adopted the same scheme (Table 1). A second system was introduced by MPO (1984) and is in general use for agricultural assessments in Bangladesh (Table 2). The MPO classification system is generally recommended for use in EIAs and agricultural assessments.

Table 1 AEZ Land Type Classification System Developed from the SODAPS Classification.

No.	Land Type	Flooding Depth (cm)	Nature of Flooding
1	Highland	0	Flood free or intermittently flooded
2	Medium Highland 1	0 - 30	Seasonally flooded
3	Medium Highland 1 (Bottomland)	0 - 30	Seasonally flooded, wetlands persist through part of dry season
4	Medium Highland 2	30 - 90	Seasonally flooded
5	Medium Highland 2 (Bottomland)	30 - 90	Seasonally flooded, wetlands persist through part of dry season
6	Medium Lowland	90 - 180	Seasonally flooded
7	Medium Lowland (Bottomland)	90 - 180	Seasonally flooded, wetlands persist through part of dry season
8	Lowland	180 -300	Seasonally flooded
9	Lowland (Bottomland)	180 -300	Seasonally flooded, wetlands persist through part of dry season
10	Very Lowland	> 300	Seasonally flooded
11	Very Lowland	> 300	Seasonally flooded, wetlands may persist through dry season

Source: Soil Resource Development Institute

Table 2 Land Type Classification System According to MPO

Land Type Designation	Flooding Depth (cm)	Nature of Flooding	Agricultural Significance
F_0	0 - 30	Intermittent	Suited to HYV rice in wet season
F_1	30 -90	Seasonal	Suited to local varieties of Aus and T. Aman in wet season
F_2	90 -180	Seasonal	Suited to B. Aman in wet season
F_3	> 180	Seasonal	Suited to B. Aman in wet season
F_4	> 180	Seasonal or Perennial	Depth, rate and/or timing of flooding do not permit cultivation of B. Aman in wet season

Source: MPO (1987)

2. Land use

Land use maps and information were provided in the Reconnaissance Soil Survey Reports published by the Soil Resources Development Institute (SRDI) in the early 1970s, using survey data from the 1960s, but are now outdated. Land use data and maps of the project area may be available from previous or current feasibility reports. Information on cropping patterns is also available in the Upazila Nirdeshika (Land and Soil Resources User's Manual) series prepared by SRDI, but these data are sometimes inadequate for a full assessment of land use since they do not contain any land use maps and the information provided does not cover many of the items necessary for doing an EIA.

3. Soils

Reconnaissance soil surveys for all greater districts of Bangladesh were carried out in the late 1960s by the then Soil Survey of East Pakistan which now functions as the Soil Resources Development Institute (SRDI) of Bangladesh. The reports were published in 23 volumes in the early 1970s containing both data and maps. Most information in respect of soil association and series, physical and some chemical properties, land capability, crop suitability, agricultural limitations, etc. are provided in these reports.

Agro-Ecological Zones (AEZ)

AEZs are described in the *Land Resources Appraisal of Bangladesh for Agricultural Development*, published in 1988 (FAO 1988) in 27 volumes. Data collected through reconnaissance soil surveys in the late 1960s were updated in respect of flood phase and computerized under this study. Meteorological data were also computerized and superimposed on the land resources database to identify 30 agroecological regions. Data available from this report include soil association and series, physical and some chemical properties, crop suitability and agricultural limitations.

The Agriculture Sector Team (AST) of the Canadian International Development Agency (CIDA) has digitized the AEZ soil maps, and the digital data are also available through FAP 19 (Geographic Information Systems).

Upazila Land and Soil Resources User's Manual

These reports are popularly known as Upazila Nirdeshika. The Bangladesh Agricultural Research Council (BARC) is coordinating the publication of the series of reports for each of the 460 upazilas with the active participation of SRDI, the Department of Agricultural Extension (DAE), the Bangladesh Agricultural Research Institute (BARI) and the Bangladesh Rice Research Institute (BRRI). Reports for more than 150 upazilas have already been published, and the rest are expected to be published by 1993.

These reports contain valuable information on soil associations and series, plus data on flood phases, post-monsoon drainage patterns, water holding capacity, pH, organic matter content, nutrient content in respect of calcium, magnesium, potassium, ammonium nitrogen, phosphorus, zinc, sulphur, boron, copper, iron, and manganese by soil series.

4. Agriculture

Baseline studies in agriculture are usually a component of the project feasibility studies. Additional information may be required for the EIA to link agricultural land use to potential positive and negative land, fisheries, wildlife and social impacts. Agricultural baseline studies typically cover the following:

- area under different cropping patterns by land type;
- area under individual crops;
- inputs including human and animal labor used;
- crop damage;
- normal and damaged yield level; and
- crop production.

Data for the items listed above are available from the publications of Bangladesh Bureau of Statistics (BBS). Data on areas under different crops and their production by upazila are available in the Upazila Statistics series and the Bangladesh Census Report of Agriculture and Livestock (latest version is for 1983-84). Crop data from BBS are available only up to 1982-83 and are reported by upazila, so the area boundaries may not coincide with the boundaries of the project under study (which often cut across several different upazilas). Similar types of information are available in the upazila level office of the Department of Agricultural Extension (DAE), but official use of these cannot be made as BBS has the final authority of publishing agricultural statistics.

FISH MOVEMENTS IN RIVERINE FLOODPLAIN ECOSYSTEMS OF BANGLADESH

The inland freshwater water fish community of Bangladesh is dependent upon and strongly influenced by seasonal variations in its rivers and floodplain ecosystems. Key among those influences is the effect of the hydrological cycle on fish migration. Almost every inland freshwater fish species in the Ganges-Brahmaputra-Meghna floodplains migrates to fulfil some biological need, whether it be spawning, feeding, larval development, or early growth. Each of these activities requires migrating to a specific habitat. Sustainable population balance, species diversity, and fish production in the floodplain river ecosystem also are heavily dependent on migration and recruitment potential. In general, fish engage in two types of migration: longitudinal, upstream and downstream in river channels; and lateral, back and forth between the river and the floodplains (Figure 1).

This paper discusses the findings of a study conducted by **FAP 16** to verify the migration of fish species and their dependence on flooding, as well as to learn more about the dynamics of the fish population in the floodplain river systems of the four study areas of Bangladesh: Chalan Beel, Surma-Kushiyara, Tangail, and Matlab. These study areas are almost representative of the floodplain fisheries in Bangladesh.

1. Fish and Floodplain Rivers

The entire floodplain fish community suffers from extreme stress during the dry season. Just before the monsoon, when most of the seasonal wetlands are dry, fish take shelter in perennial wetlands like rivers and *beels,* which also reach their lowest stage at that time. In the Chalan Beel area, this survey found, floodplains and *kuas* (small ponds excavated by land owners for the purpose of trapping fish) were almost completely dry and hardly any fish survived. In Tangail, seasonal *beels* had dried up and perennial *beels* had been intensively fished by leaseholders and villagers.

The rivers, on the other hand, are relatively safe areas during the dry season, supporting a reserve of mature fish for monsoon recruitment. These "fish in the bank" ensure that stocks of any species are not "overdrawn" in the reduced dry season habitat.

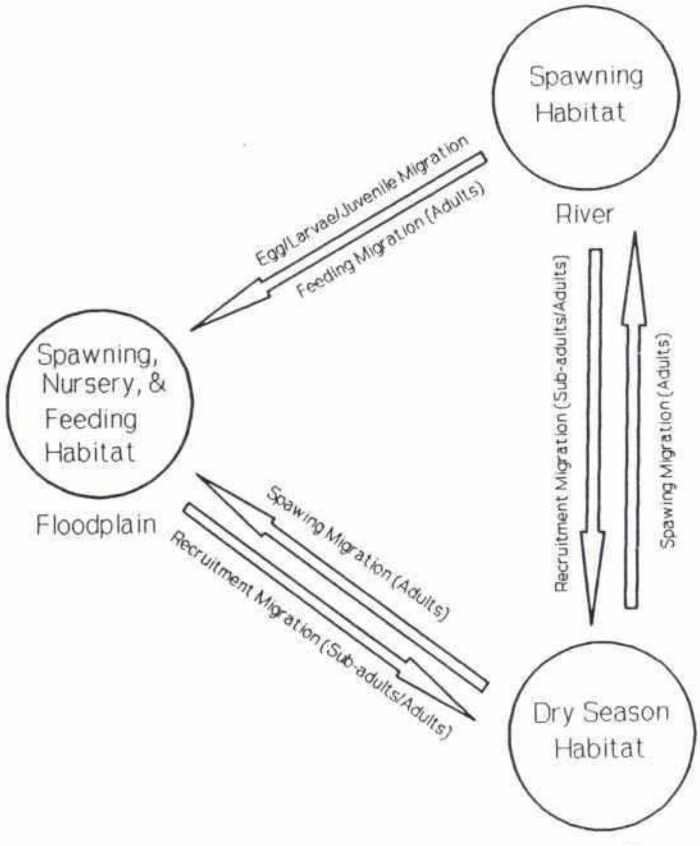

Figure 1: Migration Pattern of Floodplain Species

This study monitored fish catch in selected river segments in Tangail and

Chalan Beel, as well as in three perennial *beels* in Tangail, to determine the diversity of fish species in dry season habitats. Major portions of the Tangail rivers (Dhaleswari, Lohajong, and Pungli) and Chalan Beel (Gur) were dry preceding the monsoon except for some pools in the river channels. A total of 44 species were found in those remaining pools: 12 species of catfish, 21 small fish, six carp, three eels, and two snakeheads.

An analysis of the catch from three *beels* in Tangail during May and June found only 13 species in small quantities: two snakeheads (*taki* and *cheng*), two eels (*guchi* and *boro baim*), six small fish (*puti, bailla, koi, chanda, kholisha*, and small shrimp), and three catfish (*shing, magur*, and *tengra*).

Compared to the parent stock of fish in the rivers during the dry season, fish diversity and abundance in *beels* were negligible, primarily due to the reduction of *beel* size and intensive fishing. Fishing intensity usually increases in floodplains during late monsoon when water starts to recede. At that time, perennial *beels* and flood-fed ponds and borrow pits often are pumped dry and most of the fish they contain are caught. As a result, the fish biomass in floodplain *beels* drastically falls except in some deeper *beels* where a few species, mostly air-breathing catfish, snakeheads, eels, and small fish, remain.

The migration study also monitored fish diversity in the inundated floodplain throughout the monsoon period. A greater number of species were found there than in the rivers, *beels*, or canals (which had 33 migrating species). The floodplains yielded a total of 55 species: 15 catfish, 7 carp, 27 small fish, three eels, and three snakeheads. In addition to the fish species identified, the study found many in-migrating fish larvae and eggs, which were not identified.

Although the stocks of fish in pre-monsoon river pools were low, as soon as the water level and flow increased during the monsoon, the entire fish community in the river systems mixed and moved onto the floodplain, colonizing the habitat. This accounts for the rich species diversity found on the floodplain. The fish biomass and species diversity in *beels* and floodplain are not independent of these habitats, rather, they are heavily dependent on regular annual inundation by river flooding.

2. Migration

The findings of the migration study reveal that the floodplain species migrate for three purposes: spawning, nursing/feeding and to find winter refuge, or to find suitable dry season habitat.

2.1 Spawning Migration

Most fish in the Ganges-Brahmaputra river system leave their dry season refuge before or during early monsoon and move toward their spawning grounds. The spawning destination varies from species to species. Some prefer the river channels, some newly inundated floodplains, and some stagnant pools. Spawning is timed with temperature rise, rainfall, and increased water flow.

Among the floodplain river species, some spawn in river channels and some in the floodplain. The notable river spawners are the major carp species *catla (Catla catla) rui (Labeo rohita), calibaush (Labeo calbasu), mrigel (Cirrhinus mrigala)*, some catfish, *aair* (*Mystus aor*), *guizza* (*Mystus seenghala*), *rita* (*Rita rita*), *pabda* (*Ompok* spp.), *bacha* (*Eutropiichthys vacha*) *gharua* (*Clupisoma garua*), *batashi* (*Pseudeutropius atherinoides*), *kajuli* (*Ailia coila*), and others.

Major carp species begin their longitudinal migration between March and May, moving against current from their dry season habitats of *beels*, river scour holes, and the lower reaches of rivers to upstream areas of the Ganges and Brahmaputra, where they spawn from May to August. Major carp are thought to prefer for spawning habitat shallow areas in the river bends where vast areas of adjacent lands get flooded. Of all the rivers in Bangladesh, the Brahmaputra has the richest stock of major carp (Tsai and Ali 1986).

Among the river spawning catfish, *aair, guizza*, and *rita* build holes (breeding nest) in the river near shore during pre- and early monsoon for spawning. As soon as the pre-monsoon rains start these species move along the river channel in search of suitable places for making the nests for spawning.

In the Surma-Kushiyara area, (Map 6,next page) many mature *boal* (*Wallago attu*), *tengras* (*Mystus* spp.), *aair, rita, goinnaya* (*Labeo gonius), tatkini (Cirhinnus reba*) and some *rui, kalibaush* and *mrigel* were observed ascending against heavy current through Kakura Khal as they moved from the Surma River to the floodplain between mid-March and May (Table 1). Immigration of mature *boal* and *tengra* in huge quantity supports the fact that they prefer to spawn in the flooded lands. Although *aair* and *rita* are known to spawn in rivers, their active immigration (against current) at mature stage supports the fact that they may also spawn in the canal systems in the flooded *haor* basin. Minor carp species, notably *goinnaya* and *tatkini* may prefer flooded lands for spawning; they were found immigrating from river to floodplain in Surma-Kushiyara and Chalan Beel areas during pre- and early monsoon. Besides spawning in river channels, major carp species may also spawn in flooded *haor*/floodplain environments in the upper reaches; some mature *rui, kalibaush*, and *mrigel* were found immigrating from the Surma River to the flooded *haor* basin in pre-monsoon.

The longitudinal spawning migration in the river channel is usually active and against current and the lateral migration between river and floodplain is both against and with the current. In the Surma-Kushiyara project area, rainfall starts early in the pre-monsoon and *haor* water drain into rivers through some *khals* at high velocity (as most of the *khals* are closed). The fish species from the Surma River ascend against the water current through *khals* to the *haor* basin. In the Tangail and Chalan Beel areas the lateral spawning migration takes place when river water enters into the flooded lands through *khals* and public cuts and fish move from the river up the *khals* onto flooded lands with the current. Spawning migration and spawning start early in the Surma-Kushiyara area. Fish spawn and early fry were observed in the inundated land around *beels* in late March/early April. In Tangail and Chalan Beel, early fry were observed in May and migration commenced in late/early July when river water enters into floodplain though *khals*. Early rainfall and flooding thus can advance and widen the spawning activity and, in contrast, late rainfall/flooding can delay and limit such activity by fish.

Species that remain in *beels* throughout the dry season, such as *koi, singh, magur, puti, gutum, guchi*, and snakeheads, probably start spawning as soon as water inundates the lowlands around the *beels*. As the water rises, these species migrate locally and laterally to floodplains for spawning, feeding, and growth.

Table 1 **Migrating Species Caught in Kakura Khal (March 13 - May 17, 1992)**

Species	Number	Total wt. (kg)	Av. wt. (kg)
Boal	598	2,291	3.8
Aair	114	444	3.9
Rita	32	79	2.5
Goinnaya	92	60	0.7
Mrigal	14	40	2.9
Kalibaush	11	26	2.4
Rui	8	23	2.9

Many species, such as *mola, puti*, small shrimp, *koi, taki, shing, khalisha, guchi*, etc.—usually considered sedentary and able to spawn in the stagnant water of *beels*, pools, and ponds—were found migrating from river to floodplain even against heavy currents during pre- and early monsoon. All of these species may have a tendency to move to the biologically productive floodplain ecosystem for spawning and subsequent feeding, even though they are able to spawn in stagnant waters.

In all four study areas, mature eels laden with eggs, many species of small fish, and small shrimp carrying eggs migrated from river to floodplain during early monsoon both against and with the water current for spawning.

In the four study areas, 24 to 33 species were observed actively or passively migrating from river to floodplain during pre- and early monsoon. Most were commonly consumed species.

The highest level of lateral spawning migration occurred during the first few days of the influx of early monsoon rain waters. Appendix 1 lists the fish species found migrating through canals in the four study areas.

2.2 Migration to Nursery and Feeding Ground

Between March and May, water levels in *beels* and rivers increase with the pre-monsoon rains, eventually inundating nearby floodplains. Organic and inorganic by-products of dry season agriculture enter the water, providing essential nutrients for the biological productivity of the micro-level aquatic ecosystem. As water levels continue to rise during the monsoon, decomposed plant and animal residues also enter the inundated floodplain. These residues enhance the rapid growth of fish food organisms in the floodplain ecosystem, making it a suitable nursery habitat that is conducive to the spawning, feeding, and growth of fish.

After spawning in upstream rivers, adult major carp migrate downstream and then laterally onto floodplains to feed. The spawn and early fry are gradually swept downstream to small rivers and are dispersed through canals onto the floodplains for early growth and feeding.

During the study, larvae migrating from the Lohajong River to the floodplain were monitored in the Tangail area. Larvae were trapped in Sadullahpur Khal and Gaizabari Khal from July 1 through September 7, 1992, but monitoring was done only on days when the water flowed toward the project area. Appendix 2 details the number of larvae trapped on each sampling date. Among the larvae trapped were major carp, eels, *bailla, pabda, kajuli, aair, boal, chanda, chela*, and others that could not identified.

Fish larvae, predominantly of the major carp species, were found in the Jamuna and Dhaleswari rivers from late May through mid-August, and their numbers peaked in June (FPCO October 1992). The Tangail project area, however, which is fed by the Lohajong River via the Dhaleswari, was not inundated until July because of siltation at the confluence of the two rivers and because the canals connecting the project area to the Dhaleswari were blocked by dikes or closed regulators. Figure 2 shows that larval density peaked eight times in the Lohajong River between July 2 and September 7. Were it not for the blocked accesses to the Dhaleswari, there may have been a peak in June as well, and the first peaks in July might have been even higher. These peaks indicate that the fish spawn in batches, perhaps coinciding with rainfall or other environmental factors that can trigger spawning.

In addition to larvae, numerous fish eggs also were trapped as they entered the floodplain. It is assumed that laterally migrant fish, resident in rivers, spawn upstream in the inundated land on either side of the rivers. Their eggs are then swept downstream and through the canals to the floodplain.

During early monsoon, young *aair* also were found in the canals, indicating that this species might spawn early in rivers as well as in the floodplain. Kushiyara River fishermen confirm that finding, saying that the *aair* and *rita* build nests near the river shore prior to monsoon (March-April), and after spawning, their fry migrate to the floodplains for feeding and growth.

2.3 Migration to Dry Season Habitat

As soon as the floodplain area begins to reduce spatially, fish start migrating to deep water areas. After spending three to six months in the floodplain, all fish species (young, sub-adults, and adults) migrate back through the canals to the river along with the receding flood water. This migration is predominantly passive (that is, with the water current) and starts from mid-September and continue until November. The adults of some riverine fish (carp and catfish) may start migrating back to the river earlier than other species. When the flood water recedes some of the fish also migrate to, or are trapped in, local, relatively deep *beels,* borrow pits, ponds, and other perennial water bodies in the floodplain basin.

Fish shelter in rivers and perennial water bodies for the entire dry season (December through March). At this time they become vulnerable to over-fishing, disease, and harsh environmental conditions. The young and sub-adults grow to maturity in these dry season habitats and again migrate to their respective spawning habitats with the next spawning season, which coincides with pre-monsoon rains, water flow, and temperature rise.

3. The Role of *Khals* in Migration

Khals (canals) are crucial in providing access for fish migration during early and late monsoon. The study found that immigration begins with the initial influx of river water and peaks during the first few days of early monsoon. Emigration back coincides with the peak recession of water from the floodplain to the rivers during the last few days and weeks of late monsoon.

While fish were observed using *khals* as migration routes at both times, they presumably could also migrate at high flood stage when riverbanks overspill. This could not be confirmed, however. Because of the abnormally low flooding during the study year, none of the four study areas had any incidence of riverbank overspill. Fish were observed migrating only through canals and public cuts in embankments (particularly in Polder C in Singra). This leads to the conclusion that *khals* and embankment breaches are the only reliable routes for the lateral migration of fish.

4. Migration Obstruction

Fish migration can be obstructed in three ways: by infrastructures, through siltation, and by flooding extremes.

4.1 FCD and FCD/I Projects

FCD and FCD/I projects are designed to protect an area from river flooding, improve drainage and irrigation, and increase cropping intensity. Typical projects have three major components:

- embankments to control overbank spills;
- *khal* closures to control entry of river flood water; and
- *khal* regulators to control entry and drainage of flood water.

All three of these interventions negatively effect fish migration.

In Tangail CPP, Baruha, Kalibari, Barta, Suruj, and other areas *khals* have been closed by embankments along the Dhaleswari, Pungli, Lohajong, and Elanjani rivers. In addition, water flow in the Darjipara, Fatepur, Indro Belta, and Baro Belta canals is controlled by regulators. Despite the low level of flooding during the study year, those regulators were closed during monsoon months for unspecified reasons. As a result, fish eggs, larvae, and adults could not migrate to the floodplain from the Dhaleswari and Elanjani rivers.

In the Surma-Kushiyara area, Babur Khal, Chagli Khal, and many other canals have been closed by the embankment along the right bank of the Surma River. Moreover, water flow is regulated in Rahimpuri Khal and Sunam Khal. During the monsoon months these regulators are closed most of the time. In early monsoon, numerous fish of different species were seen moving toward *khals* from the Surma and Kushiyara rivers. These fish were stopped by the regulators and collected on the river side of the closed canal. Most of the fish were then caught by villagers and local fishermen.

4.2 Siltation

Heavy siltation in *khals* and river beds can also have serious negative effects on migration timing and, in some cases, make fish more vulnerable to capture by fishermen. In the Surma-Kushiyara area, for example, the siltation of the Karati Khal and Napit Khal delayed the filling of the water channel and therefore held up fish migration.

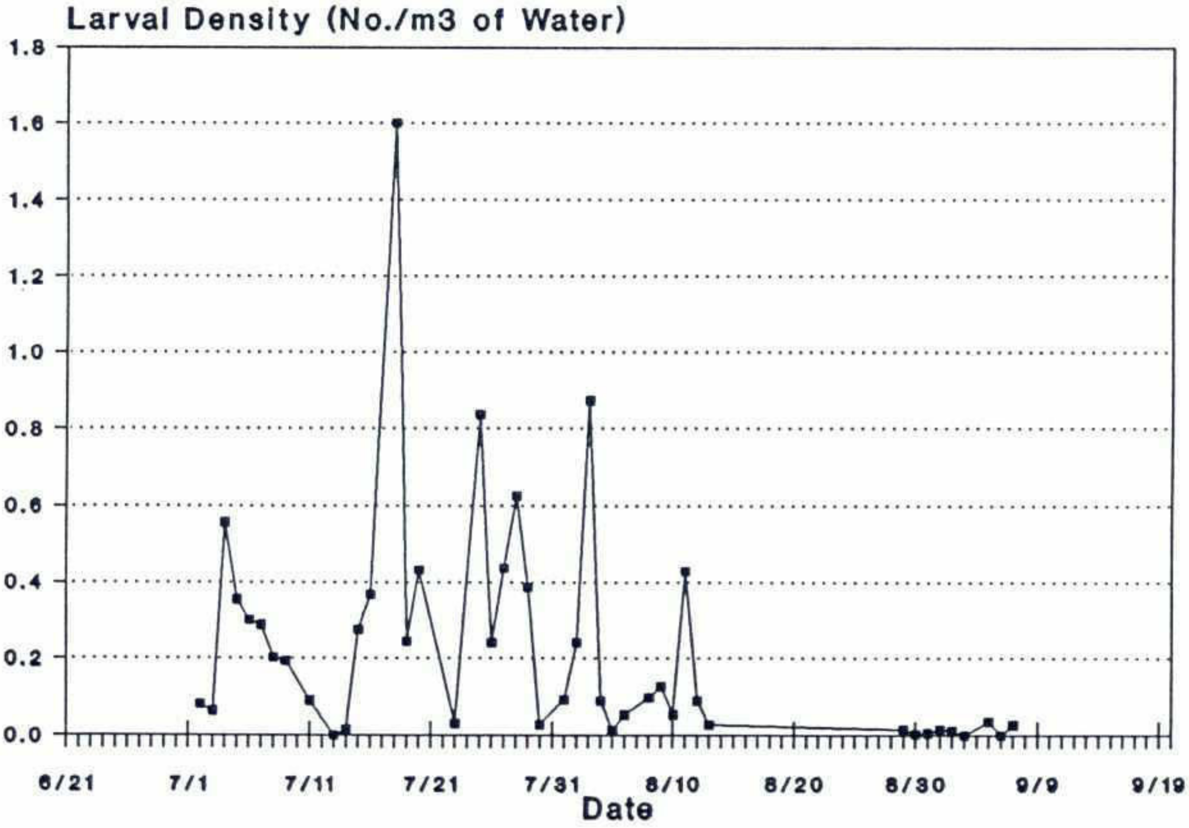

Figure 2: Density of Fish Larvae in Lohajong River (July-September 1992)

In a more severe instance, siltation at the confluence of the Jugni Khal in Tangail kept the canal completely dry during the monsoon months. People living on either side of the canal reported that it is usually inundated during monsoon, providing them with a productive fishing spot during that time.

At the confluence of the Lohajong and Dhaleswari rivers heavy siltation caused a late influx of flood water into the Lohajong and its distributary *khals*. This in turn reduced water volume and inhibited the timing of fish migration.

4.3 Controlled Flooding

The study found that fish migration is closely synchronized with the annual flooding cycle. Presumably, therefore, late flooding or reduced flooding under the controlled flooding management concept of FCD projects would hamper the biological activities of fish by delaying migration, limiting the time for migration, and reducing the time and area for dispersal, feeding, and growth.

4.4 Fishing During Migration

Apart from the hindrances already mentioned, fishing in the *khals* during migration was also observed to hamper fish in their efforts to spawn, feed, and move to dry season habitats.

Where FCD projects and roads have blocked most *khals*, migration has become more perilous, as the only routes through the canal are blocked by nets and traps. In Surma-Kushiyara, for example, the only functioning canal, Kakura Khal, carries the total burden of drainage and is the only avenue for fish migration. Fishing in this area is done by almost completely blocking the *khal* with bamboo fences and traps. During early monsoon, some small fish can migrate through the large-mesh nets, but most larger fish are caught. During the late monsoon migration, however, the fishing barriers are designed to trap all sizes of fish. Such fishing practices adversely affect the replenishment of river stock that is crucial to the following year's reproduction.

5. Consumption and Migration

The Household Survey found that most of the fish that was consumed by the rural poor consisted of non-cultured species, and that those species were caught from the floodplain, *beels*, and other flood-dependent water bodies. The migration study documented that most of the species consumed by households were migratory. The species were found in rivers, canals, on the floodplain, and in *beels*. Traps set in *khals* to monitor migration found that most species groups migrated from the river to the floodplain and back for spawning, as well as for other purposes.

It seems clear, then, that *beel* and floodplain fisheries production (which constitute the major portion of inland production) is dependent on regular annual flooding by river water. Interventions disrupting migration jeopardize fish production and species diversity and, thus, have an impact on consumption.

USE OF INTERVIEWS IN ENVIRONMENTAL IMPACT ASSESSMENT

1. Introduction

Interviews are particularly useful for collecting primary data in the field (in village settings), in eliciting social and economic information, and for exploring people's complex feelings and attitudes regarding proposed projects and local environmental issues. With encouragement and recognition of genuine interest on the part of the interviewer, village people will reveal a great deal about themselves, their beliefs, and their social and economic situation.

2. Group Interview

Group interviews can be held among individuals of the same economic and social standing, so that poorer or less powerful individuals are not forced to speak out in the presence of those who can do them social, political, or economic harm. One variation of the group interview is to convene special panels of local people who are knowledgeable about a particular aspect or resource.

Usually what happens when you go to the field is that you identify the chairman, member, or local community leader as key informants by talking to the villagers. Then you sit around with a group of people **you select to talk to** either under a tree, in someone's house, or at a mosque, school, or tea shop. The interview becomes an informal discussion, and its form is determined by the verbal give and take between all the individuals in the group, including questions and answers. It is conversation with a purpose.

Interviews with women usually occur in the privacy of their homes, most often in the kitchen. The interviewer, who should be a woman, talks to the women while they cook and work.

3. One-to-one Interview

One-to-one interviews are effective in eliciting social and economic information and opinions from the landless, poor women, religious minorities, and other ethnic groups. Their advantage is that they allow respondents to give more candid responses than they might in a group situation. In general, people are more willing to talk when they know that no one is present to make judgements about what they say.

There are several steps to conducting an oral interview. While each type of interview requires a somewhat different structure, certain principles and techniques are applicable to all. These principles divide an interview into three major parts: (1) the opening, (2) the body, and (3) the closing.

3.1 The Opening

First impressions are important. The first few seconds or minutes spent in the opening is often the most important period of the interview. A poor opening may lead to a superficial interview, inaccurate information, or no interview at all. Therefore, establishing rapport and creating good will and trust between the interviewer and the interviewee are critical. There are several things to remember when you create an interview.

- Dress appropriately. This will reduce reluctance and suspicion and encourage interviewees to respond to you more easily.
- Introduce yourself. Begin with a greeting like "How are you?" or "How have you been?" and, if necessary, talk about the weather, the family, yourself, and so on.
- Explain the nature and purpose of the interview. Be sincere and honest and try to establish a courteous and non-threatening atmosphere. Try to establish that you are concerned about the welfare of the interviewee and that the information you elicit will be used for his or her benefit.
- Talk about the organization you represent. Since an interviewee's reaction to the organization may be positive or negative, lessen the potential impact by preparing for a possible negative reaction. Be patient and polite in reacting to the interviewee's questions
- Be sure to give the interviewee time to understand what you are saying and what you expect from him or her. Since interviews should be in the form of informal discussions, allow the interviewees time to expand upon their answers as much as possible.

3.2 The Body

To impose a clear, systematic structure on an interview, it is necessary to design a questionnaire or develop a set of questions that will elicit the desired information. When talking to the respondents you will find that the conversations begin to wander and become unstructured. Listing questions makes it possible to keep the interview on track and to return to the structure when desired. Some general rules apply to the structuring of questions and questionnaires:

- Questionnaires should include both (a) structured questions, and (b) allowance for recording unstructured information.
- The questionnaire should have a section in which you can record demographic information about each interviewee. It should allow you to record the name of the key informant, name of the village, the social category of the interviewee, the sex of the interviewee, and so on
- Questions should be constructed so that they are clear and unambiguous. They should be simple, brief, and easy to understand.
- Questions should be as non-threatening as possible.
- Each question should elicit only one piece of information.

- Avoid leading questions. These are questions which you phrase as answers (e.g., "You eat three meals a day? or "You agree that....").

There are two general organizational formats for questions or questionnaires: (1) a funnel pattern, which begins with broad questions followed by more specific ones, and (2) an inverted funnel pattern, which begins with narrow questions followed by more general ones. There are certain general criteria for ordering questions. These include:

- The organization of questions should complement research objectives.
- Topically related questions should be grouped together.
- Easy to answer questions should be asked first.
- Questions should be ordered to avoid establishing a response bias. (Response bias means that the interviewee has a tendency to respond sequentially in the same way to different questions).

You will need to take notes during the interview, so take questionnaire forms, a small notebook, a large notebook or field diary, pens, and pencils. Take brief notes of answers during the interview and write up detailed reports in your field diary **as soon as you can** after each interview. This will help you to record the information before you forget it.

3.3 The Closing

Closings are brief but important parts of interviews. An abrupt closing may undo the rapport and trust established during the interview and make the interviewee feel uncomfortable. Each interview forms or adds to the relationship between the parties and creates expectations. Future interactions are enhanced by good closings and damaged by poor ones. The following are common closing techniques:

- Offer the interviewee a chance to make comments or give his or her opinion. Take time to be sincere in listening to them.
- Ask the interviewee if you have answered all of his or her questions. This is an effective closing if the interviewee perceives that you are making an honest effort to get at information or deal with his or her concerns that were not adequately addressed.
- Make personal inquiries. Talking informally about life in general is a pleasant way to end an interview. However, you must be genuinely interested in listening to the answers and exhibit real concern about them.
- Express appreciation and satisfaction.
- Summarize the interview and plan for the next meeting if you think that another one may be necessary. Note the address of the interviewee for follow-up interviews.

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- Use nonverbal and verbal signals to indicate that the interview has come to an end. You can stand up as though you are about to leave, move away from the interviewee and say "*E-bar ashee. Inshallah, aabar dekha hawbe.*"

Remember to use the closing that you think is most suitable for the interviewee. Your role in the interview, and perhaps your relationship with the interviewer may dictate some techniques and rule out others, as well as determine who will initiate the closing and when. Remember that the success of the interview will depend on how well you can adapt to the situation and the interviewee in your attempt to elicit the information you require.

MODULE 6

SUPPLEMENTAL HANDOUTS

The materials on the following pages are intended for duplication and distribution to skills workshop participants. Exercises and other handouts for this module are located in Volume I of the EIA Skills Workshop Trainer's Manual.

DISASTER MANAGEMENT PLAN

IMPORTANT TERMINOLOGIES RELATED TO DISASTER MANAGEMENT

1. Disaster

A disaster is an event, natural or man-made, sudden or progressive, that seriously disrupts the normal functioning of a society, causing human, material, or environmental losses of such severity that the affected community has to respond by taking exceptional measures. The disruption (including essential services and means of livelihood) is on a scale that exceeds the ability of the affected society to cope, using only its own resources.

2. Disaster Management

Disaster management includes all aspects of planning for and responding to disasters. It refers to risks and the consequences of disasters, and includes both:

- prevention and preparedness measures taken in disaster-prone areas in anticipation of the known hazards—often referred to as *"pre-disaster"* measures; and
- response to disasters when they occur, involving search and rescue, relief, short-term repairs (sometime referred to as *"rehabilitation"*), and long-term rehabilitation (sometimes referred to as *"reconstruction"*).

2.1 Pre-disaster Stage

The pre-disaster stage is a period when there is no immediate threat but long-term actions are taken in anticipation of the impact of known hazzards at some unknown time in the future.

2.2 Disaster Preparedness

Disaster preparedness involves the readiness and ability of the government, communities, and individuals to:

- take precautionary measures prior to an imminent threat where advance warnings are possible; and
- organize timely response in the event of a disaster.

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2.2.1 Preparedness Involves

- Forecasting and warning systems for cyclones and floods; and

- operational capability (plans, procedures, resources) to ensure timely action at all levels by communities, government, NGOs, and other aid organizations (1) when a warning is issued and (2) following a disaster. This includes arrangement (at the local level) for the evacuation of people, livestock, and movable property from threatened localities, and the implementation of other temporary, precautionary measures to protect lives and property when a warning is issued; and arrangements at all levels to organize search and rescue, provide relief, and make emergency repairs to restore essential services, when needed. Education, training and practice drills are essential at all levels.

2.3 Disaster Prevention

Disaster prevention involves adopting *preventive* or *mitigative measures* designed to permanently reduce the adverse impact of cyclones, floods, and other potentially damaging events. These can include:

- Building embankments, drainage channels, afforestation, flood proofing, or other structural measures to reduce the impact of hazards. These are sometimes referred to as *"hazard reduction measures."*

- Land use planning or zoning to ensure that people and economic assets are not located in hazardous areas, and that new developments do not create new risks. This is sometimes referred to as *"hazard avoidance."*

- Improving construction standards for new structures and strengthening existing ones to better withstand floods, earthquakes, high winds, or other phenomena that are likely to occur in the locality. These are sometimes referred to as *"hazard resistance."*

2.3.1 Vulnerability Analysis

Vulnerability is the extent to which a community, structure, service, economic activity, or geographic area is likely to be damaged or disrupted by the impact of a particular hazardous phenomenon.

Vulnerability analysis is the process of estimating the vulnerability to particular hazardous phenomena of specified elements (structures, services, or whole communities) at risk. Combined with an analysis and mapping of the hazards to which an area is prone, it provides a basis for planning relevant preventive and preparedness measures.

2.3.2 Warning

Warning stage

The warning stage is a period from the issuing of an alert or public warning of an imminent disaster threat to its actual impact, or the passage of the threat and the lifting of the warning. The period during which pre-impact precautionary or disaster containment measures are taken.

Warning systems

Warning systems are arrangements to rapidly disseminate information concerning an imminent disaster threat to officials, institutions, and the population at large in the areas immediately at risk.

Warnings normally concern cyclones or floods. A warning system involves links to forecasting systems, the organizational and decision-making processes to decide on the issuing of particular warnings, and the communications facilities (radio and others) to broadcast the warnings. Its effectiveness depends on the prior education and training of officials and the population concerning the meaning of the warnings and the actions to be taken.

3. Emergency Stage

The period during and immediately following the occurrence of a disaster, when exceptional (emergency) measures have to be taken to save lives and property and to meet the basic needs of the stricken population, i.e., shelter, drinking water, food, and medical care.

3.1 Emergency Risk Reduction Measures

These measures are actions taken in response to a disaster warning to minimize or contain the eventual negative effects. This includes, as and where needed, evacuation and other precautionary measures, flood-fighting, and similar measures. These precautionary (pre-impact) measures are pre-planned, as a part of preparedness, and put into effect when and where specified conditions arise.

3.2 Emergency Relief

Emergency relief is the assistance that is provided to save and preserve lives and meet the basic subsistence needs of disaster victims. Relief includes material aid to enable affected families to meet their basic needs for shelter, clothing, water, food (including the means to prepare food), and emergency medical care.

Emergency relief measures are planned and implemented on the basis of the (post-impact) assessment, but they may be initiated on the basis of past experience and preparedness plans until sufficiently comprehensive assessment data become available.

3.3 Assessment (Post-impact)

This is the process for determining the impact of a disaster on a society; the needs for immediate, emergency measures to save and sustain the lives of survivors; and the possibilities for facilitating and expediting recovery. Assessment is an interdisciplinary process, undertaken in phases, involving on-the-spot surveys and the collation, evaluation, and interpretation of information from various sources concerning both direct and indirect losses and short- and long-term effects. It involves not only determining what has happened, what resources are available to the affected communities, and what assistance might be needed but also defining objectives and how relevant assistance can actually be provided to the victims, considering both short-term needs and long-term implications.

3.4 Damage Assessment

This is the preparation of specific, quantified estimates of physical damage resulting from a disaster, and recommendations concerning the repair, reconstruction or replacement of structures and equipment, and the restoration of economic (including agricultural) activities.

4. Recovery

Recovery is the period following the emergency phase during which actions are taken to enable victims to resume normal lives and means of livelihood, and to restore infrastructure, services, and the economy in a manner appropriate to long-term needs and defined development objectives. Recovery encompasses both rehabilitation and reconstruction, and may include the continuation of certain relief (welfare) measures in favor of particular disadvantaged, vulnerable groups.

4.1 Short-term Rehabilitation and Repairs

These are actions taken in the aftermath of a disaster to enable basic services to resume functioning, to assist victims' efforts to repair dwelling and community facilities, and to revive economic activities, including agriculture.

Rehabilitation focuses on enabling the affected populations to resume more-or-less normal (pre-disaster) patterns of life.

4.2 Long-term Rehabilitation/Reconstruction

This is the permanent reconstruction or replacement of severely damaged physical structures, full restoration of all services and local infrastructure, and revitalization of the economy (including agriculture). Reconstruction must be fully integrated into ongoing long-term development plans, taking account of future disaster risks and possibilities in order to reduce those risks by incorporating appropriate mitigation measures. Damaged structures and services may not necessarily be restored in their previous form or locations. It may include the replacement of any temporary arrangements established as a part of emergency response or rehabilitation.

Suggested Readings

1. Disaster Management Handbook of Bangladesh, Vol I-IV by Md. Saidur Rahman, Bangladesh Disaster Preparedness Centre. February 1993

2. Disaster Management, Publishers ADB

পরিবেশ নীতি ১৯৯২
ও
বাস্তবায়ন কার্যক্রম

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ ও বন মন্ত্রণালয়

মুখবন্ধ

আমাদের উন্নয়ন প্রক্রিয়া অব্যাহত রাখার পাশাপাশি পরিবেশ সংরক্ষণের ব্যাপারেও যে করণীয় আছে সে প্রশ্নে আজ কারো দ্বিমত নেই বললেই চলে। জাতীয় পর্যায়ে সঠিক দিক নির্দেশনা প্রদানের জন্য একটি নীতিমালার প্রয়োজন দীর্ঘদিন ধরে অনুভূত হচ্ছে। পরিবেশ নীতি সেই চাহিদা পূরণের লক্ষ্যে প্রণয়ন করা হয়েছে।

বস্তুতঃ কেবল নীতিমালাই নয়, সরকারী-বেসরকারী সকল পর্যায়ে উন্নয়ন কার্যক্রম ও কর্মসূচীতে যাতে উক্ত নীতিমালার বাস্তব প্রতিফলন ঘটে এবং প্রত্যেকে তাদের করণীয় সম্পর্কে একটি রূপরেখা পান ও সে সম্পর্কে সজাগ থাকেন তা নিশ্চিত করার জন্য পরিবেশ সংক্রান্ত বাস্তবায়ন কার্যক্রম প্রণয়ন করা হয়েছে। পরিবেশ নীতি এবং বাস্তবায়ন কার্যক্রম প্রচলিত রীতি অনুযায়ী সকল মন্ত্রণালয়/বিভাগের সাথে পরামর্শের মাধ্যমে চূড়ান্ত করা হয়েছে এবং আমি এই সুযোগে যারা এ ব্যাপারে সাহায্য/সহযোগিতা প্রদান করেছেন তাদের আন্তরিক ধন্যবাদ জানাচ্ছি। উন্নয়ন এবং পরিবেশ অংগাংগীভাবে জড়িত। ক্ষেত্র বিশেষে উন্নয়নের প্রচেষ্টা এবং পরিবেশ সংরক্ষণ প্রয়াসে একটি আপাতঃ এবং সাময়িক বৈপরীত্য পরিলক্ষিত হলেও টেকসই উন্নয়নের প্রত্যয় আমাদের এই ধারনা যোগায় যে, বর্তমান ও আগামী প্রজন্মের সুষ্ঠু বিকাশের স্বার্থে এবং মানবজাতির অস্তিত্ব রক্ষার তাগিদে পরিবেশ সংরক্ষণের বিকল্প নেই। এই প্রেক্ষাপটে বর্তমান সরকার অনুমোদিত পরিবেশ নীতি ১৯৯২ ও বাস্তবায়ন কার্যক্রম একটি উল্লেখযোগ্য পদক্ষেপ। এই নীতির দ্রুত ও সুষ্ঠু বাস্তবায়নের ব্যাপারে সংশ্লিষ্ট সকলের সহযোগিতা ও উদ্যোগ কামনা করছি।

(আবদুল্লাহ্-আল-নোমান)
পরিবেশ ও বন মন্ত্রী।

পরিবেশ নীতি ১৯৯২

১। প্রস্তাবনা ও প্রেক্ষিতঃ

প্রকৃতি এবং পরিবেশের উপর প্রাণী ও উদ্ভিদ জগতের অস্তিত্ব ও উন্নতি নির্ভরশীল। সাম্প্রতিককালে প্রাকৃতিক পরিবেশের ক্রমাবনতি সকল প্রকার প্রাণের অস্তিত্ব এবং মানব সভ্যতার উন্নয়নে একটি মারাত্মক সমস্যা হিসাবে চিহ্নিত হইয়াছে।

বাংলাদেশে পরিবেশের উপর বিভিন্ন বিরূপ প্রতিক্রিয়ার প্রেক্ষাপটে সরকার পরিবেশ সংরক্ষণ ও উন্নয়নের প্রতি বিশেষ গুরুত্ব আরোপ করিয়াছেন। দেশে উপর্যুপরী বন্যা, খরা, ঘূর্ণিঝড়, জলোচ্ছ্বাস প্রভৃতি প্রাকৃতিক দুর্যোগ, উত্তরাঞ্চলে মরুময়তার প্রাথমিক লক্ষণাদি, নদ-নদীতে লবণাক্ততার বিস্তার, ভূমিক্ষয়, বনাঞ্চলের দ্রুত হ্রাস, জলবায়ু ও আবহাওয়ার অস্থিরতাসহ অন্যান্য পরিবেশগত সমস্যা বিদ্যমান। এই প্রেক্ষিতে পরিবেশ সংরক্ষণ ও উন্নয়ন সংক্রান্ত কার্যকলাপ সমন্বয় করার উদ্দেশ্যে পরিবেশ ও বন মন্ত্রণালয় ও পরিবেশ অধিদপ্তর গঠন এবং দেশের প্রধান প্রধান পরিবেশ দূষণ ও অবক্ষয় সংক্রান্ত সমস্যাগুলিকেও সুস্পষ্টরূপে চিহ্নিত করা হইয়াছে।

পরিবেশ সংরক্ষণে বিভিন্ন আর্থসামাজিক সমস্যাদি যেমন জনসংখ্যা বিস্ফোরণ, দারিদ্র, নিরক্ষরতা, অপ্রতুল স্বাস্থ্য ব্যবস্থা, গণসচেতনতার অভাব ইত্যাদি দুরূহ প্রতিবন্ধকতা হিসাবে দেখা দিয়াছে বিধায় পরিবেশ উন্নয়ন সংক্রান্ত কার্যক্রমের সংগে এই গুলিকেও সার্মাগ্রক এবং সমন্বিতভাবে সমাধান করা প্রয়োজন। একটি সুনির্দিষ্ট জাতীয় নীতিমালার আওতায় প্রাসংগিক সমস্যাদির সমাধান ও এই বিষয়ে সরকারের অংগীকারের যথাযথ বাস্তবায়ন সম্ভব।

পরিবেশ প্রশ্নে বাংলাদেশ সরকার মনে করে যেঃ—

১.১ আন্তর্জাতিক ও আঞ্চলিক প্রেক্ষাপটে পরিবেশ দূষণ ও অবক্ষয়ের সহিত বাংলাদেশের প্রকৃতি, পরিবেশ ও সম্পদের ভিত্তি সরাসরিভাবে সম্পর্কিত বিধায় এই বিষয়ে সমন্বিত সতর্কতা ও প্রয়োজনীয় কার্যক্রম গ্রহণ করা আবশ্যক।

১.২ বাংলাদেশের অবস্থান, পরিবেশের অবক্ষয় ও ক্রমাবনতি এবং সম্পদ ব্যবহারে লাগসই প্রযুক্তি, টেকসই পদ্ধতি ও প্রক্রিয়ার অভাব একটি সমন্বিত ও অগ্রাধিকার ভিত্তিক পরিবেশ নীতি গ্রহণের বিষয়টিকে অপরিহার্য করিয়া তুলিয়াছে।

১·৩ পরিবেশ সংরক্ষণ ও উন্নয়ন নিশ্চিত করার লক্ষ্যে সকল প্রকার জাতীয় সম্পদের সুষ্ঠু ব্যবহারকল্পে সর্বস্তরের জনগণকে সম্পৃক্ত করা আবশ্যক। ব্যাপক গণসচেতনতা সৃষ্টির মাধ্যমেই ইহা নিশ্চিত করা যায়।

১·৪ দেশের প্রাকৃতিক দুর্যোগজনিত সমস্যাদির তাৎক্ষণিক ও দীর্ঘমেয়াদী সমাধানকল্পে এই বিষয়টিকে দেশের সার্বিক পরিবেশ সংরক্ষণ ও উন্নয়ন এবং সম্পদ ব্যবস্থাপনার অবিভাজ্য অংশ হিসাবে বিবেচনা করা প্রয়োজন।

১·৫ দেশে স্থানীয় ও জাতীয় পর্যায়ে প্রয়োজনীয় কার্যক্রম গ্রহণ এবং সংশ্লিষ্ট বিষয়ে আঞ্চলিক ও আন্তর্জাতিক সহযোগিতার মাধ্যমে দেশ তথা বিশ্বব্যাপী পরিবেশ উন্নয়ন ও সম্পদের পরিবেশ সম্মত ব্যবহার নিশ্চিত করা সম্ভব ও আবশ্যক।

২। উদ্দেশ্য:

পরিবেশ নীতির উদ্দেশ্যসমূহ নিম্নরূপ:

২·১ পরিবেশ সংরক্ষণ ও উন্নয়নের মাধ্যমে দেশের প্রাকৃতিক ভারসাম্য সংরক্ষণ ও সার্বিক উন্নয়ন।

২·২ দেশকে প্রাকৃতিক দুর্যোগ হইতে রক্ষা।

২·৩ সকল প্রকার দূষণ ও অবক্ষয়মূলক কর্মকান্ড সনাক্তকরণ ও নিয়ন্ত্রণ।

২·৪ সকল ক্ষেত্রে পরিবেশ সম্মত উন্নয়ন নিশ্চিতকরণ।

২·৫ সকল জাতীয় সম্পদের টেকসই, দীর্ঘমেয়াদী ও পরিবেশ সম্মত ব্যবহারের নিশ্চয়তা বিধান।

২·৬ পরিবেশ সংক্রান্ত সকল আন্তর্জাতিক উদ্যোগের সহিত যথাসম্ভব সক্রিয়ভাবে জড়িত থাকা।

৩। নীতিমালা:

পরিবেশ সংক্রান্ত কার্যক্রম দেশের সকল অঞ্চল এবং উন্নয়ন সেক্টরে বিস্তৃত। তাই পরিবেশ নীতির সার্বিক লক্ষ্যসমূহ অর্জনে এই নীতিমালা ১৫টি খাতে নিম্নে বর্ণিত হইল:

৩·১ কৃষি:

৩·১·১ কৃষি উন্নয়ন ও খাদ্যে স্বয়ংসম্পূর্ণতা অর্জনের লক্ষ্যে গৃহীত সকল প্রচেষ্টা ও প্রযুক্তি পরিবেশ সম্মতকরণ।

৩·১·২ উন্নয়ন কর্মকান্ডে সকল কৃষি সম্পদের ভিত্তি সংরক্ষণ এবং উহাদের পরিবেশ সম্মত ও দীর্ঘমেয়াদী ব্যবহারের নিশ্চয়তা বিধান।

৩·১·৩ কৃষি ক্ষেত্রে যে সকল রাসায়নিক ও কৃত্রিম উপকরণ ও উপাদান ভূমির উর্বরতা ও জৈবগুণ বিনষ্ট করাসহ মানুষ ও অন্যান্য প্রাণীর উপর ক্ষতিকর প্রভাব ফেলিয়া থাকে উহাদের ব্যবহার নিয়ন্ত্রণ এবং উক্ত উপকরণসমূহ ব্যবহারকালে কৃষি শ্রমিকের নিরাপত্তামূলক ব্যবস্থা-গ্রহণের বিধান করা। সেই সাথে বিভিন্ন প্রকার প্রাকৃতিক সার ও কীট নাশকের ব্যবহার উৎসাহিত করণ।

৩·১·৪ কৃষি ক্ষেত্রে উৎপাদন ব্যবস্থাপনা ও উৎপাদন সম্পর্কের ক্ষেত্রে পরিবেশ সংরক্ষণ, উন্নয়ন ও সম্পদের টেকসই ব্যবহারের লক্ষ্যে এই ক্ষেত্রে প্রয়োজনীয় পরিবর্তনের মাধ্যমে পরিবেশ সম্মত উন্নয়নে সহায়তা প্রদান।

৩·১·৫ পরিবেশসম্মত প্রাকৃতিক তন্তু যথা পাট ও পাটজাত দ্রব্যাদির ব্যবহার বৃদ্ধিকরণ।

৩·২ শিল্প:

৩·২·১ শিল্প প্রতিষ্ঠানসমূহ কর্তৃক পরিবেশ দূষণের ব্যাপারে পর্যায়ক্রমে সংশোধনমূলক ব্যবস্থা গ্রহণ।

৩·২·২ সরকারী ও বেসরকারী সকল ক্ষেত্রে নূতন শিল্প স্থাপনের পূর্বে পরিবেশগত প্রতিক্রিয়া নিরূপনের (ই আই এ) ব্যবস্থা করণ।

৩·২·৩ পরিবেশ দূষণ করে এমন পণ্য উৎপাদনকারী শিল্প স্থাপন নিষিদ্ধকরণ, স্থাপিত শিল্পসমূহ পর্যায়ক্রমে বন্ধকরণ এবং এই সমস্ত শিল্প প্রতিষ্ঠান কর্তৃক উৎপাদিত পণ্যের পরিবেশসম্মত বিকল্প পণ্য উদ্ভাবন/প্রচলনের মাধ্যমে ঐ সকল পণ্যের ব্যবহার নিরুৎসাহিতকরণ।

৩·২·৪ শিল্প ক্ষেত্রে পরিবেশসম্মত ও লাগসই প্রযুক্তি উদ্ভাবন এবং এতদসংক্রান্ত গবেষণা ও সম্প্রসারণ কার্যক্রম উৎসাহিতকরণ এবং অনুরূপ কার্যক্রমকে শ্রমের সর্বোৎকৃষ্ট ব্যবহার ও ন্যায়সংগত মূল্য প্রদানের সহিত সামঞ্জস্যপূর্ণকরণ।

৩·২·৫ শিল্পে কাঁচামালের অপচয়রোধ ও টেকসই ব্যবহার নিশ্চিতকরণ।

৩·৩ স্বাস্থ্য ও স্বাস্থ্য বিধান:

৩·৩·১ দেশের সকল ক্ষেত্রে ও সকল উন্নয়ন কর্মকান্ডে জনস্বাস্থ্যের প্রতি ক্ষতিকারক কর্মকান্ড প্রতিরোধকরণ।

৩·৩·২ দেশের স্বাস্থ্যনীতিতে পরিবেশ সংক্রান্ত চিন্তাভাবনা সম্পৃক্তকরণ।

৩.৩.৩ স্বাস্থ্য শিক্ষা ব্যবস্থায় পরিবেশ বিষয়ক কারিকুলাম অন্তর্ভুক্তকরণ।

৩.৩.৪ শহর ও পল্লী এলাকায় স্বাস্থ্য সম্মত পরিবেশ গড়িয়া তোলা।

৩.৩.৫ শ্রমিকদের কর্মস্থল স্বাস্থ্য সম্মত রাখার ব্যবস্থাকরণ।

৩.৪ জ্বালানীঃ

৩.৪.১ যে সকল জ্বালানী পরিবেশ দূষণ করে সেইগুলির ব্যবহার হ্রাস ও নিরুৎসাহিতকরণ এবং পরিবেশ সম্মত ও কম ক্ষতিকারক জ্বালানী ব্যবহার বৃদ্ধিকরণ।

৩.৪.২ জ্বালানী হিসাবে কাঠ, কৃষি বর্জ্য ইত্যাদির ব্যবহার হ্রাস ও বিকল্প জ্বালানী ব্যবহার বৃদ্ধিকরণ।

৩.৪.৩ আণবিক শক্তির ব্যবহারে বিরূপ পরিবেশগত প্রতিক্রিয়া সম্পর্কে যথাযথ সতর্কতা গ্রহণ এবং সকল প্রকার আণবিক দূষণ ও তেজস্ক্রিয় বিকিরণ রোধে ব্যবস্থা গ্রহণ।

৩.৪.৪ জ্বালানী সাশ্রয়ের জন্য উন্নত ধরনের প্রযুক্তি উদ্ভাবন, ব্যবহার ও উহার দ্রুত সম্প্রসারণ।

৩.৪.৫ দেশের মওজুদ ও নবায়নযোগ্য জ্বালানী সংরক্ষণ।

৩.৪.৬ জ্বালানী ও খনিজ সম্পদ আহরণ সংক্রান্ত প্রকল্প গ্রহণের পূর্বে পরিবেশগত প্রভাব নিরূপণের ব্যবস্থা করণ।

৩.৫ পানি উন্নয়ন, বন্যা নিয়ন্ত্রণ ও সেচঃ

৩.৫.১ দেশের সকল পানি সম্পদের পরিবেশসম্মত ব্যবহার নিশ্চিতকরণ।

৩.৫.২ পানি সম্পদ উন্নয়নকল্পে গৃহীত ব্যবস্থাদি ও সেচ নেটওয়ার্ক যাহাতে পরিবেশে বিরূপ প্রতিক্রিয়া সৃষ্টি না করে তাহা নিশ্চিতকরণ।

৩.৫.৩ বন্যা নিয়ন্ত্রণের উদ্দেশ্যে বাঁধ নির্মাণ, নদী ও খাল খনন প্রভৃতি গৃহীত ব্যবস্থাদি যাহাতে স্থানীয়, আঞ্চলিক ও জাতীয় পর্যায়ে পরিবেশসম্মত হয় তাহার নিশ্চয়তা বিধান।

৩.৫.৪ পানি সম্পদ ও বন্যা নিয়ন্ত্রণ ক্ষেত্রে ইতিমধ্যে গৃহীত ব্যবস্থাদির পরিবেশগত বিরূপ প্রতিক্রিয়া দূরীকরণ।

৩.৫.৫ দেশের হাওর, বাওর, বিল, ঝিল, নদী প্রভৃতি সকল জলাশয় ও পানি সম্পদকে দূষণমুক্ত রাখা।

৩.৫.৬ ভূগর্ভস্থ ও ভূউপরিস্থ পানির ব্যবহার ও ব্যবস্থাপনা বিজ্ঞানভিত্তিক টেকসই, দীর্ঘমেয়াদী ও পরিবেশ সম্মতকরণ।

৩.৫.৭ সকল পানি সম্পদ উন্নয়ন ও ব্যবস্থাপনা সংক্রান্ত প্রকল্প গ্রহণের আগে পরিবেশগত প্রভাব নিরূপণের ব্যবস্থাকরণ।

৩.৬ ভূমিঃ

৩.৬.১ ভারসাম্যমূলক পরিবেশসম্মত জাতীয় ভূমি ব্যবহার নীতি ও পরিকল্পনা প্রণয়ন।

৩.৬.২ ভূমিক্ষয় রোধ, উর্বরতা সংরক্ষণ ও বৃদ্ধি, ভূমি পুনরুদ্ধার ও নতুন জাগিয়া উঠা ভূমি সংরক্ষণ ও ব্যবস্থাপনা কার্যক্রম জোরদারকরণ।

৩.৬.৩ দেশের বিভিন্ন ইকো-সিস্টেমের (Eco-system) সহিত সংগতিপূর্ণ ভূমি ব্যবহার পদ্ধতি প্রবর্তনে উৎসাহ প্রদান।

৩.৬.৪ জমির লবণাক্ততা ও ক্ষারতার প্রভাব রোধকরণ।

৩.৭ বন, বন্যপ্রাণী ও জীববৈচিত্রঃ

৩.৭.১ দেশের প্রাকৃতিক পরিবেশগত ভারসাম্য ও আর্থ-সামাজিক প্রয়োজন ও বাস্তবতার প্রেক্ষিতে প্রয়োজনীয় বন ও বৃক্ষাদি সংরক্ষণ, সম্প্রসারণ ও উন্নয়ন।

৩.৭.২ সকল সংশ্লিষ্ট উন্নয়ন কর্মকাণ্ডে বৃক্ষরোপণ কর্মসূচী অন্তর্ভুক্তকরণ।

৩.৭.৩ বন ভূমি ও বনজ সম্পদের সংকোচন ও ক্ষয়রোধ বন্ধকরণ।

৩.৭.৪ বনজ সম্পদের বিকল্প উদ্ভাবন ও উহার ব্যবহারে উৎসাহ প্রদান।

৩.৭.৫ দেশের বন্য প্রাণী ও জীববৈচিত্র সংরক্ষণ, সংশ্লিষ্ট ক্ষেত্রে গবেষণা জোরদারকরণ এবং এতদসংক্রান্ত জ্ঞান ও অভিজ্ঞতার বিনিময়ে সহায়তা প্রদান।

৩.৭.৬ দেশের জলাভূমি ও অতিথি পাখীর সংরক্ষণ ও উন্নয়ন।

৩.৮ মৎস্য ও পশুসম্পদঃ

৩.৮.১ মৎস্য ও পশুসম্পদের সংরক্ষণ ও উন্নয়নের জন্য উপযুক্ত পরিবেশ নিশ্চিতকরণ।

৩.৮.২ মৎস্য সম্পদের উৎস হিসাবে চিহ্নিত জলাভূমিগুলির সংকোচন প্রতিরোধ এবং সংস্কারমূলক ব্যবস্থাদি গ্রহণে উৎসাহ প্রদান।

৩.৮.৩ মৎস্য ও পশুসম্পদ উন্নয়নমূলক পদক্ষেপসমূহ যাহাতে ম্যানগ্রোভ বনাঞ্চল ও অন্যান্য ইকো-সিস্টেমের প্রতি কোনরূপ বিরূপ প্রতিক্রিয়া সৃষ্টি না করে তাহা নিশ্চিতকরণ।

৩.৮.৪ মৎস্য সম্পদের ক্ষতিকারক পানি উন্নয়ন, বন্যা নিয়ন্ত্রণ ও সেচ প্রকল্পের পুনঃ মূল্যায়ন এবং পরিবেশ উন্নয়ন পূর্বক মাছ চাষের বিকল্প ব্যবস্থা করণ।

৩.৯ খাদ্যঃ

৩.৯.১ খাদ্য উৎপাদন, সংরক্ষণ, প্রক্রিয়াজাতকরণ ও বন্টন পদ্ধতি স্বাস্থ্য ও পরিবেশ সম্মতভাবে নিষ্পন্ন হওয়া নিশ্চিতকরণ।

৩.৯.২ বিনষ্ট খাদ্যদ্রব্য পরিবেশ সম্মতভাবে নিষ্পত্তিকরণ।

৩.৯.৩ জনস্বাস্থ্য ও পরিবেশে বিরূপ প্রতিক্রিয়া সৃষ্টি করিতে পারে এইরূপ খাদ্যদ্রব্য আমদানী নিষিদ্ধকরণ।

৩.১০ উপকূলীয় ও সামুদ্রিক পরিবেশঃ

৩.১০.১ দেশের উপকূলীয় ও সামুদ্রিক ইকো-সিস্টেম (Eco-system) এবং সম্পদের পরিবেশ সম্মত সংরক্ষণ ও উন্নয়ন নিশ্চিতকরণ।

৩.১০.২ উপকূলীয় ও সামুদ্রিক এলাকায় সকল প্রকার অভ্যন্তরীণ ও বৈদেশিক দূষণমূলক কর্মকান্ড প্রতিরোধকরণ।

৩.১০.৩ উপকূলীয় ও সামুদ্রিক পরিবেশ ও সম্পদ সংরক্ষণ ও উন্নয়নে প্রয়োজনীয় গবেষণা জোরদারকরণ।

৩.১০.৪ উপকূল ও সামুদ্রিক অঞ্চলে ধৃত মাছের পরিমাণ সর্বোচ্চ সহনশীল সীমায় রাখা।

৩.১১ যোগাযোগ ও পরিবহনঃ

৩.১১.১ স্থলপথ, রেল. বিমান ও অভ্যন্তরীণ নৌ-পথ ব্যবস্থা যাহাতে কোনরূপ পরিবেশ দূষণ বা সম্পদের অবক্ষয়মূলক প্রতিক্রিয়া সৃষ্টি না করে তাহা নিশ্চিতকরণ এবং এই ধরণের প্রকল্প বাস্তবায়নের আগে পরিবেশগত প্রভাব নিরূপনের ব্যবস্থা গ্রহণ।

৩.১১.২ সড়ক, রেল. বিমান ও নৌ-পথে চলাচলকারী যানবাহন এবং জনগণ যাহাতে পরিবেশ দূষণমূলক কর্মকান্ডে লিপ্ত না হয় তাহা নিশ্চিতকরণ এবং অনুরূপ যানবাহন পরিচালনায় নিয়োজিত শ্রমিকদের স্বাস্থ্য সংরক্ষণের ব্যবস্থা গ্রহণ।

৩.১১.৩ অভ্যন্তরীণ নৌ-বন্দর ও ডকইয়ার্ডসমূহ কর্তৃক পানি ও স্থানীয় পরিবেশ দূষণমূলক কার্যক্রম নিয়ন্ত্রণ।

৩.১২ গৃহ ও নগরায়নঃ

৩.১২.১ গৃহায়ন ও নগরায়ন সংক্রান্ত সকল পরিকল্পনা এবং গবেষণায় পরিবেশগত চিন্তা সম্পৃক্তকরণ।

৩.১২.২ শহর ও গ্রামাঞ্চলে বর্তমান আবাসিক এলাকাসমূহে পর্যায়ক্রমে পরিবেশ সম্মত সুযোগ-সুবিধাদি সম্প্রসারণ।

৩.১২.৩ স্থানীয় ও সার্বিক পরিবেশের উপর বিরূপ প্রতিক্রিয়া সৃষ্টিকারী গৃহায়ন ও নগরায়ন নিয়ন্ত্রণ।

৩.১২.৪ নগরীর সৌন্দর্য বর্ধনে জলাশয়ের ভূমিকার উপর গুরুত্ব আরোপ।

৩.১৩ জনসংখ্যাঃ

৩.১৩.১ জনশক্তির সমন্বিত. সুপরিকল্পিত ও পরিবেশ সম্মত ব্যবহার নিশ্চিতকরণ।

৩.১৩.২ সরকারের জনসংখ্যা নীতি ও কার্যকলাপে পরিবেশ সংরক্ষণ ও উন্নয়নমূলক চিন্তা সম্পৃক্তকরণ।

৩.১৩.৩ উন্নয়নমূলক কাজে মহিলাদের ভূমিকা নিশ্চিতকরণ।

৩.১৩.৪ উন্নয়নমূলক কাজে বেকার জনশক্তির ব্যবহার উৎসাহিতকরণ।

৩.১৪ শিক্ষা ও গণ-সচেতনতাঃ

৩.১৪.১ শিক্ষার প্রসার ও দেশের সার্বিক উন্নয়নে জনগণকে অধিকতর সম্পৃক্ত করার লক্ষ্যে নিরক্ষরতা দূরীকরণ এবং শিক্ষিতের হার দ্রুত বৃদ্ধির লক্ষ্যে ব্যবস্থা গ্রহণ।

৩.১৪.২ পরিবেশ সংরক্ষণ ও উন্নয়ন, সকল জাতীয় সম্পদের টেকসই, দীর্ঘমেয়াদী এবং পরিবেশ সম্মত ব্যবহার ইত্যাদি বিষয়ে ব্যাপক গণ-সচেতনতা সৃষ্টিকরণ।

৩.১৪.৩ প্রাতিষ্ঠানিক এবং অপ্রাতিষ্ঠানিক সকল প্রকার শিক্ষা ব্যবস্থা ও মাধ্যমে পরিবেশ সংক্রান্ত জ্ঞান ও তথ্যের ব্যাপক অন্তর্ভূক্তি ও প্রসার নিশ্চিতকরণ।

৩.১৪.৪ প্রাসংগিক সকল কাজে জনগণকে স্বতঃস্ফূর্ত ও সরাসরি অংশগ্রহণে উদ্বুদ্ধকরণ।

৩.১৪.৫ সরকারী বেসরকারী কর্মকর্তা, কর্মচারীদের এবং শিল্প ও বাণিজ্য ক্ষেত্রে নিয়োজিত শ্রমিকদের প্রশিক্ষণ কর্মসূচীতে পরিবেশ বিষয়াদি অন্তর্ভূক্তকরণ।

৩.১৫ বিজ্ঞান, প্রযুক্তি ও গবেষণাঃ

৩.১৫.১ জাতীয় বিজ্ঞান ও প্রযুক্তি নীতির আওতায় পরিবেশ দূষণ তদারক ও নিয়ন্ত্রণমূলক ব্যবস্থা অন্তর্ভূক্তকরণ।

৩.১৫.২ পরিবেশ সংরক্ষণ ও উন্নয়নে সকল জাতীয় সম্পদের দীর্ঘমেয়াদী, টেকসই ও পরিবেশসম্মত ব্যবহার নিশ্চিতকরণের লক্ষ্যে প্রয়োজনীয় গবেষণা পরিচালনা এবং প্রযুক্তি উদ্ভাবন উৎসাহিতকরণ।

৩.১৫.৩ জাতীয় বিজ্ঞান ও প্রযুক্তি নীতি (১৯৮৬) এর আওতায় গবেষণা ও উন্নয়নের জন্য অগ্রাধিকার হিসাবে চিহ্নিত ক্ষেত্রসমূহে পরিবেশগত বিবেচনা একটি অপরিহার্য অংগ হিসাবে সংযোজন।

৩.১৫.৪ সকল গবেষণা ও উন্নয়ন প্রতিষ্ঠানে তাহাদের গবেষণা ক্ষেত্রসমূহের পরিবেশগত দিক বিবেচনার ব্যবস্হা রাখা।

৪। আইনগত কাঠামোঃ

৪.১ পরিবেশ ও সম্পদ সংরক্ষণ এবং দূষণ ও অবক্ষয় নিয়ন্ত্রণের সহিত সম্পর্কিত সকল বর্তমান আইন সময়োপযোগী করিয়া সংশোধন।

৪.২ পরিবেশ দূষণ ও অবক্ষয়মূলক কার্যকলাপ নিয়ন্ত্রণের জন্য প্রয়োজনীয় সকল ক্ষেত্রে নূতন আইন প্রণয়ন।

৪.৩ প্রাসংগিক সকল আইনের বিধানসমূহ যথাযথভাবে প্রতিপালন নিশ্চিতকরণ এবং এতদসম্পর্কে ব্যাপক গণ-সচেতনতা সৃষ্টিকরণ।

৪.৪ পরিবেশ সংক্রান্ত যে সকল আন্তর্জাতিক আইন/কনভেনশন/প্রটোকল বাংলাদেশ কর্তৃক অনুমোদনযোগ্য তাহা অনুমোদনকরণ এবং ঐ সকল আইন/কনভেনশন/প্রটোকলের বিধান অনুযায়ী বাংলাদেশে প্রচলিত আইনের সংশোধন/পরিবর্তন সাধন।

