BANGLADESH FLOOD ACTION PLAN

FAP 16 Environmental Study

Environmental Impact Assessment
Case Study

SURMA-KUSHIYARA PROJECT

June 1992

ISPAN IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

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EXECUTIVE SUMMARY

The report presents a feasibility-level environmental impact assessment (EIA) of the proposed Surma-Kushiyara Project in the northwestern region of Bangladesh. The EIA was undertaken from July 1991 to April 1992 as an EIA case study under the FAP 16 Environmental Study component of the Bangladesh Flood Action Plan (FAP). The main objectives of the study were to test the EIA guidelines developed for use in the FAP, and to provide a basis for training of local consultants in EIA methodologies.

The project options selected for analysis were two sets of components commonly applied in flood control, drainage and irrigation projects (FCD/I) in Bangladesh, i.e. full flood protection embankments and submersible embankments.

The main water resource problems in the study area are flash flooding, occasionally severe seasonal flooding, drainage congestion and extensive siltation. The basic engineering dimensions and features of the project options were arbitrarily designed for the purposes of the EIA case study, and may or may not bear any resemblance to the project which is actually developed for the area in due course following more detailed hydrological data collection and project design. The third option considered for the purposes of the EIA was to avoid any further development.

The main activities undertaken included all the steps recommended in the EIA guidelines and were as follows:

- Outline of problem and management objectives
- Development of people's participation
- Definition of project interventions and alternatives
- Project action definition and analysis
- Field reconnaissance
- Scoping of important environmental components
- Bounding of the study area
- Conceptual modelling of environmental resource system
- Selection of environmental and socio-economic indicators
- Field data collection programs
- Data analysis
- Impact analysis, assessment and evaluation
- Mitigation recommendations
- Monitoring recommendations

A limited people's participation program was initiated as part of the socio-economic data collection program. Villagers, especially those living in the proximity of the main rivers, identified flash floods as the major issue, with erosion and waterlogging as secondary concerns. Villages in the vicinity of the rivers were strongly in favor of improved protection from flash floods through embankments; improved drainage and irrigation were secondary measures identified as desirable.

The impacts assessed for the two main options are indicated below and assume all practical mitigation measures fully incorporated in the project design or implemented during post-project conditions. Although technically practical and feasible, some of the mitigation options identified have not been fully or successfully implemented in past flood control projects in Bangladesh. Negative impacts are indicated by shading.

		Full Flood Protection	*Submersible Embankments*
Aquatic Resources			
Wetlands	Permanent wetland surface area	Somewhat beneficial	Slightly beneficial
	Seasonal wetland surface area	Somewhat negative	No impact
	Benthic/plankton diversity/abundance	No impact	No impact
	Macrophyte diversity and abundance	Somewhat negative	No impact
	Critical habitat for endangered spp.	No impact	No impact
Capture Fisheries	Major carp abundance/production	Negative	Somewhat negative
	Minor spp. abundance/production	Somewhat negative	Slightly negative
	Fish species diversity	Somewhat negative	Slightly negative
	Fish disease incidence	Negative	Slightly negative
Culture Fisheries	Fish production	Very beneficial	No impact
Wildlife	Wetland habitat diversity	Negative	No impact
	Wetland species diversity	Negative	No impact
Land Resources			
Agriculture	Dry season soil moisture	No impact	Beneficial
	Land type ratio	Beneficial	No impact
	Soil fertility	No impact	No impact
	Soil drainage	Beneficial	No impact
	Cropping patterns	Beneficial	Slightly beneficial
	Cropping intensity	Highly beneficial	No impact
	Cropping yields	Highly beneficial	Beneficial
	Crop damage	Very beneficial	Slightly beneficial
	Crop diversity	No impact	No impact
	Livestock abundance and diversity	Beneficial	Slightly beneficial
	Feed and fodder quantity and quality	Beneficial	Somewhat beneficial

Vegetation Resources	Natural vegetation	Somewhat beneficial	Slightly beneficial
	Homestead veg. abundance	Very beneficial	Somewhat beneficial
	Species diversity	Somewhat beneficial	Slightly beneficial
	Fuelwood abundance	Very beneficial	Somewhat beneficial
	Terrestrial habitat abundance	Very beneficial	No impact
Wildlife	Terrestrial habitat diversity	Somewhat beneficial	No impact
	Wildlife species diversity/abundance	Beneficial	No impact
	Commercially valuable wildlife	Slightly beneficial	No impact
	Wildlife pests	Somewhat negative	No impact
Human Resources			
Household Damage	Damage inside embanked area	Highly beneficial	Somewhat beneficial
	Damage outside embanked area	Somewhat negative	No impact
	Flood hazards	Very beneficial	No impact
Employment	Local employment - agriculture	Beneficial	Beneficial
	Local employment - fisheries	Slightly negative	No impact
	Total income generation	Beneficial	Somewhat beneficial
Nutrition	Nutritional quantity	Beneficial	No impact
	Nutritional quality	Somewhat negative	No impact
Health & Sanitation	Drinking water quality	No impact	No impact
	Waterborne disease incidence	No impact	No impact
Quality of Life	Quality of life	Beneficial	Somewhat beneficial
	Wealth	Beneficial	Slightly beneficial
	Equity	Slightly beneficial	Slightly beneficial

Full flood protection embankments would have negative impacts on wetlands, aquatic resources and on those sectors of the human economy related to floodplain fisheries. They would have positive impacts on agriculture, vegetation resources, terrestrial wildlife and on those sectors of the human economy related to agriculture and flood protection. Submersible embankments would have negative impacts on capture floodplain fisheries, and positive impacts on some agricultural, vegetation and human resource sectors. Submersible embankments in general would produce fewer impacts but also fewer benefits than full flood protection embankments. Mitigation would not be able to fully overcome all negative impacts to wetland and fishery resources, especially those resulting from full flood protection embankments. Even with practical mitigation measures in place, residual negative impacts would occur from full flood protective embankments, especially drainage congestion, deterioration of surface water quality, reduction in wetland quantity and quality, reduction in wetland species diversity, threats to the status of some endangered and threatened wildlife species, reduction in floodplain fisheries, and reduction in income, nutritional and other impacts to landless and poorer classes. Residual negative impacts for submersible embankments would be fewer and limited to reductions in flood plain fish production and in increased negative impacts to poorer social groups of people.

Recommendations are made for mitigation and monitoring programs. The institutional basis for implementation of mitigation and monitoring is poorly developed. For these reasons and since submersible embankments would produce fewer negative environmental impacts, they are recommended for further consideration over full flood protection.

The case study demonstrated the overall practicability of the EIA guidelines to be used in the Flood Action Plan. However, it also demonstrated the need for adequate field study efforts, very good and ongoing interactions between environmental and engineering study and design teams, adequate and up-to-date baseline maps, and a clear appreciation of the scale and complexity of land and water interactions if