৫। প্রাতিষ্ঠানিক কাঠামোঃ

৫.১ পরিবেশ ও বন মন্ত্রণালয় এই নীতি বাস্তবায়নের কাজ সমন্বয় করিবে।

৫.২ এই নীতি বাস্তবায়নের কাজে সার্বিক দিক-নির্দেশনা প্রদানের জন্য সরকার প্রধানের সভাপতিত্বে একটি জাতীয় পরিবেশ কমিটি গঠন।

৫.৩ ভবিষ্যতে দেশের পরিবেশগত অবস্হা এবং আর্থ-সামাজিক ও অন্যান্য প্রয়োজনের প্রেক্ষিতে এই নীতি যথাযথভাবে পরিবর্তন ও পরিবর্ধনের জন্য পরিবেশ ও বন মন্ত্রণালয় কর্তৃক সময়োচিত পদক্ষেপ গ্রহণ।

৫.৪ পরিবেশ অধিদপ্তর সকল ই আই এ এর চূড়ান্ত পর্যালোচনা ও অনুমোদন প্রদান করিবে।

পরিবেশ সংক্রান্ত বাস্তবায়ন কার্যক্রম

জাতীয় পরিবেশ নীতির লক্ষ্য ও উদ্দেশ্য অর্জন এবং বিভিন্ন গৃহীত নীতিমালা বাস্তবায়নের উদ্দেশ্যে একটি সুনির্দিষ্ট কার্য-পরিকল্পনা থাকা অপরিহার্য। নিম্নে এতদসংক্রান্ত কার্য-পরিকল্পনা খাতওয়ারীভাবে সুপারিশ করা হইল:

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১। কৃষি :		
১.১	কৃষিক্ষেত্রে ভূমির জৈবগুণ বৃদ্ধি উর্বরতা সংরক্ষণ ও টেকসই কৃষি পদ্ধতি সম্প্রসারণের উদ্দেশ্যে একটি মাঠভিত্তিক জাতীয় পর্যায়ের সমীক্ষা পরিচালনা করিতে হইবে এবং উহার ভিত্তিতে সংশ্লিষ্ট সকল ক্ষেত্রে কার্যকর পদক্ষেপ গ্রহণ করিতে হইবে।	ক। কৃষি মন্ত্রণালয় খ। বাংলাদেশ কৃষি গবেষণা কাউন্সিল গ। কৃষি সম্প্রসারণ অধিদপ্তর ঘ। বাংলাদেশ ধান গবেষণা ইনষ্টিটিউট ঙ। পাট গবেষণা ইনষ্টিটিউট চ। বাংলাদেশ কৃষি গবেষণা ইনষ্টিটিউট। ছ। মৃত্তিকা সম্পদ উন্নয়ন ইনষ্টিটিউট জ। বাংলাদেশ চিনি ও খাদ্য শিল্প কর্পোরেশন
১.২	রাসায়নিক বালাই ও কীট নাশকের (Chemical Insecticide and Pesticide) হইবে। যে ব্যবহার নিয়ন্ত্রণ করিতে সকল বালাইনাশক রাসায়নিক দ্রব্যের বিষাক্ততা পরিবেশে দীর্ঘকাল বিরাজমান থাকে এবং ক্রমাগত পুঞ্জীভূত হয় (যেমন-ডিডিটি, ক্লোরিনেটেড হাইড্রোকার্বন সমৃদ্ধ যৌগ) তাহাদের উৎপাদন, আমদানী ও ব্যবহার বাস্তব অবস্থা বিবেচনাপূর্বক ক্রমান্বয়ে নিয়ন্ত্রণ করিয়া যত দ্রুত সম্ভব নিষিদ্ধ ঘোষণা করিবার পদক্ষেপ গ্রহণ করিতে হইবে। পক্ষান্তরে দ্রুত বিভাজনের ফলে কার্যকারিতা অচিরেই বিনষ্ট হয় এই ধরনের রাসায়নিক দ্রব্যাদি নিয়ন্ত্রিতভাবে ব্যবহার করা যাইবে। প্রাকৃতিক বালাইনাশক ব্যবহারের উপর অধিক গুরুত্ব আরোপ করিতে হইবে এবং সমন্বিত কীটনাশক ব্যবস্থাপনা চালু করিতে হইবে।	ক। কৃষি মন্ত্রণালয় খ। বাণিজ্য মন্ত্রণালয় গ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় ঘ। কৃষি সম্প্রসারণ অধিদপ্তর।
১.৩	রাসায়নিক সার ব্যবহার যথাযথ ও নিয়ন্ত্রিতভাবে করিতে হইবে এবং জৈব সার ব্যবহারের উপর ক্রমবর্ধমান হারে গুরুত্ব আরোপ করিতে হইবে।	ক। কৃষি মন্ত্রণালয় খ। কৃষি সম্প্রসারণ অধিদপ্তর

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১.৪ বিদেশ হইতে যে কোন প্রকার বীজ, চারা ও গাছপালা আমদানীর ক্ষেত্রে যথাযথ কোয়ারেন্টাইন ব্যবস্থার মাধ্যমে সম্ভাব্য বিরূপ প্রতিক্রিয়া সম্পর্কে সতর্কতা অবলম্বন করিতে হইবে।	ক। কৃষি মন্ত্রণালয় খ। বন অধিদপ্তর গ। বাণিজ্য মন্ত্রণালয় ঘ। মুখ্য আমদানী রপ্তানী নিয়ন্ত্রকের দপ্তর ঙ। প্লান্ট প্রটেকশন উইং চ। কৃষি সম্প্রসারণ অধিদপ্তর ছ। বাংলাদেশ চিনি ও খাদ্য শিল্প কর্পোরেশন
১.৫ কীট-পতংগ নাশের জন্য বিভিন্ন প্রাকৃতিক প্রতিরোধ ব্যবস্থা যেমন ব্যাঙ, মাছ, গুইসাপ, সাপ, কচ্ছপ, বন্যপ্রাণী ইত্যাদির সংরক্ষণ, নিরাপত্তা ও প্রাকৃতিক পরিবেশে বংশ বৃদ্ধির জন্য প্রয়োজনীয় ব্যবস্থা গ্রহণ করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর গ। মৎস্য ও পশু সম্পদ মন্ত্রণালয় ঘ। বাণিজ্য মন্ত্রণালয় ঙ। জেলা প্রশাসকগণ চ। মুখ্য আমদানী রপ্তানী নিয়ন্ত্রকের দপ্তর।
১.৬ এলাকা ভিত্তিক পরিবেশ উপযোগী এবং বর্ধিত জনসংখ্যা ও জাতীয় খাদ্য নীতির চাহিদা অনুযায়ী কৃষি ব্যবস্থা প্রবর্তন এবং অত্যাধিক চাপের সহনশীল কৃষি শস্য ও কৃষি পণ্যের বিকল্প চালুর ব্যবস্থা গ্রহণ করিতে হইবে।	ক। কৃষি মন্ত্রণালয় খ। কৃষি সম্প্রসারণ অধিদপ্তর
১.৭ কৃত্রিম (সিনথেটিক) আঁশের ব্যবহার হ্রাসের মাধ্যমে প্রাকৃতিক তন্তু যথা পাট ও পাটজাত দ্রব্যাদির ব্যবহার বৃদ্ধি করিতে হইবে।	ক। পাট মন্ত্রণালয় খ। শিল্প মন্ত্রণালয় গ। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয়
২। শিল্প :	
২.১ পরিবেশ অধিদপ্তর কর্তৃক চিহ্নিত শিল্প প্রতিষ্ঠানসমূহে যথাশীঘ্র সম্ভব পরিবেশ দূষণ নিয়ন্ত্রণমূলক ব্যবস্থা গ্রহণ করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। শিল্প মন্ত্রণালয় গ। জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয় ঘ। বাংলাদেশ রসায়ন শিল্প সংস্থা ঙ। বাংলাদেশ ইস্পাত ও প্রকৌশল সংস্থা। চ। বাংলাদেশ বন শিল্প সংস্থা ছ। বাংলাদেশ ক্ষুদ্র ও কুটির শিল্প সংস্থা জ। পাট মন্ত্রণালয় ঝ। বাংলাদেশ পাটকল কর্পোরেশন ঞ। বাংলাদেশ চিনি ও খাদ্য শিল্প কর্পোরেশন। ট। বিনিয়োগ বোর্ড ঠ। বাংলাদেশ পেট্রোলিয়াম কর্পোরেশন ড। বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ড ঢ। বস্ত্র মন্ত্রণালয় ণ। বস্ত্র পরিদপ্তর ত। স্থানীয় সরকার বিভাগ
২.২ প্রতিষ্ঠিত সকল দূষণ সম্ভাবনাময় শিল্পে পরিবেশ দূষণ নিয়ন্ত্রণমূলক ব্যবস্থা অন্তর্ভুক্ত করিতে হইবে।	ক। শিল্প মন্ত্রণালয় খ। পরিবেশ ও বন মন্ত্রণালয় গ। পরিবেশ অধিদপ্তর ঘ। বস্ত্র মন্ত্রণালয় ঙ। পাট মন্ত্রণালয়
২.৩ সরকারী ও বেসরকারী উভয় খাতে সকল নূতন শিল্পের ক্ষেত্রে পরিবেশগত প্রতিক্রিয়া নিরূপন (ই আই এ) এবং পরিবেশ দূষণ নিয়ন্ত্রণ ব্যবস্থা অন্তর্ভুক্ত করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ পরিকল্পনা কমিশন গ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় ঘ। পরিবেশ অধিদপ্তর ঙ। বিনিয়োগ বোর্ড চ। বস্ত্র মন্ত্রণালয় ছ। বস্ত্র পরিদপ্তর
২.৪ আবাসিক এলাকার মধ্যে অবস্থিত শিল্প প্রতিষ্ঠানসমূহ ক্রমান্বয়ে উপযুক্ত স্থানে স্থানান্তরের প্রচেষ্টা নেওয়া হইবে এবং পরিকল্পিতভাবে শিল্প প্রতিষ্ঠান স্থাপনের লক্ষ্যে স্থান চিহ্নিত করিতে হইবে।	ক। শিল্প মন্ত্রণালয় খ। ভূমি মন্ত্রণালয় গ। পরিবেশ ও বন মন্ত্রণালয় ঘ। পূর্ত মন্ত্রণালয় ঙ। শহর উন্নয়ন সংস্থাসমূহ চ। জেলা প্রশাসকগন ছ। পৌর প্রতিষ্ঠানসমূহ জ। উপজিলা প্রশাসনসমূহ ঝ। বস্ত্র মন্ত্রণালয় ঞ। বস্ত্র পরিদপ্তর
২.৫ পরিবেশের জন্য ক্ষতিকারক এবং জৈব-ক্ষয়িষ্ণু নয় এইরূপ পণ্য উৎপাদনকারী নতুন শিল্প প্রতিষ্ঠান স্থাপন অনুমোদন পর্যায়ক্রমে নিষিদ্ধ করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বাণিজ্য মন্ত্রণালয় গ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় ঘ। বিনিয়োগ বোর্ড
২.৬ যে কোন প্রকার ক্ষতিকারক ও বিষাক্ত বর্জ্যকে কাঁচামাল হিসাবে আমদানী বা ব্যবহার করিয়া কোন প্রকার শিল্প স্থাপনের উদ্যোগ নিষিদ্ধ করিতে হইবে।	ক। শিল্প ও অন্যান্য সংশ্লিষ্ট মন্ত্রণালয় খ। বাণিজ্য মন্ত্রণালয় গ। পরিবেশ ও বন মন্ত্রণালয় ঘ। মুখ্য আমদানী রপ্তানী নিয়ন্ত্রকের দপ্তর ঙ। বিনিয়োগ বোর্ড চ। বস্ত্র মন্ত্রণালয় ছ। বস্ত্র পরিদপ্তর

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
২.৭ শিল্প ক্ষেত্রে বিশেষ ক্ষতিকারক ভারী ধাতু (Heavy Metal) যথা মারকারি, ক্রোমিয়াম, লেড ইত্যাদি ব্যবহার নিরুৎসাহিত করিবার মাধ্যমে চূড়ান্ত পর্যায়ে নিষিদ্ধ করিবার ব্যবস্থা গ্রহন করিতে হইবে।	ক। শিল্প মন্ত্রণালয় খ। বাণিজ্য মন্ত্রণালয় গ। বিনিয়োগ বোর্ড ঘ। পরিবেশ অধিদপ্তর
২.৮ দূষনকারী শিল্প কারখানায় দূষণ পরিশোধন করিবার নিজ নিজ ব্যবস্থা থাকার বিষয় অন্তর্ভুক্ত করিতে হইবে।	ক। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় খ। পরিবেশ অধিদপ্তর গ। বিনিয়োগ বোর্ড ঘ। রাষ্ট্রীয় শিল্প প্রতিষ্ঠানসমূহ ঙ। বস্ত্র মন্ত্রণালয় চ। বস্ত্র পরিদপ্তর
২.৯ শিল্পে "ওয়েষ্ট পারমিট/কনসেন্ট অর্ডার" পদ্ধতি চালু করিতে হইবে যাহাতে বর্জ্য পরিশোধন ও অপসারণ ব্যবস্থার উন্নতি হয়।	ক। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় খ। পরিবেশ অধিদপ্তর গ। বিনিয়োগ বোর্ড ঘ। বস্ত্র মন্ত্রণালয় ঙ। বস্ত্র পরিদপ্তর
২.১০ শিল্পক্ষেত্রে বিভিন্ন পদার্থের পুন: ব্যবহারের মাধ্যমে বর্জ্য হ্রাসের বিষয়টি উৎসাহিত করিতে হইবে।	ক। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় খ। বিনিয়োগ বোর্ড গ। পরিবেশ অধিদপ্তর ঘ। বস্ত্র মন্ত্রণালয় ঙ। বস্ত্র পরিদপ্তর
২.১১ শিল্প প্রতিষ্ঠানে কর্মরতদের স্বাস্থ্য রক্ষার বিষয়ে যথাযথ ব্যবস্থা গ্রহণ করিতে হইবে।	ক। নিপসম খ। প্রধান কারখানা পরিদর্শকের দপ্তর গ। পরিবেশ অধিদপ্তর ঘ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় ঙ। শ্রম ও জনশক্তি মন্ত্রণালয় চ। বস্ত্র মন্ত্রণালয় ছ। বস্ত্র পরিদপ্তর

৩। স্বাস্থ্য ও স্বাস্থ্য বিধান :

৩.১ পল্লী ও শহর এলাকায় বিশুদ্ধ পানির সরবরাহ নিশ্চিতকরণ এবং কাঁচা ও ঝুলন্ত পায়খানার পরিবর্তে স্বল্প খরচের স্যানিটারী পদ্ধতির পায়খানা চালু করিতে হইবে।	ক। স্থানীয় সরকার বিভাগ খ। জনস্বাস্থ্য প্রকৌশল অধিদপ্তর গ। পৌর প্রশাসন সমূহ

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৩.২ দেশের নদী-নালা, খাল-বিলসহ যে কোন জলাশয়ে শিল্প পৌর, কৃষি ও অন্য প্রকার দূষিত/ক্ষতিকারক বর্জ্য নিক্ষেপের বিষয়টিকে যথাযথ আইন প্রণয়ন ও প্রয়োগের মাধ্যমে কঠোরভাবে নিয়ন্ত্রণ করিতে হইবে।	ক। পরিবেশ অধিদপ্তর খ। স্থানীয় সরকার প্রতিষ্ঠানসমূহ
৩.৩ শহরাঞ্চলে খোলাগাড়ীতে ও দিবাভাগে ডাষ্টবিন বা আবর্জনা স্তুপ হইতে বর্জ্য সংগ্রহ, পরিবহন ও স্তুপীকরণ নিষিদ্ধ করিতে হইবে।	ক। স্থানীয় সরকার বিভাগ খ। পৌর কর্তৃপক্ষসমূহ
৩.৪ এক্স-রেসহ সকল তেজস্ক্রিয় পদার্থ, পারমাণবিক পদার্থ, তেজস্ক্রিয় বর্জ্য পদার্থ, তেজস্ক্রিয় যন্ত্রপাতি, পারমাণবিক গবেষণা ও শক্তি চুল্লী প্রভৃতির ব্যবহার ও কার্যক্রমের ব্যবহারজনিত ক্ষতিকর প্রতিক্রিয়া হইতে জনস্বাস্থ্য ও পরিবেশ রক্ষাকল্পে সকল পদক্ষেপ গ্রহণ করিতে হইবে।	ক। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয় খ। বিজ্ঞান ও প্রযুক্তি বিভাগ গ। পরমাণু শক্তি কমিশন ঘ। স্বাস্থ্য অধিদপ্তর ঙ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় চ। বস্ত্র পরিদপ্তর
৩.৫ স্বাস্থ্য শিক্ষা পাঠক্রমে পরিবেশ বিষয় অন্তর্ভুক্ত করিতে হইবে।	ক। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয় খ। স্বাস্থ্য শিক্ষা ব্যুরো

৪। জ্বালানী :

৪.১ জ্বালানী সংরক্ষণ ও পরিবেশ সংরক্ষণের অন্যতম উদ্দেশ্যে উন্নতমানের চুলা প্রবর্তন ও সম্প্রসারণের জন্য ব্যাপক ভিত্তিক প্রকল্প বাস্তবায়ন করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বিজ্ঞান ও প্রযুক্তি বিভাগ গ। পরিবেশ অধিদপ্তর ঘ। বি সি এস আই আর ঙ। স্থানীয় সরকার প্রতিষ্ঠানসমূহ চ। বন অধিদপ্তর ছ। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয়
৪.২ গ্রামাঞ্চলে কয়লা, কেরোসিন, পেট্রোল প্রভৃতি জ্বালানীর ব্যবহার সম্প্রসারণ করিতে হইবে যাহাতে জ্বালানী কাঠ, কৃষি বর্জ্য, গোবর ইত্যাদি জ্বালানী সাশ্রয়পূর্বক কৃষিক্ষেত্রে জৈব সার হিসাবে ব্যবহার করা যায়।	ক। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয় খ। বাণিজ্য মন্ত্রণালয় গ। স্থানীয় সরকার প্রতিষ্ঠানসমূহ ঘ। বন অধিদপ্তর ঙ। কৃষি সম্প্রসারণ অধিদপ্তর

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৪.৩ গ্রামাঞ্চলে বায়ো-গ্যাস, সৌরশক্তি, মিনি হাইড্রোইলেকট্রিক ইউনিট ও বায়ুকল স্থাপনের মাধ্যমে গ্রামীণ জ্বালানী সরবরাহ বৃদ্ধির ব্যবস্থা করিতে হইবে।	ক। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয় খ। বি সি এস আই আর গ। বিজ্ঞান ও প্রযুক্তি বিভাগ ঘ। পরিবেশ অধিদপ্তর
৪.৪ ডিজেলে সালফারের পরিমাণ এবং পেট্রোলে সীসার পরিমাণ হ্রাস করাসহ বিভিন্ন প্রকার জ্বালানীতে দূষণ সৃষ্টিকারী উপাদান হ্রাসের ব্যবস্থা গ্রহণ করিতে হইবে।	ক। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয় খ। বি ও জি এম সি গ। বাংলাদেশ পেট্রোলিয়াম কর্পোরেশন।
৪.৫ প্রচলিত জ্বালানীর বিকল্প উৎস আবিষ্কারের জন্য গবেষণা জোরদার করিতে হইবে।	ক। বিজ্ঞান ও প্রযুক্তি বিভাগ খ। বি সি এস আই আর
৪.৬ যে কোন প্রকার প্রাথমিক ও বাণিজ্যিক জ্বালানীর ব্যবহার ও রূপান্তর যাহাতে পরিবেশের ভারসাম্যের উপর কোনরূপ বিরূপ প্রতিক্রিয়া সৃষ্টি না করে তৎপ্রতি সজাগ দৃষ্টি রাখিতে হইবে।	ক। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয়। খ। পরিবেশ ও বন মন্ত্রণালয়
৪.৭ জ্বালানীর উৎস বিভিন্ন প্রাকৃতিক সম্পদ যেমন, তৈল, গ্যাস, কয়লা, পিট ইত্যাদি আহরণ ও বিতরণ যাহাতে বায়ু, পানি, ভূমি, হাইড্রোলজিক্যাল ব্যালেন্স এবং ইকোসিস্টেমের উপর কোনরূপ বিরূপ প্রতিক্রিয়া সৃষ্টি না করে সে উদ্দেশ্যে যথাযথ ব্যবস্থা গ্রহণ করিতে হইবে।	ক। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয়। খ। পরিবেশ ও বন মন্ত্রণালয়
৪.৮ বাংলাদেশে পরিবেশসম্মত পেট্রোলিয়াম (সীসামুক্ত) ব্যবহারের সম্ভাব্যতা পরীক্ষা করিতে হইবে।	ক। বিদ্যুৎ, জ্বালানী ও খনিজ সম্পদ মন্ত্রণালয় খ। বাংলাদেশ পেট্রোলিয়াম কর্পোরেশন
৪.৯ যানবাহনের কালো ধোঁয়া নিয়ন্ত্রণের জন্য ফিটনেস সার্টিফিকেট প্রদানের বিষয়ে বিশেষ সতর্কতা অবলম্বন করিতে হইবে। সেই সাথে সংশ্লিষ্ট আইনের বিধান যথাযথ-ভাবে প্রয়োগের জন্য নিয়মিত ভ্রাম্যমান আদালত পরিচালনা করিতে হইবে।	ক। মন্ত্রী পরিষদ বিভাগ খ। সড়ক ও সড়ক পরিবহণ বিভাগ গ। বি, আর, টি, এ ঘ। পরিবেশ অধিদপ্তর ঙ। স্বরাষ্ট্র মন্ত্রণালয়

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৫। পানি উন্নয়ন, বন্যা নিয়ন্ত্রণ ও সেচ :	
৫.১ পানি সম্পদ উন্নয়ন, বন্যা নিয়ন্ত্রণ ও সেচ ব্যবস্থা সম্প্রসারণের লক্ষ্যে গৃহীত প্রকল্পগুলির পরিবেশগত প্রতিক্রিয়া নিরূপণের জন্য জরুরী ভিত্তিতে পরিবেশগত সমীক্ষা (Environmental audit) পরিচালনা করিতে হইবে এবং ঐ সমীক্ষার ভিত্তিতে পরিবেশগত বিরূপ প্রতিক্রিয়া চিহ্নিত করিয়া তদনুযায়ী প্রকল্প সংশোধন ও পরিবেশগত অবনতি রোধ ও দূষণ বিমোচনের জন্য পদক্ষেপ গ্রহণ করিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। বাংলাদেশ পানি উন্নয়ন বোর্ড গ। পরিবেশ ও বন মন্ত্রণালয় ঘ। এফ পি সি ও
৫.২ সকল প্রস্তাবিত ও নতুন প্রকল্পের পরিকল্পনায় পরিবেশগত প্রতিক্রিয়া (ই আই এ) নিরূপণের ব্যবস্থা অন্তর্ভুক্তকরণ এবং এতদসংক্রান্ত বিরূপ প্রতিক্রিয়া নিরসনের জন্য প্রয়োজনীয় কার্যক্রম ও বিনিয়োগ অন্তর্ভুক্ত করিতে হইবে।	ক। পরিকল্পনা কমিশন খ। পরিবেশ ও বন মন্ত্রণালয় গ। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় ঘ। বাংলাদেশ পানি উন্নয়ন বোর্ড
৫.৩ দেশের নদ-নদী, খাল-বিল ও অন্য যে কোন জলাশয়ে, গৃহ ও শিল্পজাত বা অন্য কোন প্রকার দূষিত বর্জ্য যাহাতে পরিশোধনের পূর্বে ফেলা না হয় তাহা কঠোরভাবে নিয়ন্ত্রণ করিতে হইবে।	ক। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় খ। পরিবেশ ও বন মন্ত্রণালয় গ। পরিবেশ অধিদপ্তর ঘ। বিনিয়োগ বোর্ড ঙ। রাষ্ট্রায়াত্ত শিল্প প্রতিষ্ঠানসমূহ চ। বস্ত্র পরিদপ্তর ছ। বাংলাদেশ রেশম বোর্ড
৫.৪ নদ-নদী, খাল-বিল ও অন্যান্য সকল প্রকার জলাশয় খননের মাধ্যমে উহাদের নাব্যতা সৃষ্টি ও ধারণক্ষমতা বৃদ্ধি করিবার ব্যবস্থা গ্রহণ করিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয় খ। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয়
৫.৫ জাতীয় উদ্যোগের সহিত আঞ্চলিক ও আন্তর্জাতিক সহযোগিতা সম্পৃক্ত করিবার মাধ্যমে দেশের বন্যা নিয়ন্ত্রণের, মরু প্রবণতা ও লবণাক্ততা বৃদ্ধি রোধের স্থায়ী ব্যবস্থা জোরদার করিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। পররাষ্ট্র মন্ত্রণালয় গ। পরিবেশ ও বন মন্ত্রণালয় ঘ। প্রতিরক্ষা মন্ত্রণালয় ঙ। বাংলাদেশ আবহাওয়া অধিদপ্তর

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৫.৬	বিভিন্ন উন্নয়ন কর্মকাণ্ড যেমন সেচ প্রকল্প, রাস্তাঘাট, বাঁধ ইত্যাদি নির্মাণের ফলে পানি ও পয়ঃনিস্কাশন ব্যবস্থা যাহাতে বাধাপ্রাপ্ত না হয় এবং প্রাকৃতিক জলাশয়গুলির গতি ও স্রোত যাহাতে বাধাপ্রাপ্ত না হয় ইত্যাদিসহ অন্যান্য পরিবেশগত দিকের প্রতি দৃষ্টিদানপূর্বক বিশেষ পরিকল্পনা গ্রহণ করিতে হইবে।	ক। স্থানীয় সরকার বিভাগ খ। যোগাযোগ মন্ত্রণালয় গ। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয়
৫.৭	দেশের যে সকল অঞ্চলে ভূ-গর্ভস্থ পানিস্তর গ্রহণযোগ্য সীমার নীচে নামিয়া গিয়াছে সেই সকল এলাকার পানিস্তর যথাযথ পর্যায়ে উন্নীত করিবার জন্য বিশেষ প্রকল্প গ্রহণ করিতে হইবে এবং বর্তমানে বাস্তবায়িত কার্য্যক্রমের ফলে ভূ-গর্ভস্থ পানিস্তর যাহাতে আরও নীচে নামিয়া না যায় তাহা রোধ করিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। স্থানীয় সরকার বিভাগ গ। এফ পি সি ও
৫.৮	পানিকে দেশের সবচেয়ে গুরুত্বপূর্ণ ও মূল্যবান প্রাকৃতিক সম্পদ হিসাবে চিহ্নিত করিতে হইবে এবং পানি সম্পদের উন্নয়ন ব্যবস্থাপনার সাথে সংশ্লিষ্ট প্রতিষ্ঠানগুলি নিজেদেরকে জাতীয় সম্পদ ব্যবস্থাপনা সংস্থা হিসাবে বিবেচনা করিবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। এফ পি সি ও গ। এম পি ও ঘ। বাংলাদেশ পানি উন্নয়ন বোর্ড
৫.৯	পানি উন্নয়ন ও ব্যবস্থাপনা সংক্রান্ত সকল প্রকল্পের প্রকল্প বাস্তবায়ন পরবর্তী যথাযথ অপারেশন ও মেইনটেন্যান্স নিশ্চিত করিতে হইবে এবং পরিবেশের উপর এই সকল প্রকল্পের প্রভাব নিয়মিত মনিটর করিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। পানি উন্নয়ন বোর্ড গ। এফ পি সি ও ঘ। বাংলাদেশ কৃষি উন্নয়ন সংস্থা
৫.১০	পানি সম্পদ ব্যবস্থাপনার সহিত জড়িত সকল সংস্থায় পরিবেশ সেল গঠন করিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। পানি উন্নয়ন বোর্ড গ। এফ পি সি ও ঘ। এম পি ও ঙ। বি এ ডি সি

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৫.১১	নদ-নদীর গতি পরিবর্তন, জলাভূমি ও জলাশয়ের অবস্থান ও আয়তন ইত্যাদি সম্পর্কে নিয়মিত জরীপ, মনিটরিং ও গবেষণা কাজ পরিচালনা করিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। বাংলাদেশ পানি উন্নয়ন বোর্ড গ। প্রতিরক্ষা মন্ত্রণালয় ঘ। সার্ভে অব বাংলাদেশ ঙ। স্পারসো

৬। ভূমি :

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৬.১	ভূমির উৎপাদন ক্ষমতা এবং ভূমির উপযোগিতা শ্রেণী বিন্যাস (Land capability and land suitability classification) এর ভিত্তিতে ভূমির যথাযথ ও সর্বোত্তম ব্যবহার নিশ্চিত করার লক্ষ্যে আর্থ-সামাজিক বাস্তবতার নিরিখে কৃষি কার্য্য, বনায়ন, শিল্পায়ন, নগরায়ন, গৃহায়নমূলক সুবিধা ইত্যাদিতে ব্যবহার সংক্রান্ত তুলনামূলক ও অগ্রাধিকার ভিত্তিক একটি পরিবেশ সম্মত জাতীয় ভূমি ব্যবহার পরিকল্পনা প্রণয়ন ও বাস্তবায়ন করিতে হইবে।	ক। ভূমি মন্ত্রণালয় খ। কৃষি মন্ত্রণালয় গ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় ঘ। স্থানীয় সরকার বিভাগ ঙ। পূর্ত মন্ত্রণালয় চ। বন অধিদপ্তর ছ। বস্ত্র পরিদপ্তর জ। বাংলাদেশ রেশম বোর্ড
৬.২	দেশের উত্তরাঞ্চলে মরুময়তার বিস্তার রোধে বিশেষ ও সমন্বিত ভূমি সংরক্ষণমূলক প্রকল্প বাস্তবায়ন করিতে হইবে।	ক। কৃষি মন্ত্রণালয় খ। বি এ ডি সি গ। ভূমি মন্ত্রণালয় ঘ। বন অধিদপ্তর
৬.৩	ভূমি ক্ষয়রোধ, উর্বরতা সংরক্ষণ, ভূমি পুনরুদ্ধার, উপকূলীয় অঞ্চলের ভূমি সংরক্ষণ ও উন্নয়ন ইত্যাদির উদ্দেশ্যে যথাযথ কার্য্যক্রম গ্রহণ করিতে হইবে।	ক। ভূমি মন্ত্রণালয় খ। কৃষি মন্ত্রণালয় গ। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় ঘ। বন অধিদপ্তর
৬.৪	পাহাড়ী অঞ্চলে মাটি কাটিয়া সমান করা, মাটি খোদাই ও অপসারন করিয়া কোন এলাকার ভূমির প্রাকৃতিক অবস্থা (landscape) বিনষ্ট করা, পাহাড় হইতে যথেচ্ছভাবে মাটি ও পাথর আহরণ করিয়া প্রাকৃতিক ভারসাম্য হীনতা সৃষ্টির কার্য্যক্রম বন্ধের ব্যবস্থা গ্রহণ করিতে হইবে। ওয়াটার শেড ব্যবস্থাপনাকে অগ্রাধিকার প্রদান করিতে হইবে।	ক। স্থানীয় সরকার বিভাগ খ। যোগাযোগ মন্ত্রণালয় গ। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় ঘ। ভূমি মন্ত্রণালয়

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৬.৫	পরিকল্পিত ভূমি ব্যবহার নিশ্চিত করিবার লক্ষ্যে যথাযথ ভূমি ব্যবহার আইন প্রণয়ন ও কার্যকরভাবে উহার সুষ্ঠু প্রয়োগ করিতে হইবে।	ক। ভূমি মন্ত্রণালয় খ। পরিবেশ ও বন মন্ত্রণালয় গ। কৃষি মন্ত্রণালয় ঘ। শিল্প মন্ত্রণালয় ঙ। স্থানীয় সরকার বিভাগ চ। পূর্ত মন্ত্রণালয়
৬.৬	যাহাদের নিকট হইতে ভূমি অধিগ্রহণ করা হয় অথবা যাহারা ভূমিক্ষয় ও অবনয়নে ক্ষতিগ্রস্থ হয় তাহাদের জন্য উপযুক্ত ক্ষতিপূরণের ব্যবস্থা করিতে হইবে।	ক। ভূমি মন্ত্রণালয় খ। জেলা প্রশাসন গ। সংশ্লিষ্ট সকল প্রকল্প বাস্তবায়নকারী সংস্থা
৬.৭	দেশের উত্তরাঞ্চলে মরুময়তার বিস্তার, ভূমি পুনরুদ্ধার, ভূমি ক্ষয়রোধ, ভূমির বহুবিধ ব্যবহার, উপকূল অঞ্চলে ভূমি সংরক্ষণ ও উন্নয়ন, ওয়াটার শেড এলাকার অবস্থা ইত্যাদি সম্পর্কে নিয়মিত মনিটরিং/ জরীপ ও গবেষণা কাজের ব্যবস্থা থাকিতে হইবে।	ক। সেচ, পানি উন্নয়ন ও বন্যা নিয়ন্ত্রণ মন্ত্রণালয় খ। কৃষি মন্ত্রণালয় গ। পরিবেশ ও বন মন্ত্রণালয় ঘ। ভূমি মন্ত্রণালয় ঙ। প্রতিরক্ষা মন্ত্রণালয় চ। সার্ভে অব বাংলাদেশ ছ। স্পারসো

৭। বন, বন্যপ্রাণী ও জৈব বৈচিত্র :

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৭.১	বর্তমান বনসম্পদ সংরক্ষণ, বননিধন প্রতিরোধ ও ব্যাপকভাবে নতুন বনায়ন করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর
৭.২	সরকারী বনভূমি হিসাবে চিহ্নিত এলাকা বৃক্ষাচ্ছাদিত করার কাজ ত্বরান্বিত করিতে হইবে।	ক। বন অধিদপ্তর
৭.৩	সামাজিক ও পল্লী বনায়ন কর্মসূচীর ব্যাপক বাস্তবায়নের মাধ্যমে গ্রামীণ এলাকার বৃক্ষ ও বনজ সম্পদ বৃদ্ধির বিষয়টিকে অগ্রাধিকার প্রদান করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর গ। স্থানীয় সরকার বিভাগ ঘ। স্থানীয় সরকারি প্রতিষ্ঠানসমূহ
৭.৪	ভূমির বহুবিধ ব্যবহার, অর্থনৈতিক উন্নয়ন ও পরিবেশ উন্নয়নে সহায়ক হিসাবে কৃষি-বন (Agro-Forestry) পদ্ধতিকে উৎসাহিত করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। কৃষি মন্ত্রণালয় গ। বন অধিদপ্তর

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৭.৫	দেশে বনজ সম্পদ ভিত্তিক শিল্প প্রতিষ্ঠানসমূহকে বিকল্প কাঁচামালের উৎস সন্ধানসহ প্রয়োজনীয় কাঁচামাল উৎপাদনের বিষয়ে নিজস্ব প্রত্যক্ষ কিংবা পরোক্ষ উদ্যোগ গ্রহণ করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বাংলাদেশ বন শিল্প সংস্থা গ। বন গবেষণা ইনস্টিটিউট ঘ। বি সি এস আই আর
৭.৬	সকল বিভাগীয় উন্নয়ন প্রকল্পে বনায়ন কর্মসূচী অন্তর্ভুক্তকরণের বিষয়ে সরকারী সিদ্ধান্তের যথাযথ বাস্তবায়ন নিশ্চিত করিতে হইবে।	ক। পরিকল্পনা কমিশন খ। পরিবেশ ও বন মন্ত্রণালয় গ। সকল মন্ত্রণালয়/বিভাগ
৭.৭	উপজেলা ও গ্রাম পর্যায়ের সকল বনায়ন কর্মসূচীতে মহিলাদের প্রত্যক্ষ অংশগ্রহণ নিশ্চিত করিবার উদ্দেশ্যে প্রয়োজনীয় সকল ব্যবস্থা গ্রহণ করিতে হইবে।	ক। স্থানীয় সরকার বিভাগ খ। বন অধিদপ্তর
৭.৮	বন্যপ্রাণী, জলাভূমি, পশুপাখি সংরক্ষণ কার্যক্রমকে অগ্রাধিকার প্রদান করতঃ বিলুপ্ত প্রায় প্রজাতিসমূহের সংরক্ষণের বিষয়ে গবেষণা ও উন্নয়ন কর্মসূচী গ্রহণ করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর
৭.৯	বন্য পশুপাখি শিকার এবং বন্যপ্রাণী ও চামড়া রপ্তানীর উপর বর্তমান নিষেধাজ্ঞা বহাল রাখিয়া বন্যপ্রাণীর আবাসস্থল সংরক্ষণ তথা অভয়ারণ্য সৃষ্টিকে উৎসাহ প্রদান করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর
৭.১০	জীব বৈচিত্র সংরক্ষণ সংক্রান্ত গবেষণা, জ্ঞান ও অভিজ্ঞতা বিনিময় কার্যক্রম জোরদার করিতে হইবে। এই উদ্দেশ্যে প্রয়োজনীয় গবেষণা ও তথ্যকেন্দ্র স্থাপনসহ দেশের বন্যপ্রাণী সংক্রান্ত সর্বশেষ পরিস্থিতি নিরূপনের জন্য সমীক্ষা পরিচালনা করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর গ। পরিবেশ অধিদপ্তর
৭.১১	কাঠের বিকল্প নির্মাণ সামগ্রী, জ্বালানী ইত্যাদি ব্যবহার বা কাঠ আমদানী উৎসাহিত করিতে হইবে।	ক। বাণিজ্য মন্ত্রণালয় খ। তথ্য মন্ত্রণালয় গ। বন অধিদপ্তর ঘ। বন গবেষণা ইনষ্টিটিউট ঙ। বিজ্ঞান ও প্রযুক্তি বিভাগ

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৭.১২ বন-উজাড়, বন-সম্প্রসারণ ও বনায়নের পরিস্থিতি নিরূপণের জন্য নিয়মিত সমীক্ষা পরিচালনা ও গবেষণা করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর গ। স্পারসো

৮। মৎস্য ও পশু সম্পদ :

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৮.১ হাওর, বাওর, বিল প্রভৃতি জলাভূমি সংস্কার করতঃ এইগুলিকে মৎস্য চাষের জন্য জাতীয় সংরক্ষিত এলাকা হিসাবে ঘোষণা করিতে হইবে। এই জলাভূমির আয়তন সংকুচিত করা যাইবেনা।	ক। মৎস্য ও পশুসম্পদ মন্ত্রণালয় খ। হাওর উন্নয়ন বোর্ড গ। মৎস্য অধিদপ্তর
৮.২ দেশের সকল দীঘি ও পুকুরে মৎস্য চাষ উৎসাহিত করিতে হইবে এবং দেশের পুকুর, খাল, বিল, দীঘি ইত্যাদি জলাভূমিকে প্রত্যেক বৎসর সেচিয়া মৎস্য সম্পদ সমূলে ধ্বংস করার উপর বিধি নিষেধ আরোপ করিতে হইবে। সমুদ্রের পোনা, চিংড়ি ও অন্যান্য মৎস্য-সম্পদের ব্যাপারে অনুরূপ পরিবেশ সম্মত পদক্ষেপ গ্রহণ করিতে হইবে।	ক। মৎস্য ও পশুসম্পদ মন্ত্রণালয় খ। মৎস্য অধিদপ্তর গ। উপজেলা প্রশাসন
৮.৩ চিংড়ি উৎপাদন বৃদ্ধি ও চিংড়ি সম্পদ সংরক্ষণ ও পরিবেশগত স্বার্থ অক্ষুন্ন রাখিবার জন্য পরিবেশ ও বন মন্ত্রণালয়ের পরামর্শ গ্রহণ করিতে হইবে। চিংড়ি চাষের জন্য সরকার উপকূলী এলাকা চিহ্নিত করিয়া দিবেন।	ক। মৎস্য ও পশুসম্পদ মন্ত্রণালয় খ। পরিবেশ ও বন মন্ত্রণালয় গ। বন অধিদপ্তর ঘ। মৎস্য অধিদপ্তর
৮.৪ মৎস্য রোগ ও মহামারী প্রতিরোধ কল্পে প্রয়োজনীয় গবেষণা ও কার্যক্রম জোরদার করিতে হইবে।	ক। মৎস্য ও পশুসম্পদ মন্ত্রণালয় খ। মৎস্য গবেষণা ইনস্টিটিউট গ। কৃষি বিশ্ববিদ্যালয়
৮.৫ যত্রতত্র পশু জবেহ রোধ করার জন্য স্থানীয় প্রশাসনের সহায়তায় আধুনিক কসাই খানা স্থাপন করিতে হইবে। গবাদি পশু ও পাখীর মৃতদেহ মাটির নীচে পুঁতিয়া ফেলা ও কসাইখানাসমূহের বর্জ্য পরিবেশসম্মতভাবে অপসারণ করিবার বিষয়ে গণ-সচেতনতা বৃদ্ধির জন্য পদক্ষেপ গ্রহণ করিতে হইবে।	ক। স্থানীয় সরকার বিভাগ খ। পরিবেশ অধিদপ্তর গ। পৌর প্রশাসনসমূহ ঘ। তথ্য মন্ত্রণালয়
৮.৬ গ্রামাঞ্চলে বর্তমান গোচারণ ভূমি রক্ষা এবং প্রতি গ্রামে ন্যূনতম পরিমাণ এলাকা চারণভূমি হিসাবে সৃষ্টি ও সংরক্ষণ করার বিষয়টি জরুরী ভিত্তিতে বিবেচনা করিতে হইবে।	ক। ভূমি মন্ত্রণালয় খ। পরিবেশ ও বন মন্ত্রণালয় গ। মৎস্য ও পশুসম্পদ মন্ত্রণালয় ঘ। উপজেলা প্রশাসন

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৮.৭ হাওর, বাওর, বিল, দীঘি ইত্যাদি জলাভূমির অবস্থা সম্পর্কে নিয়মিত মনিটরিং ও গবেষণা করিতে হইবে।	ক। মৎস্য ও পশুসম্পদ মন্ত্রণালয় খ। প্রতিরক্ষা মন্ত্রণালয় গ। স্পারসো ঘ। সার্ভে অব বাংলাদেশ

৯। খাদ্য :

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
৯.১ খাদ্যে ভেজাল মিশানোকে একটি গুরুতর অপরাধ হিসাবে চিহ্নিত করিয়া বর্তমান আইন সংশোধন পূর্বক এইরূপ কার্যকলাপ কঠোরভাবে নিয়ন্ত্রণ করিতে হইবে।	ক। খাদ্য মন্ত্রণালয় খ। স্থানীয় সরকার বিভাগ গ। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়
৯.২ খাদ্য সংরক্ষণে কৃত্রিম বালাইনাশকের পরিবর্তে বিভিন্ন প্রাকৃতিক পদ্ধতি ব্যবহারকে উৎসাহিত করিতে হইবে।	ক। খাদ্য মন্ত্রণালয় খ। কৃষি মন্ত্রণালয় গ। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়
৯.৩ বিদেশ হইতে শিশুখাদ্যসহ সকল প্রকার খাদ্য আমদানীর সময় খাদ্যের গুণগত মান, তেজস্ক্রিয়তা ও পরিবেশগত প্রতিক্রিয়া নিরূপণের ব্যবস্থা করিতে হইবে।	ক। বাণিজ্য মন্ত্রণালয় খ। খাদ্য মন্ত্রণালয় গ। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়
৯.৪ কৃষি জমির কৃষি বহির্ভূত ব্যবহার এবং খাদ্যশস্য উৎপাদনকারী জমি অন্য কৃষিপণ্য উৎপাদনের জন্য ব্যবহার নিয়ন্ত্রিত করিতে হইবে।	ক। কৃষি মন্ত্রণালয়
৯.৫ ফলমূল, সব্জি ও ডাল ইত্যাদিকে পোকা ও ইঁদুরের হাত হইতে মুক্ত রাখার জন্য বিষযুক্ত ঔষধ ব্যবহার কঠোরভাবে দমন করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। খাদ্য মন্ত্রণালয় গ। কৃষি মন্ত্রণালয় ঘ। তথ্য মন্ত্রণালয়

১০। উপকূলীয় ও সামুদ্রিক পরিবেশ :

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১০.১ উপকূলীয় ও সামুদ্রিক পরিবেশ সংরক্ষণ ও উন্নয়নমূলক কার্যক্রম সমন্বয় ও পরিবীক্ষণের উদ্দেশ্যে পরিবেশ ও বন মন্ত্রণালয়ে একটি বিশেষ সেল গঠন করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। বন অধিদপ্তর গ। পরিবেশ অধিদপ্তর ঘ। বন গবেষণা ইনষ্টিটিউট
১০.২ উপকূলীয় এলাকায় নূতন জাগিয়া উঠা ভূমিসংরক্ষণ ও স্থিতিশীল করিবার লক্ষ্যে বনায়নের জন্য অগ্রাধিকার ভিত্তিতে বন অধিদপ্তরের নিকট হস্তান্তর করিতে হইবে।	ক। ভূমি মন্ত্রণালয় খ। বন অধিদপ্তর

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খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১০.৩ দেশের সমুদ্রসীমার(Territorial Water) দূষণ রোধকল্পে বাংলাদেশ নৌ-বাহিনীকে সার্বক্ষণিক দৃষ্টি রাখিতে হইবে এবং সমুদ্র পরিবহন অধিদপ্তর এই কার্যক্রম পরিবীক্ষণ করিবে।	ক। প্রতিরক্ষা মন্ত্রণালয় খ। বাংলাদেশ নৌ-বাহিনী গ। নৌ-পরিবহন মন্ত্রণালয় ঘ। সমুদ্র পরিবহন অধিদপ্তর
১০.৪ সামুদ্রিক জলভাগে কোন নৌ-দুর্ঘটনার কারণে দূষণ রোধকল্পে স্থানীয় ও জাতীয় জরুরী কর্ম সূচী(Local and National Contingency)ও অধ্যায়নের ব্যবস্থা থাকিতে হইবে এবং আঞ্চলিক ভিত্তিতে কার্যক্রম সমন্বয় করিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয় খ। প্রতিরক্ষা মন্ত্রণালয় গ। বাংলাদেশ নৌ-বাহিনী ঘ। সমুদ্র পরিবহন অধিদপ্তর
১০.৫ চট্টগ্রাম ও মংলা বন্দরে জাহাজে জমাকৃত আবর্জনা স্থানান্তর এবং জাহাজ হইতে বর্জ্য তৈল ও তৈলজাতীয় সামগ্রী পরিবেশ সম্মতভাবে অপসারণের জন্য জরুরী ভিত্তিতে যথাযথ ব্যবস্থা গ্রহণ করিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয়
১০.৬ সমুদ্রে বর্জ্য পদার্থ নিক্ষেপের পূর্বে : উহার বৈশিষ্ট্য ও উপাদান নিরূপণ এবং পরিবেশে উহার বিরূপ প্রতিক্রিয়া নির্ধারণ এবং অনুমতি প্রদানের জন্য নৌ-পরিবহন মন্ত্রণালয়ে একটি বিশেষ সেল গঠন করিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয় খ। পরিবেশ অধিদপ্তর
১০.৭ উপকূলীয় অঞ্চলে সকল প্রকার সম্পদের নিরাপত্তা ও পরিবেশ ব্যবস্থাপনা কাজে সহায়তার উদ্দেশ্যে নৌ-পরিবহন মন্ত্রণালয়ে জরুরী ভিত্তিতে একটি সমন্বিত 'কোষ্ট গার্ড' ব্যবস্থা গড়িয়া তুলিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয়
১০.৮ দেশের সমুদ্র সীমার দূষণ রোধ, উপকূলীয় ও সামুদ্রিক পরিবেশ সংরক্ষণ, উপকূলীয় এলাকায় নতুন জাগিয়া উঠা ভূমির পর্যবেক্ষণ, সংরক্ষণ এবং উপকূলীয় এলাকার সকলপ্রকার সম্পদের সুষ্ঠু ব্যবহারের বিষয়ে যথাযথ ব্যবস্থা গ্রহণ করিতে হইবে।	ক। প্রতিরক্ষা মন্ত্রণালয় খ। বাংলাদেশ নৌ-বাহিনী গ। নৌ-পরিবহন মন্ত্রণালয় ঘ। নৌ-অধিদপ্তর ঙ। বন অধিদপ্তর চ। স্পারসো

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১১। যোগাযোগ ও পরিবহন :	
১১.১ দেশে স্থল পথ ব্যবস্থা যাহাতে সার্বিকভাবে পরিবেশ সম্মত হয় এবং সড়ক ও রেলপথ ব্যবস্থা যাহাতে পানি নিষ্কাশন ব্যবস্থার প্রতিবন্ধকতার সৃষ্টি না করে সেই উদ্দেশ্যে সতর্কতা অবলম্বন করিতে হইবে।	ক। যোগাযোগ মন্ত্রণালয় খ। সড়ক ও জনপথ অধিদপ্তর গ। রেলওয়ে কর্তৃপক্ষ
১১.২ রেল ও সড়ক পথে চলাচলকারী জনগণ ও যানবাহন যাহাতে গণ স্বাস্থ্যের প্রতি ক্ষতিকারক বর্জ্য ও আবর্জনা নিক্ষেপ এবং মলমূত্র ত্যাগ করিয়া পরিবেশ দূষণ না করে সেই জন্য যথাযথ ব্যবস্থা গ্রহণ করিতে হইবে	ক। যোগাযোগ মন্ত্রণালয় খ। বি আর টি এ
১১.৩ সড়ক, রেল ও জল পথে চলাচলকারী সকল যানবাহন হইতে নির্গত ধোঁয়া ও শব্দ নির্দিষ্ট মাত্রায় নিয়ন্ত্রণের উদ্দেশ্যে এবং সকল যানবাহনের প্রয়োজনীয় রক্ষণাবেক্ষণের জন্য যথাযথ ব্যবস্থা গ্রহণ করিতে হইবে। এই সকল যানবাহন তৈরীর দেশীয় কারখানাগুলিকে প্রয়োজনীয় ব্যবস্থা গ্রহণেরও নির্দেশ প্রদান করিতে হইবে এবং নির্দেশ প্রতিপালন বিষয়ে উপযুক্ত পরিদর্শন ব্যবস্থা রাখিতে হইবে।	ক। যোগাযোগ মন্ত্রণালয় খ। পুলিশ প্রশাসন গ। নৌ-পরিবহন মন্ত্রণালয় ঘ। বি আর টি এ ঙ। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয়
১১.৪ অভ্যন্তরীণ নৌ পথে চলাচলকারী নৌযান যাহাতে পানি দূষণ করিতে না পারে সেই দিকে গণসচেতনতা সৃষ্টি ও সতর্কতা অবলম্বন করিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয় খ। অভ্যন্তরীন নৌ-পরিবহন সংস্থা গ। সমুদ্র পরিবহন অধিদপ্তর
১১.৫ অভ্যন্তরীণ নৌ বন্দর ও ডকইয়ার্ডে পানির দূষণ নিয়ন্ত্রণ ব্যবস্থা নিশ্চিত করিতে হইবে।	ক। নৌ-পরিবহন মন্ত্রণালয়
১১.৬ বিমান বন্দর নির্মাণের ফলে যাহাতে সার্বিক কোনরূপ পরিবেশগত সমস্যার সৃষ্টি না হয় তৎপ্রতি সতর্কতা অবলম্বন করিতে হইবে।	ক। বেসামরিক বিমান পরিবহন ও পর্যটন মন্ত্রণালয় খ। বেসামরিক বিমান চলাচল কর্তৃপক্ষ
১১.৭ উড়োজাহাজ চলাচলের ফলে বায়ু ও শব্দ দূষণের প্রকোপ হ্রাসে সর্বপ্রকার সতর্কতা অবলম্বন করিতে হইবে।	ক। বেসামরিক বিমান ও পরিবহণ ও পর্যটন মন্ত্রণালয় খ। বেসামরিক বিমান চলাচল কর্তৃপক্ষ

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১১.৮ রেলপথ সহ যে সকল পরিবহন ও চলাচল ব্যবস্থা অপেক্ষাকৃত কম দূষণ সৃষ্টি করে সেগুলির ব্যবহার উৎসাহিত করিতে হইবে।	ক। যোগাযোগ মন্ত্রণালয়
১১.৯ রাস্তা ও রেলপথের দুইপাশে বনায়ন করিতে হইবে।	ক। সংশ্লিষ্ট মন্ত্রণালয় সমূহ খ। বন অধিদপ্তর

১২। গৃহ ও নগরায়ন :

১২.১ গৃহায়ন ও নগরায়নের জন্য প্রস্তাবিত সকল জাতীয় আঞ্চলিক প্রকল্প ও মাষ্টার প্ল্যান প্রণয়নের পূর্বে পরিবেশগত প্রভাব নিরূপণ (ইআইএ) করিতে হইবে।	ক। পূর্ত মন্ত্রণালয় খ। স্থানীয় সরকার বিভাগ গ। পরিবেশ ও বন মন্ত্রণালয় ঘ। পরিবেশ অধিদপ্তর
১২.২ শহরাঞ্চলে বস্তি বাসীদের জন্য, পরিকল্পিত পুনর্বাসন ব্যবস্থায় পরিবেশ সম্মত ব্যবস্থাদি অন্তর্ভুক্ত করিতে হইবে।	ক। পূর্ত মন্ত্রণালয় খ। স্থানীয় সরকার বিভাগ গ। নগর উন্নয়ন অধিদপ্তর
১২.৩ দেশের প্রধান ও বৃহৎ শহর গুলিতে জনসংখ্যার চাপ হ্রাস এবং পরিবেশ উন্নয়নের লক্ষ্যে উপশহর নির্মাণের ব্যবস্থা গ্রহণ করিতে হইবে।	ক। পূর্ত মন্ত্রণালয় খ। স্থানীয় সরকার বিভাগ গ। গৃহসংস্থান অধিদপ্তর
১২.৪ ঢাকা, চট্টগ্রাম, রাজশাহী ও খুলনা প্রভৃতি প্রধান নগরগুলিতে পরিবেশ উন্নয়নের লক্ষ্যে নিবিড় বনায়ন ও অন্যান্য উন্নয়নমূলক কর্মসূচী দ্রুত বাস্তবায়ন করিতে হইবে।	ক। পূর্ত মন্ত্রণালয় খ। নগর উন্নয়ন সংস্থাসমূহ গ। বন অধিদপ্তর ঘ। পৌর কর্তৃপক্ষ সমূহ
১২.৫ দেশের প্রধান বনবসতিপূর্ণ নগরগুলিতে নিবিড় ও সমন্বিত পরিবেশ উন্নয়নমূলক কর্মসূচী গ্রহন করিতে হইবে।	ক। নগর উন্নয়ন সংস্থা সমূহ খ। নৌ-কর্তৃপক্ষসমূহ গ। পূর্ত মন্ত্রণালয়
১২.৬ আবাসিক, বানিজ্যিক ও শিল্প এলাকা পৃথকীকরণের জন্য (Zoning) পদক্ষেপ গ্রহণ করিতে হইবে।	ক। শিল্প ও সংশ্লিষ্ট অন্যান্য মন্ত্রণালয় খ। পূর্ত মন্ত্রণালয় গ। নগর উন্নয়ন সংস্থাসমূহ ঘ। বস্ত্র মন্ত্রণালয় ঙ। বাংলাদেশ রেশম বোর্ড,
১২.৭ গৃহ ও নগরায়নের বিভিন্ন কর্মসূচীতে নিয়মিত মনিটরিং ও জরীপ কার্যের ব্যবস্থা রাখিতে হইবে।	ক। পূর্ত মন্ত্রণালয় খ। স্থানীয় সরকার বিভাগ গ। নগর উন্নয়ন সংস্থা সমূহ ঘ। পৌর কর্তৃপক্ষসমূহ ঙ। প্রতিরক্ষা মন্ত্রণালয় চ। স্পারসো

খাত	বাস্তবায়নকারী কর্তৃপক্ষ

১৩। জনসংখ্যা :

১৩.১ দেশের বর্তমান জনসংখ্যা, জনসংখ্যা বৃদ্ধির উচ্চহার এবং ২০০০ সন পর্যন্ত জনসংখ্যার প্রবৃদ্ধি দেশের সম্পদ ও উন্নয়ন প্রক্রিয়া এবং পরিবেশের উপর কি সুনির্দিষ্ট প্রভাব সৃষ্টি করিবে সে সম্পর্কে একটি সমীক্ষা প্রণয়ন করিতে হইবে। সমীক্ষায় প্রাপ্ত তথ্যসমূহের ভিত্তিতে সংশ্লিষ্ট সকল ক্ষেত্রে প্রয়োজনীয় পরিবেশ সম্মত ব্যবস্থা গ্রহণ করিতে হইবে।	ক। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয় খ। পরিবেশ ও বন মন্ত্রণালয়
১৩.২ দেশের জনশক্তির সমন্বিত, সুপরিকল্পিত ও পরিবেশ সম্মত ব্যবহার নিশ্চিত করিবার উদ্দেশ্যে একটি জনশক্তি পরিকল্পনা প্রণয়ন করিতে হইবে।	ক। শ্রম ও জনশক্তি মন্ত্রণালয়
১৩.৩ বিভিন্ন সেক্টরে পরিবেশ সংরক্ষণ ও উন্নয়নমূলক কার্যক্রমে মহিলাদের ভূমিকার উপর যথাযথ গুরুত্ব আরোপ করিয়া তাহাদের সক্রিয় অংশ গ্রহণ নিশ্চিত করিতে হইবে।	ক। পরিকল্পনা কমিশন খ। মহিলা বিষয়ক মন্ত্রণালয় গ। পরিবেশ ও বন মন্ত্রণালয়
১৩.৪ জনসংখ্যাকে দেশের প্রধানতম সমস্যা চিহ্নিত করিয়া এর নিয়ন্ত্রণ এবং যথাসম্ভব দ্রুত এ সংখ্যা স্থিতিশীল করিবার প্রয়োজনীয় পরিকল্পনা গ্রহণ ও তাহা বাস্তবায়ন করিতে হইবে।	ক। স্বাস্থ্য ও পরিবার কল্যান মন্ত্রণালয়
১৩.৫ দেশের দরিদ্র অংশ যেহেতু পরিবেশ অবক্ষয়ের প্রধান ও ত্বরিৎ শিকার হয়, তাই স্বাস্থ্যরক্ষা ও পরিবেশ অবনয়নজনিত সমস্যা হইতে তাহাদের রক্ষা করিবার বিষয়ে উপযুক্ত ব্যবস্থা গ্রহণ করিতে হইবে।	ক। স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়

১৪। **শিক্ষা** ও গণ-সচেতনতা :

১৪.১ পরিবেশ সংক্রান্ত গণ-সচেতনতা সৃষ্টির লক্ষ্যে একটি ৫ বৎসর মেয়াদী সমন্বিত প্রকল্প প্রণয়ন করিতে হইবে। পরিবেশ ও বন মন্ত্রণালয়ের উদ্যোগে এই প্রকল্প গৃহীত ও বাস্তবায়িত হইবে। তথ্য, শিক্ষা প্রভৃতি মন্ত্রণালয় এই বিষয়ে সার্বিক সহায়তা প্রদান করিবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। শিক্ষা মন্ত্রণালয় গ। তথ্য মন্ত্রণালয়

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১৪.২ শিক্ষা ও প্রশিক্ষণের সকল পর্যায়ে পরিবেশ সংক্রান্ত বিষয়াদি পাঠ্যসূচীর অন্তর্ভুক্ত করিতে হইবে।	ক। শিক্ষা মন্ত্রণালয়
১৪.৩ গণচেতনা সৃষ্টির উদ্যোগে মসজিদের ইমাম এবং স্কুল কলেজের শিক্ষকবৃন্দসহ সকল প্রকার ধর্মীয় এবং সামাজিক নেতৃবৃন্দ বিশেষতঃ স্বেচ্ছাসেবী সংগঠনসমূহের নেতৃবৃন্দকে সম্পৃক্ত করিতে হইবে।	ক। ধর্ম মন্ত্রণালয় খ। ইসলামিক ফাউণ্ডেশন গ। সমাজকল্যাণ মন্ত্রণালয় ঘ। শিক্ষা মন্ত্রণালয়

১৫। বিজ্ঞান, প্রযুক্তি ও গবেষণা :

১৫.১ পরিবেশগত ও টেকসই প্রযুক্তিক লক্ষ্য রাখিয়া পরিবেশ দূষণ রোধক ও নিয়ন্ত্রণ জোরদার করার পদক্ষেপ সম্পর্কে পরামর্শ প্রদান করিতে হইবে।	ক। বিজ্ঞান ও প্রযুক্তি বিভাগ খ। বিজ্ঞান ও প্রযুক্তি সংক্রান্ত গবেষণা প্রতিষ্ঠানসমূহ
১৫.২ বিভিন্ন গবেষণা প্রতিষ্ঠানে পরিবেশ সংরক্ষণ ও উন্নয়ন এবং সম্পদের পরিবেশসম্মত ব্যবহার নিশ্চিত করিবার লক্ষ্যে গবেষণা কার্যক্রম ও উপযুক্ত প্রযুক্তি উদ্ভাবনমূলক কার্যক্রম জোরদার ও উৎসাহিত করিতে হইবে।	ক। সংশ্লিষ্ট মন্ত্রণালয়সমূহ খ। বিভিন্ন গবেষণা প্রতিষ্ঠান
১৫.৩ ১৯৮৬ সালের জাতীয় বিজ্ঞান ও প্রযুক্তি নীতিতে গবেষণা ও উন্নয়নের জন্য জাতীয়ভাবে অগ্রাধিকার হিসাবে চিহ্নিত সকল ক্ষেত্রে পরিবেশগত বিষয়কে একটি অপরিহার্য অংশ হিসাবে সংযোজন করিতে হইবে।	ক। বিজ্ঞান ও প্রযুক্তি বিভাগ খ। বিজ্ঞান ও প্রযুক্তি সংশ্লিষ্ট ও অন্যান্য মন্ত্রণালয়/বিভাগ।
১৫.৪ দেশের সকল গবেষণা ও উন্নয়ন প্রতিষ্ঠান তাহাদের গবেষণা ক্ষেত্রসমূহের পরিবেশগত দিক বিশেষভাবে বিবেচনা করিবে এবং তদনুযায়ী সংশোধনমূলক ব্যবস্থা গ্রহণ করিতে হইবে।	ক। বিজ্ঞান ও প্রযুক্তি বিভাগ খ। সংশ্লিষ্ট সকল মন্ত্রণালয়/বিভাগ গ। বিজ্ঞান ও প্রযুক্তি সংশ্লিষ্ট সকল গবেষণা ও উন্নয়ন প্রতিষ্ঠান

১৬। আইনগত কাঠামো :

১৬.১ পরিবেশ সম্পর্কিত বর্তমান আইনসমূহ একটি আন্তঃমন্ত্রণালয় কমিটির মাধ্যমে পর্যালোচনাপূর্বক প্রয়োজনীয় সংশোধনের ব্যবস্থা গ্রহণ করিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। আইন ও বিচার মন্ত্রণালয় গ। অন্যান্য সংশ্লিষ্ট মন্ত্রণালয়

খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১৬.২ এই আন্তঃমন্ত্রণালয় কমিটি পরিবেশ সংরক্ষণ ও উন্নয়নের লক্ষ্যে নতুন প্রয়োজনীয় আইন প্রণয়নের ক্ষেত্রসমূহ চিহ্নিত করিয়া সুনির্দিষ্ট সুপারিশ পেশ করিবে।	ক। পরিবেশ ও বন মন্ত্রণালয়
১৬.৩ এখন হইতে নতুন যে কোন আইন প্রণয়নের সময় সংশ্লিষ্ট মন্ত্রণালয় ঐ আইন পরিবেশ সম্মত হওয়া নিশ্চিত করিবেন।	ক। সংশ্লিষ্ট মন্ত্রণালয়সমূহ

১৭। প্রাতিষ্ঠানিক কাঠামো :

১৭.১ উপরিলিখিত সকল মন্ত্রণালয়/বিভাগ এবং সরকারী প্রতিষ্ঠানসমূহে নিজ নিজ আওতাধীন সংশ্লিষ্ট কার্যক্রম পরিবেশ সম্মতভাবে বাস্তবায়নের জন্য যথাবিহিত ব্যবস্থা গ্রহণ করিবে।	ক। সংশ্লিষ্ট মন্ত্রণালয়
১৭.২ পরিবেশ সংরক্ষণ ও উন্নয়ন সংক্রান্ত কার্যাদি বাস্তবায়নে বেসরকারী সেক্টর ও বেসরকারী সংস্থাসমূহের প্রত্যক্ষ অংশগ্রহণ উৎসাহিত ও নিশ্চিত করিতে হইবে।	ক। এনজিও বিষয়ক ব্যুরো
১৭.৩ পরিবেশ ও বন মন্ত্রণালয় পরিবেশ সংক্রান্ত বাস্তবায়ন কার্যক্রম বাস্তবায়নের বিষয় সমন্বয় করিবে।	ক। পরিবেশ ও বন মন্ত্রণালয়
১৭.৪ সরকার প্রধানের সভাপতিত্বে এই কার্যক্রম বাস্তবায়নে দিক নির্দেশনা প্রদানের উদ্দেশ্যে একটি জাতীয় পরিবেশ কমিটি গঠিত হইবে। সংশ্লিষ্ট সকল মন্ত্রণালয়ের মন্ত্রীগণ এই কমিটির সদস্য হইবেন। পরিবেশ ও বন মন্ত্রণালয়ের সচিব এই কমিটির সদস্য-সচিব হইবেন এই কমিটির সভা বৎসরে অন্ততঃ একবার অনুষ্ঠিত হইবে।	ক। প্রধান মন্ত্রীর কার্যালয় খ। মন্ত্রী পরিষদ বিভাগ গ। পরিবেশ ও বন মন্ত্রণালয়

	খাত	বাস্তবায়নকারী কর্তৃপক্ষ
১৭.৫	দেশের সকল উন্নয়ন প্রকল্পে পরিবেশগত প্রভাব নিরূপনের ব্যবস্থা করিবার প্রেক্ষিতে পরিবেশ ও বন মন্ত্রণালয় এবং পরিবেশ অধিদপ্তরের কারিগরী সামর্থ্য ও লোকবল বৃদ্ধি করিতে হইবে। পরিকল্পনা প্রণয়নের সাথে সংশ্লিষ্ট কর্মকর্তাদের পরিবেশ সংক্রান্ত প্রশিক্ষণ প্রদান করিতে হইবে। প্রকল্প সারপত্র ও প্রকল্প দলিলে পরিবেশের প্রভাব সম্পর্কে বিস্তারিতভাবে উল্লেখ থাকিতে হইবে।	ক। পরিবেশ ও বন মন্ত্রণালয় খ। পরিকল্পনা কমিশন গ। সংশ্লিষ্ট সকল মন্ত্রণালয়
১৭.৬	পরিবেশ ও বন মন্ত্রণালয় প্রতি পাঁচ বৎসর অন্তর দেশে পরিবেশ অবস্থার উপর একটি অবস্থানপত্র (Status Paper) প্রণয়ন, প্রকাশ ও বিতরণ করিবে।	ক। পরিবেশ ও বন মন্ত্রণালয়
১৭.৭	ভবিষ্যতে যথাসময়ে পরিবেশ ও বন মন্ত্রণালয় প্রয়োজন অনুসারে পরিবেশ নীতি পরিবর্তন ও পুনঃ প্রণয়নের জন্য যথাবিহিত ব্যবস্থা গ্রহণ করিবে এবং পরিবেশ সংক্রান্ত বাস্তবায়ন কার্যক্রমের প্রয়োজনীয় পরিবর্তন করিবে।	ক। পরিবেশ ও বন মন্ত্রণালয়

বাঃমুঃ-৯১/৯২—৬১৬৮বি—১০০০—৯-৫-১৯৯২

FIELD REPORT

[On project areas visited by the participants of EIA Skills Workshops I, II and III in Phase IV]

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NARAYANGANJ-NARSINGHDI IRRIGATION PROJECT (BLOCK-A1)

Project Design and Maintenance

The Narayanganj-Narsinghdi Irrigation Project (NNIP), Block-A1, is a flood control, drainage, and irrigation project located 20 km east of Dhaka. It is bounded by the Meghna River on the east, the Lakhya River on the west, the Tongi-Narsinghdi railway line on the north, and the Dhaka-Comilla highway on the south (Map 1).

Block-A1 covers an area of 3,000 ha which includes a net irrigation area of 2,120 ha. The Lakhya River provides irrigation water through one pump station containing four pumps. Each pump has a pumping capacity of 1.88 m^3 water per second.

Fifty-five km of canals irrigate the area, while forty-two km of canals drain it. These canals are divided into secondary and tertiary canals. To facilitate drainage there are six regulators and four pipeline sluices. The total length of the flood embankment is 23.68 km.

Neither the sluice gates of Block-A1 nor the project's demonstration unit have functioning operation and maintenance committees. According to local people, a formal committee was appointed for the operation and maintenance of Block-A1, but it has not been given the necessary authority to meet and perform its duties.

Consequently, at the demonstration unit, when farmers need water they must bribe the pump station operator to start the pump. The villagers, therefore, have requested that the Water Development Board provide a better system to operate the project.

Changes in Land Use

Although the project is new, it has already changed land-use patterns. Some of the changes were anticipated under the project plan, but many unanticipated and unwanted changes have occurred. For example, prior to the construction of the project farmers used various irrigation practices to cultivate year-round, and drainage and water logging were not problems. Since the project was implemented, however, inadequate irrigation and drainage facilities have reduced cultivation to only one crop per year. Now, when the land is not cultivated, it lies fallow. Water logging has become a serious problem in several areas because no provision was made for drainage (Map 2).

In an attempt to improve drainage problems caused by the project, the number of historically-occurring *beels* in the area has been reduced. For example, a project-built drainage canal crossing through Baro Beel (Map 2) drains much of the *beel's* water even in the rainy season. The newly exposed land is cultivated, but the overall consequent is that wetlands are quickly disappearing.

Another change prompted by the project is that land prices have increased in the southern part of the project and along roadsides. Many marginal farmers have sold their land to developers who, in turn, sold the land to developers from outside the area who built houses or set up industries on the property.

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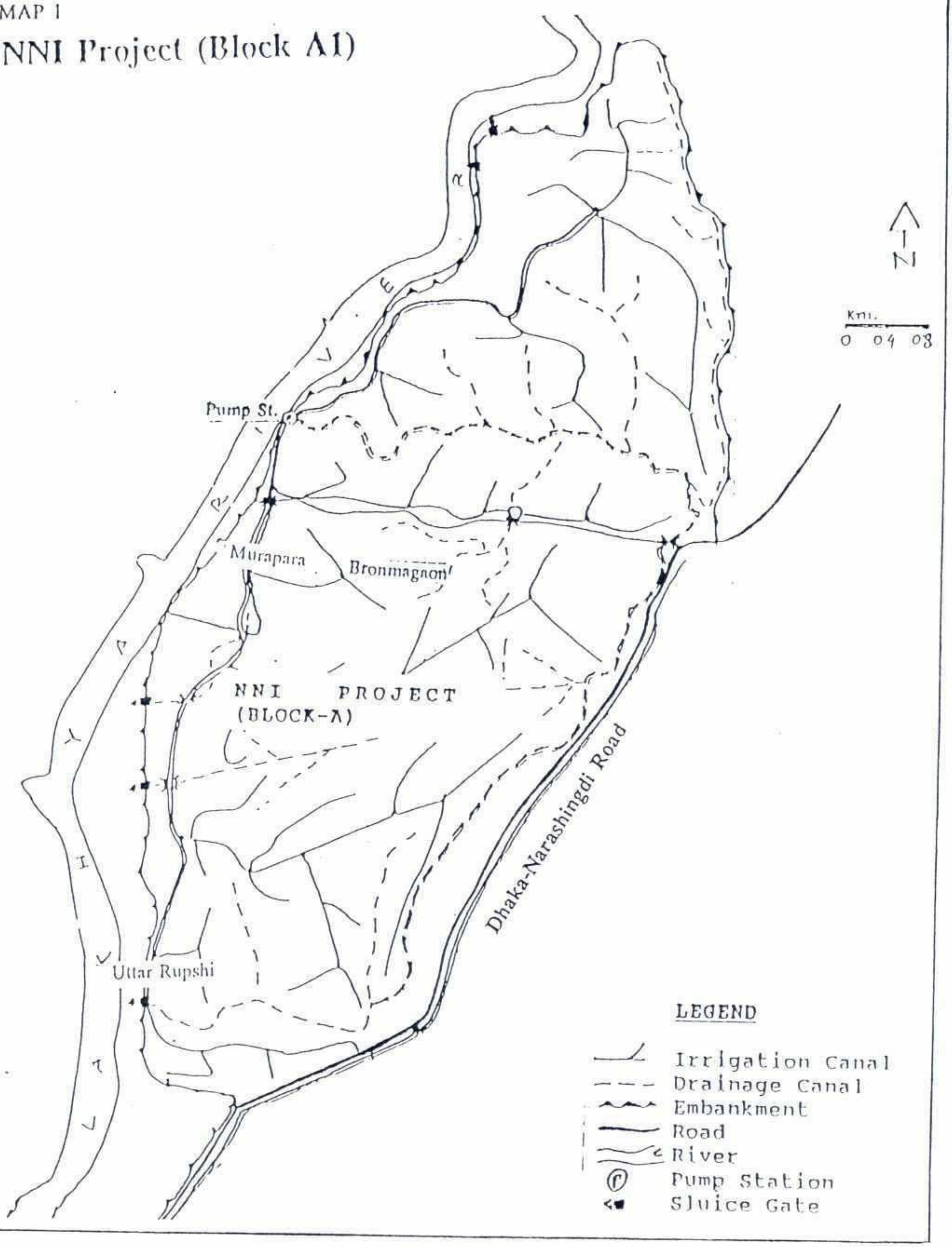
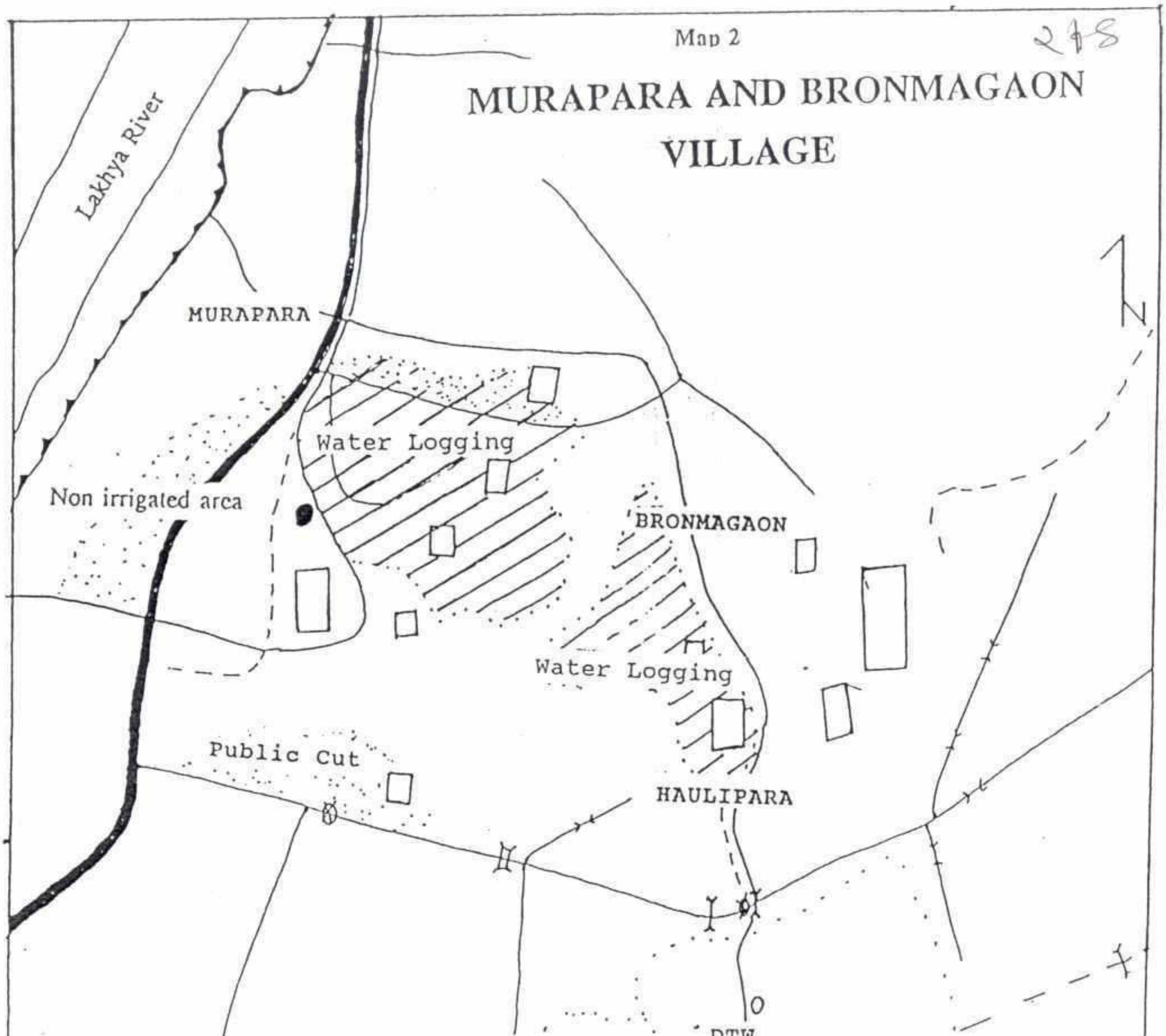
MAP 1

NNI Project (Block A1)





Map 2. Environmental Impacts on Murapara and Bronmagaon village

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Historically, agriculture has been the main activity in the demonstration project area, and, currently, there are a number of industries, such as dyeing factories, glass factories, and brick-making fields, located there. But, because the embankments have made the area more accessible, many industries have developed southwest of the project and a few are gradually moving inside the project area itself. Consequently, industrial pollution has become a problem. Many farmers claim that chemical effluents have reduced agricultural production. It also is believed that the loss of agricultural land to industry or homesteads is not offset by the small employment increase that occurs with the development of small industries.

Negative Environmental Impacts

According to local people, the project has had many negative impacts on the environment and socioeconomic conditions. In some parts of the project area agricultural production has decreased due to improperly designed drainage canals, lack of drainage entirely, waterlogging, lack of irrigation, and air pollution from brick fields and other industries. Agricultural lands that were once irrigated by farmer-owned low-lift pumps, can no longer be cultivated as irrigation canals divert the water to other areas. Many small parcels of land (10 to 100 acres per parcel) were excluded from the project's irrigation facilities.

Local farmers report that soil productivity was higher before construction of the project as annual floods brought fresh silt to replenish fields. The embankment, however, prevents flood water and the fresh silt from entering the project area. The resulting drop in soil productivity has brought about a gradual increase in the use of chemical fertilizers. The result of low productivity is that many farmers who reported never buying rice in the past now must do so to feed their families.

Agricultural workers, such as sharecroppers, reported losing interest in agricultural activities as production costs increase and yields decline. Many reported moving on to small trading or excavating work. Since the initiation of the project it was reported that landlessness had increased due to costly agricultural inputs, high land prices, and other economic factors.

Another negative impact is that many fish species have disappeared from the area, depleting the fisheries resources and resulting in a decline in per capita protein intake. Prior to the project, most villagers caught and consumed fish from nearby Baro, Noiari, Guramara, Kur, and Chaper *Beels*. Many of these *beels* have dried up due to project interventions. Villagers who used to eat fish daily before the construction of the embankment, said that now they are lucky to have fish once a week.

In particular, Baro *Beel* was a major fishing ground for professional and subsistence fishermen both inside and outside the project area. The reduced water levels in the *beel*, along with blocked canals, sluice gates, and regulators, was all brought about by the project and has greatly reduced capture fisheries production. The reduced fishery has forced many fishermen to change profession or migrate elsewhere to continue fishing.

Project interventions also seem to have created more habitat for rats. Farmers reported large increases in crop damage due to rats. In addition, drying *beels* have forced large frogs to migrate from their lost wetland habitat to nearby ponds. The local people claim that the frogs eat the pond fish fry.

Since the area became more accessible by embankment roads, several brick making businesses have been established in the area. According to locals, about 300 acres of land adjacent to brick fields have been severely affected by heat emissions from the brick fields (See Map 3). Rice production in these areas has been reduced by a quarter, and many who farm there plan to sell some of their land and change professions. Villagers claim that yields of pumpkin, cucumber, and mango also have declined. It was reported that the problem was not as bad before natural gas was used in the brick fields

Positive Environmental Impacts

Agricultural production has increased where irrigation is available. Culture fisheries has become popular among farmers who have ponds, while those without are interested in excavating ponds.

In areas where the project has created a flood-free environment, plantation programs have increased and people have shown interest in planting a variety of timber trees.

Embankment roads have improved the transportation and communication infrastructure and made many areas more accessible.

Area-Specific Environmental Impacts (Block-A1)
Location: Murapara and Brahmagaon

Drainage, Waterlogging, and Irrigation

Gukhali *Khal* is a drainage canal in the Murapara/Brahmagaon area. When a main irrigation canal was constructed over Gukhali *Khal*, the system's natural drainage was blocked (Map 2). Local farmers reported that their fields now remain underwater most of the year, granting them only one harvest from fields that used to yield two to three crops per year. There was no provision for draining water from the area. Joykali *Khal*, which served an area of about 300 *kani* (three *kani* equal one acre) also was blocked by an irrigation canal and now presents waterlogging problems.

No irrigation was provided for more than 50 acres of agricultural land between the embankment and the main irrigation canal. Those acres lay fallow during the kharif I season. This irregularity in irrigation prompted some farmers near Murapara village to cut additional irrigation canals toward their land in 1993. About 100 yards east of the irrigation canal another cut was made in the same year to drain excess water.

These problems of irregular irrigation supply and drainage congestion have resulted in a decrease in crop production. Adding to the problem is an increasing trend from farm to nonfarm land use (industry, homesteads) in the area.

Reduction in Fish Production

The project authority made no provisions for negative impacts on capture fisheries in its plan. A main drainage canal constructed through the middle of Baro *Beel* drains all but a few low-lying pockets of the *beel*, even in the rainy season. Except for those few ponds, the *beel*, once an important fishing ground,

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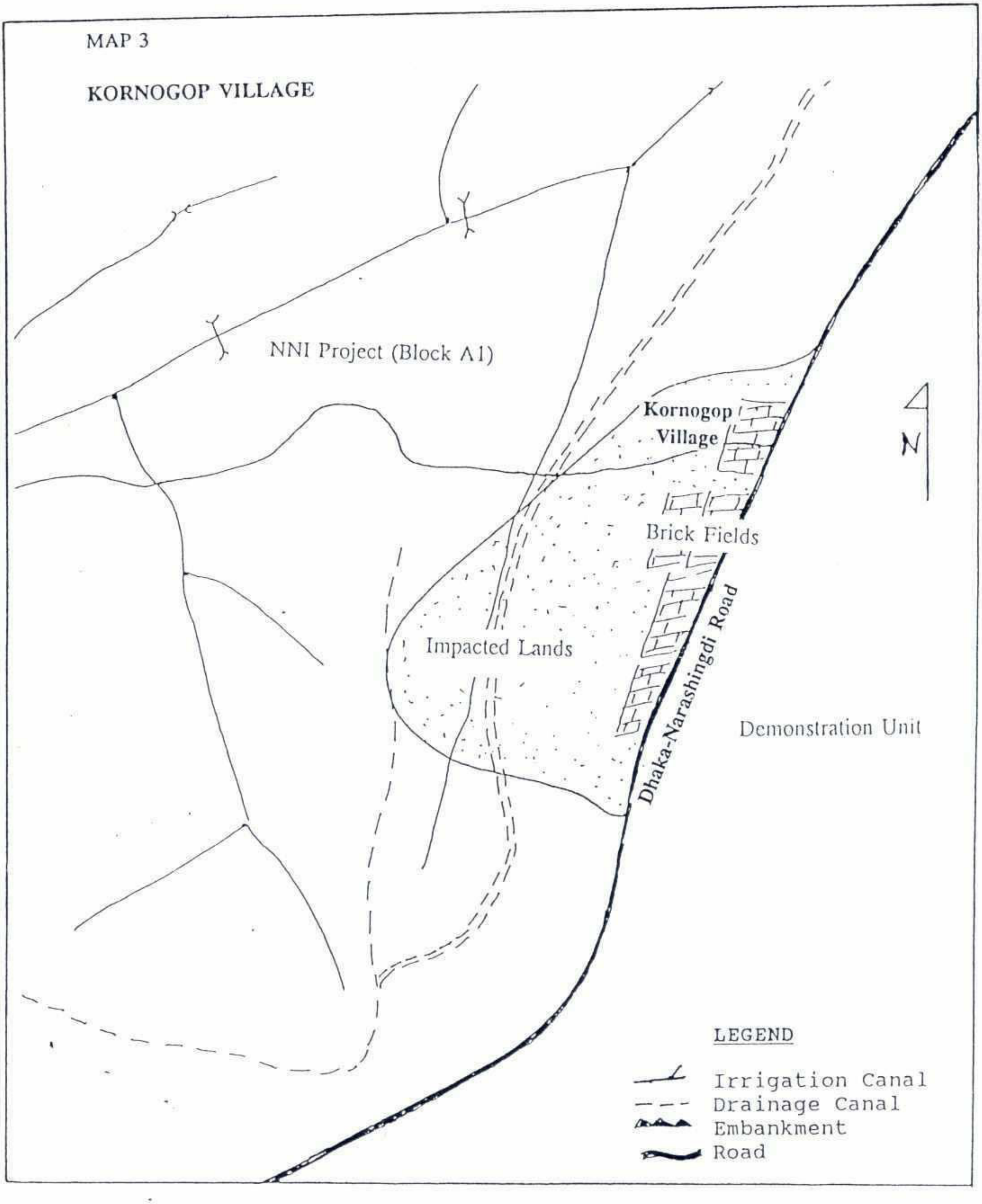


Map 3. Brick fields and associated problems

is no longer used for commercial fishing. Now, the seasonal fish catch from the *beel* is not even sufficient for the consumption needs of the people in the neighborhood. The drained *beel* areas are cultivated.

Twenty-four fishing families currently live in Majhipara. Prior to construction of the project each fisherman could save Tk. 5,000 to Tk. 10,000 per year. Now, not only are they unable to save, most are forced to supplement their income by working as laborers.

Seven or eight of the 24 fishing families are landless and have temporarily left the area to fish *beels* outside the project. The remaining fishermen, all of whom own some agricultural land, have adopted a mixed livelihood strategy. In addition to their agricultural activities, these fishermen contract to catch fish from privately owned ponds at a rate of Tk. 200 to Tk. 500 per catch.

Four *beels* in Murapara village, Noiari, Guramara, Kur, and Chaper, are privately owned. Historically, people who lived in settlements near these *beels* leased them, but owners reported that they are planning to develop ponds in the *beel* for aquaculture instead of leasing to locals. Fishing in the *beels* will therefore become restricted.

Although fishermen reported large catches of *koi, shing, magur, rui, catla, puti, chapila, maus,* and fish fry, they said that one species, *meni,* had become extinct in the area since the project was initiated.

Location: Uttar Rupshi

Although cropping intensity increased in the area where irrigation water was available, overall production was reduced because of the irregularity of the water supply. In addition, farmers who got water complained that it did not come at the proper time to irrigate.

Some areas reported no irrigation water. For example, one 400 *kani* highland area was fallow when the study was conducted because no irrigation was provided. As expected, the lack of irrigation resulted in reduced cropping.

Although capture fisheries have developed rapidly in the area, the fish fry population is severely depleted by frogs. For example, one local farmer stocked his pond with about 1,500 fish fry but harvested only 500 fish. According to locals, the frogs used to feed on floodplain fish and insects in the vast *beel* wetlands that were destroyed by the project.

The curtailment of flood water into the project area has enhanced and increased the habitat for rats. As the rat population has grown, the percentage of crop damage by these pests has gradually increased.

Another problem that affects the environment of the area is that the project has no permanent operation and maintenance committee. The 12-member committee that was formed at the beginning of the project has never been given authority to function. Consequently, with no regulating body, anyone can, and does, open or close the sluice gate.

APPENDIX

The following data were provided by knowledgeable people in the project area.

Present Land Use Pattern

Land use pattern	Before Project (%)	After Project (%)
Agriculture Land	68	80
Settlement Area	10	10
Industrial Area	02	05
Beel Area	20	05

Source: Field Survey

Occupational Structure

	Implementation Unit	
Occupation	Before project (%)	After project (%)
Farmer	80	75
Weaver	08	05
Service	03	05
Other*	09	15

Source: Field Survey

*Shopkeeper, rickshaw puller, fisherman, bidi labor, brick field worker, mishuk driver, *jamdani sari* seller.

NARAYANGANJ-NARSINGHDI IRRIGATION PROJECT: DEMONSTRATION UNIT

Project Background

The demonstration unit, a pilot project in Area-B, was implemented in March 1982 and completed in April 1984. It was situated on the Dhaka-Narsinghdi-Sylhet roadside and covered 1,300 ha. Its net irrigable area was 1,000 ha. The flood embankment was 8.26 km long. There was a pump station with three pumps in the southern part of the project at Jatramura. There were 46.22 km of irrigation canals and 22.26 km of drainage canals.

Dighi Borabo and Bhargaon Mauza are near the Jatramura pump station (Map 1). Historically, people grew two crops in these low-lying areas, one in kharif I and the other in the rabi season. In the kharif I season they used low-lift pumps to irrigate HYV boro with water from the Lakhya River. Only jute, which was planted on relatively higher ground, was grown during the kharif II season. The people in these areas expected the project to provide enough irrigation to improve their cropping regime. Irrigation water, however, did not flow properly through the area due to improper drainage.

Dighi Borabo's proximity to the Dhaka-Sylhet highway brought many new settlers to the village. As a result, land prices gradually increased. Agriculture production costs also increased, and excessive use of chemical fertilizers reduced soil fertility. Industrial pollution affected water quality, and open-water fisheries were seriously hampered by the project. Culture fisheries, however, increased.

Heat emission from brick fields reduced rice yield by a quarter of what would have been expected otherwise near Kornogop and on the road opposite the brick fields. Many farmers in these areas lost interest in agriculture, sold some of their land, and changed occupation. Prior to 1991, before the introduction of natural gas in brick fields, emission problems were not as acute.

Rupshi, Maikuli, and Borpa mauzas of Dighi Borabo all have cloth dyeing factories that pollute the Dighi Borabo drainage canal. Farmers with low-lift pumps outside the project area used the polluted water as no other irrigation water was available. Dyeing factories outside the project also pollute the water.

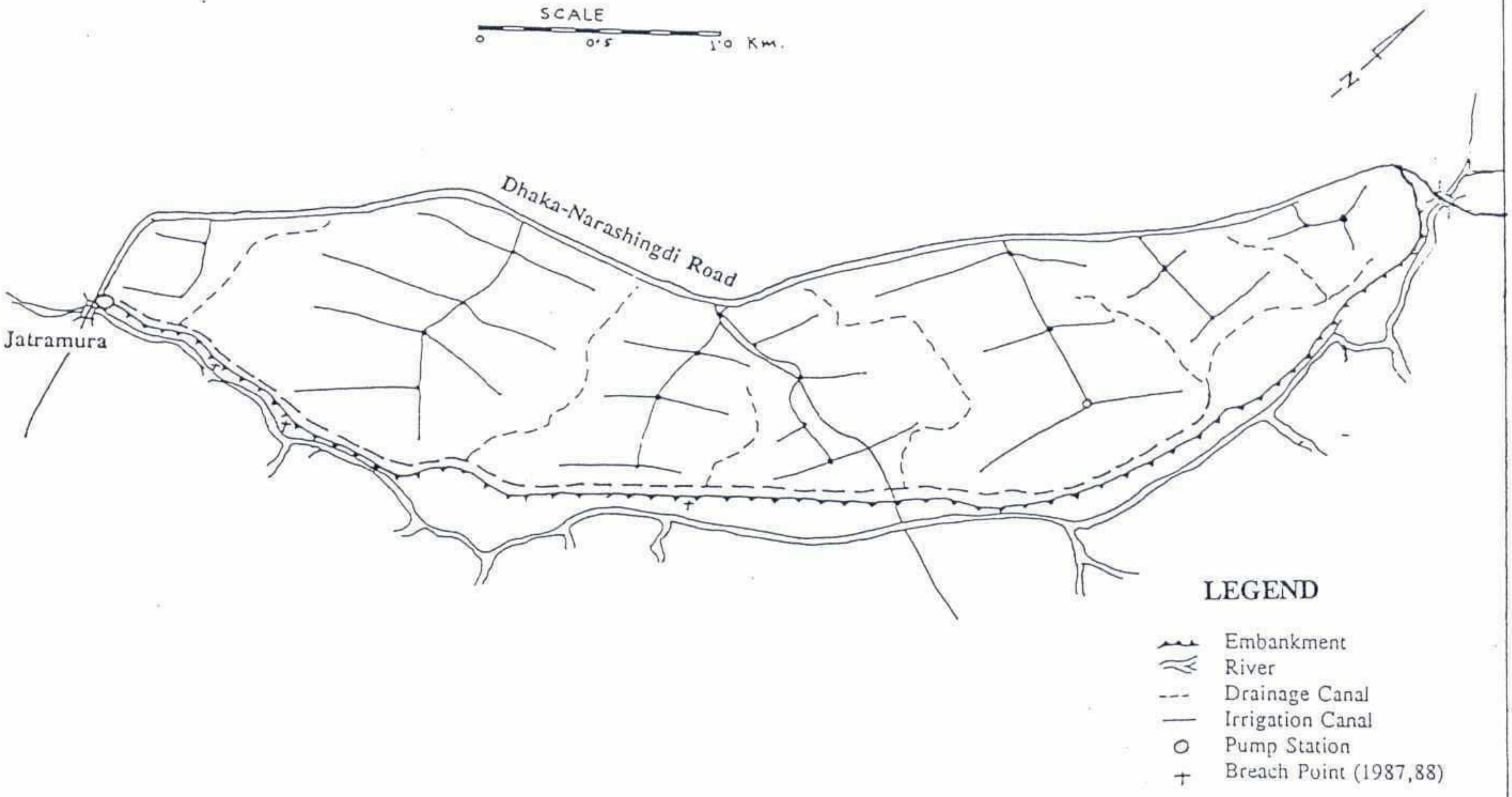
Negative Environmental Impacts

According to villagers, the canals used for irrigation before the project was built provided balanced irrigation for all areas, including some highlands. These old irrigation canals were not considered in the design of the project and many of the new canals eliminated irrigation from some areas and waterlogged others (Map 2). More than 10,000 acres of relatively high land in Dighi Borabo, Bhargaon, Behakoir, and Sutalara mauzas got no water from the irrigation canal. Only a small amount of rain would cause the drainage canal to overflow, inundating and destroying standing crops (Maps 2 and 3). In 1994, for example, several days of incessant rain destroyed about 75 percent of the local paddy variety, *mala irri*, when the drainage canal overflowed.

In order to balance the water pressure on both sides of the embankment, the project authority did not open drainage canals simultaneously across the area. Consequently, areas such as Dighi Borabo and Bhargaon villages were inundated throughout the rainy season.

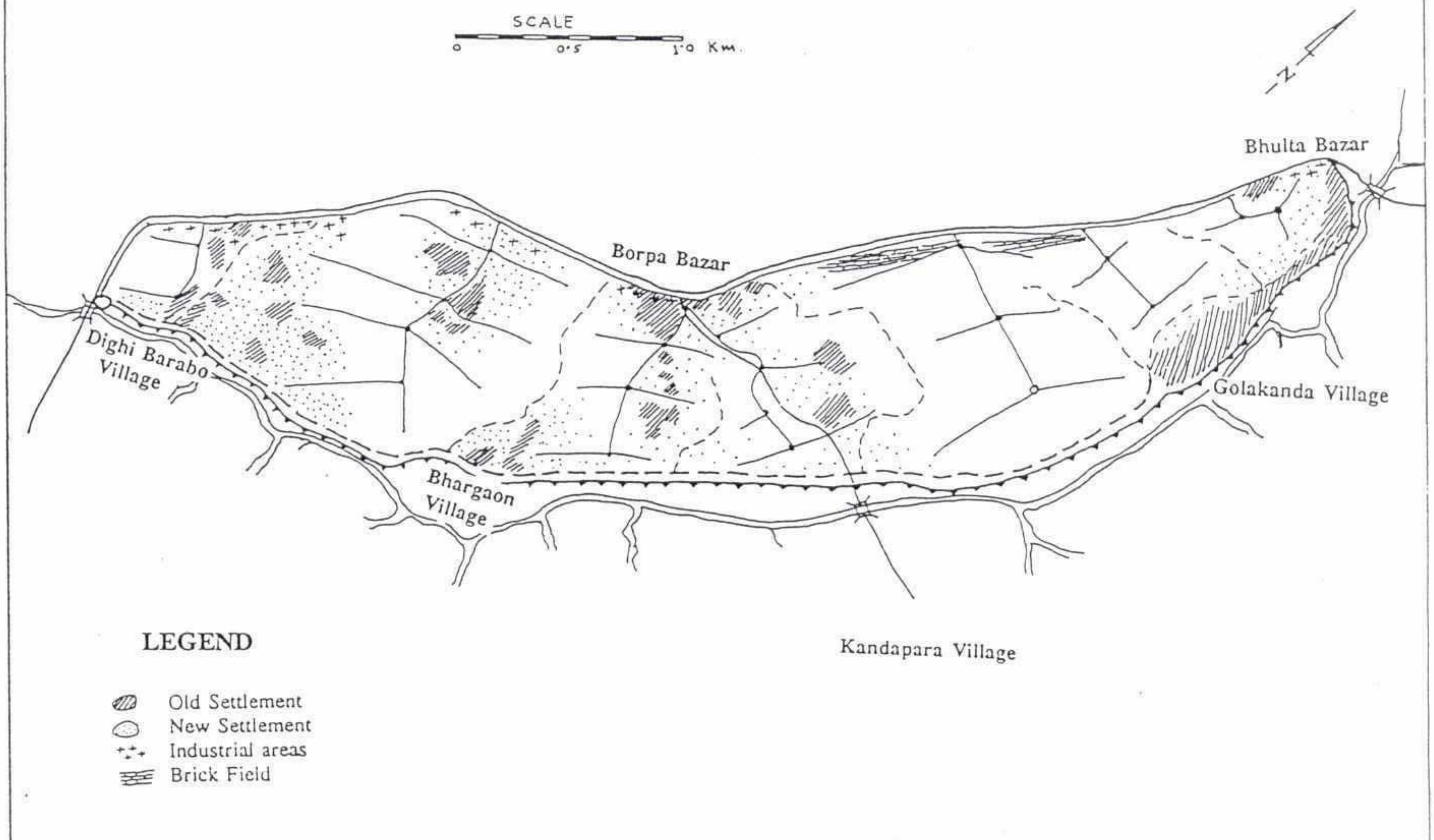
. Map 1

NNI PROJECT (DEMONSTRATION UNIT)



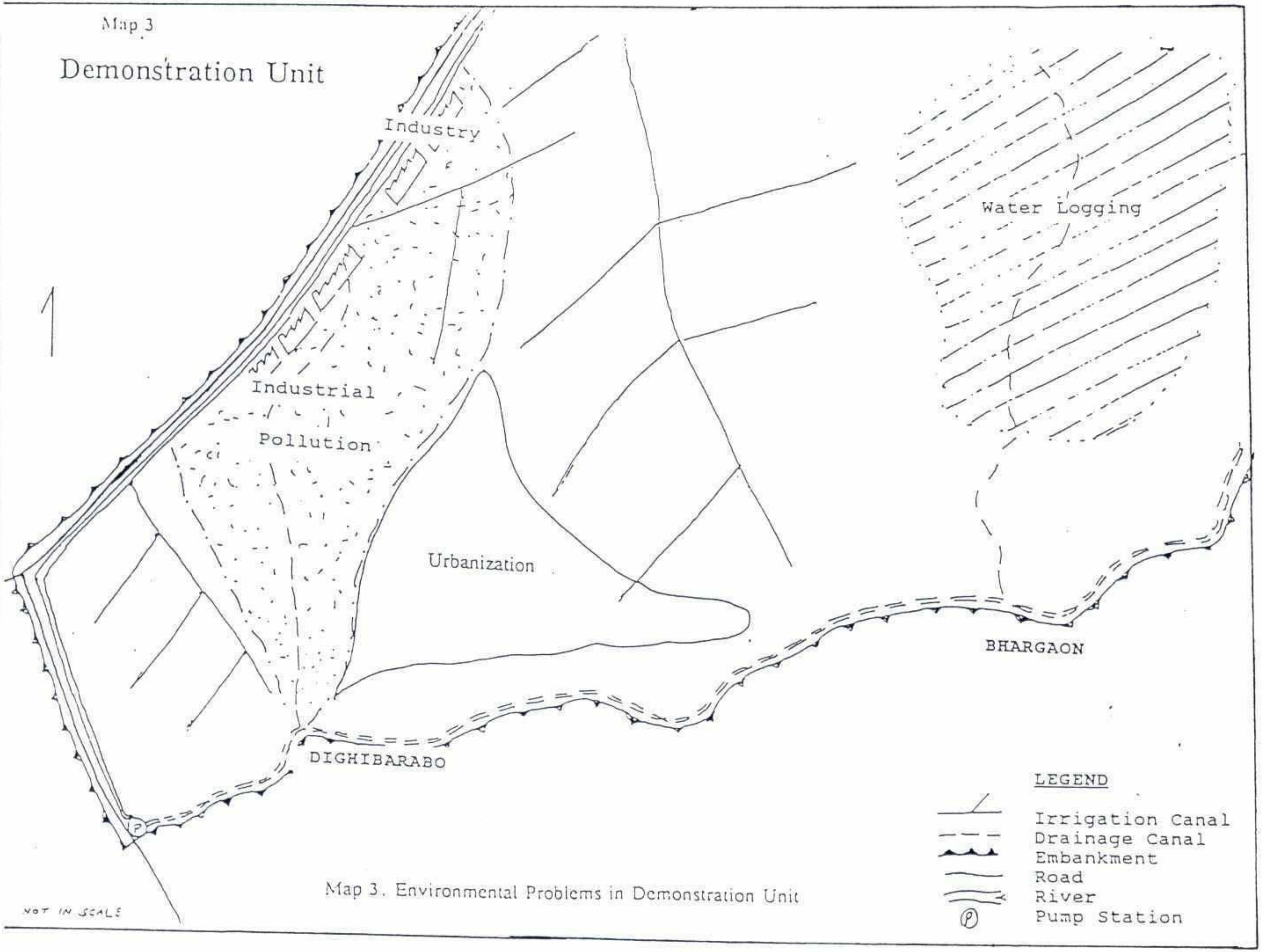
Map 2

NNI PROJECT (DEMONSTRATION UNIT)
(Different Environmental Issues)



Map 3

Demonstration Unit



Map 3. Environmental Problems in Demonstration Unit

The embankment has been breached three times since its construction: in 1985, 1987, and 1988. Because of a breach in 1988, the whole area was under four to five feet of water for about a month and all of the *irri* crop was destroyed. The flooding also destroyed earthen houses and displaced villagers temporarily settled on the embankment. Not surprisingly, many small and marginal farmers were forced to sell their land after the 1988 flood to pay debts and meet daily expenses.

The lack of flooding was also considered a problem by farmers. Because the project curtailed flooding during normal years, the area no longer received flood-borne silt. The result was a decline in soil fertility and an increase in the use and cost of chemical fertilizers and pesticides (see Appendix Table 3).

Most of the farmers in Dighi Borabo, Bhargaon, Behakoir, and Sutalara mauzas used low-lift pumps for irrigation. Although the pumps lifted water from the drainage canal, they were unable to lift enough water at crucial times, and, consequently, had lower crop yields. Moreover, the water in the canal was often polluted by chemical effluents dumped by cloth dyeing factories in the area. With no alternative, farmers used the polluted water and found their crop yields cut in half. Before construction of the project, for example, one *bigha* (three *bigha* equals one acre) produced between 25 and 30 *maunds* (2.68 *maunds* equals one ton) of HYV boro. After construction, it produces only about 15 to 20 *maunds*. Local people also reported that the polluted water caused skin diseases.

Agriculture production costs also increased after construction of the project. Farmers reported that annual floods used to help control insect pests by interrupting their life cycles. Flood protection increased the insect population inside the project area, forcing farmers to double or triple their use of pesticides. Farmers outside the project area used pesticides only once per crop cycle *(irri* crop).

Another severe problem observed during field visits was that water hyacinth almost completely blocked irrigation and drainage canals.

CASE STUDY OF A FARMER

Sahib Uddin Bhuiyan is a Bhargaon Village farmer. He and his brother each inherited 8.3 acres land from their father's property. Sahib Uddin has 10 children. Before the project was initiated his land yielded about 1,250 *maund* of paddy annually which he sold for about Tk. 150000.

In 1985, the year after the project was completed, his land yielded less than half of its previous production because of a breach in the embankment. In 1987 and 1988, flood water pouring through embankment breaches destroyed most of his crop. In 1989 he had to sell five *kani* of land to meet family needs, and to buy agricultural inputs and implements. He decided to quit farming altogether in 1990 and leased his land to a sharecropper. He also sold two *kani* of land to start a grocery shop, but he lost all his capital within two years.

After that failure, he again cultivated some of his own land, but was unable to make enough money to support his family. The land sales continued. In 1993 he sold one *bigha* of land to pay for his daughter's wedding. He was left with only 3.3 acres left.

Urbanization did and continues to expand at the expense of agriculture production (Map 2). High land prices, declining crop yields, and need prompted many small and medium farmers to sell their land. The result was an increase in landlessness. The increase in urban areas also disrupted the water distribution system.

Some fish species disappeared from the area after flood waters were blocked by the project embankment. Fishing incomes declined and many fishermen felt forced to change occupations. In the last three years, some fish species, particularly *taki, shoil, tengra,* and *bime,* have died of an ulcerous disease between the months of *Ashwin* and *Kartik* (between October and November). It could not be conclusively determined as to whether or not the project contributed to this disease.

Positive Environmental Impacts

The flood protection granted by the project brought a rapid growth in capture fisheries. This, in turn, created employment opportunities for the poor. Culture fish, however, were often killed whenever polluted water percolated into their ponds.

Flood control also increased interest in planting timber trees, such as mahogany, teak, *hilly, koroi,* and *gajari.* Such trees are no longer found outside the project area.

In addition, the embankment created a year-round road network for the area.

APPENDIX

The following data were provided by knowledgeable people in the project area.

Present Land Use Pattern

Land use pattern	Before Project (%)	After Project (%)
Agriculture Land	80	65
Settlement Area	10	20
Industrial Area	05	13
Beel Area	05	02

Source: Field Survey

Occupational Structure

	Demonstration Unit	
Occupation	Before project (%)	After project (%)
Farmer	75	68
Weaver	10	07
Service	03	05
Other*	12	20

Source: Field Survey

*Shopkeeper, rickshaw puller, fisherman, bidi labor, break field worker, mishuk driver, *jamdani sari* seller.

Production Cost of HYV Boro in Bhargaon Mauza of Demonstration Unit

	Inside the Project		
Cost (per *kani*)	Before (Tk)	After (Tk)	Outside the Project (Tk)
Water	150	500	600
Plough	100	300	300
Pesticide	60	160	100
Labor (planting and harvesting)	450	850	850
Fertilizer	40	550	300
Total	800	2360	2150

Source: Field Survey

PATAKHALI KONAI PROJECT, MIRZAPUR

Project Background and Objectives

The Patakhali Konai Project is located at the confluence of the Bangsi and Langli Rivers in Mirzapur Thana of Tangail District. It lies between the highlands of the Madhupur Tract and the alluvial floodplain of the Bangsi River (Map 1). The project covers an area of about 2,500 ha and has a benefitted area of about 1,800 ha. The project encompasses 11 *mauzas* in four unions that have a total population of about 18,000 in 3,000 homesteads.

Historically, the Bangsi River would flood unexpectedly and leave sand deposits in the area. Local people desired protection for their aman crops from these hazards, and in 1964, the villagers of Bardam officially requested that the government build an embankment.

The Trimohon to Pathorghata embankment was constructed in 1977-78, and the embankment between Trimohon and Salimnagar was constructed in 1982-83 (Map 1). A .5 km section in the southeastern corner of the project, near Konai regulator at Salimnagar, was not embanked until 1993.

The main objective of the project is to protect standing aus, jute and broadcast aman crops from river flooding, drainage congestion, high flow velocity, and sand deposition.

Within the Patakhali Konai Project, a flood control and drainage scheme, are 14 km of embankment stretching from Pathorghata to Salimnagar (Map 1). The project has two regulators: Konai Regulator, a two-vent regulator constructed in 1983, and Bardam Regulator, a one-vent regulator constructed in 1989.

Socioeconomic Situation

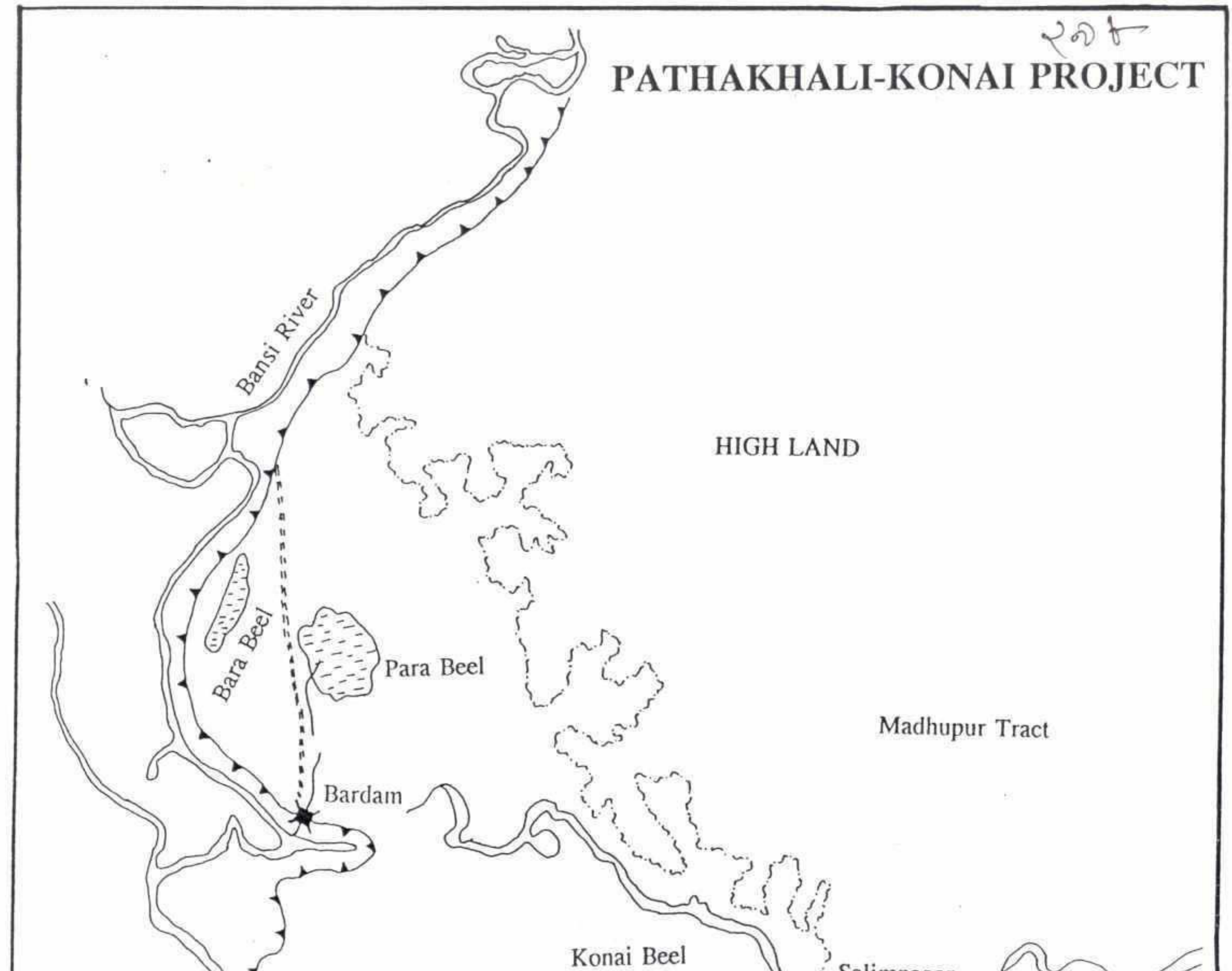
The project area is predominantly inhabited by marginal and small farmers. Of the population of 15,000, 16 percent are landless and 70 percent are small farmers who own less than 1.2 ha of land (O&M report, BETS). The project area has 20 ha of *khas* (government-owned) land, most of it in the *beel* areas.

Most of the area's economic activities are centered on Mirzapur Bazar (Map 1). Two *hats* (periodic markets) also are important: Pathorghata *hat*, held on Sundays and Wednesdays, and a small *hat* in Bardam mauza, held on Mondays. Bamboo, which is cultivated in the higher mauzas in the eastern part of the project area, is an important commodity in these *hats*. These markets also deal in seasonal horticultural commodities.

Prior to construction of the project, most villagers owned boats. Since that time road transportation has improved, in part by the embankment road, and boats are no longer as essential as they were.

Employment opportunities for day laborers have increased since the project implementation. Some have worked at operating and maintaining the project, and, in turn, the project's agricultural benefits have increased the availability of agricultural work. Wage rates for laborers are Tk. 50 per day without meals; before the project, the wage rate was Tk. 25 per day. During certain times of year, particularly during HYV boro planting and harvesting, wage rates are even higher.

PATHAKHALI-KONAI PROJECT



Changes in Land Use

According to villagers, 82 percent of the land is cultivated, 10 percent is *beel,* settlements occupy five percent, and the remainder is forest, all of which is in the eastern part of the project (Table 1). More than 80 percent of the project area is double cropped.

Table 1
Land use in the project area

Land use	Percentage (%)
Settlement area	05
Agriculture land	82
Beel area	10
Forest area	03

Source: Field Visit (RRA)

Some agricultural practices have changed since implementation of the project. Area farmers reported that before the project, 33 percent of agricultural land was under HYV boro cultivation. Now, during the kharif I season, 100 percent is used for the crop. Table 2 compares the pre- and post-project cropping patterns. Map 2 shows the pre- and post-project water flow situation.

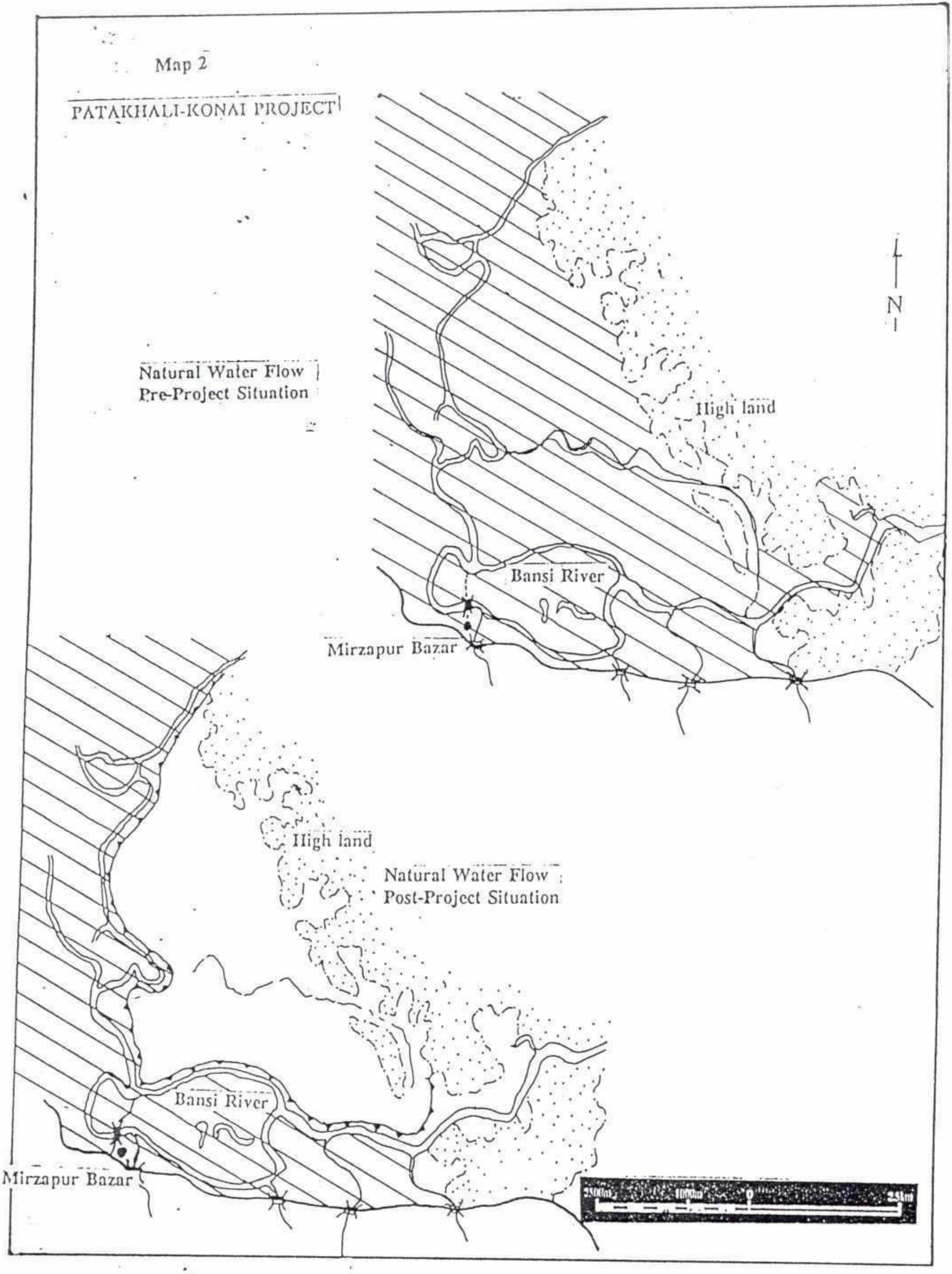
Table 2
Pre- and Post-Project Cropping Patterns in the Project Area

Kharif I (% of area)		Kharif II (% of area)		Rabi (% of area)	
Pre-project Situation					
M. aus aman	50	Aman	50	Pulses	45
Aus	25	Jute	20	Mustard	10
HYV boro	25			Wheat	10
				L.boro	30
				Other	5
Post-project Situation					
HYV Boro	100	Jute	10	Mustard	75
				Wheat	5
				Potato	5
				L.boro	10
				Other	5

Source: Field Visit (RRA)

Map 2

PATAKHALI-KONAI PROJECT



Under pre-project conditions Konai, Pora, Tengra, Zedra, and Baro *Beels* were perennial water bodies, had highly productive capture fisheries, and were frequented by migratory birds. Now, however, all the *beels* inside the project are being transformed from wetlands into agricultural lands.

The only forest remaining in the area consists of 30 to 40 acres of government reserve forest in Dahatoli, north of Bardam village. The primary species is *gajari*, but there are also some teak and mahogany trees. Other trees found within the project area include mangos, jam, jackfruit, raintree, *shimul*, *neem*, coconut palms, some date palms, and young bamboo.

During the rainy season, dry wood is scarce and villagers primarily use stored cow dung *(dhaincha)* and jute sticks for fuel. Ten to 15 years ago, people in the area collected wood from the upland areas of the Madhupur Tract, but these activities and the encroachment of agricultural activities have severely deforested the hills.

Changes in Fisheries

Prior to construction of the project, Konai *Beel* was well-known for capture fisheries, especially the southern part of Salimnagar that was the traditional fishing ground for many communities. About 70 professional fisherman once lived in Tekibari, Latifpur, and Salimnagar. Following the 1988 flood, fish populations began to decline and epizootic fish disease spread. Most of the Hindu caste fisherman have changed profession, and some fishing families have emigrated out of the area. Only four Salimnagar families now sell fish as their livelihood, buying from people who own culture ponds and selling at Mirzapur and other local markets.

Of about 30 fishing households in Bardam village, 20 are professional and the rest are subsistence fishermen. Most professional fishermen have some agricultural land. Declining fish production is forcing many to change profession.

One old fishermen reported that before the embankment was built fishermen could catch large amounts of *boal*, *rui*, *catla*, *gajer*, *shoil*, *chetol*, *koi*, *magore*, *mola*, *puti*, and *tengra*. Now these fish are relatively rare. Most fisherman said the embankment has blocked the natural migration paths of fish from the Bangsi River to floodplains and *beels* in the project area. Under pre-project conditions large fish started their upstream migration from the river to Konai *Beel* during the monsoon where they remained until the end of the flood season. Then they returned to the river. Polderization of the area has restricted this natural movement,

CASE STUDY OF A FARMER

Tanmohon Biswas, a farmer in Geraki Village, has two acres of agricultural land. Before the embankment was built he cultivated pulses *(khesari)*, and aus and aman paddy. After its construction he changed his cropping pattern; now he cultivates mustard in the rabi season and HYV boro in the kharif-I season. He is unable to cultivate any crops during kharif-2 because the area is inundated with four to five feet of water.

Although the cost of cultivating mustard and HYV boro is high, his paddy production has increased by 120 *maunds* annually, about twice his previous production. He attributes this to the fact that the embankment keeps flood water and sand deposition from damaging or destroying his crops.

and as a result, production has drastically declined in the project area's *beels*. Now the *beels* host only small numbers of *kai, magore, mola, puti,* and *tengra.*

The five *beels* in the project area are Pora, Tengra, Baro, Konai, and Zedra. Tengra *Beel* was leased by a Mirpur businessman who stocked it with silver carp, grass carp, and other species, and closed the *beel* to all fishing. Pora *Beel* is a *khas* water body, but a group of fishermen have leased the *beel* from three people who took possession of the lease illegally. Area fishermen heard that Konai *Beel* also will be leased out. If this happens, the fishermen said, they will be seriously affected.

The type of gear fishermen use is determined by the target species. Therefore, the changing species composition has affected gear use among fishermen. Before construction of the project, fishermen primarily used gear to catch large species. Now they most of the gear used is used for smaller species.

Negative Environmental Impacts

Following the first phase of embankment construction from Trimohon to Pathorghata, large tracts of agricultural land in Jogirkofa, Salimnagar, and Latifpur were seriously damaged by high flow velocities and severe sand deposition (Map 3). To alleviate this problem, villagers demanded that an embankment be built from Trimohon to Salimnagar, which was done in 1982-83. Since that time, large quantities of sand have been deposited in 1,000 ha between Salimnagar and Bhulua. More than 10 feet of sand settled over high-quality agricultural lands in this area, making them suitable only for sugarcane. In addition, a large *beel* in the area was completely silted.

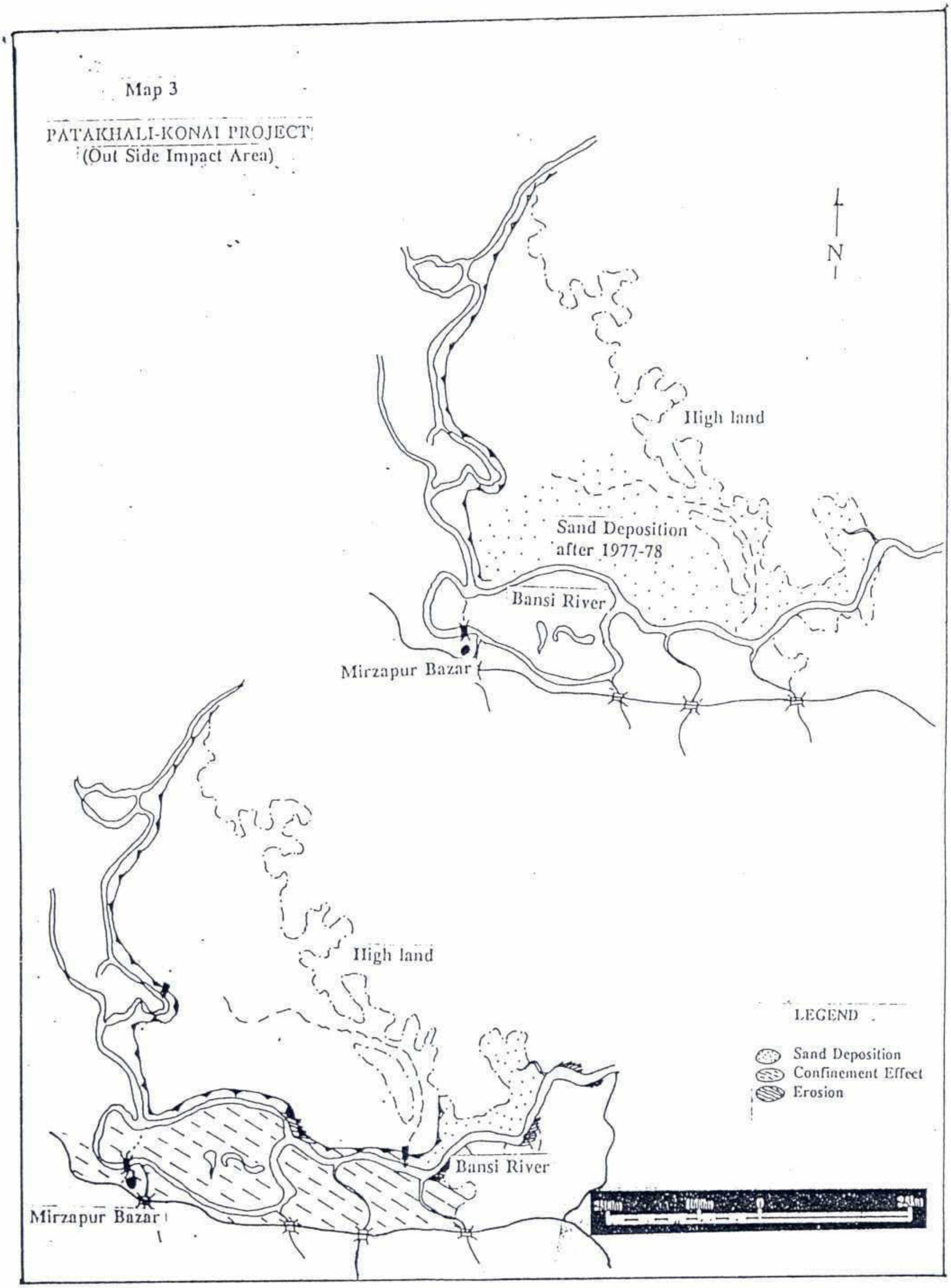
In other areas, however, the embankment prevents fertile, new soil from entering the area. As a result, soil fertility has declined and farmers have turned to using more chemical fertilizers.

The first phase of the project, undertaken in 1978-79, made no provisions for drainage facilities. As a result, large areas, particularly in areas adjacent to Pora and Konai *Beels,* were waterlogged after monsoon floods and remained so throughout the year. Survey informants reported that, at that time, large numbers of fish died in Pora *Beel* due to stagnated, polluted water and crops were damaged. In addition, farmers were unable to work in the fields because the water was infested with leeches and severely polluted. People reported that the polluted water increased skin disease.

Local people finally prompted the Bangladesh Water Development Board (BWDB) to construct a single-vent regulator at Bardam where water quality also had declined due to stagnation and the increased use of fertilizers and pesticides. The regulator, however did not completely solve the drainage problem. Some people said the canal between Bardam and Pora *Beel* was too shallow to drain the *beel's* water. Since land for the drainage canal was donated by local farmers, the BWDB has no control over it.

Highlands in the area, that were outside the reach of irrigation, once supported forests. Because the project brought irrigation to most of these areas, farmers now cultivate the former forests lands. Project interventions also have resulted in less and smaller wetlands, and a net loss of *khas* land.

Although erosion is not a major problem in the project area, the river is eroding the embankment near Jogirkofa. Strong water pressure at this location could cause a breach at any time. The embankment was



Map 3

PATAKHALI-KONAI PROJECT
(Out Side Impact Area)

breached in Latifpur, Salimnagar, and Jogirkofa during the severe flooding of 1988. According to villagers this was due to insufficient drainage facilities, and poor design and construction.

Since the project was implemented, fish production has slowed in the *beels* and floodplain areas. The result is a decrease in the availability of fish protein to area people.

Epizootic fish disease *(macher gha)* first appeared in the area following the 1988 flood. Some local farmers blamed it on agro-chemical pollution. During the study year, the disease peaked in the month of *Kartik* (October-November).

Although the embankment improved the transportation infrastructure, people living deep inside the project area still rely on boats.

Positive Environmental Impacts

Flooding inside the project area has been greatly reduced, which, in turn, has reduced crop damage, flood-related hazards, and has protected agricultural land from sand deposition and high river water velocities. In addition, the embankment has effectively prevented water hyacinth from damaging kharif season crops.

Improvements in the agriculture situation has brought about an increase in HYV boro cultivation, and, consequently, an increase in agricultural employment opportunities. Operation and maintenance of the embankment also have provided more nonagricultural employment.

The embankment has improved the area's transportation and communication infrastructure. The embankment also provides shelter from floods for people both inside and outside of the project, as well as for their cattle.

Impacts Outside the Project

Before construction of the embankment, upstream flood water and rainfall runoff flowed through, and was retained, over vast areas outside the project. Since the embankment was built, all upstream water now is channeled through the Bangsi River, resulting in severe riverbank erosion downstream (Map 3).

According to local farmers, more than 1,000 ha agricultural land between Salimnagar and Bhulua was damaged by sand deposition from the Bangsi River. Farmers now grow only sugarcane on these lands.

Due to the confinement effect of the embankment, the funnel-shaped area between the national highway and the embankment has flooded every year since the project was implemented (Map 3).

DHAKA-NARAYANGANJ-DEMRA IRRIGATION PROJECT (DND)

Project Location

The Dhaka-Narayanganj-Demra Irrigation Project (DND) is located southeast of Dhaka and is bounded by the Lakhya River to the east, Narayanganj to the south, the Buriganga River to the west, and Dhulai Khal to the north. The project covers a total area of 20,600 acres, 15,000 acres of which is cultivable land. The project is divided into two areas, Area-I and Area-II (Map 1). Area-I, which covers 10,100 acres of cultivable land, is fully protected by an embankment. Area-II, which covers the remaining 4,900 acres of cultivable land, is unprotected but is irrigated by the project.

Socioeconomic Situation

Land prices escalated shortly after the project was initiated, prompting many farmers to sell. Although their land was gone, these sellers reported that the jobs created by growing industries in the area was adequate compensation. For those who chose to stay in farming, however, increasing agricultural input costs forced many to sell their land simply to meet their families' needs. Consequently, landlessness increased throughout the project area.

With changes in land use, came changes in profession for many people. Small and medium farmers who sold their agricultural land to invest in businesses that eventually failed reported working as day laborers, rickshaw pullers, and at odd jobs.

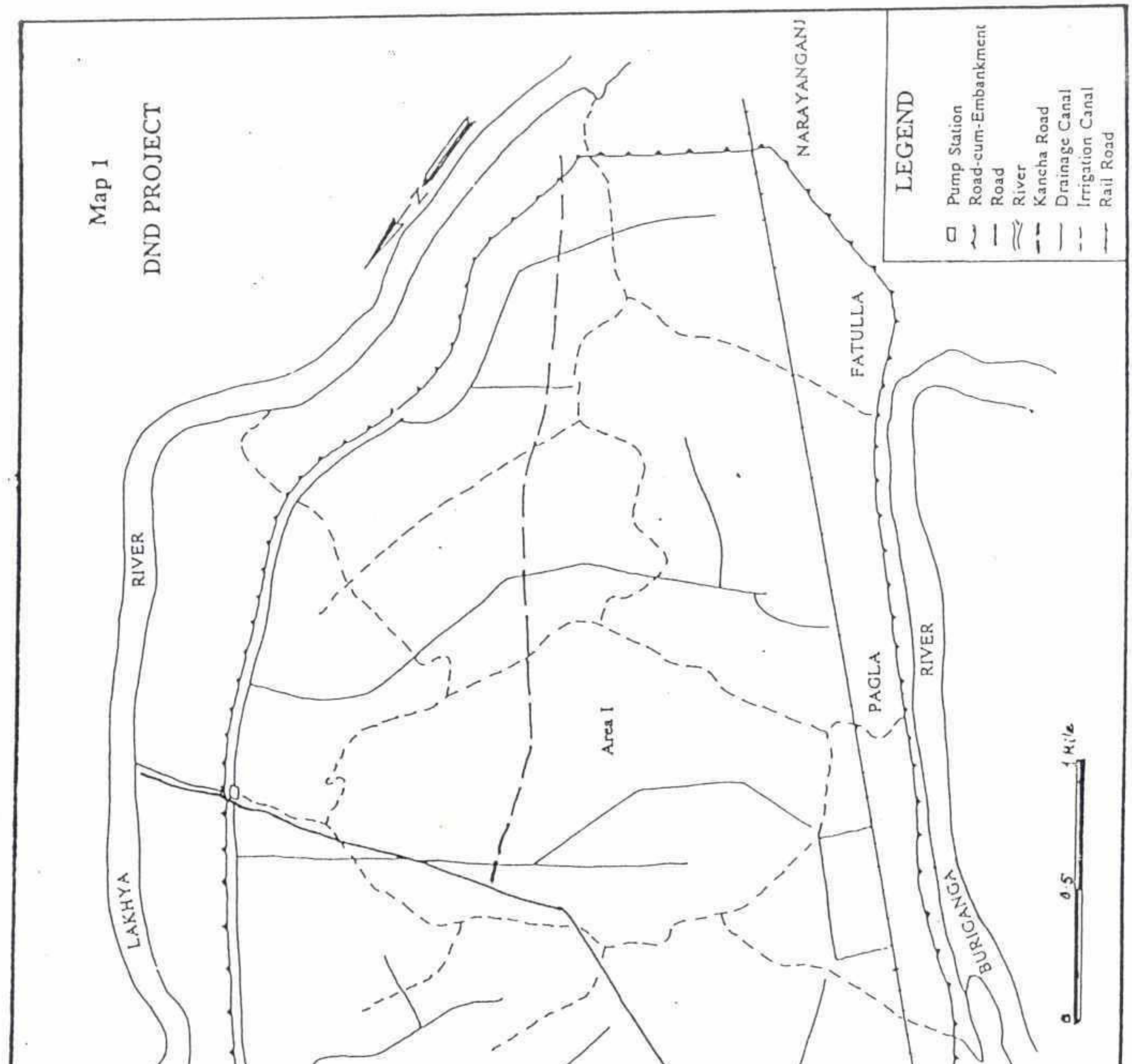
About 60 percent of Nemaikhesari villagers used to consider fishing their primary occupation; now only five percent do so. The few who continue to fish temporarily migrated to areas where year-round fishing is available. Former professional fishermen reported working as day laborers, rickshaw pullers, sharecroppers, and other occupations.

According to local people, the project authority did not consult them before or during construction of the project's canals. Consequently, locals were not able to advise the project on what areas they believed needed irrigation, such as the higher elevation areas that were left out of the project's benefits.

Changes in Land Use

Although the project was constructed to protect and expand agricultural activities, the area's proximity to Dhaka made it attractive to urbanization once it was protected from floods.
Low start-up construction costs, the proximity to Dhaka markets, and access to transportation prompted a variety of industries to move into the project area. About 70 percent of the area's agricultural land has become industrialized.

Many of the people that bought land from farmers were wealthy outsiders who had no interest in agriculture. If they do not build industries, these nonfarming owners allow large tracts of land to remain fallow every year, decreasing the area's overall cropping intensity.


Map 1
DND PROJECT
N
LEGEND
Pump Station
Road-cum-Embankment
Road
River
Kancha Road
Drainage Canal
Irrigation Canal
Rail Road
LAKHYA
RIVER
NARAYANGANJ
FATULLA
PAGLA
RIVER
BURIGANGA
Area I
DEMRA
MATUAIL
Area II
DHAKA
0
0.5
1 Mile

Under pre-project conditions, many *beels* and perennial water bodies covering the area provided fishing grounds for people near and far. Most of these *beels* and water bodies now have been filled and converted to agricultural, homestead, or industrial use. This has seriously reduced fishing in the area, and, consequently, people's protein intake.

Industrialization proceeded rapidly throughout the DND project area, with the heaviest concentration along the Dhaka-Narayanganj Highway. This growth, however, occurred without careful planning, resulting in water, air, and noise pollution that seriously impacts agriculture and human health (Map 2 and 3).

Negative Environmental Impacts

Local people reported that there was no water stagnation problems prior to the construction of the DND. Now, due to the unplanned buildup of industries and homesteads, drainage congestion occurs throughout the project area, including a vast area in Mizmizi village. Drainage canals often are blocked by homesteads, industries, and shops built on or beside canals (Map 2). In many places there is no sign that canals even exist. Although a formal operation and maintenance committee was named to govern the canals, it has not been granted authority to function.

The recently-built Mizmizi-Narayanganj Road blocked the project's irrigation facilities and created considerable drainage congestion on both sides of the road.

CASE STUDY OF A FARMER

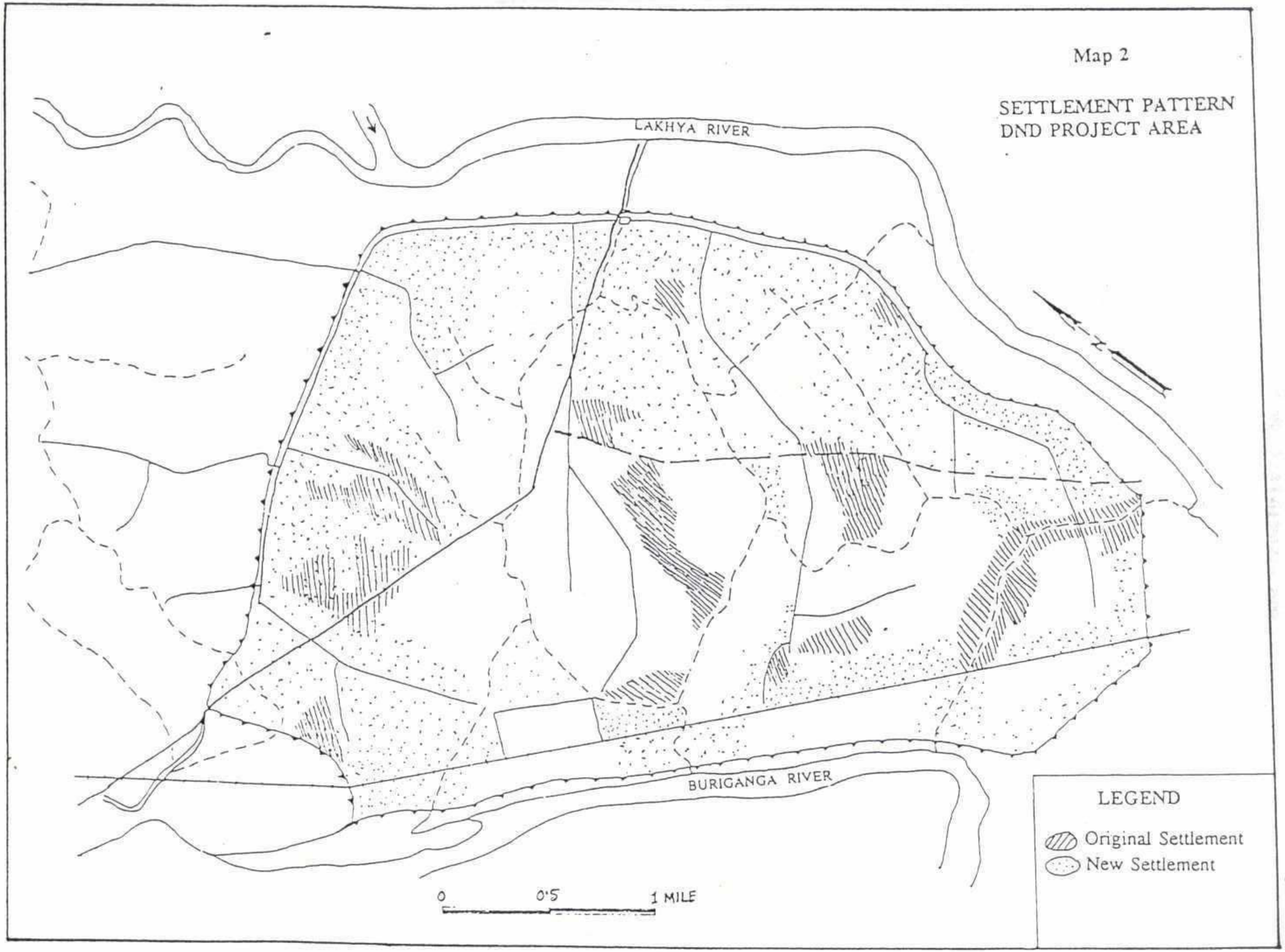
Md. Nizam Uddin, a farmer from Barisal, came to Dhaka 27 years ago in search of work. On arrival he found that Dhaka not only offered more work opportunities than Barisal but also greater earning potential. He decided to stay and worked to save Tk. 600 with which he bought 25 *katha* (one *katha* equals 1.6 decimals) of land. Once he had the land he brought his wife, three daughters, and a son to join him.

Before the DND project was constructed his land yielded only 18-20 *maund* of paddy a year, not enough to support his family. To compensate, he worked as a day laborer and sometimes as a rickshaw puller. When land prices climbed just after completion of the project he started to sell his property in the hope of investing in other economic activities. All his efforts failed. Then, realizing that buying and selling land in the area occurred often, he became a land broker. Now, he said, he is making more money than he did in any of his other endeavors.

Although agricultural productivity has increased in the DND project area, local farmers reported that crop production costs have increased. They reported that they used about twice as much fertilizer and pesticides than they did under pre-project conditions, and that this increase in agro-chemical use has lead to a decline in soil fertility.

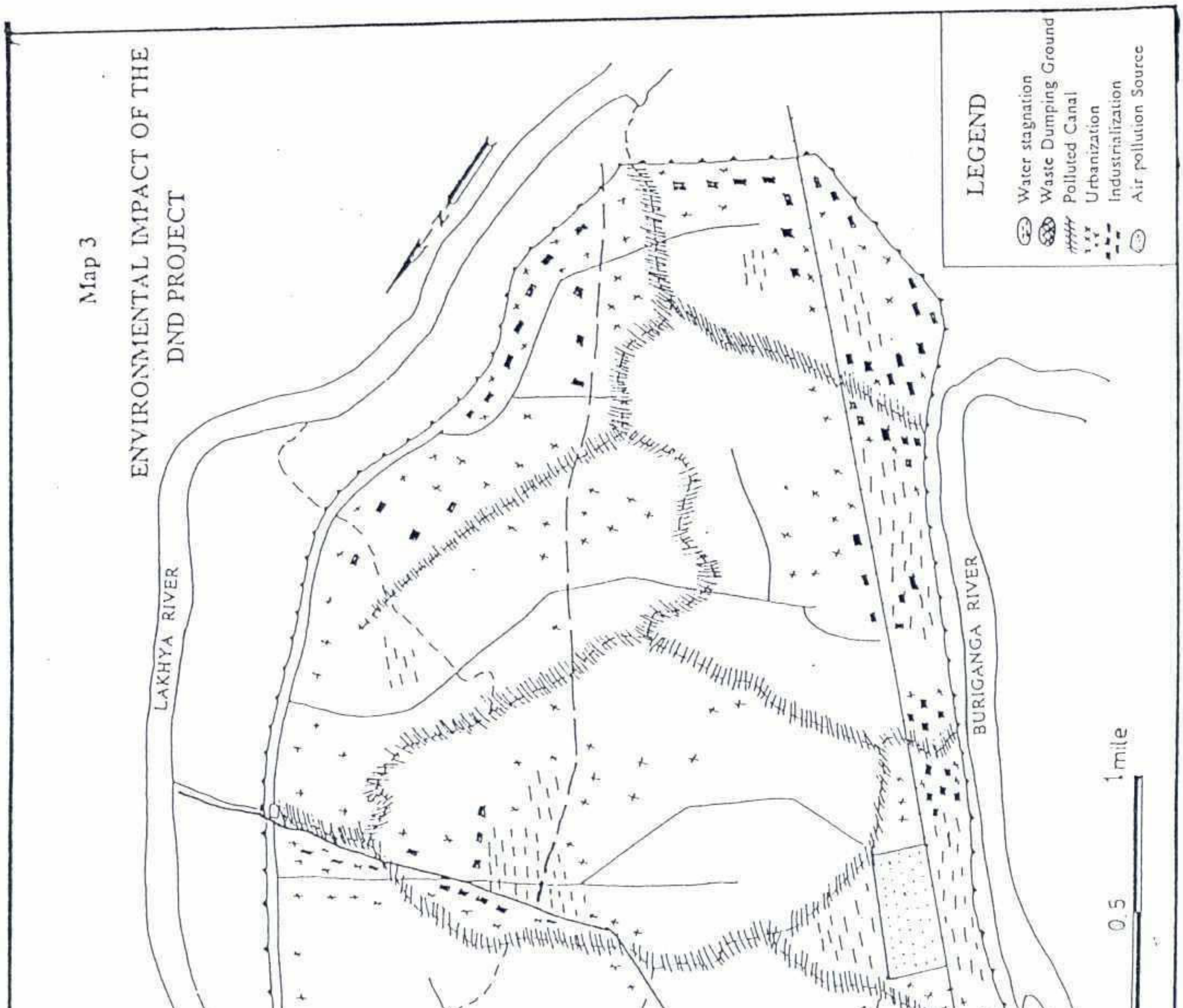
Farmers also reported that agricultural pests became a serious problem five or six years after the DND project was completed. The numbers and varieties of insects, and the number of rats, has increased in the flood-protected area resulting in substantial crop losses. Farmers reported, that in areas where they previously used pesticides only once, they must now use the chemicals three times during the same period.

Although the increased use of agro-chemicals and open latrines have deteriorated



Map 2

SETTLEMENT PATTERN
DND PROJECT AREA



Map 3

ENVIRONMENTAL IMPACT OF THE DND PROJECT

water quality, the chemical and cloth dyeing industries are primarily responsible for water pollution in the area. Their industrial waste passes through Fatulla, Pagla, and Shampar *Khals* before discharging into the DND main canal. This polluted water is then used to irrigate fields, and farmers reported that the polluted water reduces production. Standing water is particularly polluted, such as areas in Mizmizi village. Locals reported that the polluted water causes skin disease, and that fish caught in the canals taste and smell bad, especially during the winter season. Sometimes fish stock is killed when the polluted water percolates into capture fishery ponds.

In some cases, untreated industrial waste is discharged directly onto agricultural land. An iron chain industry in Matuail village, for example, disposes its waste on adjacent fields. The iron waste has rendered the fields unproductive and the land has remained fallow for the last two years.

In Nemaikhesari village of Hamaitpur Union, smoke from a foam factory used to adversely affect the health of people living nearby. Those affected eventually pressured the owner to abandon the factory. Some people in the project area also complained of noise levels produced by industries.

In the last three or four years, large numbers of fish species such as *taki, shoil, tengra,* and *bime* have died of an ulcerous disease between the months of *Ashwin* and *Kartik* (between September and November). It could not be conclusively ascertained as to whether or not the project contributed to the fish disease and deaths. In addition, many canals that allowed fish to migrate from the river to the floodplain have been blocked due to project interventions. As a result, many fish species have permanently disappeared from the project area.

Pollution, a reduction in wetlands, and the blockage of fish migration routes has deteriorated local fisheries to the point that local per capita protein intake has seriously decreased. Before the project, most villagers caught and consumed fish from nearby *beels* every day. Now many, especially the poorest, eat fish only once a week.

Under pre-project conditions, the area boasted a large number of *hizol* trees that grew in wetland habitat. Because the project significantly reduced the area's wetlands, *hizol* trees were eradicated.

Positive Environmental Impacts

Capture fisheries has increased in the area since the project was implemented, creating employment opportunities for the landless.

The flood protection offered by the project allowed for a growing interest in timber plantations of mahogany, teak, *hilly, koroi,* and *gajari.*

The project improved the area's road network, providing people with easier travel to Dhaka or other places in search of work or for daily needs.

Local people reported that new settlers coming into the area are well-educated. This was seen as a positive contribution to the development of the overall environment.

MODULE 8

SUPPLEMENTAL HANDOUTS

The materials on the following pages are intended for duplication and distribution to skills workshop participants. Exercises and other handouts for this module are located in Volume I of the EIA Skills Workshop Trainer's Manual.

FAP 16 Environmental Study

FAP 19 Geographic Information System

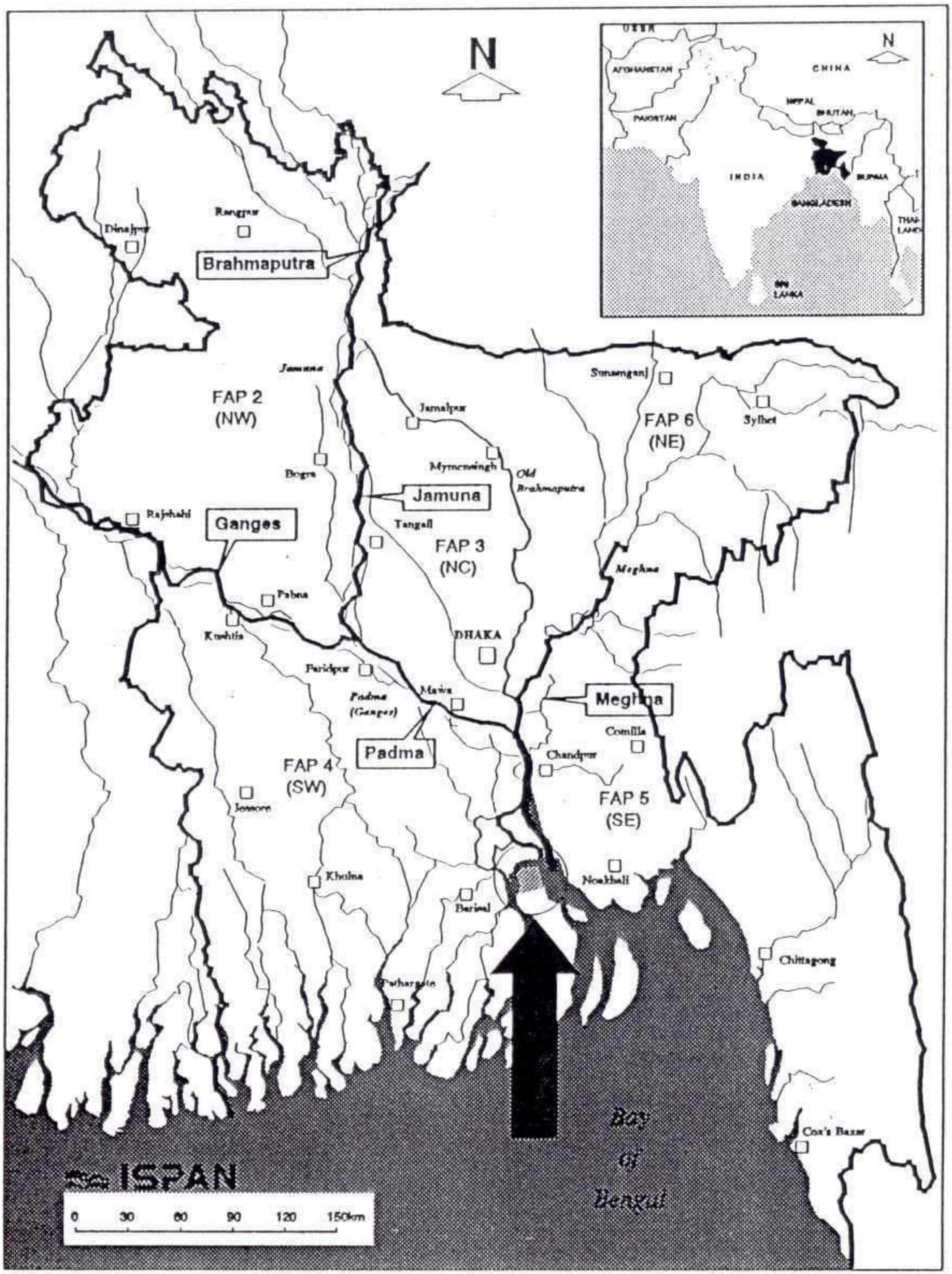
Environmental Impact Assessment

BHELUMIA-BHEDURIA PROJECT

November 1994

PART A:
CASE STUDY EVALUATION

FRONTISPIECE



Location of Proposed Bhelumia-Bheduria Project

1. Environmental Impact Assessment Within the Flood Action Plan

During the past two decades, Environmental Impact Assessment (EIA) has become an integral component of the feasibility plans prepared for development projects in many countries. The Flood Action Plan (FAP) in Bangladesh is no exception. Subsequent to the 1988 flood, a wide range of flood control-related development plans were proposed, ranging from major river training and embankment construction to community-based flood proofing. The sensitive Bangladesh environment, combined with the complex adjustments to flooding that rural people have historically established, has necessitated a careful review of the social and environmental impacts of proposed development plans. The purpose of EIA is to assist the planning and decision-making processes. EIAs are used to foster environmentally sound decisions and to aid in the development of Environmental Management Plans (EMP) for given development projects.

The 1989 G7 Summit Meeting determined that all FAP projects should be formulated with full consideration of socioeconomic, technical, and environmental aspects. Both the Bangladesh Environment Policy of 1992 and the National Conservation Strategy for Bangladesh incorporate a national requirement for EIA. The environmental concern was substantially emphasized at the Second Conference on the FAP in Dhaka, March 1992, where donors agreed that all FAP projects should be subject to EIA.

All five regional study components of the FAP, as well as the priority pilot projects, are addressing environmental and social factors in the prefeasibility and feasibility stages of project development. A set of guidelines to direct the EIA process has been produced (FPCO 1992a) to adopt, integrate, and localize applicable procedures and methodologies from a variety of international sources. The guidelines are intended to establish consistent standards for conducting and reviewing EIAs for FAP-related developments within the Ministry of Irrigation, Water Development and Flood Control and the Ministry of Environment and Forests. An EIA manual (ISPAN 1992a) is available to assist in conducting EIAs according to the guidelines. The guidelines are being tested and modified through implementation of several EIA case studies.

2. Objectives of EIA Case Studies

The purpose of the EIA case studies is to:

- test EIA guideline methodologies, approaches, and procedures under the environmental, social, and institutional conditions prevailing within the FAP, and
- provide on-the-job training for local professionals and technicians in EIA methods and procedures.

3. Selection of EIA Case Studies

FAP 16, in collaboration with other FAPs, has selected specific feasibility-stage projects for EIA case studies that meet the following requirements:

- covering as much environmental variation and as many physical, ecological, and social factors as possible;
- representing a range of FAP-related interventions including flood control, drainage, and irrigation (FCD/I) and water management;
- including projects that are in early stages of design but have developed to the point that the principal features and structural characteristics are identified and characterized in terms of location, size, and operating intentions;
- located in areas where information is adequate to establish the environmental baseline conditions.

The first EIA case study was carried out by FAP 16 in the Surma-Kushiyara area (ISPAN 1992b).

The second case study addressed the Compartmentalization Pilot Project at Tangail (ISPAN 1992c).

The current study, the third and final EIA case study, addresses a small coastal project under consideration by the Early Implementation Projects (EIP) section of the Bangladesh Water Development Board (BWDB). The study was conducted in collaboration with EIP and FAP 19 (Geographic Information Systems—GIS) and is presented as an Environmental Impact Assessment Report (EIAR) in Part B of this document.

4. Evaluation of the EIA Case Study

As with the previous two EIA case studies the procedures and steps advocated in the EIA guidelines were found achievable and practical as a process. A number of technical and procedural problems and issues were encountered in the study and are elaborated below.

4.1 Land Type Classification in Coastal Areas

The definition of land types within a study area is a very important step in an EIA process for water and agricultural development projects in Bangladesh, since it forms the basis for estimating agricultural gains and for predicting post-project flooding conditions. As presently applied in most parts of the country, a land type is an area of land subjected to specific ranges of flooding depths at times when prevailing water levels are at a three-day maximum for a return period of 1 in 5 years. At the initiation of the study, some doubts were expressed as to the practicality of the concept in a coastal area subjected to tidal inundation where water levels fluctuate diurnally. A certain amount of trial and error was required to decide which water level was an appropriate definer of land types, and whether the resulting units had any real meaning in terms of land use definition (Sections 3.2.1 and 3.2.2 of EIAR). The level chosen on the basis of normal probability and Gumbel analysis as a 1 in 5 maximum water level was 2.6m above local datum. GIS-based land type maps were produced for this water level by overlaying flood levels onto a digital terrain surface generated from a contour map (Section 3.2.1 of EIAR). Similar maps were produced for levels above (2.8m) and below (2.4m). The results are summarized in Table A. An average maximum flooding level of 2.8m was clearly too high, since this produced about 800 ha (18 percent of the project area) of F_2 land which, on the basis of field surveys and farmers' opinions, was known not to be abundant in the project area. A level of 2.4m appeared to be too low since it resulted in substantial areas of T. *aman* appearing in F_0 lands which, also on the basis of field surveys, was considered to be unlikely.

The chosen level of 2.6m produced land types within which crop types were mainly restricted to specific land types, although there was some overlap. Part of the overlap between land type and cropping pattern boundaries may be due to errors or changes in the elevational data on the base maps (made in 1964), field survey error in defining exact cropping pattern boundaries, and local variations in elevation and crops grown. There appears to be sufficient agreement between the land types designated by the 2.6m level (1 in 5 maximum daily water levels) and the cropping pattern boundaries to indicate that the standard approach of designating land types is valid for coastal areas subject to tidal conditions.

4.2 Hydrological Understanding of System

There was little hydrological information available for the study area, except that which was gleaned from field sources during fields surveys, through direct observations, and from standard water level readings from a limited number of gauging stations for a limited number of years. The area is hydrologically complex, with strong tidal inflows and outflows, and a network of interconnecting canals

Table A **Comparison of Land Cropping Patterns Within Land Types Delineated by Different Mean Maximum Flooding Levels**

Cropping Pattern	F_0			F_1			F_2			Totals	
	ha	%	%	ha	%	%	ha	%	%	ha	%
Flooding Level 2.4m											
B.Aus-T.Aman-RC	1160	88	52	1073	34	48	0	0	0	2234	100
B.Aus-T.Aman-Fallow	14	1	17	70	2	83	0	0	0	84	100
T.Aman-Boro	37	3	8	441	14	92	0	0	0	478	100
T.Aman-RC	83	6	41	118	4	59	0	0	0	201	100
B.Aus-T.Aman-RC	12	1	1	1437	46	98	15	100	1	1464	100
T.Aus-T.Aman-Fallow	7	1	44	9	0	56	0	0	0	16	100
Totals	1313	100		3148	100		15	100		4477	
Flooding Level 2.6m											
B.Aus-T.Aman-RC	187	65	8	2036	50	91	10	8	0	2234	100
B.Aus-T.Aman-Fallow	12	4	14	72	2	86	0	0	0	84	100
T.Aman-Boro	23	8	5	456	11	95	0	0	0	478	100
T.Aman-RC	64	22	32	137	3	68	0	0	0	201	100
B.Aus-T.Aman-RC	1	0	0	1344	33	92	118	92	8	1464	100
T.Aus-T.Aman-Fallow	0	0	0	16	0	100	0	0	0	16	100
Totals	287	100		4061	100		129	100		4477	
Flooding Level 2.8m											
B.Aus-T.Aman-RC	37	69	2	2021	56	90	176	22	8	2234	100
B.Aus-T.Aman-Fallow	6	11	7	70	2	84	8	1	9	84	100
T.Aman-Boro	0	1	0	475	13	99	3	0	1	478	100
T.Aman-RC	11	20	5	190	5	95	0	0	0	201	100
B.Aus-T.Aman-RC	0	0	0	850	23	58	614	77	42	1464	100
T.Aus-T.Aman-Fallow	0	0	0	16	0	100	0	0	0	16	100
Totals	54	100		3622	100		800	100		4477	

Source: Field Survey, 1992

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and creeks. Hydrological changes are the main theme of the EIA, and are the main objective of the project, i.e., reduction or elimination of storm surges and high tidal flooding. All future hydrological changes were based either on simple analyses of level frequencies or on professional judgements.

The aim of the EIA is to predict the future situation if protective embankments are constructed. It follows that any environmental predictions based on uncertain hydrological predictions are difficult to describe quantitatively or qualitatively, and are subject to considerable potential error. The future mean maximum water levels, which are important determinants of land types and future agricultural production, could be based on nothing more than educated guesses. This is unsatisfactory for water resources development in general, and for EIA in particular. Obvious solutions are more intensive water level monitoring in the project area prior to project study, field observations by experienced hydrologists, and the use of models (which require good data) for making hydrological estimations and predictions.

4.3 Level of Effort in EIA

The total level of effort (LOE) expended on the case study amounted to about 60 person-months. This included the field surveys, which required a number of enumerators to conduct the household surveys, the time spent by GIS staff in preparing and producing overlays and tabular output, and overall study planning, analysis, and reporting. Since this was a case study, there a great deal of time was spent in analytical discussions on the approach to be used in the EIA, problems in applying the guidelines, etc. The size of the study team (≈ 10 professionals plus a number of field surveyors) was larger than would normally be applied in practical cases because of the development and training nature of the case study.

It was generally felt that the LOE expended on a project as small as Bhelumia-Bheduria was excessive, and could be reduced considerably. Field effort was considered appropriate at about 7.5-10 person-months. Planning and liaison should take approximately 5 person-months, and data analysis and reporting about 15 person-months. Based on the experience in this case study, a reasonable LOE for a project of this size would be about 30 person-months for an experienced and competent multidisciplinary EIA team. This assumes that basic information on water levels, project design features, etc. are readily available. The LOE would have to be extended if project designs were changed during the course of the study, or if major deficiencies in data were detected.

4.4 Scope of EIA for Small Projects

Two common concerns of EIA were expressed at various times during the course of the case study:

- Is EIA required for small projects of the size and scope of Bhelumia-Bheduria?
- Could the scope of the EIA be reduced for a small project such as this?

Screening of projects for EIAs is commonly applied in many countries, and is a feature of many EIA guidelines. A reduced level EIA is undertaken in cases where the type of project is common, has been built and operated successfully in the past, the environmental impacts are well understood, and the environmental management and mitigation measures are well developed and known to be effective.

None of these requirements for reduced-level EIAs apply in Bangladesh at the present time, not even for projects of relatively limited size and scope such as Bhelumia-Bheduria. As noted above, a major problem with the project was the lack of clear understanding of the hydrological changes that would ensue if the area were to be embanked as proposed. The project was found to have potentially severe impacts for certain resources (fisheries) and certain social groups (fishermen), and suitable mitigation to address these had not been included in the project design. The potential impacts on the fishing community and the fisheries resource had not been taken into account in the economic evaluation of the project. From a general perspective, EIA is still in its infancy in Bangladesh, and the appropriate body of knowledge and experience in detecting environmental impacts and designing suitable mitigation has yet to be developed. From the project-specific point of view, it was readily apparent that even a small area such as Bhelumia-Bheduria can be hydrologically complex enough that specific studies and field surveys are necessary to describe the present situation and to adequately predict the future. It is concluded on the basis of this case study experience that partial EIAs cannot yet be applied in any practical sense in Bangladesh water resource development.

It would be possible to reduce the LOE and scope of work in the EIA by careful scoping during the study planning process so that the major impacts could be identified early in the process and most study effort devoted to quantifying them, with less effort spent on impacts of relatively minor concern. However, this too requires a body of experience and knowledge of environmental impacts and mitigation efficiency which is not yet available in the country. Note that this is not the same as a reduced-level EIA decided upon by pre-study screening described above; the major difference is that the scoping and determination of LOE are undertaken by the study team after thorough field reconnaissance, not as a desk-top exercise prior to project commencement.

4.5 Application of GIS

One of the objectives of the case study was to examine the role of GIS in EIA and to evaluate its use and efficiency in the process. GIS usage in this case study necessitated digitization of base maps, preparation of overlays, various associated analyses of data, and participation in team discussions and planning.

Several advantages of using GIS were readily apparent in the case study:

- It permitted the effective integration of digital terrain data and water level data to produce land type maps, which are key components of water resource planning in Bangladesh. These were produced at a level of precision and accuracy not attainable with manual analysis, and at a level of consistency not always achieved with manual mapping.
- It encouraged objectivity in the analysis of data, and discouraged manipulations and interpretations to suit preconceived impressions (which is frequently easily done with manual data analysis).
- It permitted the application of satellite image processing to examine river channel migration patterns.

The drawbacks to the GIS were also apparent:

- GIS and satellite imagery processing hardware and software are expensive to acquire, operate, and maintain.
- Time and labor required for basic data preparation are not always commensurate with the results achieved.
- Skilled and experienced GIS personnel are required.

The fundamental problem with the application of GIS to typical EIAs such as this case study is that it is underutilized to a considerable degree. The main advantage of a GIS is that it has the capability to overlay and merge spatially base data sets, to modify stored data according to some specified rules, and display the results in mapped format or as data summaries. For EIA this means that it could produce both analyses of existing situations as well as predictions of future conditions by overlaying, combining, and analyzing existing data. An example is the production of a present land type map by combining terrain elevational data with present flooding levels, and prediction of a future land type map by combining the same elevational data with some estimation of future water levels. For most environmental components, however, the conceptual models which direct how to overlay and modify present data to predict the future are not developed. Moreover, the basic data required to adequately make these predictions are either unavailable or are insufficiently precise and accurate to justify the use of sophisticated components to handle them. This is largely a question of experience and professional expertise in EIA and will hopefully develop in time as EIA matures into a scientific process in Bangladesh.

FAP 16 Environmental Study

FAP 19 Geographic Information System

Environmental Impact Assessment

BHELUMIA-BHEDURIA PROJECT

November 1994

PART B:
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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EXECUTIVE SUMMARY

This report presents an environmental impact assessment (EIA) of the proposed Bhelumia-Bheduria Project on Bhola Island in the Southwest Region of Bangladesh.

The project, as currently proposed would consist of embankments completely surrounding 5,306 ha of agricultural area between the Tetulia and Jangalia rivers. The embankment on the Tetulia (western) side of the project area would cut off all out- and inflow channels, including the large Bheduria Canal opening. Canal openings on the eastern (Jangalia) side would be left open. Other project components include drainage sluices, culverts, a cyclone shelter, and a footbridge. All internal canals would be reexcavated. The objectives of the project are to protect the area from the effects of severe tidal and storm surges and to improve drainage conditions.

The project area is a typical coastal agricultural area with a network of interconnecting canals. Erosion and accretion in the adjacent Tetulia River are very active, while the Jangalia River on the eastern side is relatively much more stable. The area population is estimated at about 42,644, consisting of 7,808 households. Professional fishermen make up more than 20 percent of the area population, while 60 percent depend on agriculture for their livelihood. Landless people and small farmers make up 90 percent of the population, but occupy less than 30 percent of the land; 70 percent of the land is owned by large farmers or absentee landlords, the latter extracting high rental fees for the use of their land. An estimated 2,400 boats, most of them manually operated, are kept in the area, and about 50 percent are devoted to fishing, the remainder are used to transport agricultural produce and other goods. Ninety percent of the available cropland is classed as medium highland (F_1). Cropping intensity in the area is high, with two paddy crops and a dry-season *(rabi)* crop obtained in most sections. Crop losses due to tidal flooding and poor drainage are estimated at about 5,646 tonnes annually (13 percent of total crop). Substantial crop losses also occur due to insect pests. Tree cover is limited to homestead areas and along high-elevation roads. More than 80 percent of the area homesteads are affected by flooding every year. Homestead horticulture is severely constrained by high water levels and repeated flooding. Professional fishermen fish inside the project area and outside in the Tetulia and Jangalia rivers. About 50 percent of the fish harvested come from the interior canals; 25 percent come from the rivers. River fish, because of their size and value, make up 80 percent of the gross fishery income in the area. Culture fisheries are extensive in the area, based on more than 1,600 ponds, but many are flooded every year.

The expected impacts of project development are summarized in Table 1. *Beneficial impacts* would include increases in agricultural and horticultural crops and income derived from these crops as well as from the labor activities associated with project construction. Secondary benefits would include improvements in the nutritional and health status of local communities, and a reduction in flooding risks to households. The most serious *negative impacts* would be the blockage of the western canal openings by the embankment, with consequent obstruction of boat passage and fish migrations. Other negative impacts would include the loss of land and displacement of some homesteads affected by the embankment, some loss in soil fertility, increased losses from wildlife and insect pests due to cropping intensification and embankment refuge areas, and possible declines in water quality and increases in the incidence of waterborne diseases.

Mitigation of most impacts is possible and would include the measures listed in Table 2.

Cumulative environmental impacts due to other proposed developments and environmental changes in the southwestern region are unlikely to significantly affect the Bhelumia-Bheduria project area, or vice-versa, due mainly to the prevailing hydrological conditions around the project area, which are strongly dependent on the Meghna River flows.

Recommendations for an Environmental Management Plan are given in the EIA report and include development of a code of good engineering practice, coordination of cooperating agencies, development of sound operating and maintenance procedures, environmental enhancement through embankment revegetation, social forestry programs and agricultural extension programs, effective people's participation, regular monitoring and inspection of the embankment, a reporting and accountability schedule, and a disaster management contingency plan.

Table 1 Summary of Environmental Impacts for an Unmitigated Bhelumia-Bheduria Project (negative impacts are shaded)

Important Environmental Component	Present Amount or Frequency	Project Impact*	Impact Type†	Impact Rating‡
Tidal flooding	Daily in monsoon season	Slower flood rise, rapid dissipation	EILM	+2
Storm surge	Annual, multiple in some years	Eliminate average surges	SIHM	+7
Land drainage	Extensive over project area	Reduce or eliminate over 80% congested area	SGHM	+5
Groundwater	Drinking purposes only	Negligible	-	0
River erosion and shifting	Extensive migration of river shorelines, possibly declining in rate	Negligible, shifting river channel may erode embankment	-⁻	0
Land types			Nil or SIHS	0 or +7
F_0	287 ha	Nil (Scenario 1) or +1,026 ha (Scenario 2)		
F_1	4,061 ha	Nil (Scenario 1) or -912 ha (Scenario 2)		
F_2	129 ha	Nil (Scenario 1) or -114 ha (Scenario 2)		
Soil quality	Moderately fertile, suitable for crop production	1. Reduction in nutrient sediment deposition	SGLR	-2
		2. Reduction in saline tidal flushing in SE	EGLS	+2
Agricultural production				
Irrigated area	≈13% cultivable area irrigated	≈5% increase in irrigated area	EGLM	+2
Crop damage	≈4,350 tonnes lost annually to floods & pests	65% reduction	SGHM	+5
Crop production	≈23,000 tonnes annually	≈17% (Scenario 1) or 19% (Scenario 2) increase	SGHM	+5
Homestead vegetation				
Homestead forests	≈400 ha	Improvements in cover and species diversity	SGLS	+4
Homestead gardens	≈50 ha	Improvements in species diversity and production	SGLS	+4
Biomass energy	≈16,000 tonnes available annually	Increase in fuel wood and crop residues	EGHS	+4
Homestead land	760 ha	Some loss to embankment possible	EGLV	-2

* Project impact is the difference between effects produced by the project and anticipated long-term changes in the absence of the project.

† Sensitive (S) or less sensitive (E) resource; immediate (I) or gradual (G) impact onset; high (H) or low (L) impact magnitude; beneficial impacts may be sustainable (S), sustainable with mitigation (M) or not sustainable (N); negative impacts may be irreversible (I), reversible with mitigation (V), or reversible (R).

‡ Impact ratings are given in Annex 2.

⁻ No impact expected by project, but project itself may be impacted.

Important Environmental Component	Present Amount or Frequency	Project Impact*	Impact Type†	Impact Rating‡
Wildlife				
Endangered species	5 species	Negligible	-	0
Threatened species	7 species	Negligible	-	0
Pest species	Abundant (rats, granivorous birds)	Increased populations and damage levels	SGHR	-3
Commercial species	Turtles: 4-5 tonnes annual production	Negligible	-	0
Pesticide contamination	No information	Likely to increase in food chain concentrations	SGHR	-2
Capture fisheries				
Fish habitats	Extensive	Decline in quality within project area	SGLR	-2
Fish diversity	61 species	Probably negligible	-	0
Annual harvests	≈2,600 tonnes	10-15% decline inside area 3-4% overall	SGHV	-3
Fishing costs and inputs	Nominal	Increase in costs, decrease in security	SIHV	-7
Pesticide contamination	No information	Likely increase in food chain concentrations	SGLV	-3
Water quality	Moderately good	Slight decline	EGLV	-2
Culture fisheries				
Ponds	1,654	Slight increase	EGLS	+2
Annual production	≈455 tonnes	Slight increase	EGLS	+2
Water quality	Moderately good	Slight decline	EGLV	-2
Local employment				
Agricultural	1,386,000 person-days annually	1-3% increase	EGLS	+2
Fishing	≈20% households reliant on fishing	Sharp decline if river access is blocked	SIHV	-7
Household income				
Large landowners	≈11% population own 70% land	Improved	EGHS	+4

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[*] Project impact is the difference between effects produced by the project and anticipated long-term changes in the absence of the project.

[†] Sensitive (S) or less sensitive (E) resource; immediate (I) or gradual (G) impact onset; high (H) or low (L) impact magnitude; beneficial impacts may be sustainable (S), sustainable with mitigation (M) or not sustainable (N); negative impacts may be irreversible (I), reversible with mitigation (V), or reversible (R).

[‡] Impact ratings are given in Annex 2.

[–] No impact expected by project, but project itself may be impacted.

Important Environmental Component	Present Amount or Frequency	Project Impact[*]	Impact Type[†]	Impact Rating[‡]
Small landowners	≈89% population own 30% land	Little change	EGLV	-2
Risks to life and property	Widespread from many causes	Reduction in flood and surge hazards	SILV	-4
Vector-borne diseases	Not common	Little change	?	0
Water-borne diseases	Widespread	Similar incidence in larger population	SGLV	-3
Nutritional status				
Total food intake	387 gm daily	Improved	SGLS	+4
Protein intake	10 gm fish daily intake	≈10-15% decline for poor and middle classes	SIHV	-7
Education and literacy	29% (M) and 19% (F) literacy rate	Small improvements	EGLS	+2
Women's status	Stable, conservative	Small improvements	EGLS	+2
Road transportation	Local paths and routes only	Embankment used as roadway	EIHS	+6
Navigation				
Number of boats	≈2,400	Slight decline	EGLV	-2
Paddy transportation	≈900 tonnes annually	≈50% boats blocked by closures	SIHV	-7
Fishing boats	≈1,200	≈50% boats blocked by closures	SIHV	-7
Boat security	Adequate	Outside boats exposed to storm damage and loss	SGHV	-5

[*] Project impact is the difference between effects produced by the project and anticipated long-term changes in the absence of the project.

[†] Sensitive (S) or less sensitive (E) resource; immediate (I) or gradual (G) impact onset; high (H) or low (L) impact magnitude; beneficial impacts may be sustainable (S), sustainable with mitigation (M) or not sustainable (N); negative impacts may be irreversible (I), reversible with mitigation (V), or reversible (R).

[‡] Impact ratings are given in Annex 2.

[**] No impact expected by project, but project itself may be impacted.

Table 2 **Recommended Mitigation Measures for Bhelumia-Bheduria Project**

Water Resources:

- Maintenance of canals through clearing and excavation to correct size and bed slope
- Appropriate O&M
- Monitoring

Land Resources:

- Embankment alignment to avoid homesteads as much as possible
- Relocation of any affected homesteads to new sites
- Good environmental engineering practice to minimize damage
- Increased use of organic fertilizers and mulches
- Judicious application of chemical/inorganic fertilizers and pesticides
- Practice of Integrated Pest Management

Water Quality:

- Extension programs to farmers to minimize agro-chemical contamination
- Health education programs to increase risk awareness

Fisheries:

- Navigation lock on Bheduria Canal
- Fish passes on all main canals on Tetulia River side
- Local stocking programs for canals
- Culture fisheries development at village and community levels

Socioeconomic:

- Careful alignment of embankment to avoid displacements
- Relocation of displaced households to new sites

ABBREVIATIONS AND ACRONYMS

BBS	-	Bangladesh Bureau of Statistics
BRDB	-	Bangladesh Rural Development Board
BWDB	-	Bangladesh Water Development Board
cm	-	centimeters
DEM	-	Digital elevation model
DOF	-	Directorate of Fisheries
DPHE	-	Department of Public Health Engineering
DTW	-	Deep tubewell
EIA	-	Environmental Impact Assessment
EIP	-	Early Implementation Projects
EMP	-	Environmental management plan
ERDAS	-	Digital image processing software
FAP	-	Flood Action Plan
FCD/I	-	Flood Control Drainage and Irrigation
FCD	-	Flood Control Drainage
FPCO	-	Flood Plan Coordination Organization
g	-	gram(s)
GIS	-	Geographical Information System
GOB	-	Government of Bangladesh
GR	-	Gini ratio
h	-	hours
ha	-	hectares
HTW	-	Hand tubewell
HYV	-	High-yielding variety
IEC	-	Important Environmental Component
ISPAN	-	Irrigation Support Project for Asia and the Near East
kg	-	kilogram
km	-	kilometer(s)
LGED	-	Local Government Engineering Department
m	-	meter(s)
m^3/s	-	cubic meters per second
mg/l	-	milligrams per liter
mm	-	millimeter(s)
MP	-	muriate of potash
mt	-	metric tonne
NGO	-	Non-government Organization
O&M	-	Operation and Maintenance
pc ARC/INFO	-	GIS application software
ppm	-	parts per million
PRA	-	Participatory rural appraisal
PWD	-	Public Works Datum
ROL	-	Rate of literacy
RRA	-	Rapid rural appraisal
SCWC	-	Subcompartmental Water Committee
STW	-	Shallow tubewell
T. aman	-	Transplanted aman
TD aman	-	Transplanted deep water aman
Tk.	-	Taka
TSP	-	Triple Super Phosphate

GLOSSARY

Aman	Rice grown during *kharif-2* season with the exception of broadcast aman, which is sown in the *kharif-1* season and harvested in the *kharif-2* season
Aus	Rice grown during the *kharif-1* season
B. aman	Broadcast aman
Bandalling	Low-cost dredging method applied to small channels involving bamboo mat panels which create spiral currents
Beel	A natural depression, the bottom of which normally remains wet throughout the year
Boro	Rice grown during *rabi* season
Bandhak	Mortgage
Barga	Sharecropping
Barsha	Normal seasonal flooding
Biri	Local cigarette
Conch	A variety of shell
Dhenki	Traditional foot-operated paddy dehusking device
District	An administrative unit comprising a number of thanas under the charge of a Deputy Commissioner
Khal	Natural channel
Kharif-1	Early summer (March through June)
Kharif-2	Late summer and fall (July through October)
Khasland	State-owned land
Macha	A high platform, usually made of bamboo
Matabbar	Informal village leader
Maund	A local unit of measurement (1 maund=37.3 kg)
Monsoon	Rainy season starting in June and ending in September
Mouza	The smallest revenue unit
Nikari	Middlemen in fish trading
Pagar	A small water body adjacent to the homestead and under individual ownership
Palan	Extension of homestead land, used for vegetable gardening
Rabi	Winter cropping season (November through February)
Sairat mahal	Places of public use given on annual or short-term lease by the government
Salish	Village court
Taka	Name of Bangladesh currency
Thana	Administrative unit (division of a district)
Union	Smallest administrative unit of the local government (division of a thana)
Upazila	Term previously used for thana

Chapter 1

PROJECT SETTING

1.1 Background

The Bhelumia-Bheduria project is one of many projects being considered as Early Implementation Projects (EIP) by the Directorate of Planning Schemes IV, Bangladesh Water Development Board (BWDB). The EIP program, supported by the Government of the Netherlands, has the objective of rapid implementation of relatively small-scale FCD and FCD/I projects in Bangladesh. Following a BWDB request that ISPAN use one of the projects as a subject for an EIA case study, the Bhelumia-Bheduria project, a small coastal project in the final feasibility stages of investigation by EIP, was selected for study.

The Bhelumia-Bheduria project area is located on the northwestern tip of Bhola Island in the Meghna River estuary, 3km west of Bhola town (see frontispiece). The project area is bounded in the west and south by the Tetulia River, by the Jangalia River in the east, and by Darogar *khal* in the northwest (Maps 1 and 2). The gross area of the flood-prone area within which the project would be located is 5,306 ha. The general slope of the area is towards the south and southeast.

The project area is presently subject to tidal flooding which spills over the banks of both the Tetulia and Jangalia rivers and the various *khals* linked to these rivers. The depth of tidal flooding increases during the monsoon period (July-September) due to a combination of high river stages and heavy rainfall. Flood waters from the Tetulia River recede during low tide, but often not completely before another high tide floods the area. Flood waters due to overspill from the Jangalia River usually recede completely as the overland slope is predominantly toward the river. Project area farmers report that the most severe crop damage is due to tidal flooding from the Tetulia River.

In addition to periodic tidal flooding, surges may occur during cyclones and severe storms; these may occur at any time but are more prevalent in October and November. During surges water rises rapidly above normal high tide levels, causing widespread crop and property damage. The last major surge occurred in 1971 and caused extensive damage to crops, homesteads, infrastructure, and property, in addition to claiming lives.

Other flood-related problems in the area indicated during initial project reviews were riverbank erosion in some areas, and possible intrusion of saline water in March and April. Erosion was subsequently found to be a problem in some places, but saline intrusions were limited to sporadic cases in the southern portions of the project area in late March.

1.2 Project Objectives

The objective of the project (BWDB 1993) is to prevent severe monsoon tidal flooding from damaging *aus* crops in June-July, and transplanted *aman* (T. aman) crops in August and September. Prevention of property and crop damage due to severe tidal surges accompanying storms and cyclones is not an objective of the project.

1.3 Environmental Assessment Methodology

The approach ISPAN used for the Bhelumia-Bheduria Project EIA was that advocated in the FAP EIA Guidelines (FPCO 1992a) and the FAP draft final EIA Manual (ISPAN 1992a) for use in FAP projects (although the Bhelumia-Bheduria Project itself is not a FAP project, but a proposed Early Implementation Project of the BWDB). The approach consisted of deploying a multidisciplinary team to undertake the studies and assessments through a 10-step process of project design and description, environmental baseline description, scoping, bounding, major field investigations, impact assessment, impact evaluation, environmental management planning, feedback to improve project design, and reporting. Project descriptions were provided by EIP (BWDB 1993).

The EIA team reviewed available literature on the EIP project and related secondary data sources. This was followed by a reconnaissance survey which helped identify the important environmental components (IECs) and formed the basis for developing the subsequent data collection methods. Extensive discussions took place at different stages of the EIA work with the EIP team in Dhaka and BWDB engineers in Bhola.

1.3.1 Data Collection

The EIA team conducted a reconnaissance survey of the study area for four days in October 1992 making an extensive tour of the area and talking to local people, BWDB engineers, and NGOs. This was followed in November by detailed data collection using semi-detailed land use surveys, household questionnaire surveys, and rapid rural appraisal (RRA) and participatory rural appraisal (PRA) techniques. The PRA is a development of the RRA especially tailored to social and community appraisal; it is designed to involve the community in the identification and analysis of local needs, issues, problems, and solutions. The individual experts visited each of 13 *mouzas* (including one uninhabited *mouza*: Annex 1) and collected information and data related to their respective discipline through observation, discussion with key informants and local knowledgeable persons, elites, groups of ordinary people, households, and professional communities. The RRA, PRA, and semi-detailed land use survey was completed in 10 days. The household questionnaire survey (Annex 1) continued through the whole of November and early December.

During fieldwork, the team used 1990 color infrared (CIR) aerial photographs (1:30,000) for the semi-detailed land use survey, SPOT imagery (1:50,000), and a global positioning system (GPS) for updating the bankline and fixing coordinates for the Land Use Survey. BWDB and EIP maps and reports were extensively used.

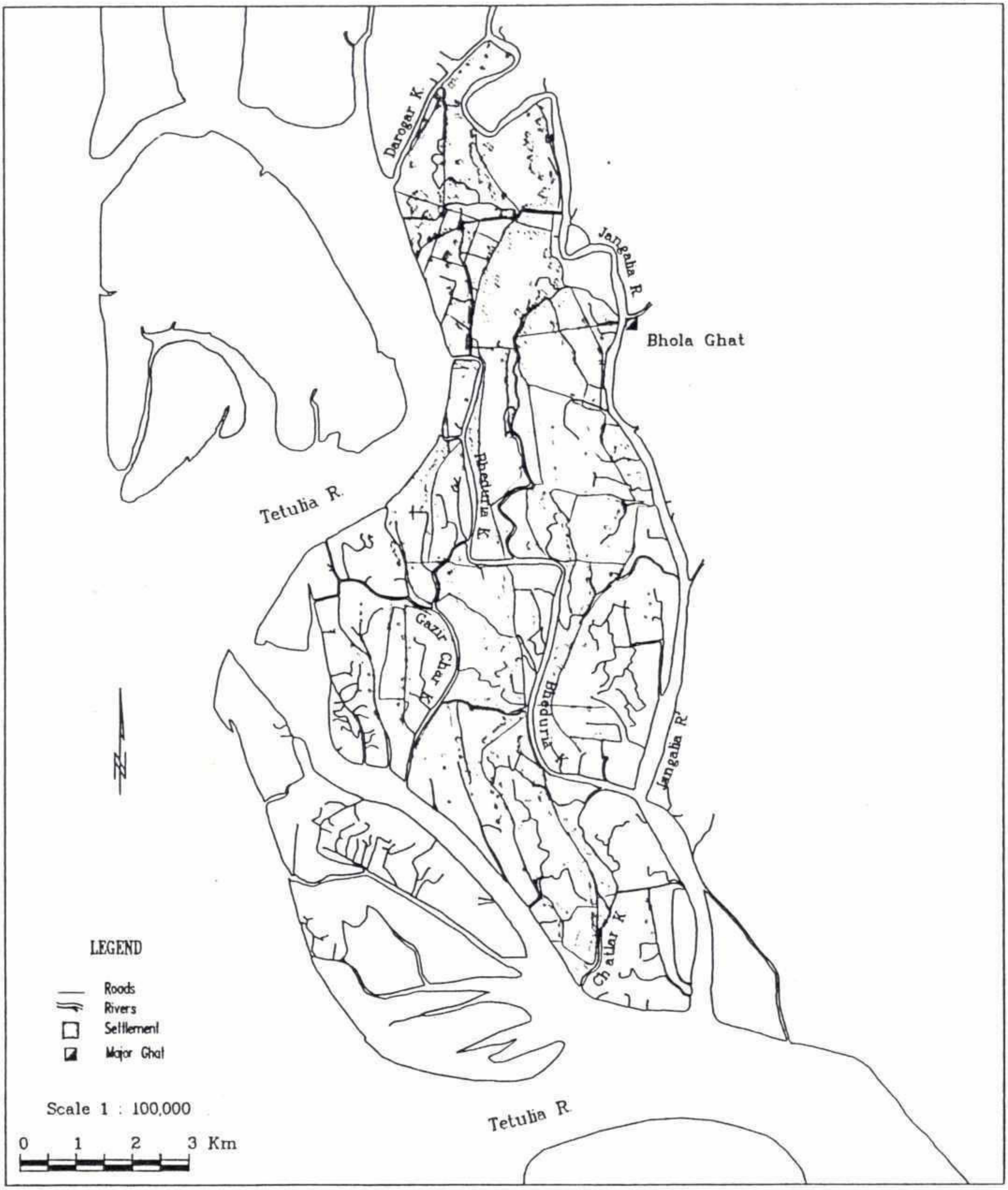
Water Resources

Hydrological information was collected through site-specific visits complemented by interpretation of aerial photographs and SPOT imagery. This information supplemented secondary data collected from the Bhola BWDB offices and the Hydrology Directorate, Dhaka.

Land Resources and Land Use

A semi-detailed land use survey using 1990 CIR aerial photographs was performed to map land use and cropping pattern. The cropping pattern units were identified from interviews with local farmers. The infrastructure, including roads, and the homesteads and other land uses were identified during the field survey. The cropping pattern units and the land uses were delineated on overlays. Crop areas, cropping patterns, crop damage, inundation levels, and modes of irrigation by season were noted on data sheets. Data on agricultural practices, crop yields, human and animal labor requirements, and crop damage were collected by interviewing knowledgeable farmers from different areas. Cross-checking was done to ensure the reliability of information. The whole study area was divided into sections and the land use survey team completed one section before moving on to the next.

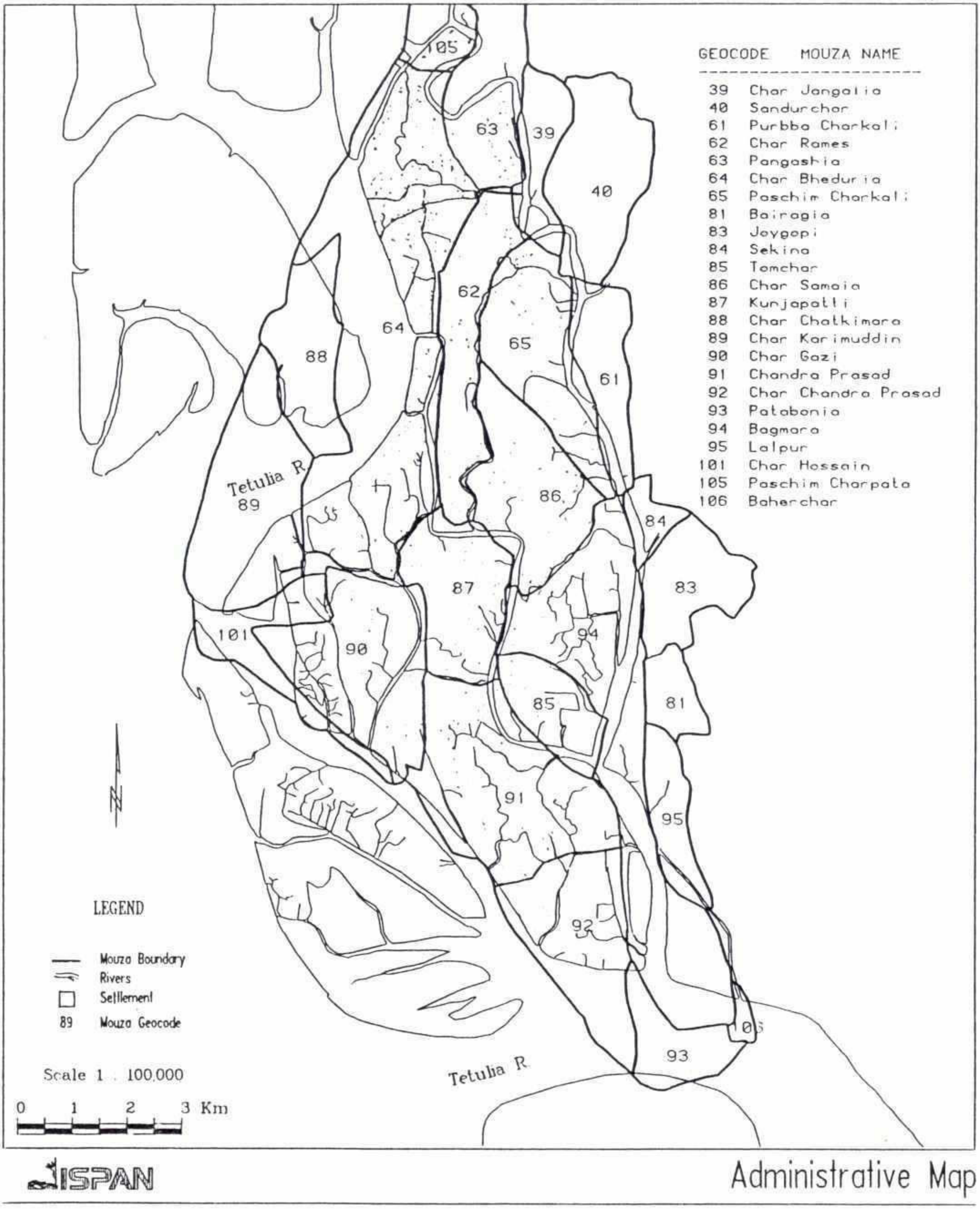
Map 1



ISPAN

Base Map

Map 2



GEOCODE	MOUZA NAME
39	Char Jangalia
40	Sandurchar
61	Purbba Charkali
62	Char Rames
63	Pangashia
64	Char Bheduria
65	Paschim Charkali
81	Bairagia
83	Joygopi
84	Sekina
85	Tomchar
86	Char Samaia
87	Kunjapatti
88	Char Chatkimara
89	Char Karimuddin
90	Char Gazi
91	Chandra Prasad
92	Char Chandra Prasad
93	Patabonia
94	Bagmara
95	Lalpur
101	Char Hossain
105	Paschim Charpata
106	Baherchar

ISPAN

Administrative Map

Forestry and Homestead Vegetation

Field data collection was based on both RRA and household surveys. Information was collected on:

- depth, duration, and frequency of inundation of homesteads at different levels;
- areas of housing, orchards, and vegetable gardens;
- abundance of species in homesteads, along roadsides, and along the verges of rivers and canals, including the nature of their consumption;
- production, consumption, and extent of damage of vegetables and other tree crops;
- biomass energy sources and their proportional and seasonal uses;
- programs and trends of alleviation for fuel crisis.

Terrestrial and Aquatic Habitats

Terrestrial habitats were surveyed during the RRA, household survey, and semi-detailed land use surveys. Aerial photographs were used to identify specific sites in each of the 13 *mouzas* for field visits. These sites included shoreline, agricultural land, homestead, and roadside sites. Habitat characteristics were noted with particular regard to species composition and growth.

Aquatic habitats were studied through RRA on a *mouza* basis. Aquatic habitats were classified into rivers/*khals*, intertidal mud flats, floodplain, and ponds. Limno-biological tests were conducted at 32 sites, 14 in rivers and *khals* and 18 in ponds. Ponds were classified as inundated or non-inundated, and sub-divided into large, medium, and small categories. The *khals* surveyed included Bheduria, Farazi, Majhirhat, Ujirer, Boalia, Napiter, Chatler, Goaliar, and Projar. The Tetulia and Jangalia rivers were also surveyed. Observation of rivers and major *khals* was done during both high and low tides at some designated points.

A Hach portable water testing kit was used to estimate levels of the following parameters: dissolved oxygen, carbon dioxide, alkalinity, hardness, chloride, ammonia, nitrite nitrogen, and pH. Surface water samples were taken from the central point of sampled canals. Plankton samples were collected by filtering 10 liters of water through a plankton net. Plankton samples were preserved in 5 percent formalin and later examined under a compound microscope using an identification key (Alfred, *et al.*, 1973). Benthos samples were collected from *khal* and pond bottoms from at least two sections for each of the selected points. Benthic invertebrates were identified alive. Aquatic macrophytes were identified by direct observation.

Channel Shifting, Erosion and Accretion

Changes in the banklines of the main rivers and chars in the study area were examined through the use of satellite imagery. Four digital Landsat images—1973 (the earliest available image), 1979, 1990 and 1993—were georeferenced to standard coordinates, overlaid using a digital image reader, and displayed by a Geographic Information System (GIS). Rates of change in bankline position from one image to the next were computed.

Wildlife

Information on wildlife was collected by visiting each category of terrestrial and aquatic habitat described in the habitat section above at different times of the day. Numbers of individuals per species per unit area within each habitat were estimated. Food habits for each species were observed. Particular attention was given to the identification and population estimation of endangered, threatened, and pest species. The critical habitat and causes of decline/degeneration, if any, of endangered and threatened species habitats were noted. Occurrence and use of commercially important wildlife were identified. Information on hunting/trapping/harvest techniques, amount of harvest, seasonality, and annual return for local consumption/export were collected from knowledgeable local persons including those who were involved in commercial exploitation. Ecological losses due to harvest were also noted.

Fisheries

Aerial photographs from 1990 were examined and representative types of aquatic areas identified and located. These were subsequently examined in the field. Wetlands were classified by type (e.g., *khals*) and location. Information on fish populations was obtained by observing fish markets, fish purchase centers, and fish catches *in situ* at various river, *khal*, and inundated rice field locations. Fish diversity and abundance were noted in catches, at markets, and in fish purchasing centers.

Information on fish migration routes, availability, and breeding was collected by interviewing knowledgeable professional fishermen, subsistence fisherman, and local villagers. Fish catch assessments were made by gear type. The cost of each type of gear, capacity of catch, and species caught were recorded from field observation and through interviews. Fish production was estimated on the basis of annual records of the fish purchasing centers. Information on marketing systems, leasing systems, and fisheries problems was collected from local knowledgeable persons, district fishery officers, thana fishery officers, Bangladesh Matshajibi Samabaya Samity (local office), fishermen, and local leaders. Information on inundated ponds, which were classified as open-water capture fisheries, were collected by visiting selected sites. Information on management aspects, including ownership patterns, stocking of ponds, and diseases and other problems was collected by interviewing fishermen and owners of inundated ponds. Information on fish consumption and other aspects related to capture fisheries was collected from the household surveys.

Information on culture ponds was collected by direct observation and by interviewing the owners of selected ponds. Information included cultured species, sources of fish seed, production management, annual fish production, marketing, and constraints to culture fisheries, including fish diseases. The number of ponds in the study area was determined from aerial photograph analysis and confirmed by field observation.

Socioeconomic

The socioeconomic data were collected through PRA, RRA, and household surveys. The social impact assessment (SIA) team visited each of the 12 inhabited *mouzas* and collected data/information from various socioeconomic groups, local elites, and households using an interview guide. The socioeconomic groups included:

- elected members of the local government, i.e., Members and Chairmen of Bhelumia and Bheduria unions;
- school/*madrasa* teachers, community leaders;
- doctors/*kabiraj*;
- large, medium, small, marginal, and tenant farmers;
- agricultural labors, including the landless;
- professional and subsistence fishermen and fish traders;
- shopkeepers and other petty traders;
- women from the households, particularly from the category of farmers, agricultural labors, and fishermen, including female-headed households;
- thana- and district-level officers in Bhola;
- NGO staff working in the study area.

Information/data were collected and people's views obtained on socioeconomic issues, including occupation/employment, income, subsistence patterns, migration, land tenure and tenancy relations, major development problems and perceived solutions, navigation, marketing and leasing (particularly fish), gender issues, education, water and sanitation, health and nutrition, and health service delivery system/outlets. These data were supplemented by BBS and other published sources wherever necessary.

Hazards and Risks

Information and data on environmental risks and hazards and perceived mitigation options were collected both through PRA/RRA and household surveys and included hazards such as flood, tidal surge, cyclone, saline intrusion, erosion, excessive rainfall, drainage congestion, waterlogging, and drought. The BWDB office files at Bhola were consulted for information on hazard events in the study area.

1.3.2 Application of GIS

A Geographic Information System (GIS) was used as a data platform for preparing base maps and for estimating land type distribution. Maps and tables were produced in pcARC/INFO on ERDAS software. Spatial data from field surveys were traced onto a stable film base at a scale of 1:50,000. Tracing was done on aerial photographs and satellite imagery overlays. *Mouza* boundaries were digitized from available police station maps. Digitizing was accurate to approximately 50m. Areas of roads were calculated by assuming a standard base width of approximately 10m including borrow pits. The distribution and areas of land types were computed by preparing a digital terrain model (DTM) based on digitization of BWDB contour maps for the area, and overlaying this with flood depth profiles based on assumed heights of flood waters above local datum.

1.4 Scoping, Bounding, and Selection of Important Environmental Components (IECs)

IECs were considered as ecological, social, and economic components worthy of sustaining at existing or enhanced levels under project conditions. Following the reconnaissance survey, the EIA team scoped the study components and bounded the *study area*. The latter was defined as the area that would be directly impacted by the proposed project, and was bounded by the Tetulia River to the west and south and the Jangalia River to the north and east. This included the *project area* enclosed by the proposed embankment, plus the *adjacent area* which comprised the southwestern char areas (Char Gazi and Char Hossain) between the Tetulia River and the embankment alignment and the small area north of Darogar Khal (Map 1). For consideration of socioeconomic impacts, the char land accreted to the west of the Tetulia River and sections of the Bhola mainland immediately east of the Bhelumia-Bheduria region were also included.

1.5 Impact Assessment and Analysis

The initially proposed approach to impact analysis was to develop two future scenarios for the project area—*future-without-project* and *future-with-project*—each considering a 20-year period into the future. Each would be predicted on the basis of available environmental baseline information and the information provided through GIS analysis of land resource data. The difference between the two scenarios for the various environmental components and resources would be considered the project impact. The purpose of considering a *future-without-project* scenario as a basis for comparison and assessment of impacts is to take account of future trends in many environmental components which are independent of any project actions, e.g., human population growth, changes in resource bases, etc.

Because of the high uncertainty associated with the hydrological changes which would take place under project conditions (see Chapter 4), it was deemed advisable to consider two possible scenarios for the *future-with-project*. One assumed no change in maximum three-day water levels in the monsoon season, and hence no change in land type distribution in the project area, the other assumed a small reduction in maximum water levels and a corresponding change in land type distribution.

Impacts were evaluated in economic terms through appropriate economic analyses. Changes in income and employment and the distribution of income were considered the major economic measures of the impacts of the project, and the underlying changes in cropping pattern and intensity, yields, labor requirements and other production inputs, and crop damages that determine farm income were computed. Similar computations were made for capture and culture fisheries production, fish trade, important waterway transportation routes, fish purchase centers, other markets, and origin and destination by type of goods. Non-economic evaluation was applied to impacts which could not be quantified in economic terms or for which suitable quantitative data were lacking.

1.6 Assessment and Scoring

Predicted impacts were scored using a 1 to 10 scale for beneficial impacts and a -1 to -10 scale for negative impacts. Scores were weighted according to the nature of the impacts, i.e.

- *sustainability* (applied to positive impacts only): sustainable (weighted 6x), sustainable with mitigation (weighted 3x), non-sustainable;
- *reversibility* (applied to negative impact only): irreversible (weighted -6x), reversible with mitigation (weighted -3x), reversible;
- *sensitivity:* sensitive (weighted 2x), less sensitive: sensitivity is defined as the readiness with which an IEC or set of IECs receive the impact.
- *magnitude:* high (weighted 3x), low: refers to the size of the impact. Can be negative or positive. Any quantifiable increase or decrease to an IEC as a result of the project action was converted to percentage values. Any direct threat to human life, internationally recognized endangered species, and environmentally sensitive areas was considered high magnitude.
- *rate*: immediate (weighted 2x), gradual: an immediate impact is effective within one year of project action, otherwise the impact was considered gradual.

The score scaling is given in Annex 2.

Impacts were not weighted by resource or by project component since alternative project options were not required to be compared. The EIA team's efforts were aimed at providing an unbiased assessment and scoring of specific IECs and presentation in the report for consideration by management and decision makers. It is believed that the decision and determination as what resource or resource use is more important than others is up to the decision makers and not individuals in the EIA team. By definition, all IECs are important, and components and resources with low weights are automatically excluded in the scoping process.

1.7 Study Team

EIA

Stan Hirst - team leader
Abu Md. Ibrahim - soils and agriculture
Dara Shamsuddin - impact assessment
Kazi Sadrul Hoque - social impacts and people's participation
Khurshida Khandakar - forests and homestead gardens
Mohiruddin Ahmed - hydrology and project liaison
Aminul Islam - climate and hazards
Afsana Wahab - social impacts and women's issues
Raguibuddin Ahmed - terrestrial and aquatic biology
Monowar Kamal - navigation and study mapping
Afroza Begum - fisheries
Carol Jones - report editing
Hena Rosline D'Rozario - word processing

GIS

Mike Pooley
Ahmadul Hasan
Md. Hasan Ali
Aneeqa Shireen Syed

1.8 EIA Level of Effort

The EIA team conducted the assessment, including the necessary field studies and household surveys from September 1992 through April 1993. Total level of effort expended for the entire team, including fieldwork, data analysis, and reporting, was estimated at 60 person-months.

1.9 Relationship of EIA to Project Feasibility

The EIA was conducted solely as a case study to develop experience in impact assessment under conditions pertaining to Bangladesh, especially in a fairly remote coastal area, and to examine the practicality of applying the EIA guidelines requirements. The study was conducted with the cooperation and assistance of the EIP group of the BWDB, but was conducted quite separately from the latter group's feasibility studies. A separate, more brief assessment of the agricultural, social, and environmental impacts of the project was conducted by EIP and incorporated in their feasibility report (BWDB 1993).

1.10 Acknowledgements

The assistance and helpful cooperation of the EIP group of the BWDB, especially Director Md. Lutfur Rahman, Executive Engineer K.T. Hussain, Socioeconomist A. Salahuddin, and Team Leader Paul A. Zijderveld, is gratefully acknowledged. The EIA team members acknowledge the cooperation and assistance of the Deputy Commissioner of Bhola, staff of the BWDB in Bhola, especially Executive Engineer Ali Akbar Hayder and Superintending Engineer Kayun Risvi, and the local chairmen, villagers, and elite of the Bhelumia-Bheduria Project area. Numerous government and nongovernmental agencies and individual officials provided information and assistance.

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Chapter 2

PROJECT DESCRIPTION

A number of project concepts have been considered by EIP for effecting flood damage protection and improved drainage in the Bhelumia-Bheduria Project area. The one considered as a basis for this EIA is described in BWDB (1993). The pertinent features are as follows.

2.1 Project Plan

2.1.1 Embankment

The project area would be protected by an embankment (Map 3) with a total estimated length of 38km. From Bheduria Khal to Napter Khal the embankment would be exposed to wave action and would be constructed as a sea dyke with side slopes of 1:5 towards the river ("riverside" or "R/S" in standard BWDB terminology) and 1:3 towards the interior ("countryside" or "C/S"), a freeboard of 1.5m, and a crest width of 4.3m. Along the Tetulia River between Napter and Majhirhat *khals* the embankment would be built as an interior dyke with side slopes of 1:3 R/S and 1:2 C/S, a freeboard of 0.9m, and a crest width of 4.3m. Between Majhirhat and Bheduria *khals* along the Jangalia River the embankment would be a marginal dyke with a crest width of 2.4m, a freeboard of 0.9m, and R/S and C/S side slopes of 1:2. All crest levels were computed on a basis of a 1:20 probability water level on both the Tetulia and Jangalia rivers. A 50m minimum set-back distance would be maintained for both sea and interior dykes, and 10-15m for marginal dykes.

All *khals* originating from the Tetulia River on the western side of the project area, including Bheduria Khal, would be closed except where boat passage facilities are required. All *khals* along the Jangalia River would be left open.

2.1.2 Structures

One two-vent drainage and flushing sluice (1.5 x 1.8m) would be constructed at the outfall of Napter Khal, and two 0.9 x 0.9m sluices, one at the outfall of Munshir Khal and the other at the southern tip of the project area. These sluices would be intended to improve drainage during the pre-monsoon and monsoon seasons. Seven culverts for drainage improvement have been proposed (BWDB 1993) in the following locations:

- Char Samaiya near Natun Bazaar, southwest of Panditer Khal
- North side of Sharupkhar Hat
- Between Natun Bazaar and Bangla Bazaar
- Near Bangla Bazaar along Bheduria Khal
- From Bhelumia Bazaar to Napter Khal
- South side of Bhelumia Bazaar
- Between Natun Bazaar and Bhelumia Bazaar

These are not necessarily the same locations as identified for drainage improvement by local people (see Chapter 6).

A footbridge would be constructed over Bheduria Khal at Bangla Bazaar.

2.1.3 Excavation

All silted *khals* would be excavated during project construction.

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2.2 Preconstruction Phase

Other than sporadic study team presence and activity in the project area from 1990 through 1992, preconstruction work has been confined to desk studies. These early activities have had no apparent or identifiable environmental impacts, apart from arousing people's expectations regarding the benefits of the project when implemented.

2.3 Construction Phase

Project construction is planned to commence in 1993 and could be completed by 1998/99, i.e., a five-year time span. All construction work undertaken by the BWDB would use local labor. The components of the project during the construction phase are listed in Table 2.1.

Supply of electricity during and after the installation of the 20 tubewells is recognized as an activity associated with tubewell development.

Table 2.1 Bhelumia-Bheduria Project Construction Components

1. Land acquisition (125 ha)
2. Embankment (including sea dike, interior dike, and marginal dike, total length: 38km)
3. Drainage/flushing sluice gate (1 no.)
4. RCB sluices (2 nos.)
5. Closures (4 nos.)
6. Reexcavation of *khals* (unspecified length)
7. Culverts (7 nos.)
8. Footbridge (1 no.)
9. Tubewells (20 nos.)
10. Cyclone shelter (1 no.)
11. Maintenance during construction
12. Borrow pit*
13. Soil disposal during *khal* reexcavation*
14. Labor mobilization and associated service requirements*

Source: BWDB (1993)

* Additional construction items identified according to the EIA Guidelines (FPCO 1992).

Embankments would be constructed from materials excavated from borrow pits immediately adjacent to the embankment alignment. For the most part the embankments would follow the course of present roads. Sea dykes would be reinforced with locally made bricks or with boulders barged in from the Sylhet area in northern Bangladesh.

2.4 Operation and Maintenance Phase

Present project plans call for a three-year operation and maintenance (O&M) phase following construction, to be undertaken by the BWDB. O&M beyond the initial three years has not been defined. The components to be considered during the O&M phase are listed in Table 2.2.

Table 2.2 Bhelumia-Bheduria Project O&M Components

1. Embankment (Total 38 kms)
2. Drainage/flushing sluice (1 no.)
3. Sluice gates (2 nos.)
4. Closures (4 nos.)
5. Reexcavated *khals* (unspecified length)
6. Culverts (7 nos.)
7. Foot bridge (1 no.)
8. Tubewells (20 nos.)
9. Cyclone shelter (1 no.)
10. Borrow pit

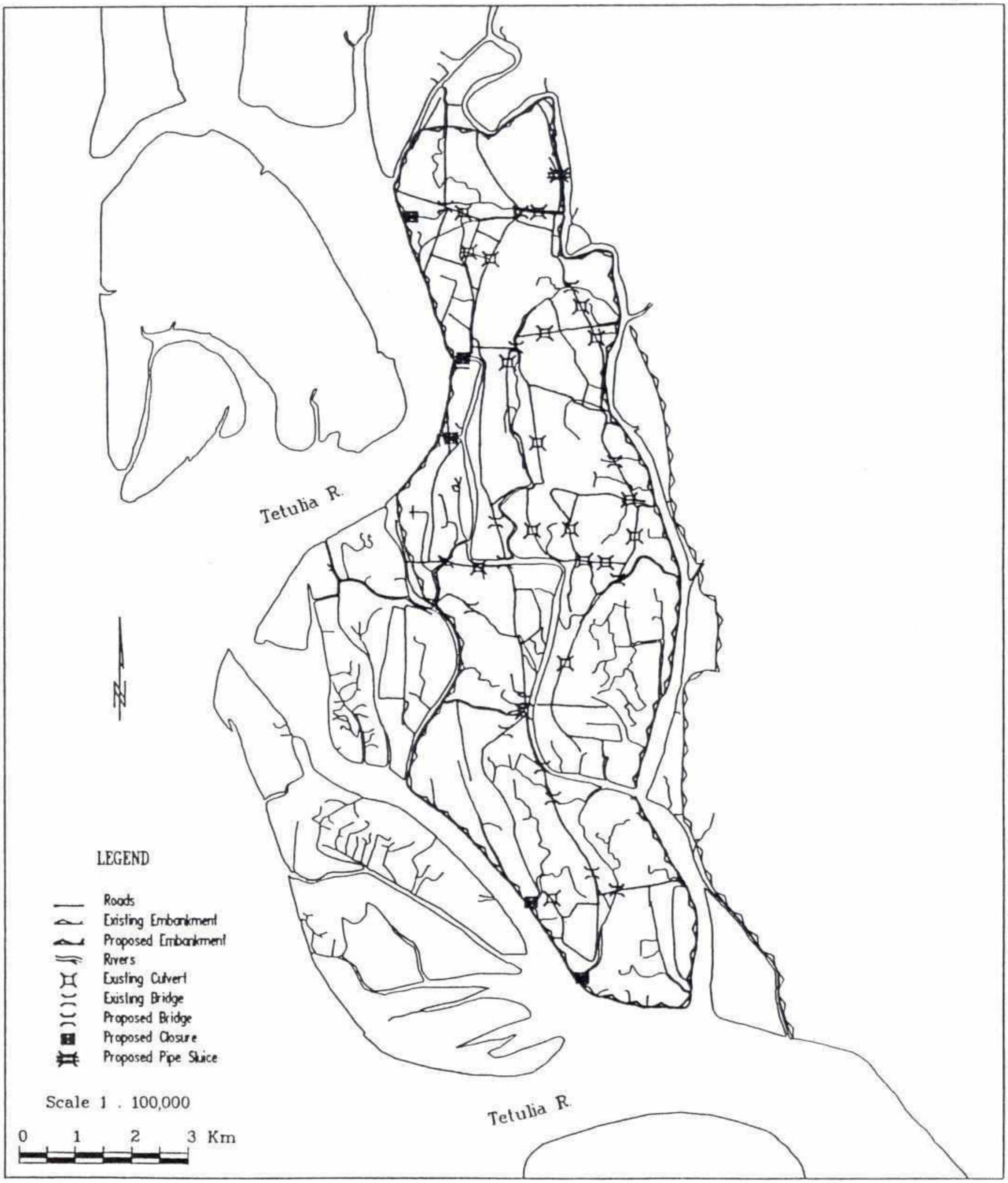
Source: BWDB (1993)

2.5 Project Alternatives

No alternatives to the project have been proposed. Project objectives (Section 2.2) are directed at reducing crop damage by floods, and this would be difficult to effect with any other project approach. Reduction of property damage and protection of human life have not been specified as project objectives.

Consideration of a no-project alternative is included in this impact assessment as a basis for compar-

Map 3



ISPAN

Infrastructure & Proposed Scheme

ison and a basis for estimating project impacts in cases where present baseline conditions are not considered to be stable (e.g., human population growth).

Chapter 3

DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 Physical Environment

3.1.1 Climate

The project area has a tropical monsoon climate and falls within a moderate rainfall zone of the country. Mean annual rainfall is about 2,301mm (compared to the national mean of 2,320mm), with 96 percent of the rain occurring between April and October. Temperature of the area begins rising in February/March, peaks in April/May, and remains fairly steady from June to October. The mean summer temperature is 25°C; the daily maximum may rise to 35°C, while the daily minimum is about 17°C. Relative humidity is high throughout the year with a maximum of 90-95 percent during the monsoon. The humidity drops gradually from October and reaches a minimum of 60-65 percent in February/March. Summary climatic data for the area are given in Table 3.1.

3.1.2 Water Resources

River System and Channel Network

The hydrology of the area is dominated by the Tetulia River, a perennial, tidal, and active river which forms the western and southern boundaries of the study area (Map 4). Darogar Khal, at the northwest tip of the project area, links with the lower Meghna and Jangalia rivers to form the eastern boundary. Many *khals* originating from the

Table 3.1 Climatological Data for the Bhelumia-Bheduria Study Area

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall monthly mean (mm)												
	7	21	50	110	218	438	458	419	302	191	42	10
Temperature mean daily maximum (°C)												
	26	28	32	34	33	32	31	31	31	31	29	26
Temperature mean daily (°C)												
	13	16	21	24	26	26	26	26	26	24	19	15
Relative humidity (%)												
9 a.m.	76	74	74	74	74	83	87	85	83	79	78	78
6 p.m.	60	56	56	66	74	82	83	83	82	77	69	64
Average wind speed (km/h)												
	3.5	4.3	6.5	8.4	9.1	8.9	9.1	7.6	6.0	3.0	2.3	1.9

Source: BWDB (1993)

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Tetulia flow inside the project area, the most important of which is the perennial Bheduria Khal. During high tide, water flows northwest from Bheduria Khal, reversing to southeast during low tide; it divides the project into two segments. Other small *khals* and creeks in the area interlink with Bheduria Khal; among the most important is Majhirhat Khal, which connects the Tetulia and Jangalia rivers as well as connecting with small creeks in the northern region. During high tide water enters Majhirhat Khal from both the Tetulia and Jangalia rivers, spreads throughout the northern region, and then recedes back to the small creeks during low tide. An existing road from Majhirhat Khal to Bankerhat divides the area into northwest and northeast regions. The northwest region drains through existing creeks into Bheduria Khal and the Tetulia River, while the northeast region drains through Kheyaghater Khal into the Jangalia River. In the central part of the project area, Chatler, Panditer, and Bheduria *khals* link with the Jangalia, and Bheduria, Kulgazir, and Kamper *khals* link with the Tetulia.

Bharanir, Chatler, and Napter *khals* play important roles in the southern portion of the project area. Bharani Khal is well defined and openly connects with the Tetulia River from its depressed, northern portion. Water from its southern portion first flows through Bharani Khal before discharging into the Tetulia.

Surface Water and Floods

During the monsoon season from July to October, high tides cause flood waters to spill over the banks of the Tetulia and Jangalia rivers. Impacts of flooding include damage to crops (Section 3.2.2) and homesteads (Section 3.2.3). Rainfall aggravates the situation. During low tide, flood waters recede through *khals* and creeks either fully or partially. In some areas, however, high tide flows in again before the previous flood water has receded. Low-lift pumps supply surface water for any needed crop irrigation during the dry season.

Drainage

While drainage congestion is not a major problem in the area, some localized congestion occurs due to accumulated rainwater and tidal flood water. In these areas, drainage is hampered because of insufficient culverts, openings, and linking *khals*, and because of unplanned roads and other types of barricades that obstruct flow.

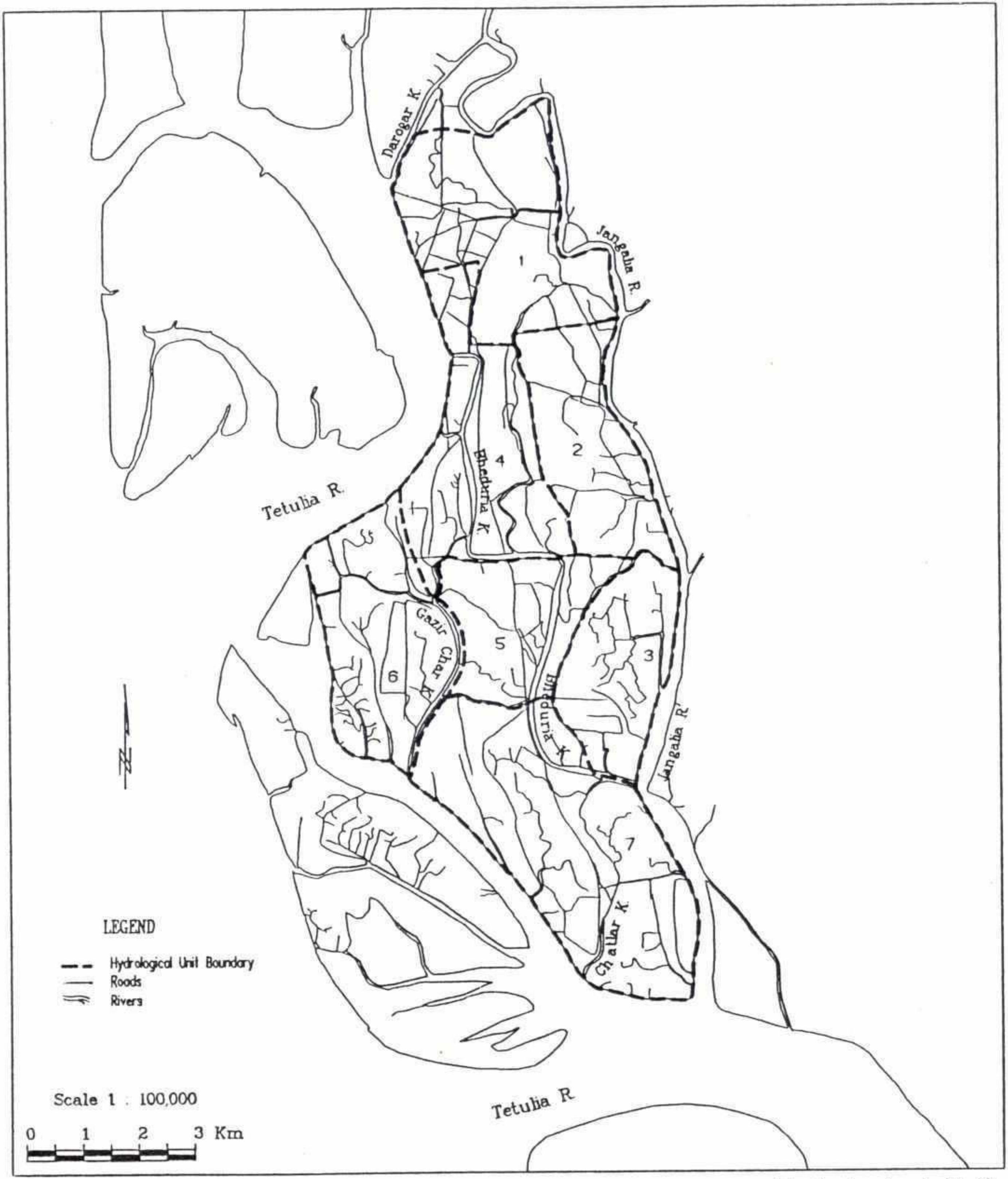
Groundwater

Groundwater is not used for irrigation because of its salinity and because of the abundance of surface water in the project area, but it is used for drinking purposes. Tubewells for drinking water vary from 275m to 370m in depth. There are 468 tubewells in Illisha, Char Samaiya, Bheduria, and Bhelumia unions to serve a population of 56,280, or 8,485 households (Public Health Engineering Bureau 1991).

3.1.3 Erosion and Channel Migration

The study area is located in a dynamic coastal area where erosion, accretion, and channel shifting have been active for millennia. The available Landsat imagery permits examination of such changes for the relatively very brief period of the preceding 20 years. Major erosional and accretional changes have taken place in this period (Maps 5 and 6), with the Tetulia River moving eastward at the rate of approximately 200m/year. The current focus of erosion is just below the mouth of Bheduria Khal where the bank migration rate is estimated to be about 30-40m/year. At the time of the study, the flow of the Tetulia is roughly split in half by the accretion of a large mid-channel char. Marked accretion on the left bank north of the study area is taking place, and the east channel, which borders the project area, could conceivably be shut off within a few years. Channel migrations are notoriously unpredictable in coastal areas, however.

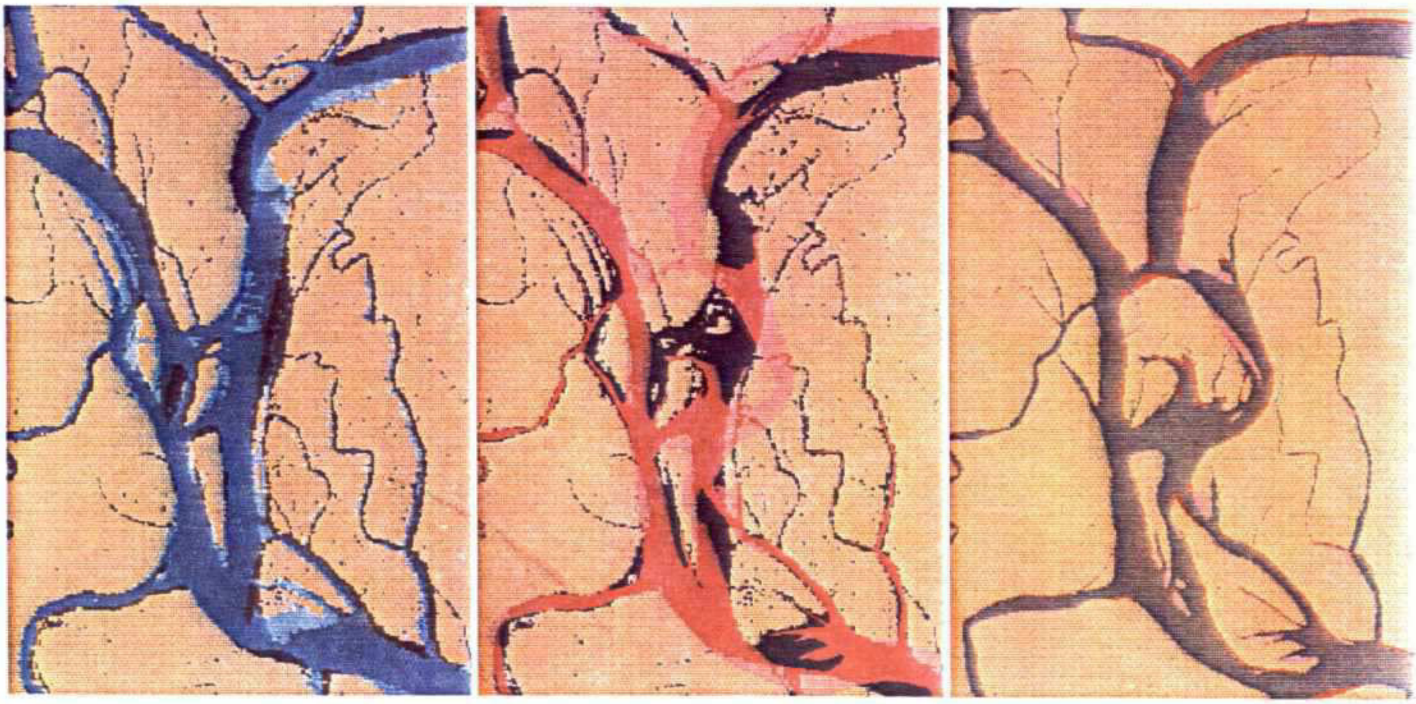
Map 4



ISPAN

Hydrological Units

Map 5



▨ Water in 1973
▨ Water in 1973 and 1979
▨ Water in 1979

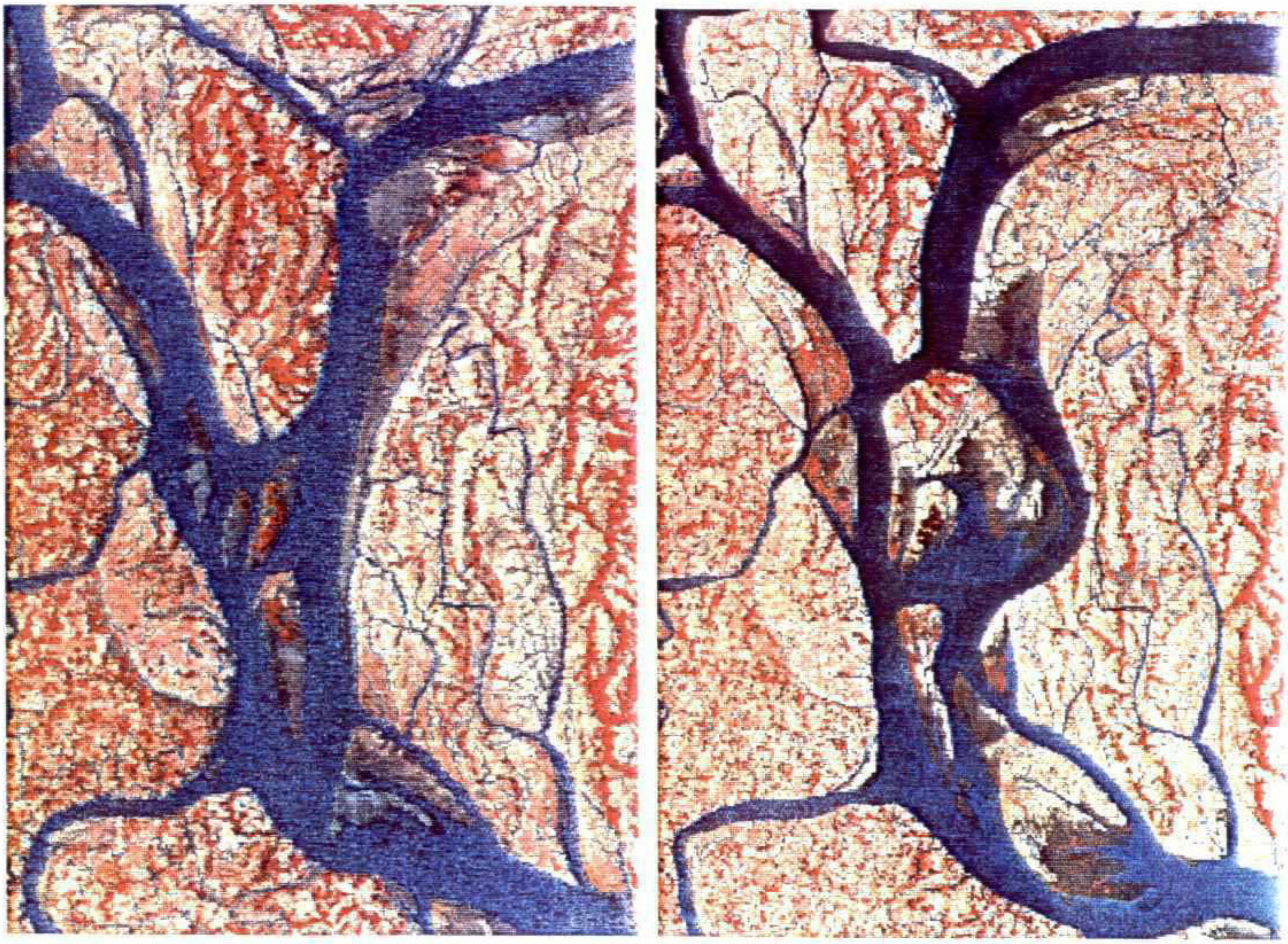
▨ Water in 1979
▨ Water in 1979 and 1990
▨ Water in 1990

▨ Water in 1990
▨ Water in 1990 and 1993
▨ Water in 1993

ISPAN

Movement of Tetulia River in the Bhelumia Bheduria Area

Map 6



1973

1993

ISPAN

Change in Bankline and Charland 1973–1993

By contrast to the dynamic Tetulia River, the Jangalia River and Bheduria Khal are stable in their locations, and have shown very little inclination to bank migration within the past 20 years.

3.2 Terrestrial Environment

3.2.1 Land Resources

Land Types

Land types are flood depth phases of floodplain soils. Common practice in Bangladesh is to designate land types according to the maximum flood depths prevailing for a minimum three-day period during the peak monsoon and occurring with an annual probability of about 1:5 (ISPAN 1992a based on MPO 1986). In the EIA case study undertaken for the Compartmentalization Pilot Project at Tangail (ISPAN 1992c) for which GIS was used, maximum water levels prevailing in an average year (i.e., about 1:2.3 frequency) were found to give more realistic results in terms of field verification of land type occurrence.

Application of land type designations and mapping to a coastal area subjected to tidal inundation presented some uncertainties, since maximum water levels during the monsoon season fluctuate diurnally according to the prevailing tides (Figures 3.1, 3.2). The maximum water levels (20-year return period) at the Meghna off-take, Bhola Kheyaghat, and Dhulia are calculated to be 3.80m, 3.79m, and 3.08m above PWD datum, respectively (BWDB 1993); these probably reflect water levels occurring during storm events. Maximum water levels prevailing during the period June through September on a five-year return basis were computed to be 2.63m (normal plot method)

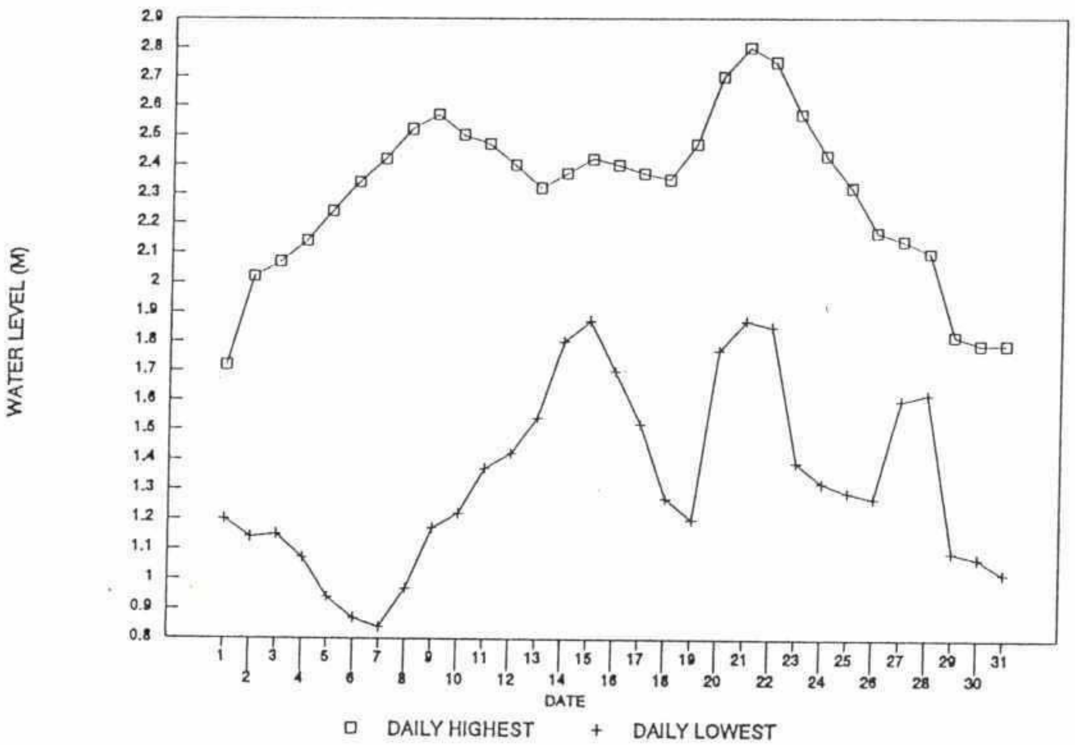


Figure 3.1 Daily highest and lowest water level fluctuations in study area (data from Bhola Kheyaghat gauging station, August, 1991)

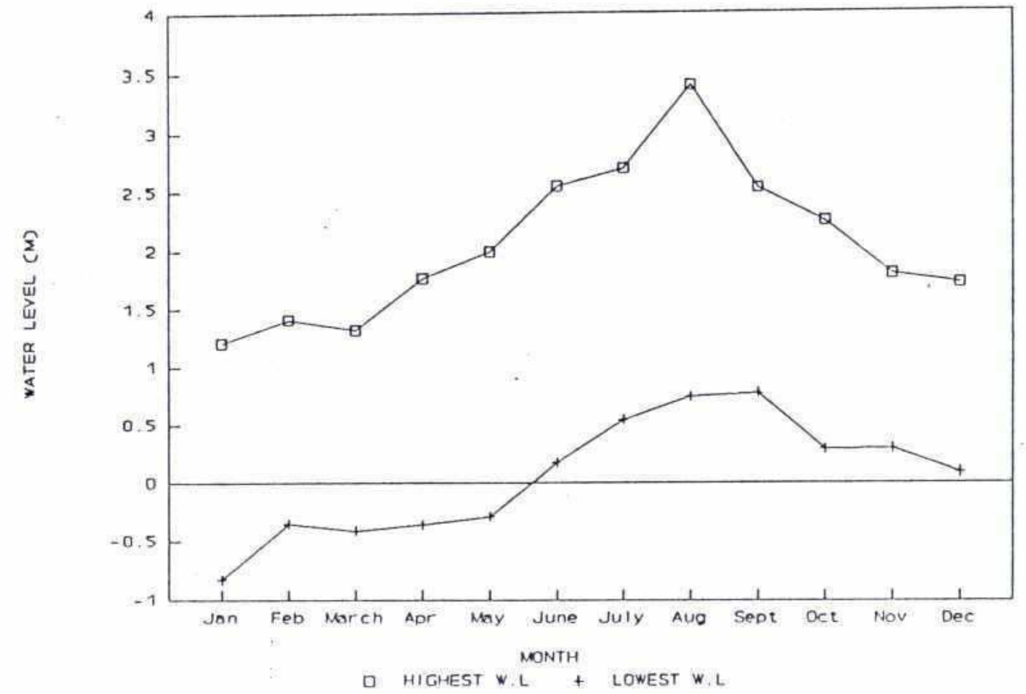


Figure 3.2 Monthly highest and lowest water level fluctuations in the study area (data from Bhola Kheyaghat gauging station, 1987)

and 2.64m (Gumbel probability method). A level of 2.6m was selected as an arbitrary level for the GIS to determine land types according to the presently accepted classification (Annex 3). The resulting land type distribution is shown as Map 7 and summarized in Table 3.2.

Table 3.2 Distribution of Land Types in the Project and Study Areas (ha)

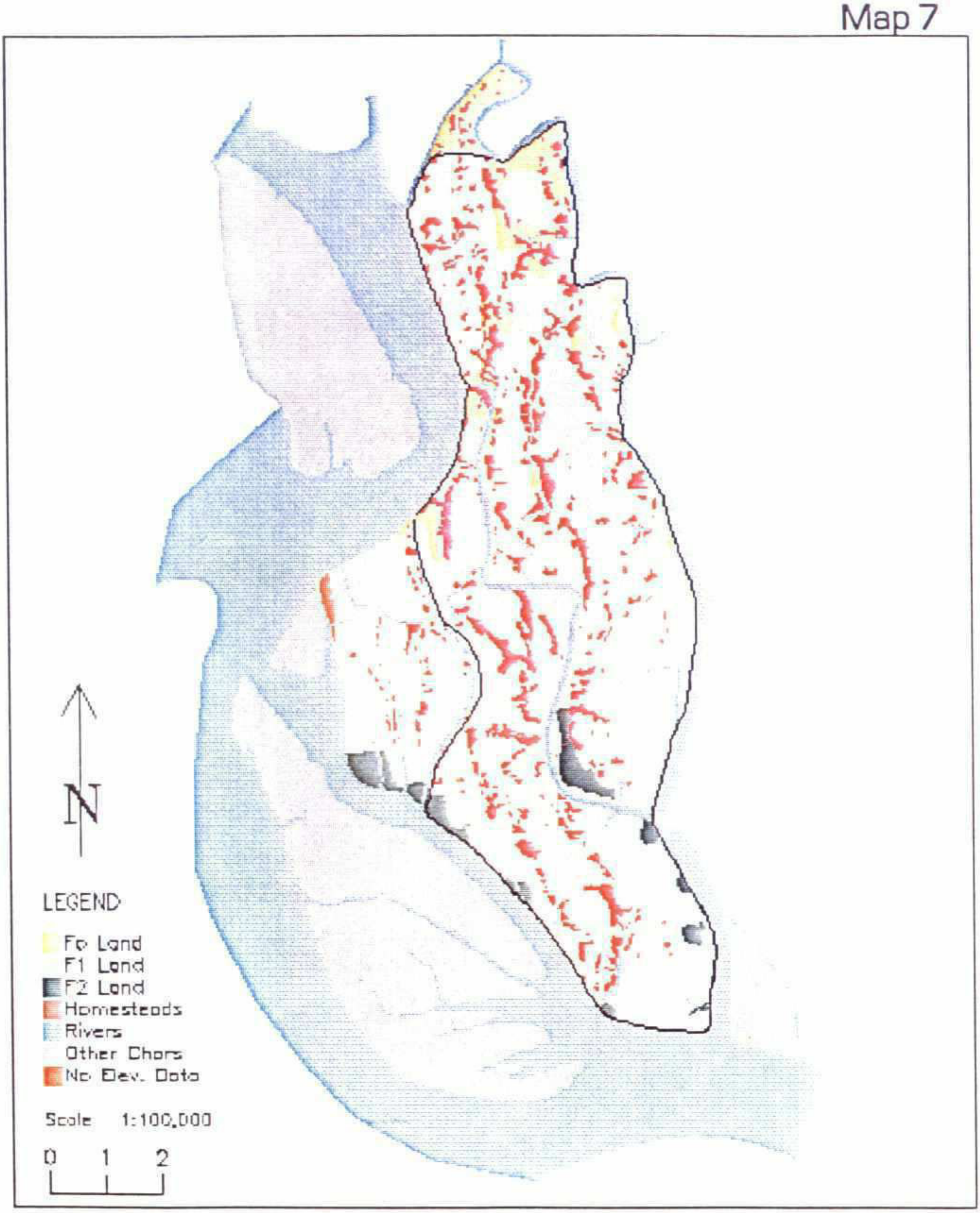
Land Type	Project Area	Adjacent Area	Study Area
F_0	287	93	380
F_1	4,061	725	4,786
F_2	129	55	184
F_3	-	-	-
Sub-Totals	4,477	873	5,350
Settlements	686	71	757
Canals and Creeks	143	38	181
Miscellaneous	-	92	92
Totals	5,306	1,074	6,380

Source: FAP 19 GIS

Soils

Soil surveys of the Bhelumia-Bheduria project area were carried out by the Soil Resources Development Institute (SRDI) in 1967. Soil association maps prepared for the area as a part of the reconnaissance soil survey of Barisal District shows that the area falls under the Ramgati-Nilkamal soil association. Soil series of the area are developed in alluvial sediments carried down by the Meghna and Tetulia rivers and deposited on the younger, lower Meghna estuarine tidal floodplain.

Map 7



ISPAN

FLOOD EXTENT FOR WATER LEVEL OF 2.6m

The soils of the area occupy flat tidal landscapes, with general patterns of olive grey to grey, calcareous, loamy soils on the ridges, and grey to dark grey, calcareous, silty clay loam soils in the basins. Ramgati soils cover about 50 to 60 percent of the cultivable area and occupy the ridges of the project area. They are of a friable and weak prismatic structure and are stratified in places. Nilkamal soils, which occupy the basin sites, or about 30 to 40 percent of the area, are of a firm, blocky, and moderately strong prismatic structure. Most of the soils are poorly drained, moderately permeable, have high to moderate moisture holding capacity, and are low in nitrogen and potassium. There is moderate phosphorus and zinc content in Ramgati soils, but little in the Nilkamal series. All other essential nutrients occur in moderate to high levels (Annex 4). Such a nutrient makeup requires balanced fertilizers for a high production level as well as the use of modern soil and crop management techniques.

About 97 percent of the project area is good agricultural land and includes highlands of the Ramgati soil series and medium highlands of the Ramgati and Nilkamal series. Moderate agricultural land makes up about 3 percent of the area on medium lowlands of the Nilkamal series.

3.2.2 *Agriculture*

Crops

Agricultural production in the area is limited by sudden, high tidal water levels at full and new moon during the monsoon season. Moderately flooded Nilkamal soils often become congested and remain wet early in the dry season, preventing the growth of *rabi* crops. Due to unfavorable hydrological conditions, Nilkamal soils on medium highlands (F_1) are not suitable for growing HYV transplanted *aman*, and local transplanted *aman* is preferred. During the dry season, *rabi* crops grown in the area suffer drought that reduces the yield of crops, and soils along the southern coast become slightly saline late in the dry season; this reduces *rabi* crop yields.

The hydrologic regime dictates area cropping patterns (Table 3.3, Map 8). *Aus*, grown during

Table 3.3 Cropping Patterns per Land Type in the Bhelumia-Bheduria Project Area

	Area Under Cropping Patterns (ha)			
Cropping pattern	F_0	F_1	F_2	Total
T. Aman (H) - Rabi crop	250	-	-	250
T. Aman (L) - Rabi crop	20	-	-	20
B. Aus (L) - T. Aman (H) - Rabi crop	17	267	-	284
T. Aus (L) - T. Aman (L) - Rabi crop	-	181	-	181
T. Aus (H) - T. Aman (L) - Rabi crop	-	65	-	65
B. Aus (H) - T. Aman (L) - Rabi crop	-	194	-	194
B. Aus (L) - T. Aman (L) - Rabi crop	-	1,398	-	1,398
T. Aman (L) - Boro crop	-	555	-	555
B. Aus (L) - T. Aman (L)	-	908	115	1,023
T. Aman (L)	-	493	14	507
Totals	287	4,061	129	4,477

Source: Field Survey, 1992

kharif 1, followed by transplanted *aman* during *kharif 2*, are the dominant crops on all land types. Non-rice crops dominate in the *rabi* season when only 13 percent of the cultivable land is planted in HYV *boro* crops. Low-lift pumps provide river water for irrigating *boro*. Local varieties of rice are commonly grown during the *kharif 1* and *kharif 2* seasons. Six percent of cultivable land is under HYV during the growing period of *aus* and 12 percent is under HYV during the *aman* growing period. Farmers generally grow HYV cultivars IR-8, BR-3, BR-10, BR-11, and BR-14. Unfavorable hydrological conditions prevent expanding HYV production during the monsoon season. Total crop production comprises yields from both normal and damaged crops (Annex 5). Current cereal production is 10,953 tonnes per year, including paddy and wheat. The cropping intensity of the net cultivable area is about 236 percent. Each year, about 2,783 tonnes of paddy are lost to tidal floods and 1,475 tonnes are damaged by pests and diseases. Cereal production adjacent to the project area has been estimated at about 2,173 tonnes per year, including wheat and paddy.

Tidal floods damage *aus* crops during harvesting in June and July, while T. *aman* is submerged soon after it is transplanted during July and August. Submergence generally is more acute during the full and new moon, especially when accompanied by heavy rainfall and wind. Localized drainage congestion aggravates crop loss during the monsoon season. Again, transplanted *aman* crops are damaged by storm surges during harvest in October and November. Early tidal flooding damages late *rabi* crops, mainly chili, along the Tetulia River and damages *boro* crops at the harvesting stage. Pests and diseases are widespread in the area, causing significant damage to major crops. About 28 percent of *aus* and 20 percent of *aman* are damaged by tidal floods, while insects and pests damage another 22 and 20 percent, respectively, inside the project area. Flood-related crop damage is slightly higher in the study area than outside the project (Annex 5, Maps 9-11).

Current input levels of human labor, animal power, seed, and fertilizers in the project area are generally low, particularly with crops that are vulnerable to flood and drainage damage. Inputs for different crops are presented in Annex 6.

Livestock

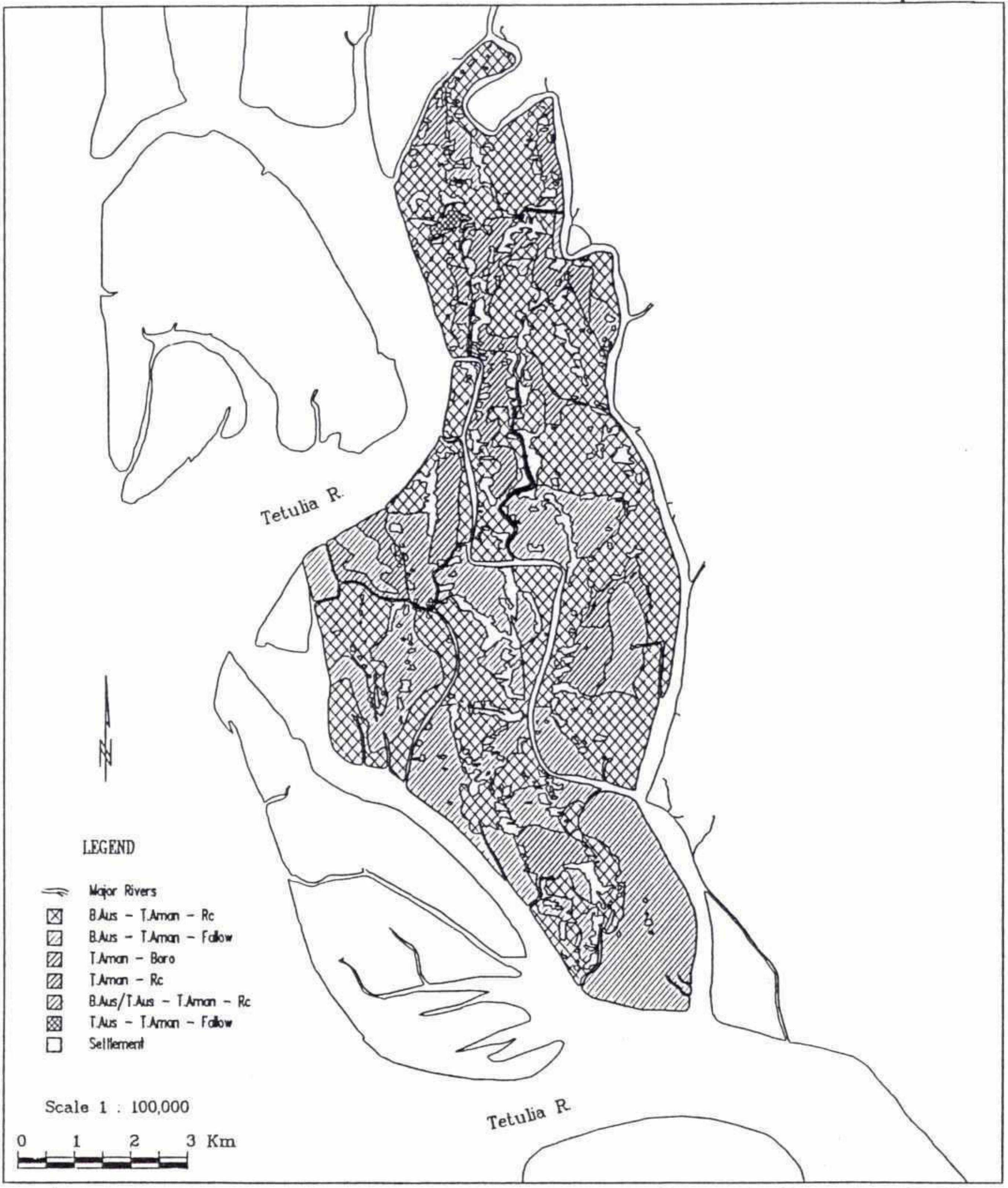
A few livestock are kept in most rural households (Table 3.4). Bullocks, buffaloes, and cows are kept primarily as draft animals; goats, chickens, ducks, sheep, and pigeons are kept for income and as a protein source. Livestock holdings per household range from 0.25-0.76 animal units, and chicken and duck holdings are 10.3 and 4.5 per household, respectively. Because there is a shortage of draft animals in the project area, farmers often use milk cows and calves to plough their land. Draft power availability in the project area is only 1.5 per ha compared to the national average of 2.6. Small farmers who cannot maintain draft animals hire them at Tk. 125/*kani* (0.65 ha). Power tillers are used by some farmers.

Table 3.4 Livestock Population in the Bhelumia-Bheduria Study Area

Species	Total No.	No. owning Households	Av. No./ owning Household
Buffalo	108	432	0.25
Bullock	204	425	0.48
Milk cow	161	424	0.38
Calf	152	422	0.36
Idle cow	54	415	0.13
Goat	166	426	0.39
Chicken	4349	424	10.26
Duck	1892	424	4.46
Sheep	7	350	0.02
Pigeon	318	424	0.75

Source: Household Baseline Survey, 1992

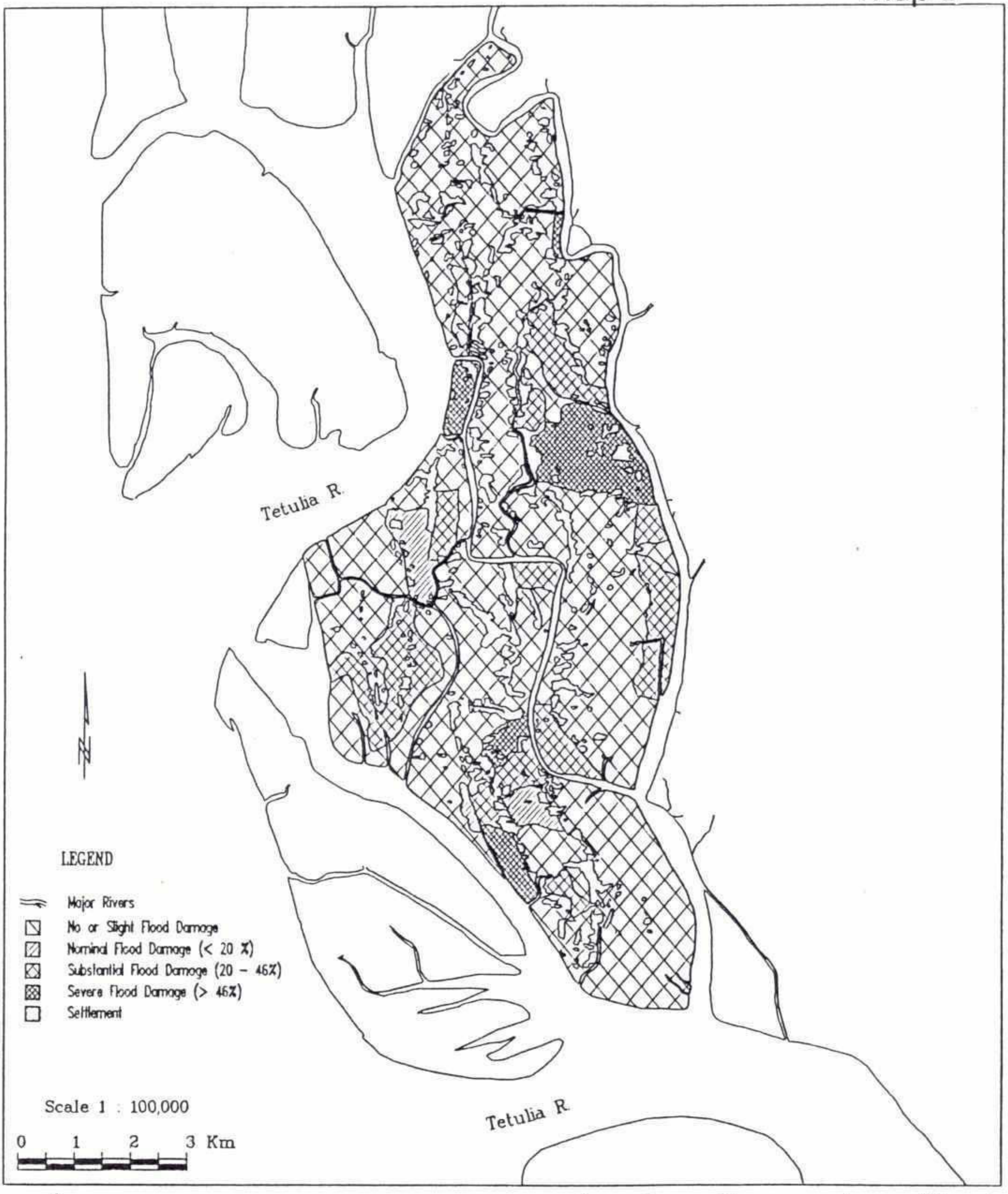
Map 8



ISPAN

Present Cropping Pattern

Map 9

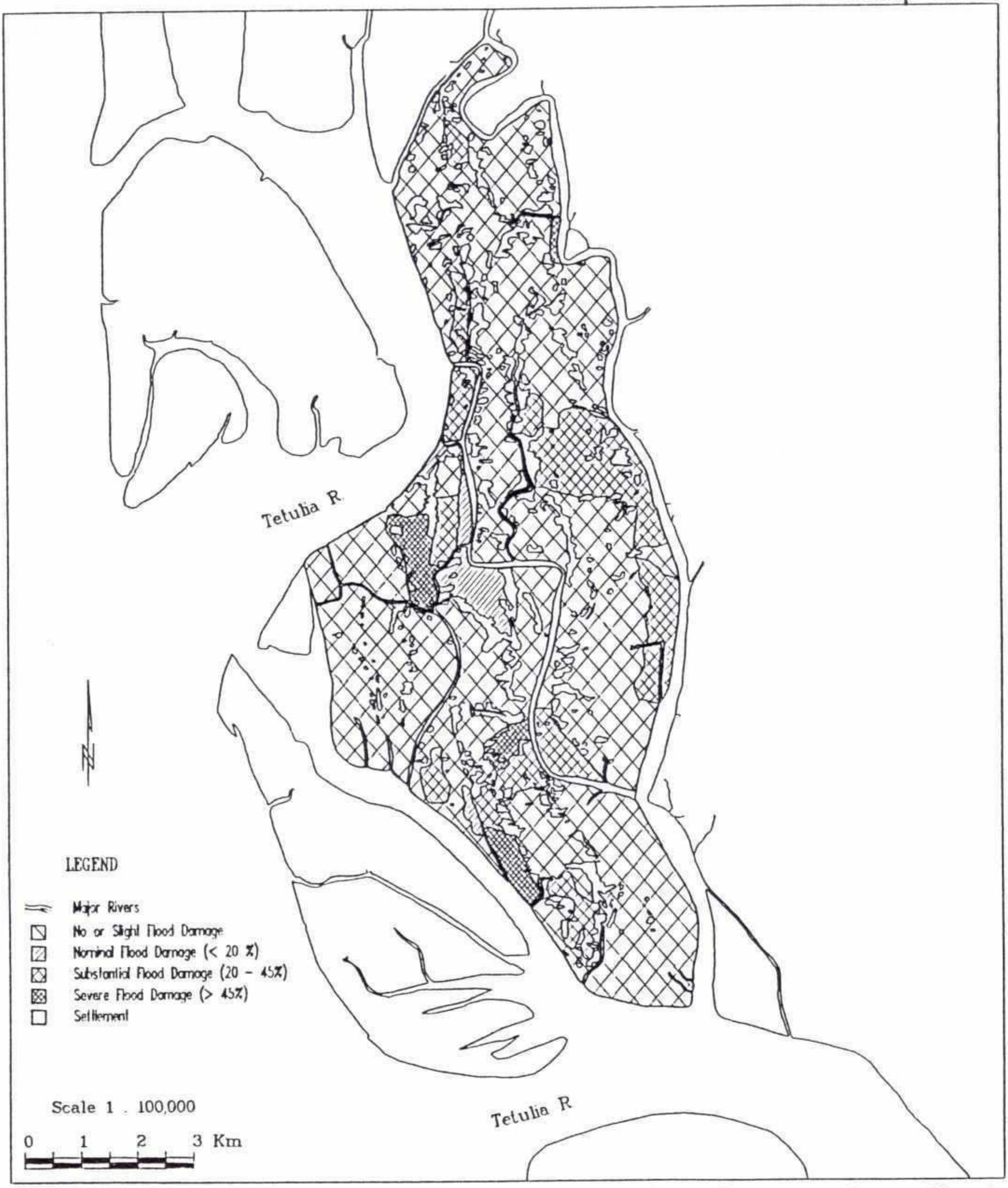


ISPAN

Aus Crop Damage from Floods

038

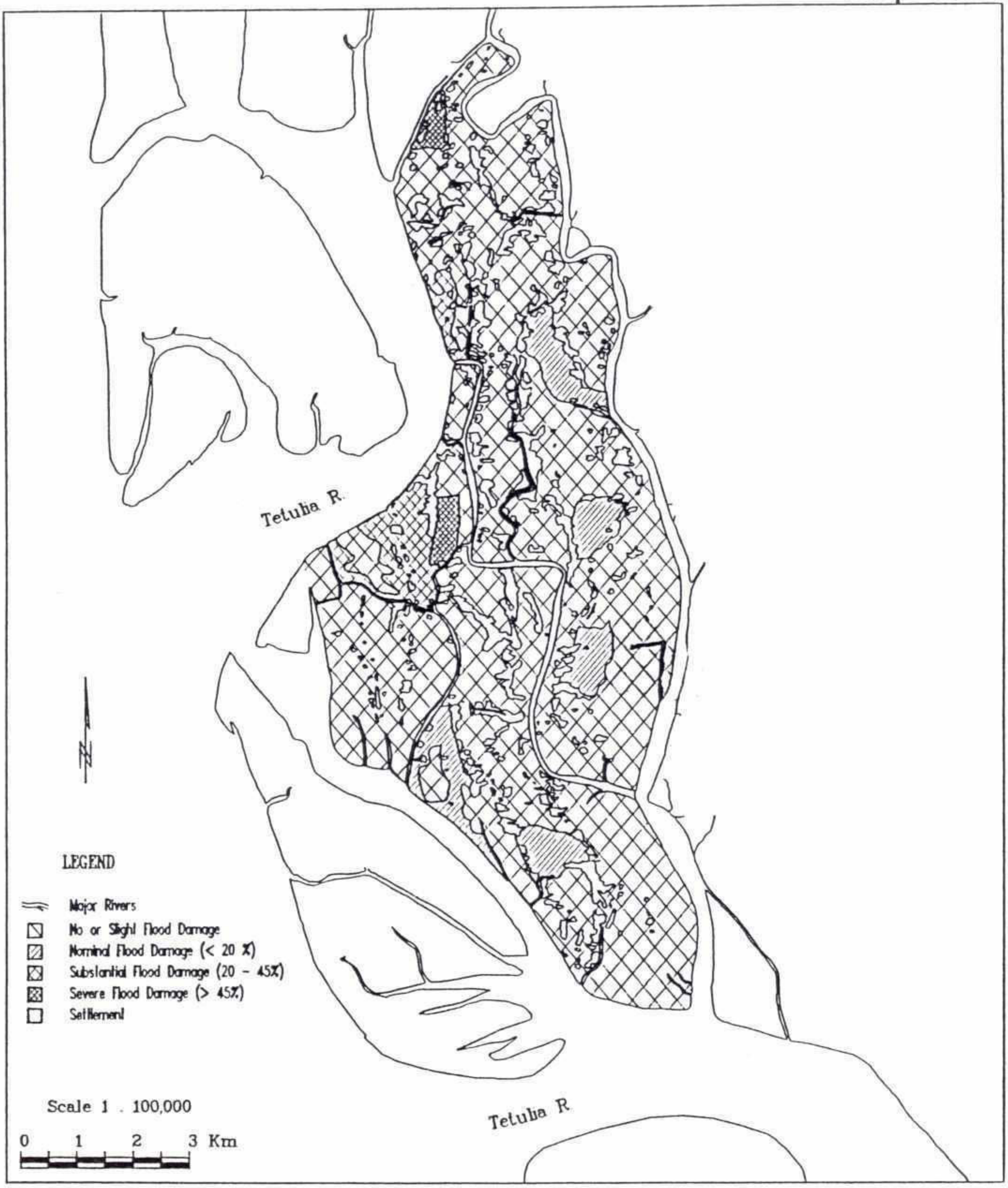
Map 10



ISPAN

Aman Crop Damage from Floods

Map 11



ISPAN

Rabi Crop Damage from Floods

Most livestock are inadequately fed due to a shortage of grazing land. The situation improves during the dry season when major crops are harvested and some of the pulse *(khesari)* crop becomes feed for grazing animals. In the rainy season, livestock are usually confined to the homestead and stall fed. Few cattle and bullocks graze year-round along roadsides and riverbanks.

Livestock disease and epidemics are common in the area. Bullocks and cows primarily suffer from diarrhoea and rheumatism. Farmers report that these diseases become epidemic when salinity levels rise in the rivers and *khals*. During the monsoon season, the soggy condition of homestead courtyards promotes foot and mouth disease in cattle. Farmers prefer roads over courtyards as animal shelter because they dry faster, therefore offering a more hygienic environment.

3.2.3 Forests and Homestead Vegetation

Forests and homestead vegetation play an important role in the environmental balance and economic life of the people in terms of food and nutrition, construction material, biomass fuel, fodder, shelter and shade, windbreaks, organic matter, erosion control, and the balance between flood and drought. This vegetation is vulnerable to damage by flooding. Flood is traditionally classified into *barsha*, normal inundation from June-October which does not overtop the homestead land or submerge *aman* crops, and *bonnya*, disastrous and damaging flood of long duration that overtops homestead land and damages *aus* and *aman* crops during the *kharif* season (Islam 1990), and results in physical and economic damage to the people and land (Zaman 1992).

Forests

The project area does not have any public forest land, limiting plant diversity to a few site-specific species. About 10 percent of the river, canal, and creek banks were found to be covered with tall reeds of *hogla (Typha* spp.) and *kash* (*Saccharum* spp.), two economically important coastal/swamp species. *Hogla* is used in the production of mats, roofing and fencing, as biomass, and provides mat-making employment for about 10 percent of the area's women. *Hogla* mats are used mainly for sleeping and sitting and for drying agricultural produce. Fish brokers also use the mats to pack iced fish. Fifty percent of households use *kash* as house construction material and as biomass fuel. An important medicinal herb, locally known as *bashok (Adhatoda vesica)*, was found growing under homestead groves, as live fencing material, and as roadside vegetation.

As the majority of the area is prone to high tides and tidal surges, tree plantations are restricted mainly to roadsides that usually rise about 120cm above the paddy fields. A tree planation project, begun in 1992 by a local NGO known as Jatyo Bandhujan Parishad, planted trees along 33km of roadside in Bhelumia, Bheduria, and Char Samaiya Unions. Two caretakers were employed to tend the 1,000 mahogany, *sisoo, chambol, koroi* (raintree), *akashmoni, arjun,* and jackfruit saplings. Each caretaker receives 4.5 kg of wheat daily for his/her work and is responsible for replacing any damaged seedlings. However, no benefit-sharing agreement has been developed between the NGO, local government, caretakers, and adjacent households. Villagers are aware that the plantation program will bring economic benefits, but they see negative impacts in losing the use of roadsides as livestock shelters during floods.

Homestead Vegetation

Homestead mounds in the area are not raised high enough to completely avoid flood inundation from the river and canal banks. Approximately 81 percent of homesteads are affected by high water about five times annually (Figure 3.3). About 51 percent are affected by seasonal floods, 15 percent by seasonal floods plus high tide floods, 13 percent by high tide floods only, and the remaining 2 percent by heavy rainfall, seasonal floods, and tidal floods. About 70 percent of the affected homesteads are inundated up to the courtyard level, including vegetable gardens, while 11 percent are inundated up to the plinth.

Forest and homestead vegetation includes natural vegetation, plantations, and homestead groves and vegetable gardens. Annex 7 lists the scientific names of economically important species of trees, shrubs, and herbs.

Homesteads are arranged in linear, clustered, and nuclear forms and each homestead ranges in size from 0.09 ha to 0.18 ha. The proportionate distribution of homestead land for housing, vegetable gardening, ponds, and orchards was noted to be 16, 7, 25, and 52 percent, respectively. Homesteads generally are bordered with live fences of *mandar, jhiga,* betelnut, and *bashok* species. About 50 percent of homesteads are more than 20 years old and have many tree species, of which betelnut is the dominant cash fruit crop, and raintree and *mandar* the dominant cash timber trees and biomass resources. The other 50 percent of homesteads range from one to 19 years old, are found in comparatively low-lying areas, and have little species diversity. Wild banana varieties and *mandar* are commonly planted when new homestead areas are established. Villagers reported that during the preceding 10 years more than 10 percent of the area's marginal crop land has been converted to homestead land.

Among the 57 economically important tree species listed in Annex 7 the most important are betelnut (occurring in 27 percent of homesteads), *bitchi kala* (23 percent), *mandar* (15 percent), and raintree (7 percent). The other 48 species occurred infrequently, these included trees resistant to normal inundation such as palm, date and coconut.

Betelnut is planted most often as it is the most important cash crop of all planation trees in the area. Since it is susceptible to waterlogging and drought, it is mainly planted in the high elevation areas of Pangasia, Char Samaiya, Char Bheduria,

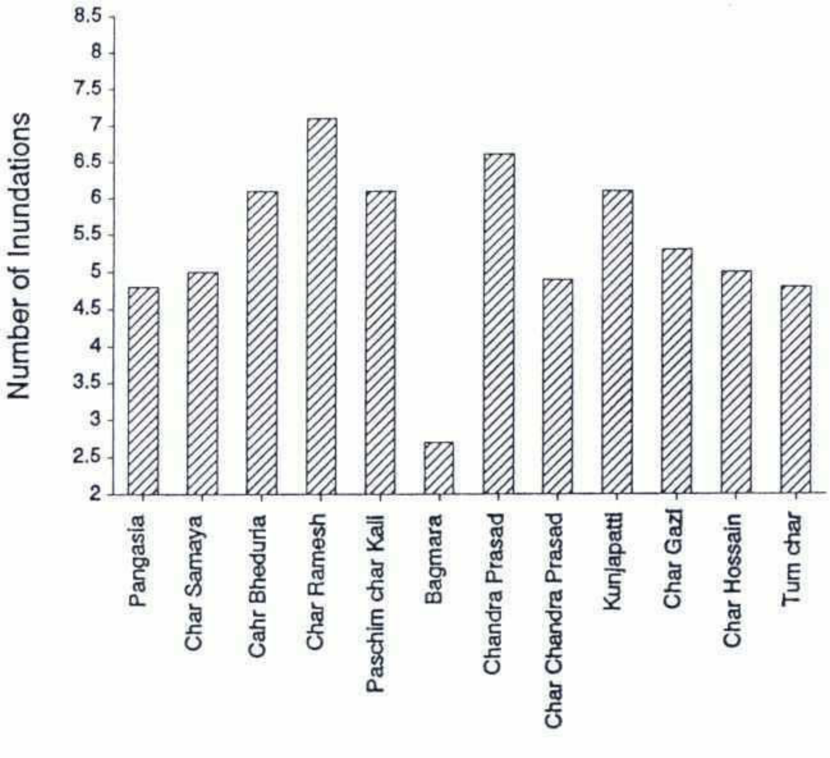


Figure 3.3 **Average annual frequency of homestead flooding**
(Source: Household Baseline Survey, 1992)

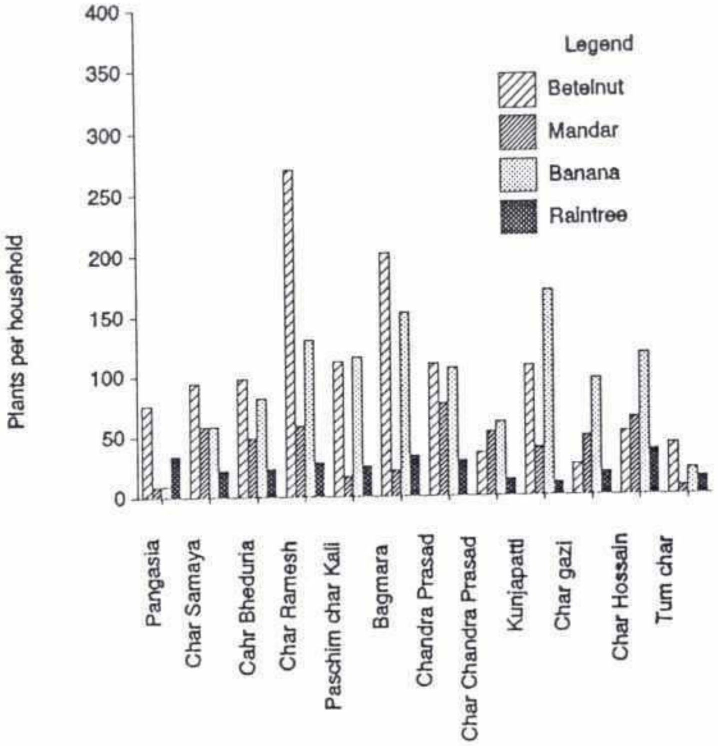


Figure 3.4 Relative abundance of homestead vegetation species
(Source: Household Baseline Survey, 1992)

Char Ramesh, and Bagmara (Figure 3.4). Indigenous varieties of banana are grown in the depressed and low elevation areas of Kunjaputti, Char Hossain, and Char Gazi. Bamboo, nationally the most important cash vegetation crop and an important source of construction material, is difficult to establish in the study area because frequent inundation and waterlogged soils damage its shoots and roots.

In 52 percent of orchards a combination of *mandar* and betelnut is grown for commercial use. *Mandar* is a leguminous species whose leaves are considered rich organic fertilizer for betelnut cultivation. Each betelnut tree can yield an income of Tk. 100 annually, and each *mandar* tree Tk. 50 annually. *Mandar* branches are often used to build fish shelters and sell for Tk. 5 each; a single *mandar* tree can produce at least 10 branches. The percent of households possessing different tree species is noted in Annex 7.

Only 7 percent of typical homesteads grow vegetables such as sweet potatoes, string beans, gourds, and spices. Important cash vegetables in other parts of Bangladesh such as cauliflower, cabbage, and *arum* (elephant's foot) are not grown in the area because of repeated inundation, while early *rabi* vegetables cannot grow in the saturated soils. In Char Samaiya, Char Bheduria, and Char Ramesh, villagers raise sweet potato seedlings and some winter vegetable such as spinach, amaranths, and radish on roadsides.

Because of the limited homestead vegetable production, about 75 percent of common fruits, vegetables, and spices in the area come from other parts of the country, mainly Dhaka, Noakhali, Barisal, and Khulna. The poor local economy, however, prevents about 60 percent of the villagers from buying imported vegetables; these people mostly depend on locally produced sweet potato and black gram that are neither nutritious nor tasty. Although the banana crop ranks second in planted numbers, and ideally could provide another food source for local people, it does not produce optimum yields because of frequent flooding and waterlogged soils.

Table 3.5 summarizes the production value of fruit, vegetables, timber, and fuel wood of the area, which totals about Tk. 29 million. Betelnut is a major contributor to the value of vegetables and fruit, while *mandar* and *koroi* (raintree) contribute to that of timber and fuel wood.

Table 3.5 **Average Annual Production and Damage Loss of Vegetables and Trees**

Production Sources	Value (Taka)
Total Actual Production	29,138,860 (100%)
Vegetables and Fruits	19,352,980 (66%)
Timber and Fuel Wood	9,785,880 (34%)
Average Damage Loss	2,254,660 (8%)
Potential Production	31,393,520

Source: Household Baseline Survey, 1992

Energy Use

Energy use differs between mouzas of the Bhelumia-Bheduria project area (Annex 8.1). Over 80 percent of fuel energy in the Bhelumia-Bheduria project area is provided by rice straw (43 percent) and firewood (38 percent). The remaining 19 percent comes from leaves and twigs (14 percent), *dhaincha* (*Sesbania canabina*; 3 percent), cow dung (0.6 percent), and rice husks (<0.5 percent). Fuel sources in the Bhelumia-Bheduria area differ considerably from the national pattern of cow dung (27 percent), jute stick (5.5 percent), *bagasse* (9.7 percent), twigs and leaves (10.1 percent), rice husks (19.3 percent), rice straw (14.7 percent), wood (3.8 percent), and other (10.1 percent) (BBS 1993). Information on indigenous fuel sources and their respective energy efficiency in terms of calorific value by weight are presented in Annex 8.2.

Based on a national minimum fuel requirement of 10 kg/day/household (Hossain and Mahfuzur 1993), the study area, with its current population of 48,196 (8,827 h/h) needs about 32,335 tones of biomass energy annually (Table 3.6). The current fuel shortage results in householders cooking one meal a day. As rice straw provides 43% of fuel energy, fuel shortage becomes severe when there is crop failure.

Table 3.6 **Average Requirement, Production, and Shortages of Biomass Energy**

Status	Quantity (tonnes/year)
Requirement	32,335 (100%)
Available	24,258 (75%)
Shortage	8,077 (25%)

Source: Household Baseline Survey, 1992

3.2.4 Wildlife

Of the 152 wildlife species observed in the area (Annex 9), most are wetland-dependent species such as shoreline birds and turtles. Turtles are abundant in the area and are commercially valuable on the international market. Other wildlife species, such as rodents and grain-eating birds, are considered pests. Seven threatened (monitor lizard, yellow lizard, white-backed vulture, bull frog, grey heron, little grebe, grey headed fishing eagle) and five endangered species (changeable hawk eagle, Pallas' hawk eagle, brown fish owl, large whistling teal, gangetic dolphin) occur in the area.

The area's wildlife can be grouped according to habitat distribution patterns:

- Shoreline species (concentrated in the mud flats of rivers, canals, and creeks).
- Woodland species (found throughout the area).
- Pest species (found on agricultural land).

- Predators (concentrated in the central part of the study area).
- Commercially important species (found in canals, creeks, and ponds).

Habitats

During the pre- and post-monsoon seasons, roughly 50 percent of the study area is available as terrestrial habitat in the form of homestead, roadside and shoreline vegetation, and agricultural land. The figure drops to 30 percent during high tide in the monsoon season. Within the terrestrial habitats there are 58 plant species that are considered economically, socially, and ecologically important.

Betelnut is the dominant tree in the study area. Of an estimated 50,000 betelnut trees established in the project area, 30 percent are full grown, 22 percent are of medium growth, and 48 percent are seedlings (proportions estimated from household questionnaires). Banana is the second most abundant species, followed by *mandar*, bamboo, raintree, mango, jackfruit, and coconut.

Betelnut is primarily found in the upper and central regions of the study area where it is grown on comparatively higher lands. Banana trees are found more often in the southwestern part of the study area, primarily in new settlements. *Mandar* in grown mostly in the southeast in low-elevation areas. Plant diversity is highest in the central part where about 42 species have been observed. In the west the number of plant species drops below 30, and in the east the number varies between 30 and 40 species.

Roadside vegetation comprises two broad categories: trees and vegetables (e.g., pulses planted by the NGO Jatyo Bandhujan Parishad). Trees planted along roadsides include mahogany, *sisoo, chambol, koroi* (raintree), *akashmoni, arjun,* and jackfruit saplings, and constitute good habitat for common village birds. The area's vast mud flats are used as breeding and feeding habitat by different shoreline birds. Shorelines of the rivers, canals, and creeks are partly covered with the reed *hogla (Typha* spp.), while various species of grass such as *kash (Saccharum* spp.) dominate the shorelines. Some of the shoreline is used as seed bed for *boro* rice. Agricultural land supports both granivorous and insectivorous wildlife, but cropping patterns and seasonal variations in crops influence the biological activities of the area's wildlife.

Shoreline Wildlife

Long shorelines along the rivers, canals, and creeks are home to resident and migratory birds such as herons, egrets, sandpipers, plovers, redshanks, greenshanks, and other common wading birds. Bitterns use the mud flat areas as feeding grounds and the adjacent reeds *(hogla)* as nesting places. Herons, cormorants, and egrets, which have established three colonies within the study area, nest in the tall trees of the homesteads. One of the three colonies is a combined colony of the three species, and includes the rare night heron.

Woodland Wildlife

Woodland wildlife are the common village wildlife that are found in or near homesteads, and include the endangered changeable hawk eagle and Pallas's fishing eagle. Some of these woodland species are beneficial to pest control. The drongo, myna, and warbler aid in agricultural insect pest control, while eagles, owls, kites, monitor lizards, foxes, mongooses, and snakes help control rodents and other vertebrate pests.

Pests

Four species of rats, of which the bandicoot rat is most common, are the primary agricultural pests in the study area; they damage an estimated 4.5 percent of paddy yield (Agricultural Officer, Bhola, pers. comm.). The rat breeding season follows the *aman* growth and cropping season. Another 2 percent of rice yield loss is attributed to birds such as parakeets, munias, weaver birds, and house sparrows.

Predators

Kites, eagles, and owls are the most common predators of the area, and they play an important role in keeping agricultural pests under control. Other important predators include lizards, snakes, frogs, and mongooses.

Commercial Important Wildlife

Turtles are the most commercially important wildlife of the study area; four species were identified during the case study. Most turtles breed in neighboring char areas during the dry season, then migrate to the study area via the southern canals during the monsoon. Turtles are caught with hooks from rivers and canals, and with harpoons from ponds. Although only a few people are involved in collecting turtles, four to five tonnes per year are collected from the study area, bringing Tk. 300-400/kg depending upon the size and variety. Most of these turtles are exported, both dead and alive. Other commercially important wildlife include frogs, monitor lizards, and snakes, but their collection is banned by government regulation.

3.3 Freshwater Environment

3.3.1 Habitats

Numerous major canals, branch canals, and creeks cross the study area. Major canals originate at the Tetulia and Jangalia rivers and divide into numerous branch canals and smaller creeks. Creeks provide the best shelter and rearing grounds for shrimp and other fish in their early growth stages. Low-elevation lands which retain water and are not cultivated due to large accumulations of water hyacinth or because they are not agriculturally productive are common in the area and constitute good fish habitat; fish are collected once a year from these areas.

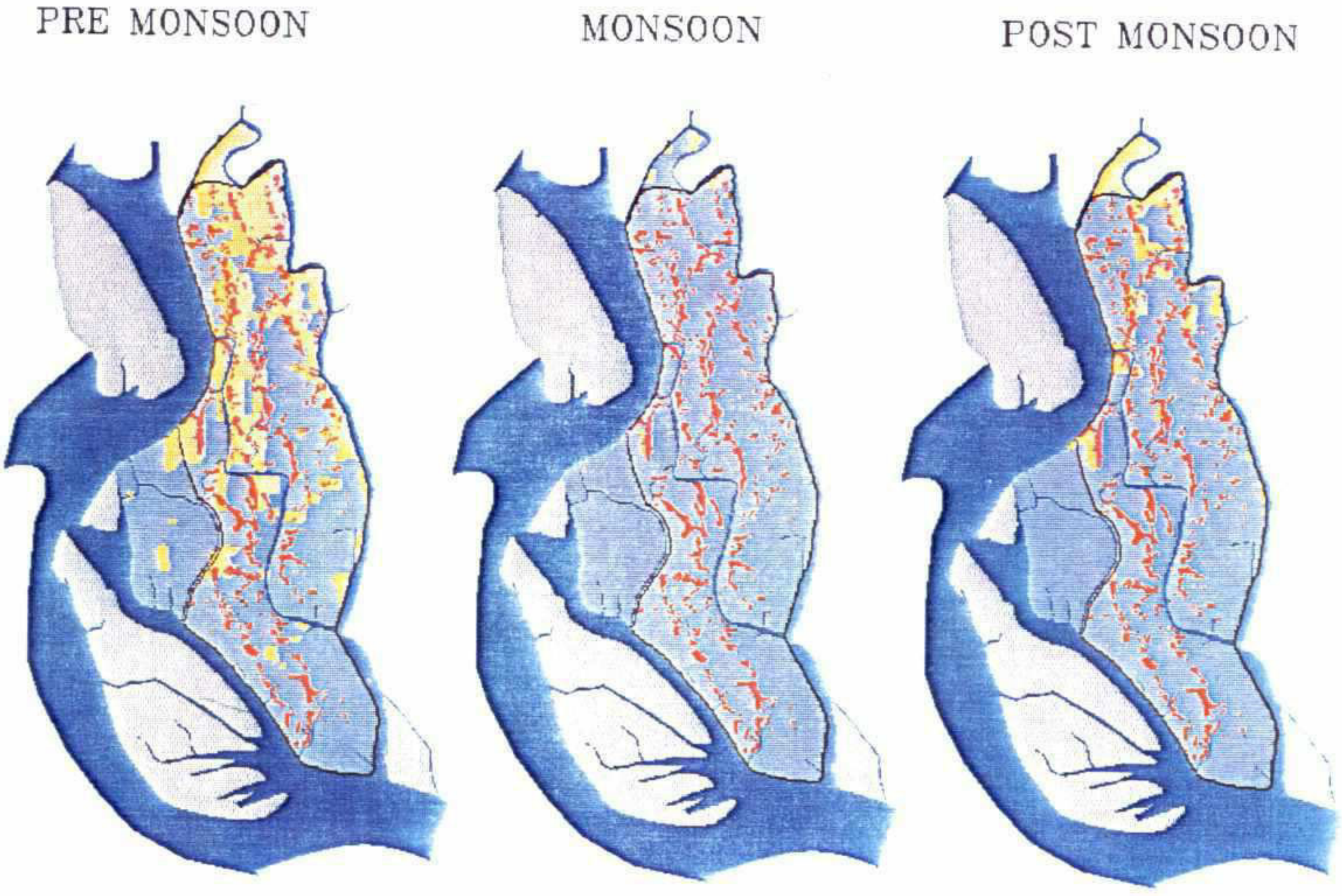
Two types of tidal influences affect wetlands: normal tide and high tide during full or new moon. Water depth in the different water bodies fluctuates within 1 m four times a day due to normal tides. During high tides the water depth fluctuates 1-2 m every 4 or 5 days. The magnitude of these two tides differs between the monsoon and non-monsoon seasons, and can rise suddenly during a storm surge. Regardless of the season, the flow direction of water remains the same: south to north during high tide and the opposite during low tide. The extent of seasonal flooding in the study area is shown in Map 12.

3.3.2 Plankton, Macroinvertebrates, and Macrophytes

A detailed species list of aquatic fauna and flora appears in Annex 10. Creeks were found to have the highest diversity and balanced distribution of plankton. Blooms of *Microcystis* are found in some ponds and stagnant waters of the floodplain areas, and great concentrations of these blooms negatively impact aquatic habitats, causing lower production. Algal blooms do not form in the creeks due to water flushing. Concentrations of most phytoplankton are low due to turbid water. Ponds are usually edged by trees that reduce the light reaching the water surface, creating favorable conditions for large populations of zooplankton. The area's macroinvertebrates include fresh water clams, snails, annelids, and a wide variety of insect larvae. Fresh water crabs are common along the shoreline of rivers and canals.

About 20 species of aquatic macrophytes were identified during the case study (Annex 10). *Typha* spp. (*hogla*) is the most common macrophyte found along the shoreline of rivers and canals; it also is observed along pond banks. As noted earlier, *hogla* is important in the rural economy in terms of mat-making; it also provides shelter for shoreline birds. Low *boro* area wetlands have the highest diversity of aquatic macrophytes, and are dominated by water hyacinth.

Map 12



2.34 m

2.8 m

2.46 m

▨ Area Submerged > 20 cm depth

ISPAN

AQUATIC HABITATS

3.3.3 Water Quality

The water quality parameters in canals, ponds, and rivers are similar, except that chloride concentrations are comparatively high in ponds. Although large quantities of pesticides and fertilizer are used during all cropping seasons, these pollutants are washed away by tides, effectively keeping water quality suitable for fish as well as human use. Some locations in the central part of the study area do not receive this flushing effect, except during the peak monsoon season. The long-term effect in all areas may involve an increasing concentration of agricultural pollutants and consequent problems for fish. Water quality parameters in the Bhelumia-Bheduria study area are shown in Annex 11.

3.3.4 Open Water Capture Fishery

About 63 species of fish have been observed in the area (Annex 12), including 25 species of small fish, 15 species of catfish, six of carp, six of predators, six of *hilsha*, three of eel, and two of shrimp. There are two exotic species and one species of tongue fish. *Hilsha* and one species of fresh water shrimp are the most common, commercially important fish. Other common fish, but not as commercially important, are predators *boal*, *aire*, *pangas*, and one small fish, *chewa*. About 50 percent of all fish are collected from canals, while 25.5 percent are caught in the Tetulia and Jangalia rivers (Figure 3.5).

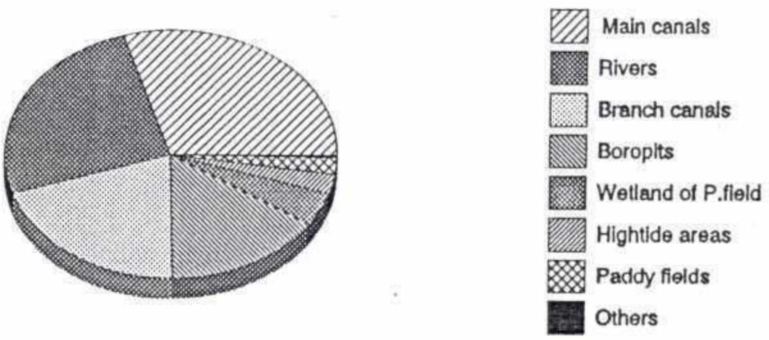


Figure 3.5 **Distribution of fish sources in Bhelumia-Bheduria study area**
(Source: Field Survey, 1992)

Twenty-one percent of the people of Bhelumia-Bheduria are full-time fishermen. There also are occasional and subsistence fishermen, and all divide the year into two fishing periods: *baissha*, the peak fishing period from mid-June through mid-December, and *dhuella*, the lean fishing period from mid-December through mid-June (Annex 13). The study area contains a high quality capture fishery due to:

- availability of commercially important fish such as *hilsha*, shrimp, *aire*, *boal*, and *pangas*;
- good fishing access which is free for subsistence fishermen;
- the proximity of the large Tetulia River
- good fishing boat harbor facilities exist for fishing activities both inside and outside the study area;
- fish are sold within, or close to, fishing areas; and
- a positive fisherman/fish purchaser relationship exists and all transactions are made in cash.

Fisheries are especially important since agriculture is difficult in the area.

Fishery problems in the area are not considered acute in comparison with other parts of the country. Problems most often cited by local people include:

- fish diseases;
- overfishing;
- no implementation of fishing laws;
- extensive use of prohibited drift nets;
- catching juvenile and immature fish; and
- poor or no fish processing facilities.

Although the area fishery is considered of good quality, some species are no longer found in the area, or are in danger of disappearing, due to some of the problems cited above. Those species include: *kayoon*, a brackish water catfish that disappeared from the area within the past 10 to 15 years, and *saur puti*, *chama chingree*, and *baush*, a ray fish, which are all declining in number.

The area provides an ample supply and wide variety of fish throughout the year for local consumption and for markets in Bhola, Barisal, and Dhaka, as well as for export to other countries (Annex 14). Study area residents capture about 2,576 tonnes of fish annually from open water sources both inside and outside the study area (Household Survey). This figure includes fish caught for consumption.

Fish in the study area depend upon the daily, monthly, and seasonal variation in tides for migration, spawning, nursery, rearing, and feeding. Strong upstream flows during early monsoon draw gravid shrimp, *aire*, *boal*, and *pangas* toward their spawning grounds. Similarly, late monsoon upstream flows help *hilsha* in their spawning migration against costal currents, while downstream tides aid spawning shrimp. Carp enter the area with upstream flows, but only during high flood years. Fishermen alter their fishing activities and gear according to tidal variation. Every six hours, at low tide, fishermen trap fish with sack nets *(bindijal)* that they have placed at the end of canals and along the Jangalia River. Long shoreline nets *(berjal)* also are used to catch fish depending on the tides.

Fishing Methods and Gear

While there are about 14 different fishing methods (Annex 15, and Figures 3.6 and 3.7) practiced in the study area, *katha*, a traditional Bangladesh method, is the most popular. Tree branches are placed in water between high tides to create fish shelters. As the tide water rises, fishermen encircle the *katha* with nets, catching the fish after removing the tree branches. Shrimp are the primary catch from the *katha* process. During the study period, 91 *kathas* were counted in Bheduria Canal, but local people claim the number increases to 300 beginning in December. *Khuchijal*, *jhakijal*, *moijal*, and hooks are low-cost fishing gear used mainly by the poor. Drift, or current, nets which often are used for catching *hilsha*, have been banned by the Bangladesh government on the grounds that they threaten fish conservation by allowing fishermen to catch fish in their early growth stages, but are in use in the study area. *Hilsha* also are caught with small and large *berjal*, a net made of natural thread rather than the synthetic material used in current nets.

Agricultural Influences

Extensive use of fertilizers and other agro-chemicals create water quality problems in the central part of the study area where drainage congestion exists. Aerial insecticide spraying in 1991 significantly affected the fish population. Local people reported that fish began dying a few hours after the spraying and continued to do so for four to five days. The fish were not safe for human consumption. In addition to these problems, complicated, deteriorating relationships between landowners and farmers drive more people out of farming and into fishing. The result may be overfishing problems in the near future.

Fishery Management

Of the area water bodies, only the Tetulia River is under lease by the Bangladesh Department of Revenue. The lease owner collects Tk. 300-500 every six months for each fishing boat that uses the river. More than 1,500 boats are involved in fishing according to Tetulia River lease owners. Boats are recorded by canal name and type of fishing gear used (Annex 15). Small boat owners have free access anywhere in or adjacent to the study area, including the Tetulia River. There are no access restrictions on fishermen using canals and creeks. Although Bangladesh law prohibits the use of drift nets, and the catching fish fry and undersized fish, these actions continue indiscriminately as there is little to no enforcement.

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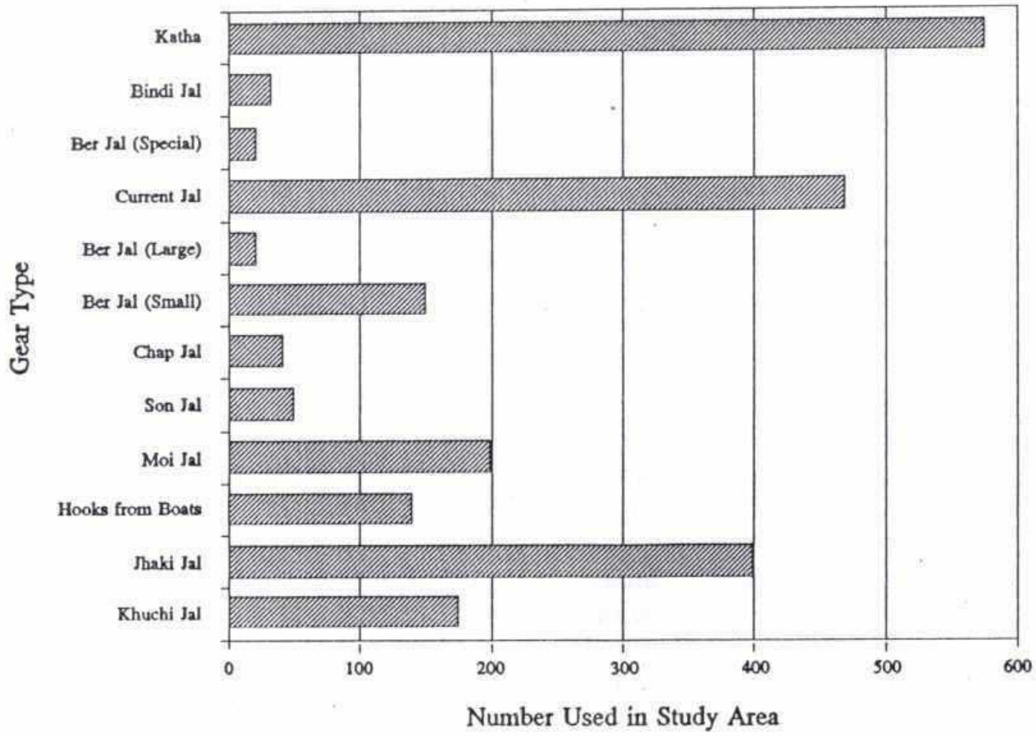


Figure 3.6 Numbers of fishing gear of various types used in study area
(Source: Field Survey, 1992)

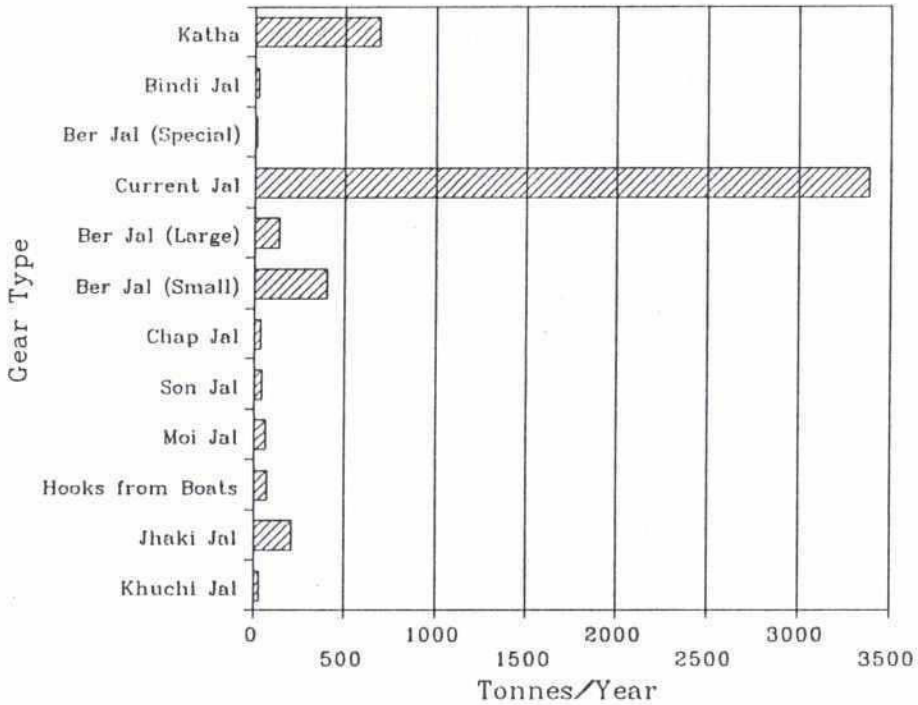


Figure 3.7 Annual fish catch in study area by gear type used
(Source: Field Survey, 1992)

3.3.5 *Closed Water Culture Fishery*

Fish culture has a long tradition in the study area. About 58 percent of all study area households have at least one pond to use in culture fisheries. Pond owners culture local carp, catfish, and other varieties. Some exotic species such as silver carp, common carp, and perch have been supplied from the Bhola and Barisal fish hatcheries.

Of the study area's 1,654 ponds, 59 percent are inundated during normal and/or monsoon tides, while 41 percent are not inundated except during storm surges (Annex 16). Of those that are flooded, inundation occurs between one and nine times per year, and about 50 percent of them remain flooded from June to mid-September. Study area ponds are broadly classified as inundated or non-inundated, and as large, medium, or small. Inundated ponds are those used only for extracting capture fish (Annex 16).

About 25 percent of pond owners maintain their fish culture by purchasing fish fry, feeding, fertilizing, liming, removing predators, re-excavating ponds, and building pond banks. About 80 percent spend more than Tk. 1,000 per pond per year, most of which goes to the purchase of fish fry. Fish feed is distributed in 63 percent of cultured ponds, fertilizer is applied in 12 percent, and liming and predator poisoning occurs only rarely.

Most ponds are within homesteads, but some are the property of markets or *masjids* (mosques). There are two government-owned ponds within the study area that are leased. In addition, two *khals* in the central part of the study area were modified 40 to 45 years ago into a series of ponds.

Almost all ponds are surrounded by dense homestead vegetation that limits the amount of sunlight reaching the water surface; the result is low phytoplankton production. *Helencha, dholkalmi, kalmi*, and duck weed are the main aquatic vegetation, and most ponds are free of water hyacinth, except in the central portion of the study area where 60 percent of the ponds are fully covered by water hyacinth. The average depth of these ponds is 2-3 m but some are as deep as 4 m. Pond bottom soil is generally favorable to mollusks and other benthos that are an important food source for pond fish. In a few cases, however, the deposition of dead leaves limits benthos survival.

Pond water quality is favorable for fish culture. The pH varies from 7.5 to 8, dissolved oxygen from 2 to 10 mg/l, and ammonia from 0.2 to 1.2 mg/l. Water quality differs little between inundated and non-inundated ponds, except that inundated ponds are more turbid.

There are few major problems related to cultured fish. Problems mentioned by local people include:

- many fish died during the aerial insecticide spraying in 1991;
- although there are fewer outbreaks of fish ulcerative disease, it is still a problem during the dry season;
- inadequate supply of fish fry;
- little to no contact between government fishery officials and ponds owners;
- overgrowth of surrounding vegetation inhibits phytoplankton production;
- multi-ownership of ponds often creates complication for culture practices; and
- availability of capture fish lowers the interest in culture fisheries.

Culture Practices

Of the fish species released into ponds, pond owners prefer local carp. *Rui (Labeo ruhita)* predominates, with *catla, mirka*, and *nilotica* following. *Catla* was reported to be the most productive. Three-inch fry grow to a weight of 750-1,000 gm over 10 months. About 89 percent of fish fry are supplied by fish hawkers, 8 percent come from private hatcheries, 1.5 percent from government hatcheries in Bhola and Barisal, and 1.5 percent from area fishermen. Fish eggs from the Bhola hatchery cost Tk. 300 per 1,000 eggs. If they are taken to the private nursery ponds near Bhelumia market, they are raised to a size of three or four inches before being sold for Tk. 1-2 per fry.

Few pond owners use chemical fertilizer or poison in their ponds, instead they fertilize them with cow dung, duck droppings, and oil cake. Fish food usually consists of rice or wheat bran.

Inundated ponds have low productivity and are not cultured, but fish enter these ponds through canals and creeks. These fish are consumed by the pond owner throughout the year, and during the dry season they are caught by net or by draining the pond. Small fish such as *puti,* catfish such as *magur,* and snakehead are the common species in inundated ponds. Carp rarely enter these ponds except during high floods when five to seven inch carp fry have been observed.

Production

The average annual production value of fish from culture sources is 456 tonnes per year, while from all sources it is 3,032 tonnes per year (Household Survey). Annual fish production in the study area is quantified by considering the value of pond owner-consumed fish, annual sales, and the value of remaining fish stock.

Annual fish production from non-inundated ponds is comparatively higher than that of inundated ponds: 317 tonnes per year from non-inundated ponds, 137 tonnes from inundated ones. Out of the total production from non-inundated ponds, 20 percent is consumed by the fisherman's family, 28 percent are sold, and 52 percent are kept for stock. In the case of the inundated ponds, 41 percent are consumed by the pond owner, 25 percent are sold, and 34 percent kept as stock.

Fish consumption

Fish consumption information collected over seven days for each sampled household revealed that the daily average expenditure on fish per household is Tk. 8.48, and that people consume about 34 grams of fish per person, per day, year-round. About 63 percent of consumed fish are bought from local markets, 20 percent are caught and 17 percent are from mixed sources.

3.4 Socioeconomic Environment

3.4.1 Population and Settlements

The total population of the study area is estimated to be 48,192, of which 42,644 live inside the project and 5,548 live outside (Annex 17). The estimation is based on the population census 1991 and the GIS (FAP 19) prepared maps showing settlements, the project boundary, and *mouza* boundaries. There are 25,123 males and 23,069 females in the study area, of which 22,164 males and 20,480 females live within the project area (Annex 17). There is a large variation in population density among *mouzas* (Map 13) primarily due to differences in the age of settlements, infrastructural development, resettlement caused by river erosion, and the influence of Bhola town. Population density also is affected by land elevation and land types. Population density in the study area is 777 persons/km², compared to the national average of 740 persons/km² (BBS 1992b).

The average household size of the 8,859 households in the study area is 5.5 (Annex 17) compared to 5.7 for Bhola *thana* and 5.4 for the nation (BBS 1992a, 1992b). Muslims constitute 98 percent of the total population, while Hindus, both caste and schedule caste, constitute only two percent; Hindus make up 12 percent of the population nationwide (BBS 1992c). Buddhists and Christians are insignificant in the total population, and there are virtually no tribal groups (BBS 1992a). Settlements mostly are concentrated along earthen roads, *khals*, and creeks in linear-linking patterns. In the central and northern part of the project area the settlements are dense, while in the southern part settlements are mostly clustered or linear. There are only a few settlements along the Tetulia and Jangalia rivers. Nearly 59 percent of the settlements are between one and 30 years of age, 18 percent between 31 and 50 years, and 23 percent above 51 years (Annex 19), indicating that the majority of the settlements are young.

Inheriting property and river erosion are the primary reasons for the establishment of many new settlements in the project and study areas. Annex 18 shows that 57 percent of the respondents had settled in their respective *mouzas* because they had inherited property, while nearly 25 percent had migrated from nearby villages or *mouzas* where they had lost agricultural and homestead lands to river erosion. Only 12 percent settled because they had purchased land, and three percent because of kinship and marriage connections.

The area inside and outside the project is connected to the town of Bhola by an extensive network of *khals*, rivers, and earthen roads that crisscross and intersect at many locations. Throughout the year, small and medium-size country boats are used extensively for internal movement of people and freight to local markets and elsewhere. Mechanized boats also are used for transportation and freight. Daily steamer and launch services between Dhaka-Bhola and Bhola-Barisal link the project area with the country's capital and the newly formed Barisal divisional headquarters.

There are 11 major and five minor markets in the area of which Bhelumia bazaar and Bankerhat are the largest. These markets are important meeting places and the link between villages and Bhola town.

3.4.2 Livelihood and Subsistence

Fifty-nine percent of the area's households earn their livelihood from agriculture (41 percent farmers, 18 percent agricultural laborers), while fishing is the primary occupation of 21 percent (Annex 20). Business, including petty trading and shopkeeping, employs only five percent of households, and there are no factories or industry in the project area.

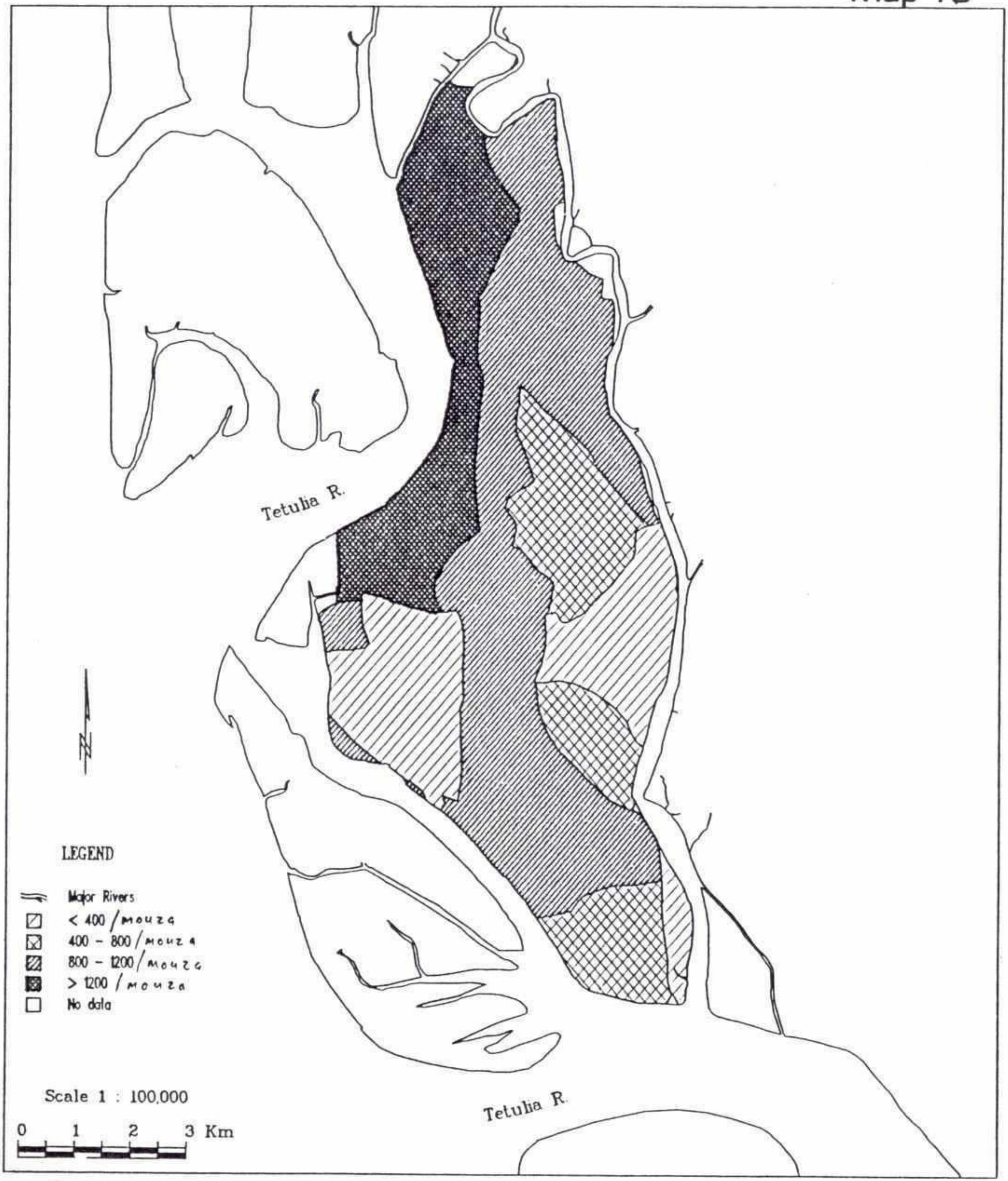
Rice is the main food crop and betelnut the main cash crop. Rice is grown on more than 90 percent of the total cultivated area. Other important crops are chili, mustard, pulses, sweet potato, watermelon, and wheat. *Dhaincha* (a legume) and *hogla* (a reed plant), two important cash crops, are grown mostly along the sides of *khals* and creeks, are used primarily for roofing or fencing material, mats, and as fuel for poor households.

Families usually work their own land and raise crops primarily for their own consumption. If used, hired and outside laborers work during peak agricultural seasons, particularly during sowing and harvesting. The daily wage rate for agricultural laborers varies between Tk. 25 and Tk. 30 (with two meals) during peak or *baishya* season and between Tk. 15 and Tk. 20 (with two meals) during lean or *dhuliya* season. In some places, day laborers take one *seer* (0.93 kg) of rice in lieu of food during the lean season. There is no advance sale of labor for cash, but sometimes contracts are made at the rate of Tk. 6,000-7,000 per year plus food and clothing. Most day laborers are from landless and poor households, and are dependent on the large, medium and absentee landowners for employment throughout the year.

Increasing population pressures prevent the agrarian sector from absorbing the area's growing labor force. This situation is further compounded by a lack of employment opportunities outside agriculture. There is little employment during the lean season, especially in September, October and February. Women do not work in the fields, and their nonagricultural income-generating activities also are limited.

Fishing-related activities employ a significant number of households in catching, selling, and trading. Annex 20 shows that while 21 percent of households depend entirely on fishing as their livelihood, nearly 35 percent are subsistence

Map 13



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Human Population Density

fishermen. Sometimes, however, this latter group sells their catch to supplement household income.

There are no perennial or seasonal beels in the study area, but closed water culture fishery is widely practiced. The Tetulia River and the Meghna estuary are the main fishing areas. Fishing occurs year-round, with April through September being the peak fishing period and late October through December, and March being the lean periods. Professional fishermen pay tolls to absentee lease holders to fish the rivers. Tolls are determined according to boat size, varying between Tk. 300 and Tk. 600 per boat per annum. Fishermen work in groups of five to 10 depending on the boat size and the fishing net to distribute financial obligations and labor requirements. The groups usually come from the same family lineage.

Most professional fishermen are poor and have insufficient equipment and no land. Rarely can they save money to invest in fishing implements. A medium-size fishing boat (9m by 2m) costs nearly Tk. 7,000 and a 700m by 6m *hilsha* fishing net *(chani jal)* costs about Tk. 18,000. Because most fishermen cannot bear such costs, they are forced to borrow money from local petty *mahajans* (moneylenders) who require that the fishermen sell them their entire catch at a rate that is usually 20 to 40 percent lower than market value. This system, known as *dadan* (meaning advance sale of fish), accounts for 80 percent of the total fish sales of the area. The petty *mahajans* are middlemen who borrow money from bigger *mahajans* living in Bhola and Barisal town. This dependency relationship, or bonded *mahajani* system, allows both the petty and big *mahajans* to prosper, while the fishermen live in chronic poverty.

Some area *jalmahals* are leased through auction for three years to local *matshajibi samity* (fishermen's coöperatives) at 10 percent increase of lease fee per year. These cooperatives, however, appear to exist in name only and are controlled by individuals outside the fishing community who dictate the terms of the leasing arrangements. These individuals control resources and marketing and are involved in wholesale fish trading. Most of the large rivers and *khals* are leased to large landowner/businessmen who do not live in the area. The most important fishing site, the Tetulia River, is leased directly by the Ministry of Land to an absentee landowner for three-year periods. The high cost of fishing equipment, the leasing system, and middleman control thus have changed the traditional ways in which fishermen used to freely fish the area's rivers, *khals,* and creeks. There also is competition with fishermen from areas adjacent to the Tetulia and Meghna rivers. In addition, fishermen are threatened by armed gangsters who rob them at night, taking everything in their boats including the fishing net.

3.4.3 Land Ownership

Sample surveys conducted by EIP in 10 villages (BWDB 1992) showed that landless, marginal, and small farm households constitute 89 percent of the population but own only 30 percent of the land, while medium and large farmers make up 11 percent of the population but own as much as 70 percent of the land. This indicates that the land ownership distribution in the study area is highly skewed. For example, the landless constitute 64 percent of the population, compared to the national average of 27 percent. Large farmers, on the other hand, make up only 3 percent of the population, but command 37 percent of the area's land. In terms of per capita owned land, the target group owns 0.03 ha compared to the nontarget group's 0.36 ha or 12 times less. The target group cultivates 63 percent of the total agricultural land while the nontarget group cultivates only 37 percent.

Much of the study area's land is controlled by absentee landowners. Although the exact percentage is not known, some villagers reported that 60 to 70 percent of the land in their areas is owned by absentee landowners who have cash rental contracts with tenants *(orkhait).*

Each absentee landowner controls between 20 and 200 ha of land. Although it is not known exactly how these landowners acquired such quantities of land. The widely held view is that they established rights over newly created charlands. Moreover, since most of the study area is created by land accretion, it is likely that the people who foresaw the future value of accreted land (and who had some power), registered the land in their name or acquired leases from the government even before the lands were cultivable. Many of the first settlers of these new lands were poor people, often displaced by riverbank erosion, who preferred to work as tenants rather than laborers or fishermen.

Data from the Bhola thana land records office indicate that there are about 44 ha of cultivable *khas* land in the project area. Data from the Bhelumia-Bheduria union land office, however, show that there are 632 ha of *khas* land which includes land under *khals, khal* sides, village roads, and cultivable lands. Much of this *khas* land is under the control of absentee owners. The exact amount of *khas* land is uncertain because of the continuous erosion-accretion of charlands.

Land conflict is endemic, and there have been reports of violent conflicts over the forced occupancy of char and *khas* lands in the area. Common property resource use is limited, confined mostly to land under *khals,* village roads, and canal shores. Roadsides are used primarily by people whose lands and houses are adjacent to the road.

3.4.4 Tenancy Relations

An extensive, informal tenancy market exists in the study area. Cash rent tenancy *(logni* or *chukti barga)* accounts for nearly 70 percent of the total rented land. The rental rate varies between Tk. 7,000 and 9,000 per hectare depending on land type. The rent usually is fixed for one year and renewed in subsequent years if the landowner receives the cash in advance. In *kudi barga,* the other type of tenancy contract, the owner and tenant agree that the owner will receive 25 to 30 *maunds* (1,000-1,200 kg) of paddy per hectare after harvest. The contractual arrangement in both cases is verbal and, therefore, insecure.

Sharecropping *(shamun barga)* and mortgaging *(bandhak)* are less common. Sharecropping usually lasts for one cropping season, but may extend further if the parties agree that the landowner will receive 60 percent of the gross produce and the tenant only 40 percent. In most sharecropping contracts the tenant provides all inputs, but with HYV crops, the cost of seed and fertilizer sometimes is paid by the landowner.

Under the mortgaging scheme known as *kot kabola,* money is loaned against a piece of land which the loaner has the right to cultivate for three years. If the borrower fails to repay the money within the stipulated period, he permanently loses his land to the loaner. *Kot kabola* rates vary depending on land type, but the usual mortgage rate is Tk. 25,000 to 30,000 per ha. Many villagers reported that the existing mortgaging system is one of the primary reasons for landlessness and poverty in the area.

Villagers also say that the land available for sharecropping is decreasing, while cash rent tenancy is increasing. Obviously, a major reason for this is that it is less risky to obtain rent money in advance than to depend on a good crop under sharecropping. Moreover, landowners can invest their cash-in-hand in other economic activities and, thus, diversify their income. River erosion and population growth have forced more people into the landless and marginal farmer categories in the past 15 years, intensifying competition among farmers who have no other choice but to rent land under any condition in order to sustain their family without turning to full-time fishing.

3.4.5 Credit Relations

Although institutional lending sources charge as low as 16 percent interest, about 97 percent of those obtaining credit obtained it from noninstitutional sources that charge as much as 120 to 160 percent interest. For every Tk. 1,000 borrowed from these informal sources, the debtor must repay with 261 to 298.5 kg of paddy, or Tk. 1,600 to

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1,800 after six months. Interest on a Tk. 100 loan is Tk. 15 to 20 per month.

Noninstitutional sources include private moneylenders, traders, shopkeepers, and large landowners, while institutional sources include commercial banks, the Bangladesh Rural Development Board (BRDB), and a few NGOs. Krishi, Agrani, and Sonali Banks offer credit delivery programs in the area, but their principal clients are those who have land for collateral. The landless and professional fishermen who do not own any land are, therefore, excluded from institutional credit facilities. However, most of the marginal, small, and medium farmers reported that in order to obtain credit from institutional sources, they had to pay 30 to 40 percent of their loan money to different agents or middlemen *(dalal)* through whom loan applications are first initiated and then processed.

In addition to such *baksheesh* requirements, farmers also have reported unusual delays in the disbursement of loans from institutional sources. These roadblocks explain why noninstitutional sources play such a crucial role and dominate the credit market. Private moneylenders are the primary sources of credit, followed closely by banks and a limited number of NGOs. Relatives, friends, and neighbors often help each other by providing *hawlat* (small loans, usually interest-free, under Tk. 100) with the understanding that the favor will be reciprocated in the future. For larger sums, relatives and friends usually ask for interest, but at a lower rate than that charged by private moneylenders.

Before-harvest crop sales are rare in the project area, but small and marginal farmers often sell their crops immediately after harvesting to meet debt liabilities and family expenditures. Debt repayment is the primary reason for land sale. Land is often sold by small and marginal farm households. The price of agricultural land varies from Tk. 80,000 to 100,000 per ha, while the price of homestead land varies between Tk. 125,000 and 150,000 per ha. Land prices have risen 20 percent in the past five years, due to increasing population pressure and social displacement by river erosion.

Grameen Bank, a community development bank, is not active in the area and, hence, income-generating activities for poorer households and women are limited. BRDB focuses its credit program on increasing income and employment of its cooperative members and for purchasing irrigation facilities like low-lift pumps. Its main beneficiaries, however, are the large and medium landowners who often default on their loans. A small number of credit-providing NGOs, such as *Proshika* and *Jatio Bandhujon Parishad*, are active in the area but based in Bhola town. Through their credit schemes they hope to expand into activities like low-cost housing, child health care, livestock vaccination, and roadside afforestation during fiscal year 1993-94.

3.4.6 *Wealth and Equity*

As stated earlier, absentee landowners own as much as 70 percent of the cultivable land in some areas. In addition, there are seven to eight large resident landowners in almost every village who own between 10 and 15 ha of land per family, or two percent of the total cultivable area. On the other hand, nearly 65 percent of the area's households are landless in both absolute and functional terms and there are also large number of households who own between 0.21 and 1.5 ha of land.

Although the absentee landowners already benefit from this lopsided distribution of wealth and equity, they also earn surplus income through a variety of tenancy arrangements. The dominant/ dependency relationship that exists between absentee landowners and poor households is a cycle seemingly impossible to break as the landless, marginal, and small landowners subsist at or close to destitution levels. Only 15 percent of households enjoy a surplus over their annual expenditures, 14 percent live on the margin, and 71 percent face acute deficits in their daily basic needs (EIP 1992).

In every village interviewed, the small and marginal farmers said that their economic condition had deteriorated during the previous five to six years due to crop damage caused by tidal flooding and agricultural pests. High cost of inputs, population pressure, and river erosion also contributed to their worsening economic situation. Furthermore, because there is no industry in the area, and little or no employment outside agriculture and fisheries, it is likely that more households are becoming poorer day by day.

3.4.7 Gender Issues

In Bhelumia-Bheduria, in spite of increasing landlessness, poverty and migrating males, the position of women remains relatively stable. Their status is characterized by conservative cultural and religious values, and a solid commitment to family and kinship ties. With a few exceptions, women carry out traditional roles as wives and mothers; they are not involved in any kind of income-generating activities.

Status of Women

The 1992 census shows that the male/female ratio in the project area is 106:100. The most likely reasons for the lower number of females are that many die during childbirth and infant daughters die from neglect. The average marrying age of girls is 12 to 15, while for men it is 18 to 20. As in other areas of the country, poor families struggle to pay high dowries that include household goods and furniture. In communities where marriage breakdown is common and females are considered a burden, the family can forgo the daughter's dowry if she is to become the second or third wife. Nonetheless, the labor of the second/third wife is undoubtedly of economic benefit to the husband's household.

Women in the study area hold a subordinate and insignificant position in family decision making. Most women said that they were consulted during discussions involving the family, but the final decision was always made by husbands or male relatives. As is the norm nationwide, women in the project area have no authority to spend money, even when they are the wage earner. Because there are no NGOs that work exclusively with women, there is no technical or financial support for women to initiate income-generating programs.

Women in the project area particularly suffer during floods. Due to their responsibilities and need for privacy they have difficulties in finding proper living and sleeping arrangements; they struggle to find water, food, fuel, and fodder. The lack of flood shelters and medical help, house damage, and the loss of livestock, trees, and vegetables also concerns them. During flood disasters, when food become scarce, they are the ones who go hungry first.

All but the poorest women send their children to school. Poverty, superstition, and religion are the main factors that families cite for removing puberty-age girls from school. Of the few professional women in the area, most are primary school teachers; 20 of the 40 primary school teachers in the area are local women.

Employment

Although there is a national trend of more women moving into the labor market, few of the sample area women participate in economic activities. Cultural prohibitions prevent most women from venturing outside their homes to seek employment. Their gardening and poultry raising activities are extremely poor, failing to even satisfy their family consumption needs.

Of the study area's 23,096 women, only 2,307, or 10 percent, are engaged in wage-earning employment. The NGO CARE employs 15 women in its road maintenance program in the Bhelumia area, and about 10 women are domestic workers for wealthy households. In Char Kali and Char Ramesh *mouzas* 25 women are employed as family planning workers and primary school teachers.

Approximately 2,266 women in Kunjaputti, Chandra Prashad, and Char Chandra Prashad *mouzas* of Bheduria Union are engaged in commercial *pati* (mat) making out of *hoglapata*, which is particularly susceptible to flood damage. It often must be bought in the market at a cost of Tk. 20 per bundle (enough for two 6 x 7.5 ft. mats). An increasing number of commercial rice mills have invaded the traditional women's job of rice husking. Only about 60 to 70 women are employed in post-harvest husking activities and they are paid in meals and, occasionally, given an old sari by the employer. In some predominantly fishing *mouzas* women are engaged in knitting and repairing fishing nets, but not on a commercial basis.

Literacy

People of all social categories said that they would like to send their children to school, but socioeconomic, sociocultural and institutional factors, and the reality that children make important economic contributions to poor households prompt many parents to keep their children home. Although primary education is free, the cost of school clothes may be too large a burden for poorer families. The literacy rate for both sexes in the study area is 25 percent (BBS 1992). In Bhola thana, 29 percent of males and only 19 percent of females are literate.

A shortage of high schools and poverty are the major obstacles to high school attendance. There are two high schools in the sample area: one in Bhelumia Bazaar and the other in Bankerhat. Most primary schools are inaccessible during the monsoons and, therefore, are closed for long periods. Only about 33 percent of primary students seek secondary education, and the high school dropout rate is 79 percent. The recent introduction of free schooling for girls class six to eight has had no impact on attendance in the over-14 age group because parents disapprove of the coeducation system. Informal adult education does not exist in the sample area and the quality of education for those who have received a minimum of formal education is very uneven.

3.4.8 Food and Nutrition

A seasonal pattern of nutritional deficiency occurs during the monsoon season when food grains and vegetables are less available. Nutrition deficiency heightens during the pre-harvest lean season in October or November and reoccurs from March to April. The landless and land poor suffer most at these times.

The most commonly consumed foods in the study area include rice, pulses, sweet potato, wheat, fish, poultry, and meat. Some of the more nutritious foods, such as vegetables, fruits, poultry, and livestock products can be produced in the homestead, but common consumption patterns reveal that these products may not be as available as expected. For example, only 25 percent of the vegetables consumed in the study area are locally produced, the remaining 75 percent are imported from outside the area. This is because vegetable cultivation is hampered by repeated flood damage. Moreover, few pulses, an important protein source, are cultivated locally. People primarily depend on rice, pulses, and fish for their nutritional needs; other foods make up a small proportion of the daily menu. Women, because of socioeconomic conditions and customs, consume almost 50 percent less food than male family members, and protein is often a negligible portion of their diet. The RRA showed that average food grain consumption is 387 gm/day/person (1,341 kcal) and fish protein is 10 gm/day/person (29 kcal). A woman's consumption of food grain is 194 gm/day/person (776 kcal) and fish protein is 5 gm/day/person (15 kcal).

The national figure for per capita daily calorie intake is 2,021 (WBR 1992), but BBS's recommended calorie intake for extreme poverty-stricken people is 1,805 cals/day/person (BBS Household Expenditure Survey 1985-86). The per capita household calorie intake in the study area is only 1,628 kcal, for women the figure is 814 kcal.

3.4.9 Health and Family Planning

The household survey found that people in the sample area conform to national seasonal trends for diarrhoeal and respiratory diseases. Typically, both are endemic throughout the year but are seasonally acute in early, late, and post-monsoon seasons. Diarrhoeal diseases, fever, and skin and eye infections were reportedly common during post-monsoon in virtually all the villages. Hookworm and roundworm, caused by lack of adequate sewage disposal, are common as is helminthiasis (parasitic worm infestation). These infections all contribute to the overall poor health and nutritional deficiency of the local population. More research is needed to determine the role of rainfall in the incidence of disease.

Public health facilities in the area are few for the population size. Family planning and maternal and child health care suffers due to lack of staff, infrastructure, and medical supplies. Although there are upazila health complexes, there are few union health centers for the outlying areas. Illisha, Bheduria, Bhelumia, and Char Samaiya unions have 26 family welfare assistants, but most health centers have no attending doctors or trained nurses for long periods of time. These health centers are run mostly by paramedics.

The existing medical service delivery centers for Bhola district (population 14,51,676) consist of two mother and child welfare centers, 31 union health and family welfare centers, two Public Works Department constructed union health and family welfare centers, one union family planning clinic, seven upazila health projects, three health-related NGOs, and seven health sub-centers.

It is unlikely that the 47 percent of families in the project area officially said to be using temporary or permanent contraception are actually using it. Some women said that they were aware of family planning but had no access to contraceptive supplies and services. Officially there are adequate numbers of union health and family welfare centers operating in the area but, in reality, they are hopelessly understaffed. The Department of Family Planning in Bhola said that poor roads in the area coupled with lack of transport facilities discouraged personnel from regularly attending their posts. Supervisors often made only one visit a month instead of one every week as required. Service users, especially those using contraceptives, said that field workers often did not come at all during the monsoons due to travel constraints. Family Planning Officers said that staff recruitment is problematic: women do not come forward because such employment is unacceptable in a conservative area like Bhola.

3.4.10 Water and Sanitation

There are 468 tubewells in Illisha, Char Samaiya, Bheduria, and Bhelumia unions to serve a population of 8,485 households (Public Health Engineering Bureau 1991). This 1:18 households to tubewells ratio apparently could supply enough safe water for the population. To avoid walking long distances to fetch clean water, however, women often use canal, pond, or river water for washing, bathing, and even cooking. In one village, residents said there was no pump for drinking water, in another it was reported that the pump was far away, and in a third, respondents said access to the pump was limited by the family who owned it. These responses imply that many families have either no access or limited access to safe drinking water. Moreover, households without boats or rafts often have no access to tubewells during floods.

Only 10 percent of the project area's population use proper sanitation facilities. Despite local efforts to promote low-cost water-sealed latrines, most are still built hanging over water surfaces, over pits, or in open fields. In addition, women commonly relieve themselves in vegetation growth around the homestead. The Tk. 200 charge for transporting a water-sealed latrine to a home convinces most villagers to use the polluting traditional-style latrines. But such open sanitation facilities, and animal wastes, totally contaminate the surface water. Women who use surface water understand the need to boil it before use, but they often cannot afford the fuel to do so. The household survey shows that 92 percent of the population drink tubewell water, but 93 percent use surface water for all other household purposes. As a result, the number of reported diarrhoeal diseases has increased from 36 cases in 1990 to 535 cases in 1992 (EPI, Bhola). The actual number of water-borne diseases in the sample area in 1992 is: diarrhoea, 512; dysentery, 529; cholera, 17; fever, 1,322; skin disease, 355; and others, 183 (FAP 16 Household Survey).

3.4.11 Cultural Resources

The area appears not to have any permanent structures of archaeological or cultural significance. No sites were identified to which people attach any specific cultural values.

3.4.12 Navigation and Transportation

Most of the many canals crisscrossing the Bhelumia-Bheduria study area are navigable year-round. The hydrological and physical characteristics of the area create a dependency on navigation for various household and business purposes. The total number of boats within the study area was estimated at about 2,400, based on extrapolation of numbers provided by a 5 percent sampling of households. Waterways are used for fishing from boats and most fishermen are concentrated year-round on the Tetulia River. About 50 percent of the boats in the area are estimated to make use of Bheduria Khal. Twenty-one percent of households are directly involved in fishing activities and most own boats. The trading system in the project area is highly dependent on navigation routes. Paddy and jute brokers usually travel by boats to conduct business with farmers.

The household survey (Annex 21) showed that of all study area boats, 89 percent are manually operated and 11 percent are mechanized. About 50 percent of boats are used for fishing activities, 17 percent for agricultural activities, nine percent for household use, and 34 percent for income-generating activities (some general-purpose boats used for fishing as well). Annex 21 shows boat use by *mouza* and reveals that 55 percent of the total fishing boats are used in Char Bheduria, 15 percent in Paschim Charkali, and the remaining are fairly distributed among the other *mouzas*.

Many people living inside the study area grow crops on the chars of the Tetulia River. Boats are used to carry the 922.5 tonnes of annually produced paddy to the mainland at a rate of 1,845 trips per year (Annex 21). The household survey showed that 50 percent of this annual crop transport occurred in Chandra Prashad. Only households on Char Chandra Prashad and Chandra Prashad reported using boats for household purposes.

Of the 1,238 fishing boats in the study area, 660 are small boats and 538 are large. Large boats, found primarily on the Tetulia and Jangalia rivers, are used by professionals, while small boats, found on canals and the Jangalia River, are used by poor farmers and subsistence fishermen.

3.4.13 Natural Hazards

The coastal physiography, the multiple river systems, and geophysical and man-made features have made the Bhelumia-Bheduria study area vulnerable to several environmental hazards. The area experiences natural and anthropogenic hazards such as seasonal floods, tidal floods, storm surges, cyclones, droughts, riverbank erosion, drainage congestion, exposure to pests and pesticides, saline intrusion, and health problems. At risk are people's lives, livelihood, and property.

Hazard Profile

Key problems in the study area are related to uncontrolled monsoon flooding during full and new moon, and by storm surges accompanying cyclones during pre- and post-monsoon periods.

Based on GIS and application of a digital elevation model, 64 percent of the study area is estimated to be flooded to a depth of 0.3-0.9 m during the monsoon, while another 14 percent is flooded between 0.9 and 1.8 m. Only 22 percent of the area is usually flood-free, but during storm surges even these areas may be affected.

Spatiotemporal aspects of flood characteristics in the study area differ by land type as does risk. Based on household survey data, relative risks can be quantified and their impacts on the area and land use predicted. Annex 22-1 shows the extent, depth, and duration of floods over the past 5 years on study area homesteads and crop land. Flood depth and duration was highest in 1988, 1989, and 1991. In 1989 and 1991 storm surges affected the study area, while in 1988 flood water from the north and the high tide from the south coincided, consequently increasing flood depth and duration.

Cyclones affect the study area almost every year (Annex 22-2). Monsoon flooding usually occurs once in 1.25 years, saline intrusion once every two years, drought every other year, and storm surges once every five years. Fifty-four percent of households are affected by drought, 42 percent by storm surges, 38 percent by cyclones, 28 percent by flood, and 22 percent by erosion.

Flooding Patterns

Of all study households, Char Samaiya and Char Gazi households are the most frequently affected by monsoon floods, particularly during high tide. Char Gazi is a relatively low-lying area with a network of channels directly linked with the Tetulia River. Char Samaiya, in the eastern portion of the study area along the Jangalia River, is a depressed area with a dense internal channel network. Areas that also are likely to flood include Char Bheduria, Pangasia, Char Chandra Prashad, and Kunjaputti. Developed rural roads impede flood flow in these low-lying areas.

Storm Surges

Large storm surges, such as the one in 1970, sweep over the entire study area. Even low surges, such as those of 1989 and 1991, typically flood Patabunia, Char Chandra Prashad, Bagmara, Tum Char, Char Bheduria, and Kunjaputti *mouzas*. Because the study area is in the northern part of the Bhola island, fierce storm surges are rare since cyclones usually track in a southwesterly direction, and cross more than 100 km of land and forested area before reaching the project area. Severe surges, which affect all the area homesteads, appear to have an occurrence probability of about 1:20 years, while moderate surges have an occurrence rate of about 1:10 years and affect approximately 40 percent of area homesteads.

River Bank Erosion

Char Bheduria is the only *mouza* subject to continuous bank erosion by the Tetulia River. Char Chatkimari, adjacent to Char Bheduria, has totally eroded during the past two decades. Char Ramesh, Paschim Charkali, and Pangasia *mouzas* experience minor erosion problems.

Saline Intrusion

Saline water regularly intrudes on Samaiya, Bheduria, and Gazi chars. Other study area *mouzas* are rarely affected by salinity. When it does occur, saline water usually intrudes during the dry season when sea water enter the rivers and cyclonic winds create high waves that fall on *rabi* fields.

Drainage Congestion

Drainage congestion is a continual problem in Pangasia, Char Ramesh, Char Bheduria, Char Chandra Prashad, and Kunjaputti. Most drainage congestion occurs when canals are closed by siltation or during unplanned road construction.

Drought

Drought is a common problem all over the study area, usually occurring every other year. Adequate water supplies for crop production are not available except during the monsoon period. Water conservation and management is needed for growing crops at other times of the year.

Cyclones

Cyclones are common in the study area and occur almost every year. Char Gazi, Pangasia, and Char Ramesh are the most frequently affected *mouzas*. Poorer households are the most affected by cyclones, mainly because their homes are built of weak materials.

Flood and Surge Damage Patterns

Standing crops suffered more damage than other property or assets in 1987, 1990, and 1991. Pond fish were the next most affected in those years. Livestock suffered most in 1988 and 1989, followed by standing crops. Annex 22-3 summarizes the estimated monetary values of flood and storm surge damage in the past five years.

Distribution patterns of average flood damage in 1991 show that landowners in Char Samaiya, Char Bheduria, and Char Ramesh were the most affected. In Paschim Charkali, Bagmara, Char Hossain, and Char Gazi sharecroppers were the most affected group, while in Char Chandra Prashad and Kunjaputti service holders were the primary victims. Fishermen were damaged most in Char Chandra Prashad. Annex 22-4 details household damage by *mouza* and occupation, and Annex 22-5 summarizes household resources damaged by flood in 1991.

In the study area 54.6 percent of households perceive flood to be their greatest risk, followed by cyclone and drought (Annex 22-6).

Chapter 4

IMPACT ASSESSMENT

The impact assessment of the proposed Bhelumia-Bheduria Project is based on the development of three scenarios.

- *Future Without Project*: this considers physical, biological, and socioeconomic changes likely to occur within the next 20 years due to prevailing environmental and social trends.
- *Future With Project*, assuming no change in land types. This considers the total changes likely to occur over the next 20 years with the project in place, and attempts to separate the impacts of the project from underlying natural trends in the baseline environment.
- *Future With Project*, assuming a change in land types due to a 20 cm reduction in maximum 1:5 frequency monsoon water levels. The rationale for this assumption is given below.

4.1. Physical Environment

4.1.1 Water Resources

Future Without Project

The primary hydrological problems in the Bhelumia-Bheduria project area are tidal flooding, tidal surges, and drainage congestion. During high tide, flood water spills over the river banks and through *khals* originating from the Tetulia and Jangalia rivers. Rainwater aggravates the flooding during the monsoon. During low tide, flood water usually recedes to the rivers. Storm surges, which can occur at any time of the year, also are a major hazard to the area. All these events are likely to continue. Storm surges may change in frequency due to regional and global climatic changes, but such changes are difficult to predict with any level of certainty.

Drainage congestion is caused by unplanned road construction and ill-maintained and insufficient small canal culverts, openings, and interlinks with the rivers. An insufficient number of culverts and openings also prevents flood water from receding during low tide. As a result, flooding lasts longer, is deeper than usual, and does not drain completely before high tide occurs again, resulting in waterlogging and reduced crop production. This situation is expected to continue. Other than the currently proposed Bhelumia-Bheduria Project, no major drainage improvement project is under consideration for the area.

Bheduria Khal is the area's most important *khal* for navigation and fishing. During low tide, water recedes mainly through this *khal* and other small *khals* and creeks that interlink with the Bheduria. When flood water recession is prevented, the discharge and velocity into Bheduria Khal is reduced, accelerating siltation that eventually will raise the canal bed and hamper navigation and fishing. In this area, low-lift pumps bring the Bheduria Khal surface water to irrigate fields. If the current siltation situation continues, the flow of water through Bheduria Khal and others may be reduced enough to hinder irrigation and consequently reduce crop production. In the absence of any sustained excavation, Bheduria Khal could silt up completely over the next 20 years.

In general, if flood control and drainage measures are not taken in the future then flooding, drainage congestion, and insufficient irrigation will continue to reduce crop production as well as negatively effect navigation and fishing.

Future With Project

There is likely to be little or no hydrological impact during the construction phase of the project, provided precautionary measures are taken against erosion of the new embankments. Following completion, the embankments along the Tetulia and Jangalia rivers and the proposed structures would prevent overspilling of the river bank during high tide, especially during the monsoon season. Extreme high floods of low probability (<1:20 years) would not be prevented, but the embankments would substantially reduce the potential destruction. Since the canals originating on the Tetulia River would be completely closed, the only route for entering flood waters in most years would be the canals connecting the Jangalia River. This flood water could sometimes overspill canal banks and inundate the agricultural lands on either sides of the canal. The general slope of the area is towards the south and southeast, and during low tide complete recession of flooding would take place, resulting in shorter durations of inundation and reduced crop damage. Reexcavation of canals would prevent overtopping in many cases.

The net impact of the project on tidal flooding damage would be positive and beneficial.

Drainage congestion in the area is due to unplanned construction of roads and a lack of sufficient culverts and sluices in proper positions. Seven culverts, one footbridge, and two sluices are proposed for construction: one sluice at the offtake of Munshir Khal will prevent over-drainage, thus facilitating low-lift pump (LLP) irrigation when necessary. This sluice would improve drainage in the northern region of the project area during the monsoon and pre-monsoon periods. The other sluice, at the southern tip of the project, would improve drainage in the southern region. Culverts plus *khal* reexcavation would improve the interlinkage of the canals as well as facilitating drainage. The proposed 2-vent (1.5 m x 1.83 m) drainage+flushing sluice at Napter Khal would improve drainage in the southern part of the project area during monsoon and facilitate LLP irrigation during the dry season. In the central part of the project area, especially in Char Ramesh, drainage congestion would be aggravated for want of a canal linking this low-lying area to other nearby canals. If all the proposed sluices and culverts are maintained properly, approximately 80 percent of the drainage congestion would be removed. Embankments, culverts, and bridges would have positive impacts on communication.

In summary, the net impact of the project on alleviation of drainage congestion would be positive and beneficial.

Canals originating on the Tetulia River would be closed, thereby restricting flows and associated fish migrations and fishing boat passage along the canals inside the project area. These impacts are described further in Section 4.3.2. In addition, the maximum water levels attained during periodic inundation may or may not be reduced; these are described further in Section 4.2.1.

4.1.2 Bank Erosion and Channel Shifting

Future Without Project

Satellite imagery analysis indicates that the Tetulia River is highly changeable and unpredictable. From 1973 to 1990 it underwent major changes as convolution of the channel adjoining the study area increased. Since 1990 the rates of erosion and accretion appear to have declined. The 1993 Landsat image suggests that accretion could close the east channel, thereby making the western boundary of the project area relatively more stable. Any prediction of river behavior remains uncertain, however, and the only reliable statement that can be made is that it will probably remain highly dynamic during the life of the project. The

Jangalia River and Bheduria Khal have changed little over the past 20 years and are likely to remain stable through the life of the project.

Future With Project

The project would have little effect on the powerful geomorphological forces causing river erosion and accretion, although the presence of a strong embankment on the Tetulia River side could be a stabilizing force in specific locations, especially where it has been strengthened to sea-dike standards. The main concern would the impact of future Tetulia River channel shifts on the integrity of the embankment itself—this would have to be taken into consideration in the final design. The Jangalia River channel is likely to remain stable, with or without the project in place.

The project would have little effect on overall erosion and accretion patterns as presently apparent in the general study area.

4.2 Terrestrial Environment

4.2.1 Land Types and Soils

Future Without Project

Current land types are not expected to change, and prevailing cropping practices are expected to continue if no project is built. Each year, fresh sediments are deposited within the project area, primarily near the river and canal sites. These sediments may add nutrients to the soils and help raise land levels. Local farmers believe annual sedimentation increases crop production.

Future With Project

Since the Tetulia River canal openings would be closed by the proposed embankment, the only water entering the project area during the monsoon period would normally come through the canals originating at the Jangalia River. This inflow could be significantly less than at present due to the limited periods available for rising tidal inflows to enter through the canal openings. Inflow current velocities would be increased, however, which would compensate to some extent for the limitations on inflow access and time available for flows to enter. The detailed hydrology of the study area has been superficially studied and documented, and no modelling has been undertaken, consequently there is no adequate basis for predicting the extent to which mean maximum water levels (in the monsoon period) would be reduced. To deal with the resulting uncertainty in hydrological predictions, two scenarios have been considered for mean maximum water levels and the associated distribution of land type phases:

Scenario 1:

> No change of land type; the post-project mean maximum water level would be the same as under present conditions: 2.6 m (1-in-5-year mean maximum level for the months June, July, August, and September). Land types are shown in Map 7.

Scenario 2:

> Change of land type due to a reduction in mean maximum water levels to 2.4 m. The reduction has been estimated on the basis of judgement—taking into consideration the topography of the area and its drainage pattern—and is subject to confirmation at a later stage when more information is available. The associated change in land types is shown in Table 4.1 and depicted in Map 14.

The 125 ha of land acquired for embankment construction would come partly from existing agricultural land. Following project completion, the soils of the project would be largely free from drainage congestion and protected from seasonal tidal surges and therefore more intensively used for agricultural production. As described above, the depth of surface inundation of soils might not be significantly changed in the monsoon season (*Scenario 1*) in which case there would be no change of soil phases and land capability of the areas. Alternatively, maximum monsoon water

Table 4.1 Distribution of Land Types Under Two Post-Project Scenarios

Land Type	Scenario 1		Scenario 2	
	ha	%	ha	%
F_0	287	5.4	1,313	24.7
F_1	4,061	76.5	3,149	59.4
F_2	129	2.4	15	0.3
Homestead	686	12.9	686	12.9
Rivers	143	2.7	143	2.7
Total	5,306	100.0	5,306	100.0

Source: FAP 19 GIS

levels might be reduced (*Scenario 2*), in which event the areas covered by the highland phase would increase and the medium highland and medium lowland phases would be reduced proportionately. Parts of the medium highland phase of Ramgati soils would become a highland phase while the medium lowlands of Nilkamal soils may be changed to a medium highland phase of the same soil series. The change would increase areas considered good agricultural land.

The project would control tidal flooding, which may in turn reduce fresh sediment deposition inside the project areas. The land accretion process, which is continuing within the project area, would be stopped. This may result in land subsidence in the future. Addition of essential nutrients to the soils from fresh sediments would no longer continue. This would probably be compensated by farmers using more fertilizers and manures. Increased use of chemical fertilizers may degrade the natural fertility of soils.

The proposed embankment is likely to prevent saline tidal flooding during storm surges, and this would enhance soil quality in the southeastern part of the project area.

The cyclone shelter would be used to store crop produce and seed, and protect livestock during cyclones. It would contribute to agricultural rehabilitation after the cyclone and therefore would play an important role in maintaining crop production the following season.

Overall, the project would have some negative impacts on area soil fertility, but would have small beneficial effects in reducing soil salinity in specific locations. The land types may or may not be changed by the project—present hydrological information is inadequate to predict this.

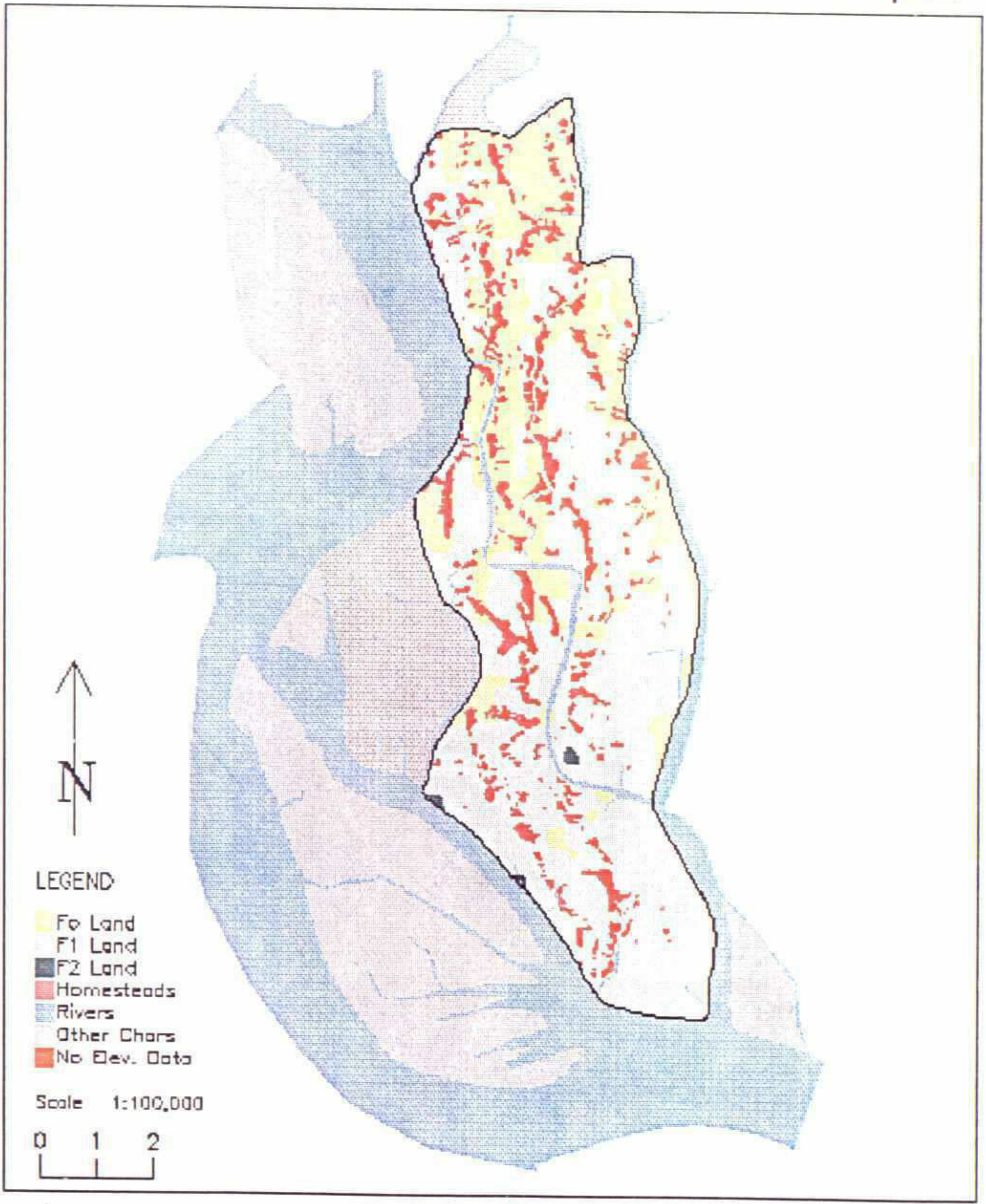
4.2.2 Agricultural Crops

Future Without Project

Tidal floods would continue to damage *aus* crops during harvesting in June and July and early growth stages of T. *aman* during July and August. Drainage congestion may increase and damage HYV *boro* crops during the pre-monsoon season, especially when heavy rain and winds occur. It is estimated that areas subjected to crop damage would increase from the current 1,726 ha to 1,855 ha, while flood- and drainage congestion-related crop losses would increase from the current 2,500 tonnes/year to 3,000 tonnes/year (Table 4.2). Crop estimates for future conditions have assumed that present agricultural land areas would not be substantially impacted by increased homestead areas necessary to accommodate the increases expected in human populations (see Sections 4.2.3 and 4.4.1), although some loss seems inevitable.

To compensate for crop losses due to damage and any losses in agricultural land areas, farmers are likely to increase *boro* cultivation by installing more low-lift pumps, increasing the area of irrigated land from 12 percent to 20 percent. These additional irrigated areas probably would involve F_1 and F_2 land types, replacing the B. *aus*/T. *aman*/*rabi* season cropping pattern with T. *aman* and HYV *boro* season. This replacement would be at the expense of pulse crops and local rice varieties. Pests and diseases would continue to damage crops unless farmers adopt effective controlling measures. Despite these changes, future cropping intensity is expected to remain the same, but food

Map 14



ISPAN FLOOD EXTENT FOR WATER LEVEL OF 2.4m

Table 4.2 Expected Cropping Patterns in the Absence of Project Development

	Area under cropping patterns (ha)			
Cropping pattern	F_0	F_1	F_2	Total
T. Aman (H) - Rabi crop	250	-	-	250
B. Aus (L) - T. Aman (L) - Rabi crop	-	1,319	-	1,319
T. Aus (L) - T. Aman (L) - Rabi crop	-	181	-	181
T. Aus (H) - T. Aman (L) - Rabi crop	-	75	-	75
B. Aus (H) - T. Aman (L) - Rabi crop	-	210	-	210
B. Aus (L) - T. Aman (H) - Rabi crop	37	300	-	337
T. Aman (L) - Boro (H)	-	925	-	925
B. Aus (L) - T. Aman (L)	-	608	115	723
T. Aman (L)	-	443	14	457
Totals	287	4,061	129	4,477

Source: FAP 19 GIS and Field Survey, 1992

grain production would increase by an estimated 570 tonnes (Annex 23-1). An estimated 1,418,000 person-days per year would be required for agricultural activities under the "without project" scenario (Annex 23-2), a figure slightly higher than the baseline estimate of 1,387,000 person-days.

Currently, about 1,200 tonnes of chemical fertilizers are being applied annually in the area. An increase of 100 tonnes/year is expected for the increased production of HYV *boro* and T. *aman* crops. The increase in cultivated HYV crops also is expected to increase pesticide use from the current 5.9 tonnes/year to 6.2 tonnes/year.

Future With Project

With the implementation of the project, agricultural crops would be protected from the high tidal flooding during the monsoon season and average storm surges in the months of October and November. Improved drainage conditions would reduce damage to *boro* crops at the harvesting stage, which in turn would encourage farmers to increase the cultivation of this crops by installing more low-lift pumps. At present, 12 percent of the cultivated land is irrigated. This is judged likely to increase to about 25 percent.

If the distribution of land types is unchanged (*Scenario 1*), the hydrological situation would remain unfavorable for the introduction of HYV paddy during the monsoon season, and agricultural gains would come from reduced crop damage. Paddy production could increase up to 18,646 tonnes annually (Table 4.3). Benefits of production would come from HYV *boro* only in the dry season. If the proposed embankments reduce maximum water levels during the monsoon season (*Scenario 2*), the land types of the project area would be changed and the cultivation of HYV paddy would increase significantly as a result of the increase in the highland (F_0) (Table 4.4). Paddy production, mainly composed of HYV *boro* and HYV *aman* crops, is projected to increase from 14,000 tonnes to 19,000 tonnes annually.

Increased crop production would increase the agricultural labor requirements, which may lead to a more active economic environment in the project area. About 2,783 tonnes of crop damage could be

Table 4.3 Expected Cropping Patterns Under Scenario 1 (no change in land types)

	Area under cropping patterns (ha)			
Cropping pattern	F_0	F_1	F_2	Total
T. Aman (H) - Rabi crop	250	-	-	250
B. Aus (L) - T. Aman (L) - Rabi crop	-	1,195	-	1,195
T. Aus (L) - T. Aman (L) - Rabi crop	-	231	-	231
T. Aus (H) - T. Aman (L) - Rabi crop	-	125	-	125
B. Aus (H) - T. Aman (L) - Rabi crop	-	210	-	210
B. Aus (L) - T. Aman (H) - Rabi crop	37	300	-	337
T. Aman (L) - Boro (H)	-	1,119	-	1,119
B. Aus (L) - T. Aman (L)	-	508	115	623
T. Aman (L)	-	373	14	387
Totals	287	4,061	129	4,477

Source: FAP 19 GIS and Field Survey, 1992

Table 4.4 Expected Cropping Patterns Under Scenario 2 (change in land types)

	Area under cropping patterns (ha)			
Cropping pattern	F_0	F_1	F_2	Total
T. Aman (H) - Rabi crop	250	-	-	250
B. Aus (L) - T. Aman (L) - Rabi crop	-	803	-	803
T. Aus (L) - T. Aman (L) - Rabi crop	-	231	-	231
T. Aus (H) - T. Aman (L) - Rabi crop	125	-	-	125
B. Aus (H) - T. Aman (H) - Rabi crop	210	-	-	210
B. Aus (L) - T. Aman (H) - Rabi crop	728	-	-	728
T. Aman (L) - Boro (H)	-	1,119	-	1,119
B. Aus (L) - T. Aman (L)	-	623	-	623
T. Aman (L)	-	373	15	388
Totals	1,313	3,149	15	4,477

Source: FAP 19 GIS and Field Survey, 1992 prevented annually. However, annual losses caused by pests and diseases would likely increase from 1,475 to 1,630 tonnes annually, unless farmers adopt effective controlling measures, which would include the introduction of Integrated Pest Management (IPM) programs in the area. Farmers would use more chemical fertilizers and pesticides to raise their agricultural production. In *Scenario 1* about 170 additional tonnes of fertilizers may be used annually in the project area. At present, about 1,200 tonnes of fertilizers are applied annually. In *Scenario 2* about 200 additional tonnes of chemical fertilizers would be used.

Overall, project development would have positive and beneficial impacts on agricultural production, especially if maximum monsoon water levels are reduced and highland land types are increased in the area. Potential crop gains would be reduced by pest damage. Increased use of agricultural chemicals would potentially lead to negative impacts on water and soil quality, and on human health.

4.2.3 Livestock

Future Without Project

A continued high frequency of flooding, especially during high lunar tides, will probably continue to keep homestead courtyards wet and muddy, creating unhygienic conditions for livestock, especially cattle. Expansion of irrigated land in the dry season may further constrain the already limited grazing areas. Replacement of pulse crops such as *khesari* by irrigated *boro* would further reduce the supply of livestock fodder.

Future With Project

Reduced flooding levels in the monsoon season (*Scenario 2*) may permit slightly drier courtyard conditions for livestock, although heavy rainfall would continue to create generally wet and muddy conditions. An increase in paddy production associated with the project may increase the amounts of straw available as stall feed, but the quality of such feed would be low due to the shortage of pulse production in the area. Increased economic gains to farmers may encourage them to purchase feed. Draft power would likely continue to be limited in the area.

4.2.4 Forests and Homestead Vegetation

Future Without Project

Tidal inundation and drainage congestion would continue to limit the establishment of economically important forest and homestead vegetation species in the area if no flood control project is built. Local people would increasingly have to depend on imported fruits and vegetables. The expected 36 percent increase in population size (over 20 years) would lead to heavy utilization of trees for food, fuel, fodder, and cash. Unless actively managed and replanted, vegetative cover would gradually decrease, leading to deficiencies of nutritious food, fodder, durable building materials, and energy efficient fuel wood. Rice straw and *mandar* would increasingly be used as energy sources for cooking. When burned, rice straw and *mandar* wood leave soot that is hazardous to human health. Using these energy sources would be particularly detrimental for women as they do the cooking. Moreover, because women primarily are responsible for forestry products and homestead gardens, they would feel the economic stress caused by a reduction in economic tree species. The expected 36 percent increase in population and associated expansion of homestead areas could take some cropland out of production. About 50 percent of the total homestead area within the project has been developed in the past 20 years, but this trend of homestead expansion is unlikely to continue at the same rate as it would rapidly engulf the already limited amount of highlands, which are key areas for *rabi* and cash crops. At present rates of population increase, shortfalls of vegetables, fruits, spices, and fuel would occur over 20 years and create serious nutritional deficiencies and fuel shortages. Women would continue to meet the fuel shortage by cooking only one meal per day and

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serving deteriorated food, locally known as *bashi panta*.

Future With Project

Land used for construction of the embankment would affect some homestead land, particularly along the Tetulia River, causing a reduction in the homestead land in those areas. In addition, there would be a loss of natural vegetation, including *hogla*, which is a source of household income. Disposal of soil along reexcavated *khals* would bury *hogla* shoots that grow along the *khals*. Loss of other natural vegetation would adversely affect the availability of biomass energy. The amounts of homestead land lost would depend on the alignment of the embankment.

Some excavated soils would be disposed of on existing homestead mounds, raising them and making them drier and more suitable for homestead vegetable cultivation. This would also reduce damage to homestead trees and other vegetation from tidal and rainwater flooding.

Under post-project conditions, flooding from sporadic tidal surges would be reduced. Mean maximum water levels might remain the same as at present (*Scenario 1*), or might be reduced slightly (*Scenario 2*). Inundation losses of homestead plantations and vegetables would be reduced, including those along canal banks. Because of embankment construction, displaced households in the Char Hossain and Char Gazi areas may be resettled within the project area, resulting in a loss of homesteads and cropland production both outside and inside the project area.

The project would have direct positive impacts on the establishment of economically important vegetation species such as mango, jackfruit, cultivable varieties of banana, bamboo, and common summer and winter vegetables, resulting in higher production of food, fodder, construction material, and firewood, improved protection from wind through provision of shelter and shade, and reduced topsoil erosion. Betelnut cultivation on highlands and medium highlands would be more successful due to reduced levels of sporadic inundation. Any changes in land types (*Scenario 2*) would increase field crop production and thus reduce the stress demand on trees and non-crop vegetation. As over 40 percent of traditional resources of household energy is related to field crops in the form of straw and husks, reduction in crop losses would also improve the availability of household fuel.

The drainage condition of low-lying homestead areas towards the Tetulia River would be improved during the early *rabi* season, and various cash vegetables such as chili, sweet gourd, brinjal, cauliflower, and cabbage, could be grown, harvested, and marketed in time. Drainage/flushing sluices and sluice gates would reduce drainage congestion and increase irrigation facilities inside the project area. Reduced drainage congestion during the rainy season would help summer vegetables grow better. Irrigation facilities would help grow more winter vegetables.

The reexcavated *khals* would hold more water for dry season irrigation of homestead vegetables, leading to an increase in homestead vegetable production. In addition, tubewells sunk for drinking purposes would provide irrigation water for homestead vegetable production. The cyclone shelter would likely be used to protect vegetable seeds during cyclones, and the seeds thus saved would be used in post-cyclone rehabilitation of homestead vegetable production.

The indirect positive impact of the project would improve the nutrition level from fresh fruits and vegetables. Women should have a better opportunity for income generation and biomass production from homestead plantations and vegetable cultivation. Denser vegetative cover would lessen the local negative effects of floods, droughts, cyclones, and other environmental disasters. *Bandhujan* or some other local NGO may take up an embankment plantation program, therefore increasing vegetation and biomass production and contributing towards alleviating the fuel shortage.

Overall, construction of the project would have some negative impacts on natural vegetation, and some homestead land would be lost near embankment alignments. Most post-project changes would be beneficial in terms of homestead vegetation production, diversity, and biomass. An expected increase in land requirements for homesteads would lead to a small decrease in available cropland.

4.2.5 Wildlife

Future Without Project

Terrestrial habitat area has increased in size and quality in the project area over the past few years and is likely to continue doing so during the next 20 years through increases in homestead vegetation tree cover and diversity. The age distribution of some dominant plant species, such as betelnut, banana, and *mander* suggests that these species are self-sustaining. This qualitative improvement of economically important plants would likely expand from the central part of the study area toward the east and west. *Mander* and betelnut, as natural climax species, would succeed banana, and species diversity would likely increase as local NGOs introduce new species.

Wildlife populations in the area are decreasing. Whether they are decreasing at rates similar to those in other parts of Bangladesh is not certain. Land is being lost to erosion in Char Bheduria, reducing the area's quality wildlife habitat. The population of shoreline birds, however, is expected to remain unchanged because their shoreline habitat always would be available in some form or another and they are not routinely hunted. Freshwater turtles probably would decline because they are over-hunted and because a large proportion of juveniles are harvested. One positive note for wildlife is that plantation production and management may improve some terrestrial habitats.

Pest control by the thana agricultural officers has reduced rat populations in the area in the past, and this would likely occur in the future.

Future With Project

The embankment along the Tetulia River would stop immigration of such economically important species as turtles, affecting both their exploitation and production. They would, however, continue to gain access to the project area via the open canals along the Jangalia River. Harvestable numbers of turtles might decline because of the restricted access, the exact amount of such decline is difficult to predict without detailed studies of migration and harvesting patterns.

Pest wildlife species such as rats would become common along the embankment, as this would represent a valuable flood refuge for them. Extensive rat damage to the embankment is likely to ensue, unless active control measures are taken. Biological control, e.g., propagation and protection of rat snakes, would be the preferred method of rat control.

Habitat and land use changes are unlikely to significantly affect the habitats or populations of threatened and endangered wildlife species, although they are likely to decline further, possibly to the point of local extinction, due to continuing human population increase and resulting pressure on habitats and land and water resources.

4.3 Freshwater Environment

4.3.1 Habitats and Water Quality

Future Without Project

The area, flooding magnitude, and inundation duration of the area's perennial water bodies should remain close to what it is now during the next 20 years. Bheduria Khal probably would continue to silt up as far as the Bhelumia market area, increasing the water's salinity during the dry season. Water quality would be affected by an increased use of pesticides, and water quality would degrade in the north and central part of the study area due to canal blockages.

Future With Project

If maximum monsoon water levels are unchanged by the project (*Scenario 1*) then post-project aquatic habitat conditions would not differ greatly from those prevailing at present. About 70 percent of the area is inundated to a depth of 20 cm or more during the monsoon at present (Map 12) and this might continue to be the case. Under present conditions, post-monsoon maximum water levels decline slightly (≈0.3-0.4 m) and the amount of area under inundation drops slightly to about 66 percent. Similar conditions are likely to prevail during the monsoon season if water levels are slightly reduced by the project (*Scenario 2*) since the assumed water levels are approximately the same (≈2.4 m above local datum). Thus, under either scenario, the quantitative change in aquatic habitats would not be great.

The increased use of agro-chemicals, chiefly fertilizers, pesticides, and herbicides, would increase the run-off of these substances into existing habitats, diminishing the habitats' value to the aquatic biota using them.

4.3.2 Open Water Capture Fishery

Future Without Project

National statistics indicate that freshwater fish production declined between 1974 and 1989. Use of restricted nets, harvesting of juvenile fish, and poor to no fishery management are the main reasons for the decline. If capture fish production in the study area follows the national trend, it would decline during the next 20 years from the current 2,576 tonnes/year (1992) to 2,194 tonnes/year by the year 2012. Commercially important species such as the catfishes *aire*, *boal*, and *pangas*, as well as *hilsha* are often harvested too early in their life cycles, reducing the number that reach breeding maturity. Another problem adding to the expected decline in fisheries is the anticipated increase in the number of professional fisherman from the current 21 percent of the area's population to 25 percent. Despite declining fish stocks, the numbers of fishermen are likely to increase in proportion to the total population increase, since fishermen have little opportunity to change their vocation under socioeconomic conditions prevailing in the study area, and some poor farmers might even be forced to adopt fishing as a lifestyle if forced from the land by existing tenancy conditions.

Future With Project

During the construction phase, closures of the canals along the Tetulia River would preclude fish migrations. These migrations could continue to a reduced extent through the canals on the Jangalia River side. Reexcavation of *khals* would disturb fish populations and fishing activities in the *khals* and, hence, capture fisheries production would be reduced. The reexcavation work would have a temporary negative impact on capture fisheries production.

The embankment would stop fish migration from the Tetulia side altogether and reduce it substantially from the Jangalia side by blocking innumerable small creeks which at present overflow during high tide. The embankment would also stop fish migration during tidal floods. Furthermore, water quality inside the project would decline because of the reduced flushing effect and increased use of agro-chemicals due to the increased HYV cropped areas. This would adversely affect fish habitat. The combined effect of the two would greatly reduce capture fisheries production inside the project. The sluice gates, although allowing water in and out, would affect fish entry/migration into the project area from the rivers to a large degree.

The reexcavated *khals* would have more water holding capacity, and would therefore provide improved aquatic habitat for capture fisheries. Borrow pits would also provide suitable habitat for capture fisheries. Based on the information available for fish species present in the area (Annex 12) and their spawning and rearing sites (Annex 13), it is apparent that habitat declines and corresponding declines in production would affect mainly *pangas* and some portions of the carp and catfish populations. Many of the main commercial and food species, including *hilsha*, carps, catfish, and shrimp, breed outside of the project area and utilize it in part for rearing and migration.

Consideration of the fish production and purchasing information (Annex 14), and the distribution and types of fishing gear and boats (Annex 15), many of which are specifically for river use, it is apparent that the bulk of the fish produced and harvested comes from populations in the Tetulia and Jangalia rivers. Computing proportional production on the basis of the distribution of fishing gear (Figures 3.6, 3.7) suggests that about 78 percent of total fish harvests come from the main rivers or elsewhere outside the project area. The remaining 22 percent is derived from the canals inside the project area and represents an annual value of approximately 7 million taka.

The fish harvested in the Tetulia River are captured by boats operating from within the project area. Fishermen traditionally live in separate fishing communities within the project area and move once or twice daily from their home villages to the fishing grounds and back. These movements in and out of the canals on the Tetulia River side would be blocked by the proposed embankment.

In summary, the embankment would reduce fish harvests in the project area by a moderate amount, judged subjectively to be about 10-15 percent because of blockages to fish movements through the Tetulia River channels, and reductions in fish populations inside the project area. Fish populations in the Tetulia and Jangalia rivers would be substantially unaffected by the project, but fishermen's access to their traditional fishing areas would be blocked.

4.3.3 Closed Water Culture Fishery

Future Without Project

Culture fishery production in the study area is currently 455 tonnes/years and is expected to increased to about 597 tonnes/year by the year 2012 if the trend in the area is similar to the national trend. Tidal flooding would continue to be a constraint on culture fish production.

Future With Project

The embankment would protect ponds in the project area from sudden storm surges, but overall inundation from monsoon tidal flooding levels would not be affected. Most culture fish ponds have their own protective dikes that isolate them to some extent from surrounding flooding conditions. The reduction in storm surge damage might encourage local farmers to invest more in culture fisheries.

The project would have a slightly beneficial impact on culture fisheries in the area due to a slight increase in the amount of flood protection offered.

4.4 Socioeconomic Environment

4.4.1 Population and Settlements

Future Without Project

Without intervention, the population of the project area would continue to increase at an assumed rate of about 1.5 percent per year (Annex 26) between 1991 and 2011; the population of the project area would thus increase by 36 percent by the year 2011 to just over 58,000. This increasing population would put tremendous pressure on the existing land and water resources, further reducing the land/person ratio and per capita agricultural land availability. With an increase in farm households and farm population, the average farm size would decrease (Annex 26) and land would be further subdivided into smaller plots. This would reduce the productive efficiency of the farmers and land productivity probably would decrease.

Localized drainage congestion would be further aggravated, especially during heavy rainfall and high tidal flood, putting more agricultural lands under water for prolonged periods and causing increased damage to crops. Farmers would feel forced to make more cuts across village roads to drain stagnant water from croplands. Erosion would continue to displace more households along the riverbanks, exacerbate landlessness, reduce the amount of productive agricultural land, and promote internal as well as external migration. Facing such difficulties, farmers would feel discouraged to cultivate the land as intensively as in the past.

Bank overspill would continue to make living difficult for those along the *khals* and riverbanks, while those outside the proposed embankment would be more affected during high flood years. High tidal floods may lead to the break up of linear settlements along the *khals* and creeks, and increase the number and density of clustered settlements on medium and highlands. Moreover, tidal flooding makes it necessary to raise homestead mounds every year, creating extra financial burdens for many poor households. Consequently, these households may move from low-lying areas to medium highlands that currently are under cultivation.

Future With Project

With the implementation of the project, particularly with increased income from agricultural and homestead production and improved infrastructure, there may be a positive impact on the rate of literacy which, in turn, may have an indirect impact on the growth rate of population in the area. This would, by implication, reduce the anticipated increase in total population and therefore bring down the population pressure on the existing land and water resources.

The reduction in population growth rate would have a positive impact on the existing land-person ratio and per capita agricultural land availability, leading to decreased land fragmentation. This would improve the productivity of the farm holdings and as a consequence, farmers would cultivate the land more intensively. Areas under HYVs would increase and farmers would use more chemical fertilizers and pesticides to augment agricultural production.

Families living outside the project area, but inside the impact area, (especially parts of Char Bheduria, and Char Hossain and Char Gazi), would be more vulnerable to changes induced by the construction of embankments. These families may have to migrate to the project area and to Bhola town in large numbers, causing tremendous pressure on the already tight employment market.

Furthermore, families displaced by embankment construction and its setback requirement would permanently lose ancestral homes, homesteads, and agricultural land. This may cause considerable stress, particularly to the poor who would become refugees.

Given the limited availability of *khas* land in the area, those displaced families would face severe difficulties in finding a suitable place to build new homesteads and begin a new settlement with their meager sources of income. The compensation claim for those people has to be made in full and as quickly as possible.

In summary, the project would benefit farmers and landowners through increased agricultural production, but is likely to have negative impacts on people in the adjacent areas and on poorer people displaced by the embankment.

4.4.2 Livelihood and Subsistence

Future Without Project

Without project intervention, the expected increase in agricultural production by only 715 tonnes by the year 2011 would not keep pace with the growth of population and high input cost. As a result, per capita gross availability of major cereal grains would be reduced from the current 934 grams to 718 grams per day by the year 2011. Total gross food availability per capita/day would also be reduced from the current 1102 grams to 841 grams (Annex 25).

The growing imbalance between land availability and population increases, and the lack of employment outside peak agricultural seasons, would lead to progressive deterioration in the quality of people's lives. This deterioration would force many landless and land-poor households to migrate to Bhola, Barisal, and other urban centers in search of employment.

There is an existing rural-to-urban migration trend, and if this continues the 1981-1991 urban population growth rate of 7.15 percent for Bhola town (BBS 1992a) would be sustained. As a consequence, the population of Bhola town would be nearly 144,000 by the year 2011, which is four times more than its existing population. This would create tremendous pressure on the over-crowded urban center, aggravate resource over-consumption, and increase pollution. Increased migration also would negatively impact already over-crowded Barisal town and its environment. The net effect of continuing the current livelihood and subsistence patterns would be increasing poverty, inequality, and unemployment.

The project area is highly dependent on its fishery resources. If species extinction, loss of fish diversity, over-fishing, and prevalence of fish diseases due to water pollution continue, the animal protein intake of area households would be dangerously reduced. In addition, deteriorating water resources and declining capture fisheries production would negatively impact professional fishermen.

Future With Project

Construction of embankments, sluices, closures, culverts, footbridges, a cyclone shelter, excavation of borrow pits, and reexcavation of *khals* would all generate additional employment, provide incoming and food security. The additional employment would attract skilled labor and professionals from outside the project area. The increased population and the money supply would increase demand on the existing market outlet. New shops and expanded markets would meet the increased demand of essential items. However, there is likely to be extortion from the contractors, so that there would pressure on security forces. To serve the increased labor requirements and in response to labor mobilization drives by the contractors and others connected with project implementation, Landless Contracting Societies (LCS) may be formed. There will be an increase in the movement of labor both within the project area as well between the project area and outside. This would increase demand on the existing transport facilities and other services.

With the project, crop production would increase, and this would increase agricultural labor requirements from the existing 1,386,000 person/days to 1,464,000 person/days for a one-year cropping activity. Year-round agricultural production activities would be facilitated and would widen the opportunities for agricultural employment. Opportunities for non-agricultural employment and small-scale industries and marketing would also expand.

Intensification of agricultural activities would generate employment and may increase wage rates. Such impacts would increase the income of the landless and land-poor households and help absorb the expanding labor force in agriculture. With an increased income, households may have the capacity to improve their present nutritional deficiency and enhance their standards of living. Flood protection measures may alleviate the existing inequality in the distribution of capital resources in the sense that it potentially can increase the income of landless and land-poor households from various project-generated sources and project spinoff activities. Small and marginal farmers may also gain as their land would be protected from flooding. More opportunities would be available for gainful employment, and landless laborers may have more cash in hand to improve their living standards.

On the negative side, the project would have impacts on fishing in the *khals* and creeks as well as employment in the fish subsector. Fish consumption by communities dependent on capture fisheries may decrease due to reduced fishing areas. Navigation would also be affected by the closure of important *khals* on the Tetulia side. Although some structural measures are being considered to allow fish migration and reduce project impact on capture fisheries production in general and fish stocks in particular, the project would have residual impacts on fish catch, fish consumption, and nutrition, especially among fish-dependent communities.

Professional fishermen may abandon fishing and seek agricultural or other occupations, pressing the already tight employment situation. It is likely that some of the narrow streams and lowlands that are currently being used as fishing areas would be converted to agricultural land. This trend would have residual impact on the ecological, biological, and navigational aspects of fisheries. Increased use of chemical fertilizers and pesticides would have residual impact on surface and groundwater quality, thus increasing the risks of human health and fish diseases.

The project would improve the livelihoods of farmers and landowners on a long-term basis, and would provide short-term benefits to local labor forces during the construction period. The project in its unmitigated form would have major negative impacts on fishing communities by preventing their traditional access to their fishing grounds. Long-term project benefits would accrue mainly to landowners, with other groups receiving a much lower share, if any.

4.4.3 Land Ownership Distribution Pattern

Future Without Project

As resource productivity and income decreases in the project area, many small and marginal farmers would be forced to sell their land, probably for less than value, to feed their families. Leasing and mortgaging would increase and, in many cases, land would be permanently transferred to the lender because the farmer would not be able to pay his debt. This trend would further concentrate land and income into the hands of large absentee landowners and the area's few large landowners. If such trends continue and if the population increases as expected between 1991 and 2011, almost 76 percent of households could become landless by the year 2011 (Annex 25).

Future With Project

With the implementation of the project, more land would be brought under HYV crops which would increase crop production. The benefits of increased production would not be shared equally by all categories of households as land and other capital resources are highly unevenly distributed. Since the distribution of capital resources varies greatly among household categories, those with access to more resources would be more likely to take advantage of and benefit from the opportunities created by the project. The embankment would provide protection against tidal flooding, giving an increased sense of security to those living inside the embankment. This increased sense of security against flood loss would improve the investment climate and likely encourage increased investments in various income-generating activities, including agriculture, culture fisheries, livestock, business, and commerce.

Land prices for F_1 land would increase and some of the F_2 land that became flood-free would be sold at higher prices. This may allow some economic benefits to small and marginal farmers who must sell or mortgage land in distress situations. The small and marginal farmers would probably sell less, however, as the risk of crop damage due to flooding would be greatly reduced. Distress sales and mortgages of land would also be reduced for the same reason.

In general, the project would reinforce existing land ownership patterns.

4.4.4 Tenancy Relations

Future Without Project

As more land is acquired by large and absentee landowners, the tenancy market would expand and work exclusively in their favor. Population pressures and limited available land would reduce opportunities for tenancy contracts, because too many people would run for too few lands. In addition, the lack of employment opportunities outside agriculture would, inevitably, increase competition among the landless and land-poor for tenancy contracts. Such competition and growing land shortages would allow large landowners to impose stiffer tenancy terms and conditions and to dominate the tenancy market. Cash rent tenancy probably would increase and sharecropping may disappear due to the fact that landowners find the former more profitable and risk-free than the latter.

Future With Project

The existing tenancy market would further expand and as more land becomes flood-free, the rental rate for *logni* and *kudi barga* would increase. Given the growing imbalance between land availability and population growth, not enough land would be available for all possible tenants. Land shortages would enable large and absentee landowners to dictate the terms and conditions of tenancy in their favor. In other words, competition for land would cause severe downward pressure on tenure terms to the full advantage of large and absentee landowners. In a situation where all tenancy contracts are mainly verbal and insecure, it is likely that tenant farmers would work the land under more inequitable terms and conditions. As the costs of irrigation and other HYV inputs increase, landowners may not share the cost of production in the same proportion as is currently being shared. Traditional sharecropping (*barga*) systems may disappear and give way to various forms of annual cash leases with higher rates and terms imposed by the landowners.

The project would reinforce existing land tenancy and probably further aggravate the present inequitable land-sharing system.

4.4.5 Credit Relations

Future Without Project

Non-institutional credit sources with usurious interest rates would continue to dominate the credit market unless institutional credit facilities are enhanced or expanded. If the existing difficulties in obtaining credit from institutional sources are not removed, more households would seek loans from informal credit sources at even higher interest rates. This, in turn, would enhance transfer of resources from poor to wealthy households, exacerbating the landlessness process. The advance sale of crops before harvesting (*dadon*) may occur more often and distress land sales may increase due to continued tidal flood-related crop losses.

Future With Project

The average credit obtained by farm households from informal sources is significantly higher than from formal sources. With the project, it could be expected that institutional credit facilities would improve and more marginal and small farmers would gain access to formal credit sources to meet their financial needs. As long as the existing bottlenecks pertaining to collateral and terms are not removed, the informal credit sources would continue to operate with high interest rates. Prevalence of high interest rates would facilitate transfer of resources from poorer to richer households and exacerbate the inequality in the distribution of land in the long run. The credit delivery schemes of some of NGOs, when expanded as planned, could ease the credit constraints of the small producers. In addition, Grameen Bank activities, when introduced, could help alleviate credit constraints on many landless and poor women in the locality.

In summary, the project would have minor effects on existing credit institutions.

4.4.6 Wealth and Equity Situation

Future Without Project

Over time a large number of households would face increasing poverty, inequality, and landlessness. On the other hand, a few large absentee landowners who already own a highly disproportionate share of land would continue to benefit disproportionately, enabling them to extract surpluses from the area without any effective contribution to the improvement of agricultural production. The "patron-client" relationship would persist and possibly turn into other forms of impersonal relationships of domination and dependence, giving way to an increasing marginalization and polarization process. The implication of such a situation for the overall distribution of wealth and equity is that the rich would get richer and the poor poorer.

Future With Project

The loss of agricultural land from embankment construction would lead to financial loss and emotional/psychological stress. The financial loss would arise from the fact that compensation is fixed at the level of a three-year average price prior to the serving of the acquisition notice, but since the price of land goes up whenever a project is implemented, the compensation money cannot buy the amount of land lost. There is an invariable delay in the payment which causes additional hardship. Land loss may be accompanied by displacement, either because the agricultural land that has been acquired makes it unprofitable for the family in question to remain there, or the homestead land itself has been acquired. Some of the displaced households would belong to the fishing community, particularly along the Tetulia River.

Given the existing land ownership distribution, it is unlikely that increased production from HYVs would benefit all categories of households equally. Large and absentee landowners who already stand to benefit disproportionately would benefit more and they would also be able to diversify their income from many non-agricultural sources, further improving their socioeconomic status.

Unless boat passage facilities are provided for fishing boats, the fishing community would suffer major declines in their economic situation, with increased costs of travel, fish trans-shipments and transport, and higher damage and loss risks to any fishing boats moored outside the project area.

Overall, the project would improve the economic situation for landowners and most farmers. It would have minor if any benefits for landless and displaced people, and it would create major negative impacts on the economic status of the Tetulia River fishing communities. The project would have major negative impacts on displaced households unless adequate mitigative measures are taken.

4.4.7 Gender Issues

Future Without Project

The status of women in the Bhelumia-Bheduria area would probably deteriorate over time. Limited employment opportunities, continued inundation and drainage congestion, and damage to homestead production have specific negative impacts for women. For example, with continuing population increases and declines in traditional rural-based activities such as paddy husking by *dheki,* work opportunities for women would be reduced. With no skill or training women are limited in what they can do, and with little or no income-making activities, their position becomes weaker. Women in remote areas do not have access to development organizations (NGOs) whose activities focus on women. Women's mobility would continue to be hindered by a lack of adequate transportation modes and routes. Often they are unable to travel even in health-emergency situations.

Future With Project

Increased family income arising from improved agricultural and other sources probably would not have a significant and immediate positive impact on the women in the project area. Such increases, however, would have an indirect impact on women through an overall improvement in the quality of life of the people. Most of the income-generating activities involving women are in traditional and manual tasks, e.g., *pati* weaving and paddy boiling and husking. Very few NGOs are working in the project area because of bad communication. Road improvement work planned under the project would improve road communications and may extend GOB and NGO services, including basic technical and skill development training to the more remote areas. This may provide more diversified work opportunities.

Furthermore, with the project, increased labor requirements in the agricultural sector would increase the opportunities for women to engage in paid work to supplement their family income. Employment in the *pati* weaving sector would probably remain static. An increase in family income and purchasing capacity and availability of food grain may increase grain consumption by women. Since more land would come under agriculture it is expected that homestead vegetation would increase, thus contributing to improvement in their calorie intake. The potential negative impact on capture fisheries, however, would have a significant residual impact on the nutrition of women in poor fishermen's families and in subsistence fishing households.

In general, the impacts of the project on women would be beneficial due to improvements in food availability from agricultural crops and homestead gardens, and reductions in flood stress.

4.4.8 Health

Future Without Project

Baseline data indicate that 92 percent of the people in the project area have access to safe drinking water. In spite of the statistics, incidence of water-borne diseases like diarrhoea, cholera, and typhoid are high. The use of *khal*, river, and pond water for bathing (people and animals) and washing appears to be the prime contributing factor. The current number of tubewells, although apparently adequate for the sample area population, would not function properly without maintenance. People would continue to use other water sources for domestic purposes, proliferating water-borne diseases. In addition, if people continue to build and use unhygienic latrines, surface water would continue being contaminated.

Women are frequently in contact with contaminated water during their household chores and with patients suffering from those diseases. This, coupled with the women's already weaker physical condition, make them more prone to diseases. Although MCHFP services are being provided through the GOB, women normally have less access to those services.

Without project intervention and with increases in population, the per capita food intake is expected to decline. Because disparity in the eating/feeding patterns of females and males is poverty related, the nutritional status of females is expected to drop lower. This situation would be aggravated by expected declines in capture fisheries that, in turn, would reduce animal protein intake.

The existing health delivery system is inadequate to cope with increasing health concerns. Poor sanitary conditions are a primary health hazard in the project area, especially for women. Based on existing data and past trends, it is predicted that water-borne diseases such as dysentery, and scabies and acute respiratory diseases would increase considerably. However, increased efforts by NGOs probably could slow the incidence of diarrheal diseases and malaria.

Future With Project

Increased levels of production of agricultural and homestead crops under project conditions would lead to enhanced nutrition and improved health for most communities, although poorer and landless communities would share disproportionately in these benefits. Improved road communication as a result of the project would help access to existing facilities. Improved drainage in the project area may also have an impact on health since stagnant and contaminated water that is used for all domestic and personal purposes facilitate the incidence of scabies, skin, and parasitic infections. Increased levels of agro-chemicals in standing water may pose a new and increased health threat.

Tubewells, although part of the project, are not part of the FCD component and are intended for drinking purposes, although some irrigation of homestead vegetation may be expected. Provision of safe drinking water will greatly contribute towards improving the water-borne disease situation in the project area.

The cyclone shelter will to some extent mitigate losses due to tidal surges against which the embankment will not provide any security. The shelter would also provide positive benefits in terms of security of life and property.

The project would do little to improve existing poor health facilities, and hence would not alleviate some of the major causes of disease and poor health care in the project area.

The project would mainly have beneficial impacts on community health and nutrition, with potential negative impacts if high levels of agro-chemicals are employed. Poorer and landless groups are less likely to share in health benefits.

4.4.9 Education

Future Without Project

The Bhola District population census shows that the literacy rate for the total population was 22 percent in 1981 and 25 percent in 1991. The rate for females only was 21 percent and 19 percent, respectively. In comparison, the Household Survey found that the overall literacy rate in the sample area was 26 percent for males and 13 percent for females. Between 1981 and 1991 the literacy rate for females decreased by 6 percent. Assuming that there would be no external intervention and all other factors remain the same, the literacy rate for the total population is expected to rise by 3 percent, while for females it should fall by 6 percent.

One of the reasons given by parents for withdrawing their female children from schools at puberty is the poor quality or lack of roads to distant schools. During the rainy season, these schools become totally inaccessible to girls, and those who do go must make long detours to reach the schools. Improvement in the road network would encourage parents to send their daughters to schools more regularly and for longer periods. Thus, this would indirectly help in delaying the marriage of these girls.

Future With Project

Access to existing schools would be improved by the construction of embankments and improvements to road communications, culverts, and bridges. This would have some, probably only marginal, beneficial impact on educational levels. The cyclone shelter would likely provide permanent infrastructural facilities for schools as is the normal practice in the coastal areas. Other educational factors would probably not be affected.

The project would have minor beneficial impacts on educational levels in the project area.

4.4.10 Navigation

Future Without Project

A gradual increase in the number of boats used in the study area could be anticipated to match the rise in human population levels, and the associated increased flow of goods back and forth. The proportions of mechanized and manually operated boats is not expected to change significantly in the absence of any specific programs to encourage mechanization. Boats would remain the chief mode of transportation in the area due to the poor road network and abundance of easily navigated channels. The continual silting of the Bheduria Canal and other major waterways may lead to temporary closures, but due to the importance of this waterway, it is likely that excavations would be undertaken to maintain free passage.

Future With Project

The Tetulia River embankment would seal off all western navigable canals from boat access. Project options (BWDB 1992) do not specify any particular considerations for navigational activities in the project area, but provision of boat passage facilities would be made if required. Due to the very high importance of boat transportation to the area's economy, it is almost certain that such boat passage facilities would be demanded by local inhabitants and would have to be built into the project.

Most professional fisherman presently use waterways for fishing in the Tetulia River, usually making two trips per day in and out of the western canal openings. This would be stopped by the unmitigated project. Fishermen using the Tetulia River would be unable to effectively access their normal fishing grounds through the eastern canals because of the long distances involved. There would be no impact on navigational activities in the eastern side of the project. Even after closure of the canals, boats could still move freely inside the project area, and internal passage would be facilitated by the proposed reexcavation of *khals*.

Fishing boats maintained outside the embankment on a permanent basis would be highly susceptible to damage from tidal surges and storms, unless adequate protective harbor facilities were made available.

Paddy harvested and transported by boat through the western side of the project area would have to be transhipped over the embankment. This could be achieved at an additional cost to the farmers.

In summary, unless boat passage facilities are provided, the project would have major negative impacts on navigation, both for fishermen and for the transportation of commercial and agricultural goods.

4.4.11 Hazards and Risks

Future Without Project

Providing the frequency and intensity of large-scale seasonal and tidal floods remains the same (see Chapter 3), the flooding hazards and risks would essentially remain the same in the foreseeable future. With increases in population (see Section 4.4.1), however, more people would be exposed to them. Sedimentation in the internal canals would increase, creating drainage congestion and flooding problems. It is likely that the duration of floods due to rain water would increase in low-lying areas due to the deterioration of drainage conditions (see Section 4.1.1). The outlet of the Bheduria Canal in the west may eventually close off due to siltation, consequently affecting navigation and fisheries.

Natural hazards such as drought, tidal surges, cyclones, hailstorms, and pests would continue at sporadic intervals, although the frequency may change if global weather patterns are altered as sometimes expected (see Chapter 5).

There is a possibility of geomorphological changes in terms of land raising and stabilization, particularly in the southern part of the study area and on the floodplains subject to regular tidal inundation.

Future With Project

The probability of damage by seasonal floods and the flood associated with high tide is expected to be sharply reduced by the project embankment. The risk of frequent crop and property loss would be diminished, but there would be an increased risk of severe losses due to embankment failure. Due to increases in the growth of populations and settlements, flood risk may disproportionately affect poor and landless people encroaching on low-lying areas.

The proposed project would have major positive impacts in terms of protecting against the damaging effects of storm surges. It would be markedly beneficial in terms of reducing crop, property, homestead resource, and infrastructure damages. It is estimated that damages would be reduced (in monetary value) by about 60 percent per household (estimate based on current losses reported in household surveys).

Improved drainage would reduce the risks of crop and homestead damage, but these could be offset by an increased risk of drainage congestion due to poorly planned rural roads creating water stagnation in low-lying pockets. Many canals and canal mouths may gradually silt up, causing water stagnation in low-lying areas.

The prevalence of drought conditions in the post-project situation is expected to increase only slightly within the project area. Due to reduced flooding, soil moisture content may be reduced, but this would largely be offset by normal rain water flooding.

At present, about 5 percent of the study area households are subject to erosion. This could increase under project conditions due to the confinement of in- and outflows though canal openings, both inside and outside the project area. Due to population growth, a larger number of landless people are likely to seek shelter in and around erosion-prone areas.

The likelihood of pest attacks on crops would be more severe within the project area, since there would be less flood flushing to destroy insect pests, and the drier conditions would be favorable for pest activity.

Post-project changes in the hydrological regime may transform the geomorphological characteristics inside and outside the project area. The area under regular tidal effects is increasing in elevation due to silt deposition. With the project intervention such deposition would be reduced. Outside the project area, however, the rate of deposition would be higher than inside the project area, creating a long-term differential change in elevation between the inside and outside areas. This would create drainage congestion problems in the newly formed low-lying southern areas in future.

Embankments tend to generate a false sense of security against any kind of flood. Ordinary villagers do not understand the implications of a designed flood, particularly in the absence of sustained information programs. Therefore they may well gain a false sense of security against massive tidal surges, for against which the embankment is not designed to protect. People may invest in developments they would not have otherwise made had they understood the embankment's limitations.

In summary, the project would have beneficial effects by reducing the risk levels of many natural hazards, especially tidal surge damages of average magnitude. Potential negative impacts include higher risk of pest attacks on agricultural crops. The potential hazard of severe tidal surges would not be fully overcome by the project.

4.5 Environmental Impact Summary

Table 4.5 summarizes the anticipated project environmental component impacts. The scale used is explained in Annex 2 and encompasses impact magnitude, duration and reversibility, and environmental component sensitivity to the impacts. Negative impacts are indicated in shaded cells.

Table 4.5 Environmental Impact Matrix (project components/IECs) for the Proposed Bhelumia-Bheduria Project (unmitigated)

CONSTRUCTION	Tidal flooding	Drainage	Irrigation	Agricultural land	Agricultural production	Homestead land	Homestead production	Natural vegetation	Biomass energy	Capture fisheries production	Culture fisheries production	Economic wildlife species	Financial security	Emotional stability	Household income	Local economy	Local security	Existing transport	Security of life & property	Risk to life & property	Employment & income	Navigation	General health	Education & literacy
Land acquisition													-5											
Embankment				-2	-2	-2	-2	-2	-2					0	+6	-2								
Drainage sluices															+2	-1								
RCB sluices															+2	-1								
Closures										-7					+2	-1								
Khal excavation										-2					+2	-1								
Culverts															+2	-1								
Footbridge															+2	-1								
Tubewells															+2	-1								
Cyclone shelter															+2	-1								
Maintenance															+2	-1								
Borrow pit															+2	-1								
Soil disposal					-1		+2							-1			-2							
Labor mobilization																		-2						
OPERATION AND MAINTENANCE																								
Embankment	+6				+7		+3		+4	-7	+4	-6		+3				+4	+7	-5				
Drainage sluices		+6	+6		+7		+3			-7	+4										+3			
RCB sluices		+6			+7		+3			-7	+4										+3			
Closures	+6				+7		+3			-7	+4	-6										-7		
Reexcavated khals		+6	+3		+7		+2			+3												+5		
Culverts		+6			+7													+3						
Footbridge		+3																+3						
Tubewells							+2																+4	
Cyclone shelter					+3		+2													+7				+2
Borrow pit										+3														

Chapter 5

CUMULATIVE IMPACTS

Two sets of environmental impacts may interact with those produced by the project: those produced by regional and coastal developments and those stemming from continental and global environmental changes.

5.1 Regional Developments Within Bangladesh

The Bhelumia-Bheduria project area lies within the Southwest Water Resource Management Region which is currently under study by the FAP (FAP 4). It has been identified as an eventual long-term project for further consideration in terms of the Southwest regional plan (FPCO 1993b). Further development of the Bhola Irrigation Project, which is adjacent to the Bhelumia-Bheduria Project, is also proposed to take place between 1993 and 2000. There are no impacts within the Bhola Irrigation Project that presently affect the Bhelumia-Bheduria Project and extension of the project is unlikely to produce any significant effects.

The major regional developments in the southwest are expected to be development of a Ganges barrage, augmentation of the Gorai River flows, and construction of coastal cyclone shelters and coastal polders and irrigation schemes. The northern end of Bhola Island, the location of the Bhelumia-Bheduria Project, is remote from the direct influence of the Ganges and its distributaries, and any changes in the lower Meghna induced by flow changes in the Ganges (e.g., by water retention behind a future barrage) would be reduced by large-scale variability in the flows of the Meghna itself and in other component discharges, e.g., those of the Padma and Jamuna. A major cyclone shelter development program (apart from the one shelter proposed as part of the project, see Chapter 2) is not planned for the Bhelumia-Bheduria Project area.

The hydrology of the Bhelumia area is related to discharge conditions in the lower Meghna River. Discharges in that river could potentially be altered by large-scale interventions in the upper Meghna basin and in the lower Ganges and Padma basins. However, the largest such interventions planned within the context of the FAP relate to structural protection of urban areas and important agricultural zones. Retention of large volumes of water is not being considered for any of these developments, and any flow changes in the lower Meghna and its distributaries near Bhola Island would likely be too small to detect against the normal variability in flows.

Large-scale alterations in some environmental and social development and resource management policies in Bangladesh could potentially affect the people and resources in the Bhelumia-Bheduria area and interact with project-related impacts. One example is a change in land use ownership policies which would bear on the present situation where a few landowners control large areas and demand very high rents from tenants (see Sections 3.4.4 and 3.4.5). A second is a major improvement in birth control programs, which might reduce the very high rate of population increase in the project area. These types of national change are very slow or unlikely to take place within the time frame of the proposed project, and the interactive effects are expected to be negligible.

5.2 Regional Developments Outside Bangladesh

Developments in river basins outside of Bangladesh affect discharges and water quality within main rivers in the country. Examples are retention of water behind the Farakka Barrage in India, which restricts dry season discharges in the lower Ganges and its distributaries such as the Gorai River, and eventual retention of water behind the Tipaymukh Dam in India, which will affect both wet- and dry-season discharges in the Barak and Meghna rivers.

Hydrological changes in the Tetulia River as a result of changes in the Meghna and Ganges are possible, but would likely be very small in relation to present discharge levels and probably difficult to detect. The consequent secondary effects on levels of inundation within the project area would be smaller yet.

At present there are no regional developments planned on a scale that would be expected to have any measurable effect on development in the Bhola Island area.

5.3 Global and Continental Impacts

The global impact of major concern for a low-lying area such as Bhelumia-Bheduria is the possibility of a sea-level rise following an increased rate of polar ice-cap melting, which would in turn be due to an increased global mean temperature following increased atmospheric heat retention (the "greenhouse effect"). Actual likely amounts of change in sea-levels are highly speculative, but a round figure of a 1 m rise is frequently quoted. For an area such as Bhelumia-Bheduria where a change in mean maximum water levels of 20 cm could produce a measurable changes in land types and agricultural production (see Sections 4.2.1 and 4.2.2), an increase of 1 m would produce physical environmental and ecological changes of unprecedented scale. Most village homesteads in the area are at elevations within centimeters of maximum annual flood levels, and in most years some homestead courtyards are inundated (see Sections 3.2.3 and 3.5.1). An 1 m increase in water levels would probably render the whole area permanently uninhabitable, and it would be reduced to the status of a large char, able to sustain crops only during limited periods in the dry season.

Chapter 6

PEOPLE'S PARTICIPATION AND SCOPING OF PUBLIC OPINION

6.1 Background

People's participation has been identified (FPCO 1993) as a key process in sustainable development by giving a wide cross-section of affected people an opportunity to share responsibility in key decisions regarding project development. This is to be done through a series of steps:

- assessment of local people's perceptions and needs;
- identification of specific groups and consultation with them;
- attention to marginal groups such as the poor, ethnic minorities, women, fishermen, boatmen, and those dependent on fragile resources;
- identification of essential land and water resources utilized by communities; and
- development of an organizational structure for ongoing consultation.

The aim of the FAP 16 fieldwork was to involve local people in project planning and designing. Informal group discussions were conducted with men and women from various social and economic categories in 12 *mouzas* inside and outside the project area (see Annex 27). Special attention was given to the landless and marginal farmers, occupational groups such as fishermen and boatmen, and other vulnerable groups (such as women involved in mat-making) who are most likely to be affected by project interventions. In two villages, discussions were held with people living outside the proposed embankment. Discussions were focused on the villager's occupations and livelihoods, the local agrarian structure, their perceptions of flooding and flood-related problems, and their views on remedial measures.

6.2 Participation Context

The majority of the villagers interviewed were illiterate, but were open, highly responsive, and knowledgeable about their local problems and the environment. They understood their water management needs clearly and had concrete suggestions to make about the measures to be adopted (Annex 27). The poor will feel free to express their views if discussions are held separately with groups of people from similar socioeconomic categories and with the women of these groups.

Fieldwork indicated that people had a clear understanding of social issues such as rural power structures, concentration of wealth, and the processes leading to landlessness. Villagers who are affected, regarded indebtedness resulting from tidal flooding, drainage congestion, and erosion as contributing to increased poverty and land loss, and cited payment of dowry as one of the important reasons for landlessness. In areas where people face severe flooding and flood-related problems, they expressed a willingness to participate in a water management program. They even offered to contribute their labor. Mobilization, to gain the cooperation of those not directly affected, would be needed during operation and maintenance of the project.

In some areas villagers expressed distrust of their elected representatives, but they appeared to have confidence in their traditional village *matabars*

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(informal leaders). *Matabars* adjudicate divorces, abandonment cases, and land disputes at the *salish* (informal village court). Although some are leaders by virtue of their inherited status, a majority are large and medium farmers with some level of literacy.

6.3 People's Perceptions of Flooding and Views on Remedial Measures

The Bengali word *joar* means daily high tide and *bhata* the daily low tide. The high tide during full moon is locally called *jo*. Inundation caused by *jo* damages standing crops, both at their early and mature stages. Unusually high *jo* damages homestead compounds and their surrounding vegetation. Eighty three percent of the people in the 12 *mouzas* visited regard tidal flooding as a serious problem. Pest attacks and the high cost of agricultural inputs were also considered by many farmers to be important deterrents to increasing crop production (Annex 27).

Drainage congestion was considered a problem in six of the 12 *mouzas* visited. Villagers realize that congestion is caused by siltation of *khals* and by man-made obstructions such as unplanned roads. Salinity affects agricultural production in four *mouzas*. Land is lost and households displaced due to riverbank erosion in one-third of the *mouzas* visited (Annex 1).

Villagers of the two *mouzas* (Paschim Char Kali and parts of Pangasia, which are inside the proposed embankment) said that they were not much affected by tidal flooding, while those outside the project area (such as Char Hossain and Char Gazi) reported that their homesteads and agricultural crops were damaged almost every year. In Pangasia and Char Bheduria, drainage congestion is not a problem, but they are erosion-prone and agricultural lands are subject to river erosion.

Villagers inside the proposed embankment opined that the embankment should be constructed high enough for protection against tidal surges. However, a community of landless households living outside the project area indicated that they will incur increased damages because they will remain completely unprotected from tidal floods and surges.

Women in *mouzas* closer to the rivers indicated that during *jo* their homesteads are flooded. During the floods of 1990 people in the area had to leave their houses for seven to 10 days and take shelter on the road, or build *machas* (high platforms) to live on. Since tubewells were submerged, they drank river water. They were also unable to store food and fuel and remain in their homes.

In group discussions, 91 percent of the villagers present were in favor of embankment construction. Seventy five percent of them favored construction of sluice gates at selected locations; however, fishermen and boatmen said that this would adversely affect their livelihoods due to obstruction in navigation. Nearly 60 percent suggested construction of bridges and culverts at specific locations. Drainage improvement was also recommended.

Man-made breaches, particularly of village roads, are made mainly to drain out water. A lack of roads was perceived to be a problem in one-third of the *mouzas* visited. The construction, raising, and improving of roads was proposed by 41 percent of the villagers.

6.4 Institutionalization of People's Participation

Impromptu discussion with groups of villagers during RRA surveys is an invaluable method of involving local people in the early stages of project identification and planning. The poor and women will feel free to voice their opinions in this context. However, efforts to institutionalize participation (through project committees, for example) run the risk of being dominated by locally powerful political and economic interest groups. For this reason, long-term people's participation in the Bhelumia-Bheduria project area should not be based solely on elected bodies such as union parishads. It will also require inputs from genuinely representative local people's organizations involving people from all socioeconomic categories.

The study area has a comparatively low level of social organization and NGO activity. Village leaders generally are said to represent the interests of all social groups. Participation efforts might benefit from using the existing network of formal and informal socio-political institutions.

In the designing and implementing of specific project interventions, particularly water management in the project area, it is recommended that the local, knowledgeable people from various social and occupational groups, including the landless, should be identified and developed as spokespersons. Women from all social groups should also be properly represented.

Regular meetings with spokespersons and village leaders, at selected sites, initially to discuss project plans and alternatives, should be the second step in the process of popular participation. Large and absentee landowners and other elites should be interviewed separately.

A high priority should be given to representation of the interests of those communities living outside the project boundary who may be adversely affected by the project. Meeting sites could be selected according to a range of criteria, e.g., the degree to which they represent different hydrological features, land types, occupational groupings, and key geographical locations in relation to project interventions.

The EIA team believes that the approach described herein will make possible the establishment of representative structures whereby spokespersons are elected from *mouza*- or village-level to Union- or project-level committees. During the construction, operation, and maintenance phases, any funds allocated should be properly utilized, and committee members should be held accountable for funds dispersed.

The success of people's participation in the project will depend to a great extent on the development of genuinely representative people's institutions and the effectiveness of the interaction between these institutions and local formal/informal bodies.

Chapter 7

ENVIRONMENTAL MANAGEMENT PLAN

A full Environmental Management Plan (EMP) should be drawn up when the project has been fully appraised and approved. At that stage, the details of the EMP can be fully integrated with the project design, since many features depend closely on this. In addition, at that stage the details of supplementary programs requiring the participation of agencies such as the Department of Agricultural Extension (DAE) and Department of Fisheries (DOF) and any collaborating NGOs can be established. The following presents the preliminary requirements of the EMP.

7.1 Main Impacts and Recommended Mitigation Measures

Table 7.1 summarizes the most significant environmental and social impacts of the proposed Bhelumia-Bheduria Project and lists the recommended mitigation measures. Costs of the measures are addressed in Chapter 8.

7.2 Pre-construction and Construction Requirements

Navigation Lock

A navigation lock at the Tetulia entrance of the Bheduria Canal is needed to overcome serious potential impacts on fishermen and boat transport operators. The final design criteria will require additional study of potential water levels on either side of the lock, the required capacity of the lock, and the modes of operation.

Code of Good Engineering Practice

A code of good engineering practice should be established to ensure minimal negative environmental and social impacts associated with the construction and operation the project facilities. These include:

- preconstruction alignment surveys to select embankment alignments that minimize disruption to existing homesteads as well as minimizing the loss of productive land;
- construction monitoring and testing to ensure adequate compaction and reinforcement of the embankment to prevent premature erosion and breach risk; and
- establishment of health and sanitation practices in construction labor camps to minimize the risks of food and water contamination.

Coordination of Cooperating Agencies

A coordinating committee should be established to ensure communication and cooperation among the agencies that will develop the project and those that will have to deal with preventing significant impacts; these include BWDB, DAE, DOF, and various social agencies concerned with human labor, health, and welfare.

7.3 Operating and Maintenance

Effective operating and maintenance (O&M) of the project, especially pertaining to embankments and

Table 7.1 Impacts and Associated Mitigation Measures for Bhelumia-Bheduria Project

Impact		Mitigation		Resp.
A.	Water Resources			
1.	Siltation of canals inside project	Maintenance of canals through clearing and excavating to correct side and bed slope		BWDB
2.	Siltation in vicinity of regulators and sluices	Appropriate O&M		BWDB
3.	Local erosion of embankment from rain, runoff, rats, settlements	Monitoring and O&M		BWDB
B.	Land Resources			
1.	Loss of some homesteads, homestead land, and vegetation due to embankment construction	1.	Careful embankment alignment to avoid homesteads as much as possible	BWDB
		2.	Relocation of affected homesteads to new sites	BWDB
2.	Loss of agricultural land from embankment construction (permanent due to embankment, temporary due to dumping of excavation spoil)	1.	Careful embankment alignment to avoid encroaching on productive lands	BWDB
		2.	Good environmental engineering practices to minimize damage	BWDB
3.	Reductions in soil fertility due to absence of sediment deposition	1.	Increased use of organic fertilizers and mulches	DAE
		2.	Judicious application of synthetic fertilizers	
4.	Higher crop loss risks in HYVs due to pests	1.	Practice of Integrated Pest Management	DAE
		2.	Judicious application of pesticides	
C.	Wildlife			
Reduction in populations and harvests of economic wildlife, e.g., turtles		Promote alternative resources for affected people		•
D.	Water Quality			
Increased risk of agro-chemical contamination		1.	Extension programs to inform farmers and minimize excess use	DAE
		2.	Health education programs to increase risk awareness	NGOs
E.	Fisheries			
1.	Reduction in fish harvests inside project area due to blockage of fish migrations	1.	Local stocking programs for canals	DOF
		2.	Culture fisheries development at village and community levels	
		3.	Fish passes on all main canals on the Tutulia River side	
2.	Reduced access of fishermen to fishing areas outside project area by closure of Bheduria Canal	Boat lock on Bheduria Canal		BWDB
E.	Socioeconomic			
1.	Displacement of poorer and landless households due to embankment construction	1.	Careful alignment of embankment to avoid displacements where possible	BWDB
		2.	Relocation of displaced households to new sites	
2.	Disruption to water-based transportation by closure of Bheduria Canal	Boat lock on Bheduria Canal		BWDB

*There is currently no wildlife agency in Bangladesh to undertake wildlife mitigation.

the proposed navigation lock, should be ensured by:

- clearly defining the responsibilities and rights of BWDB and various community groups and beneficiaries, with good communication links between all parties;
- dedicating staff and budgetary resources to ensure adequate O&M; and
- routine maintenance and inspection of embankments, regulators, sluices, canals, and any structures and facilities permitted on them (housing, reforestation projects, etc.).

7.4 Monitoring Plans

Because of the relatively small size of the proposed Bhelumia-Bheduria Project and the fact that, apart from fisheries, it would have relatively modest impacts, an extensive monitoring program is not required. However, a requirement for periodic checking of specific issues should be included in the final EMP to ensure that they are not overlooked with the passage of time. These include the following.

Inspection of Embankment

The completed embankment should be subject to periodic detailed checking by geotechnical engineers to ensure its structural soundness and reliability in the face of severe tidal and storm surges.

Monitoring Navigation Lock Efficiency

The operating performance of the Bheduria Canal lock should be checked at periodic intervals to ensure its efficient operation and ability to enable fishermen and boat transport operators to gain rapid access to either the safety of the canal or the navigational space of the Tetulia River.

Water Quality Monitoring

Regular chemical and biological quality tests of water within the project area, especially that used by communities, should be undertaken to ensure early detection of any build-up of hazardous chemicals and health contaminants.

7.5 Environmental Enhancement

Two basic extension programs would enhance some of the benefits of the project.

Embankment Vegetation and Social Forestry

Planting embankments with fodder, vegetable, and tree crops such as epil-epil has become commonplace in many parts of Bangladesh, and can increase crop, timber, and fuel wood production while simultaneously stabilizing the embankment and reducing the rates of erosion from rainfall and overtopping. Most effective embankment plantation programs are run by NGOs.

Agricultural Extension Programs

The potential agricultural and horticultural production gains in the area, brought about by protection from damaging floods and drainage congestion, could be further enhanced by the application of available knowledge of cropping patterns, the use of new crop varieties, crop diversification, and more efficient use of fertilizers, seeds, and pesticides. This could be effected by cooperating agencies such as DAE.

7.6 People's Participation

The requirements for people's participation are outlined in Chapter 6. Such participation programs should continue throughout project construction, which is expected to last a number of years, to ensure that all communities are aware of the intentions of the project, its potential benefits, and its limitations in terms of restricted protection against major tidal surges and storms. Feedback from local communities should be obtained to ensure incorporation of effective local suggestions

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into project design and operation, e.g., operating schedules for the proposed Bheduria Canal navigation lock.

7.7 Reporting and Accountability

Since EIA of water resource projects is relatively new in Bangladesh, the institutional framework for full accountability of project development and the achievement of environmental planning and protection aims, is not yet in place. A major first step toward achieving this would be the appointment of an *environmental officer (EO)* who would be charged with all environmental supervision of the project during construction, and who would interact with the project engineers to ensure that mitigation measures are developed. The EO should report periodically (e.g., monthly) through the standard BWDB regional reporting channels on the status of the project, its progress in terms of environmental protection measures, and any problems that have arisen and require resolution. The ultimate accountability for the project lies with the BWDB.

7.8 Disaster Management (Contingency) Plans

A full disaster management plan should be devised and included in the final EMP. An EO, if appointed as suggested above, would be in a ideal position to develop the detailed features of such a plan, and its potential implementation in collaboration with local BWDB officials and officials from other agencies. The key features of the plan should address:

- identification of all refuge sites, including the new cyclone shelter, to be used in the event of a major disaster such as a cyclone or breaching of the embankment;
- establishment of an effective early warning system to be used for potential disasters, including appointment of disaster monitors and supervisors; and
- frequent disaster preparedness training for local communities, to advise them of the above measures and to devise means by which their early reaction to warning signals and appropriate action might be obtained.

Chapter 8

ECONOMIC EVALUATION OF PROJECT IMPACTS AND ENVIRONMENTAL MANAGEMENT

A full economic assessment of the project should appear in a separate analysis and report. The objective of this chapter is to:

- checklist all environmental impacts, both beneficial and negative, which should be taken into account in the economic analysis (Table 8.1);
- provide an estimate of the most significant environmental benefits or losses which should be accounted for (Table 8.1);
- identify the mitigation and environmental management items which should be included (Table 8.2);
- provide a provisional estimate of the costs of the environmental management and mitigation measures (Table 8.2).

A number of potentially significant environmental and social items were not quantified or costed in the study for reasons given in the text. These are listed in Table 8.3.

Table 8.1 Estimated Benefits and Losses/Expenses of Major Environmental Impacts: Bhelumia-Bheduria Project

Impact	Benefits	Expenses and/or Losses	Periodicity
Increase in paddy production	5,000 tonnes		Annually
Increase in agricultural inputs		10% increase	Annually
Decline in fish harvests:			Annually
a. unmitigated project		a. 100 tonnes	
b. mitigated project		b. No change	
Increase in fish harvesting costs:			Annually
a. unmitigated project		a. ≈25% increase	
b. mitigated project		b. No change	
Increase in culture fish production	5% increase in net gains		Annually
Water-borne transportation:			Annually
a. unmitigated project		a. ≈10-15% increase in costs	
b. mitigated project		b. No change	
Increase in agricultural labor	63,000 person-days		Annually

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Table 8.2 Costs of Major Mitigation and Environmental Management Measures: Bhelumia-Bheduria Project

Item	Estimated Cost	Periodicity
Environmental Officer	Tk.200,000 (20 lakh)	Annually
Navigation lock construction	Tk.600,000 (60 lakh)	Initial construction
Navigation lock operation and maintenance	Tk.60,000 (6 lakh)	Annually
Canal and embankment maintenance	Included in engineering estimates	Annually
Embankment plantation program	Tk.300,000 (30 lakh)	Annually
Fish stocking programs	Tk.100,000 (10 lakh)	Annually
Fish passes	Tk.500,000 (5 lakh)	Initial construction
Agricultural extension program	Tk.50,000 (5 lakh)	Annually
Water quality monitoring program	Tk.100,000 (10 lakh)	Annually
People's participation program	Tk.150,000 (15 lakh)	Planning and construction phases

Table 8.3 Non-Quantified Environmental Benefits and Losses: Bhelumia-Bheduria Project

A. *Benefits*:

Increase in homestead crop production
Increase in biomass energy availability
Increase in tree products from embankment plantations
Land transportation benefits
Increase in general nutrition for some social groups
Improvements to health for some groups from drinking water provision
Minor benefits to women
Minor benefits to educational status

B. *Losses*:

Decline in soil fertility
Rat damage to embankment
Increase in water borne disease
Reductions in water quality
Human health risks for some from agro-chemical contamination
Higher hazards from severe storms and embankment breaches
Decline in protein nutrition for poorer classes
Social inequity of gains

Chapter 9

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ANNEXES

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Annex 1

Household Survey Method

The study required that the data be representative of both agro-ecological and socioeconomic conditions in the study area. Each of the inhabited *mouzas* in the study area was sampled. From each mouza, 5 percent of the total households were randomly selected on the basis of the household figures found in the 1991 census report (BBS 1992), updated to 1992 with the Union Parishad data. These households were further subdivided according to the occupational category followed by EIP. Distribution of households according to occupational category was computed on the basis of the list of households obtained from the Union Parishad Offices as well as through discussion with Union Parishad Chairmen and key informants. Reconnaissance surveys were conducted to verify the concentrations of fishing communities in Char Chandra Prashad and Char Bheduria.

The total number of households actually sampled was 424, distributed as shown in the table on the following page. Of 14 *mouzas* in the study area, 12 were actually covered by the survey. Houses in Char Chatkimara in Bhelumia Union had been completely displaced by erosion, and Char Patabunia was found to be uninhabited. Displaced households from Char Chatkimara had settled in Char Bheduria and taken up fishing as the main profession, thus giving a high percentage of professional fishermen not only for Char Bheduria but also for the entire study area.

Percentage Distribution of Household Heads by Mouza and Primary Occupation

Mouza	1	2	3	4	5	6	7	8	9	10
Pangasia (N=10)	0	0.5	0.2	0.5	0.2	0.2	0.5	0.2	0	0
Char Samaiya (N=26)	0.7	2.1	0	1.7	0.5	0.2	0.2	0.2	0.2	0.2
Char Bheduria (N=108)	3.1	4.5	1.9	1.2	0.7	0.7	12.3	0	1.2	0
Char Ramesh (N=53)	2.8	2.6	0.5	3.3	0.5	0.5	1.2	0.2	0.5	0.5
Paschim Charkali (N=38)	0.5	2.1	0.7	1.2	1.4	0.2	1.4	0.2	0.5	0.7
Bagmara (N=13)	0.5	0.9	0	0.9	0.2	0.2	0	0	0	0.2
Chandra Prashad (N=68)	3.5	3.8	0	3.3	0.7	0.7	1.4	0.5	1.4	0.7
Char Chandra Prashad (N=21)	0.9	0.9	0	0.2	0	0.7	1.7	0	0.2	0.2
Kunjaputti (N=47)	1.4	2.4	0.2	4.5	0	0.2	0.9	0.2	0.5	0.7
Char Hossain (N=10)	0.5	0.7	0	0	0.2	0	0.5	0	0.2	0.2
Char Gazi (N=20)	0.5	0.7	0.9	0.9	0	0.2	0.7	0.2	0.2	0.2
Tum Char (N=10)	0	0.7	0	0.5	0	0	0.5	0.2	0.5	0
Total Number (N=424)	61	93	19	77	19	17	90	9	23	16

Source: Household Baseline Survey, 1992

N = Number of Households

Column headings:
1. Farming Own
2. Farming Own+Share
3. Share Cropper
4. Farm Labor
5. Nonfarm Labor
6. Service
7. Fishing
8. Boatman
9. Business
10. Other

Annex 2

Impact Scoring Categories

Beneficial Impacts			Sustainable	Sustainable with Mitigation	Not Sustainable
Sensitive	Immediate	High Magnitude	+10	+7	+4
		Low Magnitude	+6	+4	+2
	Gradual	High Magnitude	+7	+5	+3
		Low Magnitude	+4	+3	+2
Less Sensitive	Immediate	High Magnitude	+6	+4	+2
		Low Magnitude	+3	+2	+1
	Gradual	High Magnitude	+4	+3	+2
		Low Magnitude	+2	+2	+1

Negative Impacts			Irreversible	Reversible with Mitigation	Reversible
Sensitive	Immediate	High Magnitude	-10	-7	-4
		Low Magnitude	-6	-4	-2
	Gradual	High Magnitude	-7	-5	-3
		Low Magnitude	-4	-3	-2
Less Sensitive	Immediate	High Magnitude	-6	-4	-2
		Low Magnitude	-3	-2	-1
	Gradual	High Magnitude	-4	-3	-2
		Low Magnitude	-2	-2	-1

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Annex 3

Land Type Classification System

Land Type Designation	Flooding Depth (cm)	Nature of Flooding	Agricultural Significance
F_0	0 - 30	Intermittent	Suited to HYV rice in wet season
F_1	30 -90	Seasonal	Suited to local varieties of Aus and T. Aman in wet season
F_2	90 -180	Seasonal	Suited to B. Aman in wet season
F_3	> 180	Seasonal	Suited to B. Aman in wet season
F_4	> 180	Seasonal or Perennial	Depth, rate, and/or timing of flooding do not permit cultivation of B. Aman in wet season

Source: MPO (1986, cited by ISPAN 1992a)

Annex 4

Fertility Status of the Topsoils in the Bhelumia-Bheduria Project Area

Soil Series	Land type	pH	Org. Matt. %	EC ds/m	Ca	Mg	K	NH_4	P	S	B	Cu	Fe	Mn	Zn
					meq/100 gm soil			μg/g							
Ramgati I	High	6.8	1.3	0.15	6.5	2.0	0.15	25	23	75	0.2	17.9	385	19	3.3
Ramgati II	High	7.2	1.0	0.27	5.3	1.9	0.17	25	30	30	0.1	19.3	481	22	3.2
Ramgati III	High	7.3	1.1	0.18	5.7	1.9	0.15	25	25	12	0.1	18.4	425	23	2.6
Average		7.1	1.1	0.20	5.8	1.9	0.15	25	26	39	0.1	18.5	430	21	3.0
Nilkamal I	Med. high	6.5	2.3	0.16	9.7	4.0	0.15	20	7	23	1.3	14.5	178	19	1.1
Nilkamal II	Med. high	6.5	2.5	0.13	9.1	4.1	0.12	20	6	145	1.3	13.1	70	20	0.8
Nilkamal III	Med. high	6.4	2.5	0.17	10.2	4.5	0.18	20	5	45	1.0	14.2	74	16	0.8
Average		6.5	2.4	0.15	9.7	4.2	0.15	20	6	71	1.2	13.9	107	18	0.9

Source: Field Survey, 1992. Laboratory Analysis, BINA, 1992

Annex 5

Present Crop Production and Damage in the Bhelumia-Bheduria Study Area

Annex 5.1 Project Area

Crop	Damage Free (a)		Damage by Flood (b)		Damage by Pests (c)		Total Production (Tonnes) a+b+c	Production Lost to Floods (tonnes)	Production Lost to Pests (tonnes)
	ha	t/ha	ha	t/ha	ha	t/ha			
B. Aus (L)	1,150	1.7	856	0.5	699	1.0	3,082	1,027	489
T. Aus (L)	181	2.0	-	-	-	-	362	-	-
T. Aus (H)	65	2.5	-	-	-	-	163	-	-
B. Aus (H)	174	2.0	20	0.4	-	-	356	32	-
T. Aman (L)	2,283	2.3	842	0.7	818	1.5	7,067	1,348	654
T. Aman (H)	374	3.0	70	0.6	90	2.0	1,344	168	90
Boro (H)	385	4.3	65	1.1	105	2.0	1,938	208	242
Paddy	-	-	-	-	-	-	14,312	2,783	1,475
Pulses	938	0.7	-	-	-	-	657	-	-
Chilli	604	0.86	174	0.40	50	0.60	619	80	13
S. Potato	151	12.0	-	-	-	-	1,812	-	-
Watermelon	133	40	-	-	-	-	5,320	-	-
Wheat	146	1.5	-	-	-	-	219	-	-
Oilseed	92	0.5	-	-	-	-	46	-	-
Vegetables	50	3.0	-	-	-	-	150	-	-
Other rabi crops	54	-	-	-	-	-		-	-

Source: Field Survey, 1992

Annex 5.2. Adjacent Area

Crop	Damage Free		Damage by Flood		Damage by Pests		Total Production (tonnes)	Production Lost to Flood (tonnes)	Production Lost to Pests (tonnes)
	ha	t/ha	ha	t/ha	ha	t/ha			
B. Aus (L)	459	1.7	190	0.5	155	1.0	1,030	228	109
T. Aman (L)	476	2.3	220	0.7	210	1.5	1,564	352	168
T. Aman (H)	52	3.0	-	-	-	-	156	-	-
Boro (H)	10	4.3	-	-	-	-	43	-	-
Paddy	-	-	-	-	-	-	2,793	580	277
Pulse	162	0.70	-	-	-	-	113	-	-
Chilli	71	0.86	190	0.40	20	0.60	105	41	5
S. Potato	33	12.0	-	-	-	-	396	-	-
Watermelon	41	40	-	-	-	-	1,640	-	-
Wheat	52	1.5	-	-	-	-	78	-	-
Oilseed	69	0.5	-	-	-	-	35	-	-
Other rabi crops	41	-	-	-	-	-		-	-

Source: Field Survey, 1992

Annex 6

Present Agricultural Inputs in the Bhelumia-Bheduria Project Area

Annex 6.1 Draught Animals, Seeds, and Fertilizers

Crop	Person days	Animal pair days	Seed (Kg)	Fertilizers (Kg/ha)				Pesticides (kg/ha)
				Urea	TSP	MP	2n	
B. Aus(L)	140	35	100	70	30	-	-	0.6
T. Aus (L)	160	38	25	94	31	-	-	
T. Aus (H)	165	40	25	150	31	-	-	
T. Aman (L)	130	30	30	75	30	10	-	0.6
T. Aman (H)	170	30	30	130	91	18	2	0.7
Boro (H)	195	30	30	200	139	19	15	0.7
Chili	145	33	4	60	63	4	-	0.5
S. Potato	90	35	-	-	40	-	-	
Pulses	40	10	30	20	-	-	-	
Oilseeds	90	30	10	40	31	-	-	
Wheat	115	28	124	95	97	-	-	
Watermelon	250	30	-	200	500	20	-	

Source: Field Survey, 1992

Annex 6.2 Labor Requirements

Crop	Area (ha)	Person Days Per Hectare												Total person days
		J	F	M	A	M	J	J	A	S	O	N	D	
B.Aus	2,899			15	35	35	15	30	10					140
T.Aus (L)	181			10	40	30	15	25	25	15				160
T.Aus (H)	65			10	40	30	20	20	25	20				165
T. Aman (L)	3,943						10	35	30	10	10	15	20	130
T. Aman (H)	534						10	40	30	25	15	25	25	170
Boro (H)	555	30	30	25	25	25	20					10	30	195
Chili	828	30	30	15	20	30	20							145
S. Potato	151	10	10	20								20	30	90
Pulses	938		10	10								10	10	40
Oilseeds	92	20	10	10	20							10	20	90
Wheat	146	10	10	10	30							30	25	115
Watermelon	133	50	20	20	30	30						50	50	250
Total person		53	57	90	152	152	120	252	169	57	47	102	135	1,387

Source: Field Survey, 1992

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Annex 7

Plant Species of Economic Importance in the Bhelumia Bheduria Study Area

Local Name	English Name	Scientific Name	Abundance (%)	Household (%)	Average No./ Household
		FRUITS, OTHER USES			
Aam	Mango	*Mangifera indica*	4	71.00	17.60
Alachi	Cardamum	*Elettaria cardamomum*	0.03	0.50	0.12
Amrah	Hog plum	*Spondias spp.*	1.00	20.30	4.84
Ata (Nona)	Bullockheart	*Annona reticulata*	0.5	8.00	0.43
Badam	Indian almond	*Terminalia catappa*	0.2	9.40	1.09
Bel	Wood apple	*Aegle marmelos*		2.10	0.10
Boroi	Plum	*Zizyphus jujuba*	0.1	2.00	0.50
Chalita	Elephant apple	*Dillenia indica*	0.02	7.30	0.25
Dalim	Pomegranate	*Punica granatum*	0.3	0.90	0.01
Deoa	Monkey dack	*Artocarpus lacucha*	0.03	5.40	0.24
Gab	Mangosteen	*Diospyros spp.*	0.3	16.50	5.08
Jalpai	Olive	*Olea europaea*	0.03	.70	0.01
Jaam	Blackberry	*Eugenia jambolana*	0.3	18.90	1.26
Jambura	Grapefruit	*Citrus grandis*	0.2	2.00	0.10
Jamrul	Wax apple	*Eugenia javanica*	0.03	5.20	0.12
Kala	Banana/Plantain	*Musa spp.*	23	75.00	102.48
Kamala	Orange	*Citrus reticulata*	0.02	1.00	0.03
Kamranga	Carambola	*Averrhoa carambola*	0.02	4.30	0.10
Kanthal	Jackfruit	*Artocarpus heterophyllus*	4	32.30	2.88
Karamcha	Karanda	*Carissa carandus*	0.01	0.50	0.25
Khejur	Date palm	*Phoenix sylvestris*	3.0	43.4	11.76
Lebu	Lemon	*Citrus spp.*	0.1	6.13	0.29
Lichu	Litchi	*Litchi chinensis*	0.03	0.94	0.12
Narikel	Coconut	*Cocos nucifera*	2.0	45.3	8.13
Pepe	Papaya	*Carica papaya*	0.4	16.51	2.08
Peyara	Guava	*Psidium guajava*	0.3	9.70	2.58
Safeda	Sapota	*Achras sapota*	0.01	0.24	0.01
Sharifa	Custard apple	*Annona squamosa*	0.1	3.54	0.38
Supari	Betelnut	*Areca catechu*	27.0	81.13	117.82

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Local Name	English Name	Scientific Name	Abundance (%)	Household (%)	Average No./ Household
Tal	Palm	*Borassus flabellifer*	6.0	12.50	1.09
Tetul	Tamarind	*Tamarindus indica*	0.2	11.32	0.70
		TIMBER, OTHER USES			
Akashmoni	Acacia tree	*Acacia moniliformis*	0.01	0.24	0.20
Arjun	White murdha	*Terminalia arjuna*	0.01	0.47	0.03
Babla	Gum arabic	*Acacia spp.*	0.01	0.71	0.29
Bansh	Bamboo	*Bambusa spp.*	0.01	0.10	0.02
Chambal		*Artocarpus chaplasha*	0.1	4.95	0.29
Debdaru		*Polyalthia longifolia*	0.1	0.94	0.02
Gamari	White teak	*Gumelina arboria*	0.01	0.25	0.10
Hijal	Indian oak	*Barringtonia acutangula*	0.01	0.24	0.01
Hunal		*Oroxylum indicum*	0.02	0.24	0.03
Jhiga		*Lannea grandis*	2	25.94	12.78
Jilapi		*Inga dulcis*	0.04	0.24	0.13
Koroi		*Albizia spp.*	1.0	18.87	4.34
Krishnachura		*Delonix regia*	0.3	0.71	0.10
Mahogany	Mahogany	*Swietenia mahogany*	0.3	18.16	5.42
Mandar	Coral tree	*Erythrina variegata*	15.0	76.98	49.87
Royna		*Aphanamixis polystachya*	0.1	5.19	1.27
Sajna	Round drum	*Moringa olifera*	0.02	0.24	0.04
Sal/gajari		*Shorea robusta*	0.2	0.47	0.10
Shimul	Silk cotton	*Bombax malabaricum*	0.1	4.72	1.20
Sisoo	Sisoo	*Dalbergia sisoo*	0.04	3.30	0.28
Sonal/B.Lath		*Cassia fistula*	0.01	1.18	0.20
Sristri	Raintree	*Samanea saman*	7.0	71.70	23.97
Tejpata	Bay leaf	*Pimenta acris*	0.04	4.72	0.20
Telikadam	Ipil-Ipil	*Leucaena leucocephala*	0.03	5.90	1.73
Varanda	Castor oil	*Ricinus communis*	0.02	2.47	2.13
-		VEGETABLES, SPICES			
Barbati	String bean	*Vigna sinensis*		27.36	
Begun	Eggplant	*Solanum melongena*		12.26	
Danta	Amaranths	*Amaranths lividus*		5.66	
Dharas	Okra	*Hibiscus esculentus*		0.71	

Local Name	English Name	Scientific Name	Abundance (%)	Household (%)	Average No./ Household
Dhundhul	Smooth loofah	*Lufa cylindrica*		2.36	
Halud	Turmeric	*Curcuma longa*		2.00	
Jhinga	Ribbed gourd	*Luffa acutangula*		5.66	
Kachu	Arum	*Colocasia spp.*		2.83	
Kankrol	Spiny gourd	*Momordica cochinchinensis*			
Korolla	Bitter gourd	*Momordica chantea*		1.42	
Kumra	Sweet gourd	*Cucurbita maxima*		25.00	
Lalshak	Red amaranths	*Amaranthus gangeticus*		14.86	
Lao	Bottle gourd	*Lageneria vulgaris*		75.00	
Marich	Chili	*Capcicum spp.*		3.77	
Mou sim	Country bean	*Dolichos lablab*		0.71	
Mula	Radish	*Raphanus sativus*		7.55	
Palong shak	Spinach	*Spinacea oleracea*		0.94	
Pan	Betel leaf	*Peper betel*			
Patol	Pul wal	*Trichosanthes diocia*		1.18	
Peaj	Onion	*Allium cepa*		4.48	
Puishak	Indian spinach	*Basella alba*		7.31	
Rekha	Snake gourd	*Trichosanthes anguina*		7.55	
Rosun	Garlic	*Allium sativum*			
Shosha	Cucumber	*Cumis sativus*		0.24	
Sim	Country bean	*Dolichos lablab*		71.7	
Tarmuj	Watermelon	*Citrulus vulgaris*			

Source: Household Baseline Survey, 1992

Annex 8

Biomass Energy Sources and Use in the Bhelumia-Bheduria Study Area

Annex 8.1 Energy Sources and Proportional Contribution (kg) Per Household by Mouza

Mouza	Straw	Wood	Leaves	Dhaincha	Hogla	Dung	Husk	Total
Pangasia	148	105	96	27	0	0	0	376
Char Samaiya	589	469	145	45	17	17	0	1282
Char Bheduria	2292	2498	120	103	67	0	5	5018
Char Ramesh	1223	913	497	59	18	55	0	2747
Paschim Charkali	1052	1220	402	30	0	0	0	2704
Bagmara	1236	166	191	22	0	20	0	1635
Chandra Prashad	1515	1632	856	161	14	0	0	4178
Char Chandra Prashad	375	323	124	131	0	14	0	967
Kunjaputti	837	1268	870	88	10	0	0	3073
Char Hossain	250	128	64	15	5	5	0	467
Char Gazi	715	235	102	32	31	27	0	1111
Tum Char	230	390	29	51	0	0	0	700
Total	10462	9347	3496	764	162	138	5	24258
Percentages	43.0	38.3	14.4	3.13	0.6	0.55	0.02	100.0

Source: Household Baseline Survey, 1992

Annex 8.2 Qualities and Energy Efficiency of Firewood Species

Species	Weight (kg/cft*)	Specific Gravity	Calorific Value (Kcal/kg**)
Am (*Mangifera indica*)	21	-	-
Arjun (*Terminalia arjuna*)	29	0.74	5,030-5,128
Deshi Badam (*Terminalia catappa*)	15	0.46	4,398
Hijal (*Barringtonia acutangula*)	18	-	-
Khejur (*Phoenix sylvestris*)	18	-	-
Mahogany (*Swietenia mahogany*)	20	0.63	-
Mandar (*Erythrina spp.*)	9	0.20	4,307
Neem (*Azadirachta indica*)	24	0.85	5,000
Raintree (*Samanea saman*)	24	0.50	4,550
Shaora (*Strebulus asper*)	21	-	-
Shimul (*Bombax malabaricum*)	11	0.39	4,885
Sisoo (*Dalbergia sisoo*)	23	0.82	4,903-5,175
Supari (*Areca catechu*)	28	0.80	5,444
Tal (*Borassus flabellifer*)	31	-	-
Teli Kadam (*Leucaena spp.*)	-	-	4,200-4,600
Tetul (*Tamarindus indica*)	38	-	-

Source: RRA (K.U. Ahmad 1984; ** Alam and Mohiuddin 1992)*

Annex 9

Wildlife Species in Bhelumia-Bheduria Study Area

CODES USED IN THE TABLES:
STATUS: C = Common, UC = Uncommon, E = Endangered, T = Threatened, R = Resident, M = Migratory
FOOD BEHAVIOR: I = Insectivorous, P = Piscivorous, G = Granivorous, A = Predator, MO = Molluscs/crustaceans, F = Fructivorous, V = Aquatic vegetation, S = Scavenger, H = Herbivorous, and O = Other

Bangla name	English name	Scientific name	Remarks		
		REPTILES			
Terrestrial:					
Kochop	Tortoise	*Kachuga tecta*	C	R	H
Tiktikee	Wall lizard	*Hemidactylus*	C	R	I
Tokkhok	Gecko	*Gecko gecko*	UC	R	I
Roktochosa	Garden lizard	*Calotes* sp.	C	R	I
Angila	Skink	*Mabuya carinata*	C	R	I
Kalo gui	Monitor lizard	*Varanus bengalensis*	T	R	A
Atail kacho	Blind snake	*Typlina porrectus*	C	R	I
Tashira	Striped K. back	*Amphiesma stolata*	C	R	I
Nila sap	B.B. tree snake	*Dendrilaphis tristis*	C	R	I
Draj sap	Rat snake	*Ptyas mucosus*	C	R	A
Gokhra sap	Cobra	*Naja naja*	C	R	A
Shonkhine	Banded krait	*Bungarus fasciatus*	C	R	A
Aquatic:					
Kasim	Flap-shell turtle	*Lissemys punctata*	C	R	P
Kasim	Soft-shell turtle	*Chitra indica*	C	R	P
Sona gui	Yellow lizard	*Varanus flaviscence*	T	R	P/A
Dora sap	C.K. watersnake	*Xenochrophis piscator*	C	R	P
Matia sap	C. watersnake	*Enhydris enhydris*	C	R	P
Lal dora	Dark B.M. snake	*Xenochrophis cerasogaster*	C	R	P
		AMPHIBIANS			
Sona bang	Bullfrog	*Rana tigrina*	T	R	I
Kotkoti bang	Cricket frog	*R. cynophyctis*	C	R	I
Kotkoti bang	Skipper frog	*R. limnecharis*	C	R	I
Kuno bang	Toad	*Bufo melanostictus*	C	R	I

Bangla name	English name	Scientific name	Remarks		
		BIRDS			
Terrestrial					
Bhuban cheel	Black kite	*Milvus migrans*	C	M/R	S
Sada cheel	Black-wing kite	*Elanus cacruleus*	E	R	I/A
Showkoon	White-backed Vulture	*Gyps bengalensis*	T	R	S
Tilla baz	Crested serpent eagle	*Spilornis cheela*	C	R	A
Baz	Kestrel	*Falco tinnunculus*	C	R/M	A
Lal ghughu	Red turtle dove	*Streptopelia tranquebarica*	C	R	G
Jalali cobutor	Blue R. pigeon	*Columba libia*	C	R	G
Mala gugu	Ring dove	*Streptopelia dccaocto*	C	R	G
Botcol	Green pigeon	*Treron pompadora*	C	R	G/F
Tila ghughu	Spotted dove	*Streptopelia chinensis*	C	R	G
Teya	Parakeet	*Psittacula krameri*	C	R	G
Chok galoo	Hawk cuckoo	*Cuculus varius*	C	R	I
	Plaintive cuckoo	*Cacomantis merulinus*	C	R	I
Kokil	Koel	*Eudynamys scolopacea*	C	R	I
Kanakoka	Lesser coucal	*Centropus bengalensis*	C	R	A
Lokhipacha	Barn owl	*Tyto alba*	UC	R	A
	Scops owl	*Otus sunia*	C	R	A
	Brown hawk owl	*Ninox scutulata*	C	R	A
Bhutum pacha	Spotted owlet	*Athena brama*	C	R	A
	Red-wing lark	*Mirafra erythroptctra*	C	R	I
	Bush lark	*Mirafra assamica*	C	R	I
	Tree pipit	*Anthus trivialis*	C	R	I
	C. wood shrike	*Tephrodornis pondicerianus*	C	R	I
	Black W. cuckoo shrike	*Coracina melaschistos*	C	M	I
	Small minivet	*Pericrocotus cinnamomeus*	C	R	I
	White tailed fantail fly-catcher	*Rhipidura albicollis*	C	R	I
	Grey H. flycatcher	*Culicicapa ceylonensis*	C	R	I
Nishi chor	Nightjar	*Caprimulgus macrunus*	UC	R	I
	Ashy swallow shrike	*Cypsiurus balasiensis*	C	M	I
	Chestnut headed bee eater	*Merops leschenaulti*	C	R	I
Sui chora	Common bee eater	*Merops orientalis*	C	R	I
	Dusky leaf warbler	*Phylloscopus fuscatus*	C	M	I

Bangla name	English name	Scientific name	Remarks		
	Fantail warbler	*Cisticola exilis*	C	R	I
	Inornate warbler	*Phylloscopus inornatus*	C	M	I
	Greenish warbler	*Phylloscopus trochiloides*	C	M	I
	Collared bush chat	*Saxicola torquata*	C	M	I
	Pied bush chat	*S. jerdoni*	C	M	I
Nilkontho	Roller	*Coracias bengalensis*	C	R	I
Huopu	Hoopoe	*Upupa epops*	C	R	I
	Lineated barbet	*Megalaima lineata*	UC	R	F
Boshonto baure	Coppersmith barbet	*Megalaima haemacephala*	C	R	F
	Rufous woodpecker	*Micropternus brachyurus*	C	R	I
Kat thokra	Golden-backed woodpecker	*Dinopium javanense*	C	R	I
Shobuz kat thokra	Scaly-bellied green woodpecker	*Picus myrmecophoneus*	C	R	I
Ababil	Common swallow	*Hirundo rustica*	C	M	I
	House swift	*Apus affinis*	C	R	I
	Palm swift	*Cypsiurus parvas*	C	R	I
Shipahi bulbul	Red-whiskered bulbul	*Pycnonotus jocosus*	C	R	I
Bulbul	Red-vented bulbul	*Pycnonotus cafer*	C	R	I/F
Doyal	Magpie robin	*Copsychus saularis*	C	R	I
Taowfique	Iora	*Aegithina tiphia*	C	R	I
	Grey tit	*Parus major*	UC	R	I
Tuntune	Tailor bird	*Orthotomus sutorius*	C	R	I
Sat bhai	Common babbler	*Turdoides striatus*	C	R	I
Tila munia	Spotted munia	*Lonchura punctulata*	C	R	G
Kalo munia	Black-headed munia	*Lonchura malacca*	C	R	G
	Purple-rumped sunbird	*Nectarinia zeylonica*	C	R	O
Mautushi	Purple sunbird	*Nectarinia asiatica*	C	R	O
Kutum	Black-headed oriole	*Oriolus chinensis*	C	R	I/F
	Long-tailed shrike	*Lanius schach*	C	R	I
	Brown shrike	*Lanius cristatus*	C	M	I
Finga	Black drongo	*Dicrurus macrocercus*	C	R	I
Harichacha	Tree pie	*Dendrocitta vagabunda*	C	R	I
Pati kak	House crow	*Corvus splendens*	C	R	S
Dar kak	Jungle crow	*Corvus macrorynchos*	C	R	S
Bhat salik	Common myna	*Acridotheres tristis*	C	R	G
Go salik	Pied myna	*Sturnus contra*	C	R	I

Bangla name	English name	Scientific name	Remarks		
Jhuti salik	Jungle myna	*Acridotheres fuscus*	C	R	I
Kat shalik	Grey H. myna	*Sturnus malabaricus*	C	R	I
Chorui	House sparrow	*Passer domesticus*	C	R	G
	Paddy field pipit	*Anthus novaeseelandiae*	C	R	I
	Yellow B. bunting	*Emberiza aureola*	C	R	G
Babui	Baya	*Ploceus philippinus*	UC	R	G
Aquatic					
Pancowri	Little cormorant	*Phalacrocorax carto*		R	P
Go bok	Cattle egret	*Bubulcus ibis*	C	R	I
Boro bok	Great egret	*Egretta alba*	C	R	P
Sada bok	Little egret	*Egretta garzetta*	C	R	I/P
Sada bok	Intermediate egret	*Egretta intermedia*	C	R	I/MO
Kali bok	Black bittern	*Ixobrychus flavicollis*	UC	R	P
Lal bok	Cinnamon bittern	*Ixobrychus cinnanmeocus*	UC	R	I/P
Kani bok	Pond heron	*Ardeola grayii*	C	R	P/I/MO
Nishi bok	Night heron	*Nycticorax nycticorax*	UC	R	P
Nol bok	Grey heron	*Ardea cinerea*	T	R	P
Chonkho cheel	Brahminy kite	*Haliaster indus*	C	R	P
Bali hash	Lesser whistling teal	*Dendrocygna javanica*	C	R	P
Choto duburi	Little grebe	*Podiceps ruficollis*	T	R	V
Mechopacha	Brown fish owl	*Bubo zeylonensis*	E	R	P
	Pallas's Fishing eagle	*Halieetus leucoryphus*	E	R	P
Kura	Grey-headed fishing eagle	*Icyhthophaga ichthyaetus*	T	R	P
	Pied harrier	*Circus melanoleucos*	C	M	O/P
	Pheasant-tailed jacana	*Hydrophasianus chirurgus*	UC	R	MO
Jal pipi	Bronze-winged jacana	*Metopidius indicus*	C	R	V
Dahuk	Water hen	*Gallicrex cinerea*	C	R	P
Kalo pipi	Coot	*Fulica atra*	UC	R	V
Hot titi	Red-wattled lapwing	*Vanellus indicus*	C	R	V
	Golden plover	*Pluvialis fulva*	C	M	I
	Little ring plover	*Charadrius dubius*	C	M	V/MO
	Pintail snipe	*Gallinago stenura*	C	M	V/MO
	Fantail snipe	*Gallinago gallinago*	C	M	V/MO

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Bangla name	English name	Scientific name	Remarks		
	Woodcock	*Scolopax rusticola*	C	M	V/MO
	Common sandpiper	*Tringa hypoleucos*	C	M	V/MO
	Wood sandpiper	*Tringa glareola*	C	M	V/MO
	Common red shank	*Tringa totanus*	C	M	I
	Common green shank	*Tringa nebularia*	C	M	I
	River tern	*Sterna hirundo*	UC	R	P
Choto machranga	Common kingfisher	*Alcedo atthis*	C	R	P
Machranga	White-throated kingfisher	*Halcyon pileata*	C	R	P
Dora mach ranga	Pied kingfisher	*Ceryle rudis*	UC	R	P
	White wagtail	*Motacilla alba*	C	R/M	I
	Pied wagtail	*Motacilla maderaspatensis*	UC	M	MO
	Grey wagtail	*Motacilla cinerea*	C	M	V
	Yellow wagtail	*Motacilla flaya*	C	M	MO
	Yellow-headed wagtail	*Motacilla citreola*	C	M	V
		MAMMALS			
Boro badur	Flying fox	*Pteropus giganteus*	UC	R	F
Badur	False vampire bat	*Megaderma lyra*	C	R	I
Khak shial	Jackal	*Canis aureus*	C	R	A
Shial	Fox	*Vulpes bengalensis*	C	R	O
Kattas	S.I. civet	*Viverina malaccensis*	C	R	A
Beje	Mongoose	*Herpestes edwardsi*	C	R	A
Indur	L. bandicoot rat	*Bandicota bengalensis*	C	R	G
	G. bandicoot rat	*Bandicota indica*	C	R	G
	House rat	*Rattus rattus*	C	R	O
Chika	I. Shrew	*Suncus murinus*	C	R	S
Sehsu	Gangetic dolphin	*Platanista gangetica*	E	R	P

Source: Field Survey, 1992

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Annex 10

Aquatic Biota of the Bhelumia-Bheduria Study Area

Annex 10.1 Plankton

	Plankton Concentration (H=High, M=Moderate, L=Low)				
Scientific Name	Pond	Canal	River	Creeks	Floodplain
Diatoms	-	L	L	M	M
Chlamydomonas	-	L	-	L	M
Phacus	-	L	-	L	L
Spirogyra	-	-	-	M + L	M
Microcystis (blue-green algae)	L	-	-	-	L + -
Cyclops	H	L	L	M	L
Daphnia	H	L	L	M	L
Vorticella sp	L	L	L	L	-
Rotifers	M	L	L	M	L

Source: Field Survey, 1992

Macroinvertebrates

Bangla name	Scientific name
Shamuk	*Pila globosa*
Jhinuk	*Lamellidens marginalis*
unidentified	Freshwater clam
Jhinuk	*Unio sp*
Gura kacho	*Tubifex sp*
Kacho	*Pheretima posthuma*
Insect larvae	

Source: Field Survey, 1992

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Annex 10.2 Aquatic Macrophytes

Bangla Name	Scientific Name
Hogla	*Typha spp*
Modhu	*Hygrophila auriculata*
Halencha	*Enhydra fluctuans*
Kalmi	*Ipomoea aquatica*
Dholkalmi	*Ipomoea fistulosa*
Ghechu	*Aponageton sp*
	Cryptocoryne sp
	Hydrilla sp
	Najas sp
Ram karalla	*Ottelia alismoides*
Jhangi	*Uricularia sp*
Chandmalla	*Nyphoides sp*
Topa pana	*Pistia stratiotes*
	Hygroryza sp
	Leeria sp
Kochuripana	*Eichhornia crassipes*
Cochopana	*Monochria sp*
Khudi pana	*Lemna minor*
Duck weed	*Spirodella sp*
Duck weed	*Wolffia arrhiza*
Guri shapla	

Source: Fleld Survey, 1992

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Annex 11

Water Quality Measurements Taken in Bhelumia-Bheduria Study Area

No.	Sampling Site	Mouza	Temp (°F)	pH	DO (mg\l)	Ammonia (mg\l)	Nitrites (mg\l)	CO_2 (mg\l)
1	Pond	Bheduria	82	7.5	8	1.0	Nil	2.5
2	Pond	Bheduria	80	7.8	7	0.8	Nil	3
3	Pond	Char Samaiya	82	8.0	8	0.6	Nil	3
4	Pond	Kunjaputti	81	8.0	10	0.5	Nil	3
5	Pond	C.Prashad	82	7.5	3	1.0	.01	6
6	Pond	CC.Prashad	82	8.0	8	0.8	Nil	2.5
7	Pond	Char Gazi	80	7.5	2	1.2	0.05	4
8	Pond	Tum Char	81	7.8	8	0.2	Nil	2
9	Gazir Khal	Char Gazi	88	7.3	9	0.8	Nil	1
10	Bheduria Khal	Tum Char	84	7.5	6	0.2	Nil	2
11	Darogar Khal (Low tide)	Pangasia	84	8.0	7	0.5	Nil	2
	(High tide)		82	8.0	9	0.5	Nil	2
12	Napiter Khal	Char Chandra Prashad	82	7.5	8.0	0.4	Nil	3
13	Tetulia River	Char Bheduria	80	7.8	7	0.2	0.01	3
14	Tetulia River	Patabunia	81	7.7	6	0.2	0.02	4
15	Jangalia River (near Bholaghat)		80	7.9	8	0.5	0.03	5

Source: Field Survey, 1992

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Annex 12

Fish Species Occurring in Bhelumia-Bheduria Study Area

Codes:

Habitat: R = River, C = Canal, CR = Creeks, P = Pond, and ALL = Various water bodies
Status: F = Fairly Common, C = Common, and R = Rare

Bangla Name	Scientific Name	Status	Habitat
Air	*Mystus aor*	F	R C
Baacha	*Eutropiicthys vacha*	C	R
Baim	*Mastacembelus armatus*	C	ALL
Bata	*Labio bata*	C	R P
Batashi	*Pseuttotropius atheronoides*	C	ALL
Bele	*Glossogobius giuris*	C	R C CR
Bheda	*Nandus nandus*	R	P
Boal	*Wallago attu*	F	ALL
Bojori tengra	*Mystus tengra*	C	R C
Chanda	*Chanda nama*	C	ALL
Chapila	*Gudusia chapra*	C	ALL
Chela	*Oxygaster bacaila*	C	ALL
Chep chela	*Chela atpar*	R	ALL
Chetal	*Notopterus chital*	R	R C P
Chingree icha	*Caridina gracilirostris*	F	ALL
Darkina	*Esomus dauricus*	C	ALL
Foli	*Notopterus notopterus*	C	R C P
Ghaura	*Clupisoma garua*	C	R
Ghonia	*Labio gonius*	R	R P
Golda chringree	*Macrobrachium rosenbergii*	F	ALL
Golsha	*Mystus bleekeri*	C	R
Gozar	*Canna marulius*	R	P
Ilish	*Hilsha ilisha*	F	R
Kajuli	*Ailia coila*	R	ALL
Kalibaush	*Labeo calbasu*	R	R P
Kanchki	*Corica soboma*	C	R
Kani pabda	*Ompok bimaculatus*	C	R C

Bangla Name	Scientific Name	Status	Habitat
Katla	*Catla catla*	C	R P
Kholisha	*Colisa fasciata*	C	ALL
Koi	*Anabas testudineus*	C	P C CR
Magur	*Clarius batracus*	C	C CR P
Mola	*Amblypharyngoden microlepis*	C	ALL
Mrigal	*Cirrhinus mrigala*	C	R P
Pabda	*Ompok pabda*	C	R C
Pangas	*Pangasius pangasius*	F	R C
Poa	*Pama pama*	C	R
Punti	*Puntius puntio*	C	ALL
Reyeg	*Cirrhinus reba*	R	R P
Rita	*Rita rita*	R	R
Rui	*Labeo rohita*	C	R P
Shada chewa	*Tryauchen vagina*	F	R
Shilong	*Silonia silondia*	C	R
Shing	*Heteropneustes fossilis*	C	C CR P
Shol	*Channa striatus*	R	P
Shorpunti	*Puntius sarana*	C	R
Taki	*Channa Punctatus*	R	P CR
Tara baim	*Macrognathus aculeatus*	R	C CR P
Tengra	*Batasio tengra*	C	ALL
Titpunti	*Puntius ticto*	C	ALL
Topshi	*Polynemus sexfilis*	R	R

Source: Field Survey, 1992

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Annex 13

Breeding, Migration, and Extraction Periods of Commercially Important Fish

Species	Gravid Available	Spawning Periods	Spawning Grounds	Rearing Areas	Rearing Periods	Extraction Period		Remarks
						Peak	Lean	
Hilsha	Mid. Jan-Mid. Aug	Oct-Jan.	Upstream	Upstream, sea	6 - 8 months	Jun-Sep	Oct-May	Jatka catch Oct-Feb.
Shrimp	Jun-Jul	Mid Jul.	Downstream	Upper narrow canals, creeks	Whole year	Jul-Nov	Dec-Jan	Adjacent chars, low areas, and creeks are shrimp habitat
Air, Boal	Jun-Jul	Jul-Aug	Down to Tetulia River	River, major canals	Whole year	Jul-Oct	Nov-Jan	From Bheduria Khal & Tetulia River
Chewa, Chingree (Gura)	Dec-Jan	Mar-Apr	Tetulia River Char-land	Tetulia River, canals	6 - 8 months	Nov-Mar		From Bindijal within project area & chars of adjacent areas
Pangus	May-Jul	Jun-Sep	Freshwater of southern part	Down to upstream	Whole year	June-Oct	Nov-May	In chapjal & also caught in hilsha nets
Carps			Upstream	Canals, rivers	Whole year	Jun-Sep		Spawn available in study area Jun - Jul, 5" to 7" long

Source: Field Survey, 1992

Annex 14

Annual Fish Production and Purchases in the Bhelumia-Bheduria Study Area

Markets/ Arots	Species	No. Cen- ters	Daily Pur- chase (kg)		Fishing Months		Rate (Taka/kg)		Annual purchase (Taka x 1000)		
			Peak	Lean	Peak	Lean	Peak	Lean	Peak	Lean	Total
Bhelumia Bazar	Shrimp, Air, Boal	3									1131
Napiter Khal	Hilsha	3	800	160	3	9	27	32	1944	1382	3326
Chatlar Khal	Hilsha	2	400		6		27		1944		1944
Banker Hat	Chewa and Gura chingree	2	300		4		35		1260		1260
Bank of Tetulia River	Hilsha	10	2000	300	4	8	40	45	9600	3240	12,840
Bhola from Bhelumia	All	All									11,314
Total per year											31,816,075

Source: Field Survey, 1992

Annex 15

Fishing Gear and Boats Used in Bhelumia-Bheduria Study Area

Annex 15.1 Fishing Gear Use

Gear Type	Cost (Taka)			No. Handlers	CPUE* (Taka)	Season	No. in Area	Species Caught
	Net	Boat	Engine					
Khuchijal	100			1	30-50	Year	150-200	Small fish
Jhakijal	300			1-2	100-200	Year	W/boat=211 W/O +200	Small fish, shrimp
Hooks	20-100	500-1,200		1-2	100-300	Year	144 W/Boat	Shrimp
Moijal	300			1-2	100-200	Year	+200	Small fish, shrimp
Sonjal	7,000	5,000		4-5	300-400	Oct-Mar	50	Air, boal, pangas, big shrimp
Chapjal	10,000-15,000	10,000	10,000-20,000	5-7	400-500	Oct-Mar	42	Air, boal, pangas, big shrimp
Berjal (small)	50,000-60,000	10,000-20,000		5-7	500-1,000	Year	151	Hilsha, faisha, poa
Berjal (Large)	100,000	20,000-30,000	30,000	10-12	1,000-2,000	Year	20	Hilsha, faisha, poa
Current jal	30,000-50,000	10,000-20,000	15,000-20,000 (Y/N)	3-5	1,000-2,000	Year	472	Hilsha, faisha, poa
Bindijal	7,000-8,000	3,000-5,000		6	400-500	Nov-Feb	32	Chewa, baila, shrimp, other small fish
Berjal	5,000-10,000	3,000-5,000	Sticks-300-500	2-3	200-500	Nov-Mar	20	All fish, shrimp
Katha	Tree branches = 300-500 for 6 months (Catch after every 15 days)			5-10	500-1,000	Year	W/boat 275 W/O +300	Carps, air, boal, shrimp
Mosarijal	125,000	10,000	30,000	10-12		Dec-May	7	Any fish
Hafsa	600,000-700,000	200,000	50,000	30-50	100,000-200,000	Dec-Feb	2	River & marine fish

Source: Field Survey, 1992

* CPUE = Cost Per Unit Effort

Annex 15.2 Distribution of Fishing Boats Using Different Gear Types in the Study Area

	Large				Small				
Canal	Current	Son/ Chap	Ber (Suta)	Total	Hooks	Khata	Bindi	Jhaki	Total
Uttar Majher Hat Khal	72	5	33	110	13	20	2	20	55
From Bheduria road to Launch Ghat	22	12	6	40	2	8	5	15	30
Chikonmala Kala	46	20	14	80	25	46	4	35	110
Bankerhat Khal	68	7	60	135	26	50	4	42	120
Somiter Bazaar	20	-	5	25	2	10	2	6	20
S.Bheduria Hajierhat Khal	40	10	10	60	19	8	3	22	52
Camper Khal	42	12	6	60	5	7	4	4	20
Doskhali Khal	20	5	5	30	12	20	2	22	56
Kunjaputti Khal	30	5	5	40	10	32	2	18	62
Napiter Khal	42	6	7	55	20	38	2	15	75
Chatler Khal	70	10	20	100	10	36	2	12	60
Other boats									150
Fishing Trawlers									7
Totals	472	92	171	735	144	275	32	211	819

Sources: Tax collection list for the Tetulla River, lease owners, and local people using the canals.

Annex 16

Culture Fish in the Bhelumia-Bheduria Study Area

Annex 16.1 Number of Culture Ponds

	Inundated			Noninundated			
Mouza	Large	Medium	Small	Large	Medium	Small	Total
Mid Bheduria	-	3	28	-	1	-	32
Paschim Char Pata	-	1	8	-	-	-	9
Pangasia	1	5	12	1	5	21	45
Uter Bheduria	4	18	133	6	7	6	174
Pata Bheduria	1	13	14	1	10+(5)*	21	65
Char Ramesh	3	22+(4)	136+(8)	3	33	63	272
Paschim Charkali	3	25	67+(6)	13	33	67	214
Char Samaiya	-	5	2	2+(2)	73+(6)	32	122
Char Karimuddin	-	-	-	-	-	-	0
Char Gazi	-	9+(1)	28+(2)	1	12	6	59
Char Hossain	-	-	13	-	-	1	14
Kunjaputti	2	60+(4)	87	1	18	5	177
Chandra Prashad	1	58	138	8	42+(1)	38	286
Char Chandra Prashad	4	18	12	4	20	31	89
Patabunia	-	-	-	-	-	-	0
Tum char	-	-	-	4	13	18+(1)	36
Bagmara	2	10	5+(1)	2	22	18	60
Subtotal	21	247+(9)	683+(17)	46+(2)	289+(12)	327+(1)	GT
GT	21	256	700	48	301	328	1654

Source: Field Survey, 1992

* Numbers in () = Pond fully covered by water hyacinth

Annex 16.2 Pond Classification, Expenditures, and Income

Type	Type/ Size	Size/area (dec.)	Annual Expend. (Tk)	Annual Income (Tk)	Number of Ponds	Minimum Income (Tk per Year)
Inundated	Large	≥66	None	800-2,000	21	16,800
	Medium	33-65	None	500-800	256	128,000
	Small	1-32	None	200-500	700	140,000
Not inundated	Large	≥66	≥3,000	≥10,000	48	480,000
	Medium	33-65	1,000-3,000	5,000-10,000	301	1,505,000
	Small	1-32	500-1,000	2,000-5,000	328	656,000

Source: Field Survey, 1992

Annex 17

Mouza Areas, Household Numbers, and Populations in the Bhelumia- Bheduria Study Area

Mouza	Area (km^2)	No. of Households	Population			
			Male	Female	Total	Density/km^2
Project Area						
Pangasia	1.90	388	1,118	1,052	2,170	1,142
Char Samaiya	5.51	500	1,542	1,366	2,908	528
Char Bheduria	8.85	1,716	4,852	4,489	9,341	1,055
Char Ramesh	4.94	1,070	2,998	2,743	5,741	1,162
Paschim Charkali	5.05	932	2,655	2,435	5,090	1,008
Bagmara	6.20	178	504	481	985	159
Chandra Prashad	8.55	1,362	3,795	3,479	7,274	851
Char Chandra Prashad	3.61	403	1,202	1,122	2,324	644
Kunjaputti	4.62	965	2,648	2,507	5,155	1,116
Tum char	2.50	194	546	532	1,078	431
Char Hossain	0.03	06	14	09	23	767
Char Gazi	1.48	94	290	265	555	375
Sub Total	53.24	7,808	22,164	20,480	42,644	801
Adjacent Area						
Char Bheduria	2.82	542	1,532	1,418	2,950	1,046
Char Hossain	0.91	195	456	285	741	814
Char Gazi	5.08	314	971	886	1,857	366
Subtotal	8.81	1,051	2,956	2,589	5,548	630
Totals	62.05	8,859	25,123	23,069	48,192	777

Source: BBS (1992a) and GIS

Note: 32% of the area of Pangasia, 76% of Char Bheduria, 69% of Bagmara, 3% of Char Hossain, and 23% of Char Gazi fall inside the project area. All other mouzas are 100% inside the study area.

Annex 18

Reasons for Establishment of Settlements Inside and Outside Bhelumia-Bheduria Project Area

	Reason (percent of households)							
	Inherited Land	Bought Land	Landlord Pressure	Kinship Connection	Marriage Connection	Riverbank Erosion	Other	Total
<u>Project Area</u>								
Pangasia	0.9	0.5	0	0.2	0	0.7	0	2.4
Char Samaiya	3.3	1.2	0	0.5	0	0.7	0.5	6.1
Char Bheduria	13.0	2.4	0	0.5	0.2	9.0	0.5	25.5
Char Ramesh	6.6	1.9	0	0.5	0.2	3.1	0.2	12.5
Paschim Charkali	4.0	0.5	0	0	0.2	3.3	0.9	9.0
Bagmara	2.1	0.7	0	0.2	0	0	0	3.1
Chandra Prashad	11.3	2.1	0.2	0.5	0.3	1.2	0.5	16.0
Char Chandra Prashad	1.9	1.4	0	0	0	0.9	0.7	5.0
Kunjaputti	9.7	0.2	0	0	0	0.7	0.4	11.3
Tum Char	1.2	0.5	0	0.2	0	0.2	0.2	2.4
Subtotal	52.0	11.3	0.2	2.6	0.9	19.9	4.0	92.9
<u>Adjacent Area</u>								
Char Hossain	1.4	0	0	0	0	0.9	0	2.4
Char Gazi	1.2	1.2	0.3	0.5	0	1.4	0.2	4.7
Subtotal	2.6	1.2	0.3	0.5	0	2.3	0.2	7.1
Study Area Total	56.6	12.5	0.5	3.1	0.9	22.2	4.2	100.0

Source: Household Baseline Survey, 1992

Annex 19

Age of Settlements by Mouza (by Percent)

	Age (in Years)							
Mouza	1-5	6-10	11-20	21-30	31-40	41-50	51+	Total
Inside Project								
Pangasia	0	0.5	0.5	0.2	0.2	0.5	0.5	2.4
Char Samaiya	0.2	0.9	1.9	1.2	0	0.5	1.4	6.1
Char Bheduria	5.4	5.4	3.5	2.6	1.4	1.4	5.7	25.5
Char Ramesh	1.4	1.2	2.4	1.2	1.2	2.1	3.1	12.5
Paschim Charkali	1.4	2.8	1.4	1.2	0.7	0.5	0.9	9.0
Bagmara	0.9	0	0.7	0.2	0.5	0.5	0.2	3.1
Chandra Prashad	2.1	1.7	3.1	1.2	1.4	.2	6.4	16.0
Char Ch. Prashad	0.5	1.2	0.2	0.5	0.7	0	1.7	4.7
Kunjaputti	0.9	0.9	0.5	0.5	3.1	2.8	2.4	11.1
Tum Char	0.2	0.9	0.5	0.5	0	0	0.5	2.6
Subtotal	13.2	15.6	14.7	9.1	9.2	8.5	22.7	92.9
Outside Project								
Char Hossain	0.2	0.2	1.4	0.5	0	0	0	2.4
Char Gazi	1.7	0.2	1.4	0.5	0.2	0.5	0.2	4.7
Subtotal	1.9	0.4	2.8	1.0	0.2	0.5	0.2	7.1
Study Area Total	15.1	16.0	17.5	10.1	9.4	9.0	22.9	100.0

Source: Household Baseline Survey, 1992

Annex 20

Primary Occupation of Household Heads

Mouza	Occupation (Percent of Households)											
	Farming (own)	Farming (own+share)	Share Cropper	Farm Labor	Nonfarm Labor	Service	Fishing	Boatman	Business	Broker	Other	Total
Project Area												
Pangasia	0	0.5	0.2	0.5	0.2	0.2	0.5	0.2	0	0	0	2.4
Char Samaiya	0.7	2.1	0	1.7	0.5	0.2	0.2	0.2	0.2	0.2	0	6.1
Char Bheduria	3.1	4.5	1.9	1.2	0.7	0.7	12.3	0	1.2	0	0	25.5
Char Ramesh	2.8	2.6	0.5	3.3	0.5	0.5	1.2	0.2	0.5	0.2	0.2	12.5
Paschim Charkali	0.5	2.1	0.7	1.2	1.4	0.2	1.4	0.2	0.5	0	0.7	9.0
Bagmara	0.5	0.9	0	0.9	0.2	0.2	0	0	0	0.2	0	3.1
Chandra Prashad	3.5	3.8	0	3.3	0.7	0.7	1.4	0.5	1.4	0	0.7	16.0
Char Chandra Prashad	0.9	0.9	0	0.2	0	0.7	1.7	0	0.2	0	0.2	5.0
Kunjaputti	1.4	2.4	0.2	4.5	0	0.2	0.9	0.2	0.5	0	0.7	11.1
Tum Char	0	0.7	0	0.5	0	0	0.5	0.2	0.5	0	0	2.4
Subtotal	13.4	20.5	3.5	17.3	4.3	3.8	20.0	1.9	5.0	0.7	2.6	92.9
Outside Project												
Char Hossain	0.5	0.7	0	0	0.2	0	0.5	0	0.2	0	0.2	2.4
Char Gazi	0.5	0.7	0.9	0.9	0	0.2	0.7	0.2	0.2	0.2	0	4.7
Subtotal	1.0	1.4	0.9	0.9	0.2	0.2	1.2	0.2	0.4	0.2	0.2	7.1
Study Area Total	14.4	21.9	4.5	18.2	4.5	4.0	21.2	2.1	5.4	0.9	2.8	100.0

Source: Household Baseline Survey, 1992

Annex 21

Water Transportation in the Bhelumia-Bheduria Study Area

Annex 21.1 Numbers and Uses of Boats by Mouza As Reported in Household Survey*

Mouza	Fishing	Agricultural	Household	Income	Total
Pangasia	4	0	0	0	4
Char Samaiya	0	0	0	2	2
Char Bheduria	27	5	0	14	46
Char Ramesh	2	0	0	8	10
Paschim Charkali	7	0	0	5	12
Bagmara	0	0	0	0	0
Chandra Prashad	1	10	2	5	18
Char Chandra Prashad	1	0	9	0	10
Kunjaputti	2	3	0	4	9
Char Hossain	1	0	0	0	1
Char Gazi	1	2	0	2	5
Tum Char	2	0	0	1	3
Total	48	20	11	41	120

Source: Field Survey, 1992

* 5 percent of all households in study area sampled

Annex 21.2 Paddy Carried by Boat from the Charlands of the Tetulia River

Khal	Trip	Total Paddy with Straw Carried by Boat (mt.)
Napiter Khal	75	37.5
Chatal Khal	120	60
Chargazir Khal	1,500	750
Shamitar hat	150	75
Total	1,845	922.5

Source: Field Survey, 1992

Annex 21.3 Distribution of Boats by Mouza

Canal	Large Fishing Boat	Small Fishing Boat
Uttar Majher Hat Khal	110	55
From Bheduria road to Launch ghat	40	30
Chikonmala Kala	80	110
Bankerhat Khal	135	120
Somiter Bazar	25	20
S.Bheduria Hajierhat khal	60	52
Camper Khal	60	20
Doskhali Khal	30	56
Kunjaputti Khal	40	62
Napiter Khal	55	75
Chatler Khal	100	60
Total	578	660

Source: Field Survey, 1992

Annex 22

Natural Hazards in the Bhelumia-Bheduria Study Area

Annex 22.1 Flooding Characteristics Within Last Five Years

Flood Variables	Location	1991	1990	1989	1988	1987
Maximum Flood Depth (Average in feet)	On Crop Field	4.41	3.96	4.84	4.63	4.15
	On Home yard	1.70	1.50	2.25	2.00	1.75
	On House Plinth	1.00	0.75	1.50	1.25	1.00
Maximum Flood Duration (Average Days)	On Crop Field	6.48	4.50	7.58	6.59	5.00
	On Home yard	3.50	2.00	3.75	3.60	2.50
	On House Plinth	1.50	1.00	2.00	1.50	1.00

Source: Household Baseline Survey, 1992

Annex 22.2 Hazards Affecting Sampled Households Within Last 10 Years

Number of Times Event Occurred in last 10 years	Percent (number in sample) Households Affected by Hazard in Last 10 Years					
	Flood	Storm Surge	Drought	Saline Intrusion	Erosion	Cyclone
1 - 3	30 (124)	89 (24)	87 (252)	57 (60)	32 (7)	13 (46)
4 - 6	60 (243)	11 (3)	9 (25)	23 (24)	14 (3)	40 (148)
7 - 9	10 (39)	0 (0)	4 (12)	15 (16)	18 (4)	45 (164)
10 >	<1 (2)	0 (0)	<1 (1)	6 (6)	36 (8)	3 (10)
Affected Total Percent	100 (408)	100 (27)	100 (290)	100 (106)	100 (22)	100 (368)
Percentage of Total Households Sampled (424)	96%	6%	68%	25%	5%	87%

Source: Household Baseline Survey, 1992

Annex 22.3 Average Damage (Tk.) to Households due to Flood and Tidal Surges in the Last Five Years (% in Parentheses)

Element at Risk	Damage due to Flood					Damage due to Tidal Surge				
	1987	1988	1989	1990	1991	1987	1988	1989	1990	1991
Household Assets	0	1420 (9.0)	1440 (8.0)	0	1451 (9.0)	0	0	36 (1.3)	500 (35)	333 (21)
House structure	0	1919 (12.0)	967 (5.4)	500 (7.5)	1305 (8.1)	0	0	125 (4.4)	0	198 (12.6)
Vegetable garden	152 (2.7)	611 (3.8)	519 (2.9)	268 (4.0)	718 (4.5)	0	0	11 (0.4)	0	2
Stored crops	0	0	0	0	2000 (12.5)	0	0	2050 (72.7)	0	900 (57)
Standing crops	3200 (57)	2869 (18.0)	3764 (21.0)	4076 (61.0)	6591 (41.0)	0	26 (100)	318 (11.3)	931 (65)	77 (4.9)
Livestock	0	6613 (41.6)	7000 (39.0)	0	467 (3.0)	0	0	0	0	0
Poultry	0	192 (1.2)	414 (2.3)	200 (3.0)	505 (3.1)	0	0	64 (2.3)	0	15 (1.0)
Tree/Tree crops	436 (7.8)	778 (9.9)	1277 (7.2)	352 (5.3)	461 (2.9)	0	0	56 (2.0)	0	54 (3.5)
Pond Fish	1824 (32.5)	1513 (9.5)	2553 (14.2)	1287 (19.2)	2546 (15.9)	0	0	160 (5.6)	0	0
Total	5612	15915	17934	6683	16044	0.0	26	2820	1431	1577

Source: Household Baseline Survey, 1992

Annex 22.4 Average Flood Damage (Tk.) by Mouza and Occupation in 1991 (% in parentheses)

	Mouza (listed by name in next table)											
Occupation	1	2	3	4	5	6	7	8	9	10	11	12
Farming Own Land	0	5000 (38.9)	67579 (93.3)	3082 (26.1)	935 (12.5)	150 (1.7)	1911 (22.8)	1700 (26.0)	530 (3.8)	175 (1.4)	300 (1.1)	0
Farming Own + Share	0	1470 (11.4)	423 (0.6)	1080 (9.1)	2483 (33.0)	7600 (85.0)	310 (3.7)	833 (12.8)	1234 (13.4)	5750 (46)	20200 (77.0)	1750
Share Cropping	400 (3.4)	0	1350 (.8)	1000 (8.5)	347 (4.6)	0	0	0	0	0	2000	0
Farm Labor	4000 (34.2)	900 (7.0)	350 (.5)	280 (2.4)	750 (10.0)	988 (11.0)	288 (3.4)	0	525 (5.7)	0	1067 (4.1)	0
Nonfarm Labor	0	0	700 (1.0)	230 (2.0)	320 (4.3)	200 (2.3)	217 (2.6)	0	0	1000 (8.4)	0	0
Service	0	500 (3.9)	350 (.5)	1600 (13.5)	700 (9.3)	0	3067 (36.7)	733 (11.3)	4000 (43.5)	0	1200 (4.6)	0
Fishing	1200 (10.2)	2000 (15.5)	1052 (1.5)	940 (8.0)	1580 (21.0)	0	250 (3.0)	3250 (49.9)	0	1150 (9.2)	1000 (3.8)	0
Boatman	200 (1.7)	0	0	150 (1.3)	0	0	150	1.8	0	0	0	0
Business	0	0	600 (0.8)	1050 (8.8)	0	0	205 (2.5)	0	350 (3.8)	400 (3.2)	300 (1.1)	0
Rickshaw Puller	0	0	0	0	0	0	0	0	0	0	0	0
Other	5925 (50.5)	3000 (23.3)	0 (0)	2400 (20.3)	400 (5.3)	0 (0)	1967 (23.5)	0 (0)	2750 (29.8)	4000 (32.2)	200 (0.7)	0 (0)
Total	11725 (100)	12870 (100)	72404 (100)	11812 (100)	7515 (100)	8938 (100)	8365 (100)	6516 (100)	9209 (100)	12475 (100)	26267 (100)	1750 (100)

Source: Household Baseline Survey, 1992

Annex 22.5 Resource Damage to Households Due to Flood in 1991 (% in parentheses)

	Average Flood Damage (in Tk.)								
Mouza	H/H Assets	Housing	Vegetable Garden	Stored Crop	Standing Crops	Live-stock	Poultry	Trees	Pond Fish
1.Pangasi	0.00	1333 (8.0)	100 (1.2)	0	1150 (2.1)	0	0	0	2950 (8.6)
2.C.Samaiya	200 (1.95)	1644 (10.0)	688 (8.3)	0	3875 (7.0)	0	0	1190 (16.3)	3275 (9.6)
3.C.Bhedu	1533 (15.0)	1215 (7.3)	401 (4.8)	0	17067 (31.2)	0	0	288 (4.0)	2156 (6.3)
4.C.Rames	300 (3.0)	1117 (6.7)	3366 (40.5)	0	2996 (5.5)	0	60 (2.0)	450 (6.2)	1950 (5.7)
5.P.Chark	0	991 (6.0)	416 (5.0)	6000 (100)	1638 (3.0)	100 (7.1)	550 (18.1)	181 (2.5)	2667 (7.8)
6.Bagmara	0	1500 (9.0)	425 (5.10)	0	4943 (9.0)	0	0	1542 (21.0)	5050 (14.7)
7.Chandra	4120 (40.30)	952 (5.8)	269 (3.3)	0	1876 (3.4)	0	0	188 (2.6)	2467 (7.2)
8.C.Chandra	0	2111 (12.7)	375 (4.5)	0	3778 (7.0)	300 (21.4)	250 (8.2)	1065 (14.6)	4750 (13.9)
9.Kunja	70 (.07)	1363 (8.2)	772 (9.3)	0	2652 (4.8)	0	0	221 (3.0)	1667 (4.9)
10.C.Hose	4000 (39.1)	1175 (7.0)	930 (11.2)	0	3600 (6.6)	1000 (71.5)	1200 (39.5)	564 (7.7)	1190 (3.5)
11.C.Gazi	0	1050 (6.3)	335 (4.0)	0	8377 (15.4)	0	275 (9.0)	399 (5.5)	1100 (3.2)
12.Tum C.	0	2176 (13.0)	238 (2.8)	0	2700 (5.0)	0	700 (23.2)	1207 (16.6)	5000 (14.6)
Total	10223	16618	8315	6000	54652	1400	3035	7295	34222
Percent	100	100	100	100	100	100	100	100	100

Source: Household Baseline Survey, 1992

Annex 22.6 People's Perception of Hazard Risks

Hazard	Level of Risk Perception (%)					Total (%)	Affected Households
	No Risk	Low	Moderate	High	Extreme		
Flood Risk	45.4	3.2	13.7	24.1	13.7	100	54.6
Storm Surge	95.9	0.8	1.7	1.1	0.5	100	4.1
Salinity	85.8	6.0	7.0	1.0	0.2	100	14.2
Cyclone	50.5	3.2	31.4	12.2	2.7	100	49.5
Drought	61.0	0.3	15.4	23.0	0.3	100	39.0
Erosion	95.0	1.0	1.0	2.0	1.0	100	5.0
Drainage Congestion	0	96.0	1.0	2.0	0.5	0.5	4.0

Source: Household Baseline Survey, 1992

Annex 22.7 Average Flood Damage Per Household (% in parentheses)

Mouza	Average Damage (Tk.) per Affected Household (%)				
	1991	1990	1989	1988	1987
Pangasia	3233	4725	800	2725	-
	(60)	(20)	(10)	(50)	-
Char Samaiya	4987	1531	3286	4167	3760
	(73)	(31)	(96)	(65)	(19)
Char Bheduria	3276	1340	3765	2672	1111
	(75)	(14)	(86)	(56)	(8)
Char Ramesh	2799	6875	3293	2427	1025
	(66)	(8)	(70)	(49)	(4)
Paschim Charkali	2065	-	2528	3254	-
	(89)	-	(66)	(61)	-
Bagmara	14306	8328	7936	8394	-
	(69)	(46)	(54)	(54)	-
Chandra Prashad	2178	695	2816	1940	1020
	(81)	(9)	(87)	(71)	(7)
Char Ch. Prashad	5714	1515	4572	2882	6000
	(71)	(19)	(48)	(43)	(10)
Kunjaputti	3054	3100	6870	5732	1150
	(64)	(6)	(47)	(85)	(4)
Char Hossain	5185	2200	4280	2140	-
	(100)	(20)	(50)	(60)	-
Char Gazi	4946	3016	4655	7938	-
	(70)	(30)	(55)	(20)	-
Tum Char	5835	1998	7321	3553	560
	(80)	(30)	(70)	(30)	(10)

Source: Household Baseline Survey, 1992

Annex 22.8 Average Drought Damage (% in parentheses)*

	Average Damage per Household (Tk.)			
Mauza	1991	1990	1989	1988
Pangasia	2700 (50)			
Char Samaiya	2600 (15)		5000 (4)	
Char Bheduria	2324 (25)		1400 (1)	
Char Ramesh	2312 (32)			4600 (4)
Paschim Charkali	2829 (18)		1167 (8)	3925 (11)
Bagmara	10350 (15)			
Chandra Prashad	860 (29)			
Char Ch. Prashad	6750 (19)	2750 (10)		
Kunjaputti	2044 (34)		5000 (4)	2625 (17)
Char Hossain	1000 (10)			
Char Gazi	6667 (15)		8000 (5)	
Tum Char	3500 (30)			

Source: Household Baseline Survey, 1992

* Blanks indicate no data and/or no damage reported

Annex 23

Agricultural Projections: Future Without Project

Annex 23.1 Estimated Future Crop Damage Without Project

	Damage-free		Damage by flood		Damage by pests		Production (ton)	Production lost by flood (ton)	Production lost by pest (ton)
Crop	ha	t/ha	ha	t/ha	ha	t/ha			
B. Aus(L)	1,156	1.7	825	0.5	699	1.0	3,077	990	489
T. Aus(L)	142	2.0					284		
T. Aus(H)	65	2.5					163		
B. Aus(H)	174	2.0	20	0.4			356	32	
T. Aman(L)	2,089	2.3	770	0.7	752	1.5	6,472	1,232	602
T. Aman(H)	518	2.9	90	0.6			1,556	207	
Boro(H)	589	4.3	150	1.1	105	2.0	2,908	480	242
Paddy							14,816	2,941	1,353
Pulses	581	0.70					407		
Chili	660	0.86	124	0.40			618	57	
S. Potato	150	12.0					1,800		
Watermelon	133	40					5,320		
Wheat	190	1.5					285		
Oilseed	95	0.5					48		
Vegetables	50	3.0					150		
Other rabi crops	49								

Source: Field Survey, 1992

Annex 23.2 Agriculture Labor Requirements for Crops Without Project

Crop	Area (ha)	Person Days per Hectare												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
B.Aus	2589			15	35	35	15	30	10					140
T.Aus(L)	181			10	40	30	15	25	25	15				160
T.Aus(H)	75			10	40	30	20	20	25	20				165
T.Aman(L)	3890						10	35	30	10	10	15	20	130
T.Aman(H)	587						10	40	30	25	15	25	25	170
Boro(H)	925	30	30	25	25	25	20					10	30	195
Chili	828	30	30	15	20	30	20							145
S. Potato	151	10	10	20								20	30	90
Pulses	918		10	10								10	10	40
Oilseeds	92	20	10	10	20							10	20	90
Wheat	146	10	10	10	30							30	25	115
Watermelon	133	50	20	20	30	30						50	50	250
Total(000 P/D)		64	68	94	151	150	123	243	167	58	48	106	146	1418

Source: Field Survey, 1992

Annex 24

Estimated Future Crop Production and Damage in the Bhelumia-Bheduria Study Area Following Project Development

Annex 24.1 Scenario 1 (no change in land types)

	Damage-free		Damage by pests			
Crop	ha	t/ha	ha	t/ha	Production (tonnes)	Production Lost to Pests (tonnes)
B. Aus (L)	1,595	1.7	560	1.0	3,272	392
T. Aus (L)	231	2.0	-	-	362	-
T. Aus (H)	125	2.5	-	-	312	-
B. Aus (H)	210	2.0	-	-	420	-
T. Aman (L)	3,074	2.3	816	1.5	8,294	653
T. Aman (H)	488	3.0	99	2.0	1,662	99
Boro (H)	907	4.3	212	2.0	4,324	488
Paddy	-	-	-	-	18,646	1,632
Pulses	894	0.70	-	-	626	-
Chilli	778	0.86	50	0.60	699	13
S. Potato	151	12.0	-	-	1,812	-
Watermelon	133	40	-	-	5,320	-
Wheat	146	1.5	-	-	219	-
Oilseed	92	0.5	-	-	46	-
Vegetables	50	3.0	-	-	150	-
Other rabi crops	54	-	-	-		-

Source: Field Survey, 1992

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Annex 24.2 Scenario 2 (change in land types)

Crop	Damage-free		Damage by pests		Production (tonnes)	Production lost to pests (tonnes)
	ha	t/ha	ha	t/ha		
B. Aus (L)	1,594	1.7	560	1.0	3,270	392
T. Aus (L)	231	2.0	-	-	362	-
T. Aus (H)	125	2.5	-	-	312	-
B. Aus (H)	210	2.0	-	-	420	-
T. Aman (L)	2,598	2.3	691	1.5	7,012	552
T. Aman (H)	986	3.0	202	2.0	3,362	202
Boro (H)	907	4.3	212	2.0	4,324	488
Paddy	-	-	-	-	19,062	1,634
Pulses	893	0.70	-	-	625	-
Chilli	778	0.86	50	0.60	699	13
S. Potato	151	12.0	-	-	1,812	-
Watermelon	133	40	-	-	5,320	-
Wheat	146	1.5	-	-	219	-
Oilseed	92	0.5	-	-	46	-
Vegetables	50	3.0	-	-	150	-
Other rabi crops	54	-	-	-	-	-

Source: Field Survey, 1992

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Annex 25

Agriculture Labor Requirements for Crops with Project

Annex 25.1 Agriculture Labor Requirements for Crops with Project Development (Scenario 1)

Crop	Area (ha)	Person Days Per Hectare												Total per-sons
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
B.Aus	2,365			15	35	35	15	30	10					140
T.Aus(L)	231			10	40	30	15	25	25	15				160
T.Aus(H)	125			10	40	30	20	20	25	20				165
T.Aman(L)	3,890						10	35	30	10	10	15	20	130
T.Aman(H)	587						10	40	30	25	15	25	25	170
Boro(H)	1,119	30	30	25	25	25	20					10	30	195
Chilli	828	30	30	15	20	30	20							145
S.Potato	151	10	10	20								20	30	90
Pulses	894		10	10								10	10	40
Oilseeds	92	20	10	10	20							10	20	90
Wheat	146	10	10	10	30							30	25	115
Watermelon	133	50	20	20	30	30						50	50	250
Total(000 P/D)		70	74	96	152	150	125	239	167	60	48	108	152	1440

Source: Field Survey, 1992

Annex 25.2 Agriculture Labor Requirements for Crops with Project Development (Scenario 2)

Crop	Area (ha)	Person Days Per Hectare												Total Persons
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
B.Aus	2,364			15	35	35	15	30	10					140
T.Aus(L)	231			10	40	30	15	25	25	15				160
T.Aus(H)	125			10	40	30	20	20	25	20				165
T.Aman(L)	3,289						10	35	30	10	10	15	20	130
T.Aman(H)	1,188						10	40	30	25	15	25	25	170
Boro(H)	1,119	30	30	25	25	25	20					10	30	195
Chilli	828	30	30	15	20	30	20							145
S.Potato	151	10	10	20								20	30	90
Pulses	893		10	10								10	10	40
Oilseeds	92	20	10	10	20							10	20	90
Wheat	146	10	10	10	30							30	25	115
Watermelon	133	50	20	20	30	30						50	50	250
Total(000 P/D)		70	74	96	152	150	125	242	167	69	51	114	155	1464

Source: Field Survey, 1992

Annex 26

Predicted Changes in Selected Socioeconomic Parameters in the Project Area (without project)

Parameter	1981	1991	2001	2011
Total Population	35,236	42,644	50,043	58,142
Growth Rate (%)	3.3	1.7	1.6	1.5
Density/km^2	662	801	940	1,092
Farm Population	22,747	26,962	31,640	36,760
Farm Households	4,062	4,993	6,457	7,991
Average Size of Farm Households (no.)	5.6	5.4	4.9	4.6
Average Farm Size (ha)	1.1	0.9	0.7	0.6
Total Land Availability per capita for Farm Population (ha)	0.23	0.20	0.17	0.14
Agricultural Land Availability per capita Farm Population (ha)	0.20	0.17	0.14	0.12
Agricultural Labor Requirements (man-days annually '000)	N.A.	1,386	1,402	1,418
Landlessness (%)	60	64	70	76
Gross Food grain availability per capita (rice and wheat)				
Per day (gm)	N.A.	934	826	718
Per year (kg)	N.A.	341	301	262
Total gross food availability (rice, wheat, potato, pulses, vegetables)				
Per day (gm)	N.A.	1,102	972	841
Per year (kg)	N.A.	402	355	307

Data for population, farm households, farm size and landlessness are based on Population Census 1981, 1991 and Agricultural Census 1983-84. Food availability data from FAP 16 Land Use Survey, 1992.

People's Perception of Flooding and Flood Related Problems and Suggested Solutions

Mouza	Union	Perceived Problems							Suggested Solutions					REMARKS
		TF	DC	Sa	Er	PA	HCI	LR	CE	CS	CCB	SCI	CR	
Project Area														
Pangasia	Illisha				*	*	*	*	*	*		*	*	Opening of the closed culvert near Matabbar bari in north Pangasia.
Char Samaiya	Char Samaiya	*	*	*		*	*		*	*	*	*		Sluice gate on Mazirhat Khal. Sluice gate on the offtake of Ujirer Khal.
Char Bheduria	Bheduria	*		*	*	*	*	*	*		*	*	*	Bridge on the Atharobari Khal and culverts on village roads. Construction of bridges and culverts on village roads.
Char Ramesh	Bheduria	*				*	*		*	*		*		Sluice gate on Kunjaputti and Saheber khals.
Paschim Charkali	Bheduria					*	*		*	*		*		Culverts on village roads. Sluice gate on Saheber Khal. Culverts on earthen roads.
Bagmara	Bhelumia	*	*			*			*	*		*		Sluice gate on Ujirer Khal.
Chandra Prashad	Bhelumia	*	*		*		*		*	*	*	*		Construction of unplanned roads creates drainage congestion. Sluice gate on Napiter, Chatler, Goaliar and Gazir khals. Bridge on Bhelumia Khal. Construction of culverts near Khan bari and Molla bari.

(CONTINUED)

Mouza	Union	Perceived Problems							Suggested Solutions					REMARKS
		TF	DC	Sa	Er	PA	HCI	LR	CE	CS	CCB	SCI	CR	
Char Chandra Prashad	Bhelumia	*	*	*	*	*	*			*	*	*		Sluice gate on Chatler and Napiter khals.
														Construction of culverts and cyclone shelter.
														Construction of embankment on the southwest of Tetulia.
Kunjaputti	Bhelumia	*	*	*					*		*			Culvert on the mid-point of Banglabazar and Bechu Khan bari.
														Sluice gate on the offtake of Dosh Khal and closure of Rishir Khal.
Tum Char	Bhelumia	*				*	*	*	*			*	*	Construction of bridge on the Bhelumia Khal.
														Construction of culverts in village roads.
Adjacent Area														
Char Hossain	Bhelumia	*	*			*	*	*	*	*	*	*	*	Sluice gate on the offtake of Satbaria Khal.
														Construction bridges and culverts.
Char Gazi	Bhelumia	*				*	*		*	*	*	*	*	Construction of cyclone shelter.
														Sluice gate on Satbaria and Camper Khal.
														Bridge on Gazir Khal and culverts on village roads.
Total (%)		83	50	33	33	83	83	33	91	75	58	91	41	

Source: Household Baseline Survey, 1992

TF = Tidal Flood
DC = Drainage Congestion
Sa = Salinity
Er = Erosion

PA = Pest Attack
HCI = High Cost of Inputs
LR = Lack of Roads

CE = Construction of Embankments
CS = Construction of Sluice gate
CCB = Construction of Culvert/Bridges
SCI = Supply of Inputs
CR = Construction of Roads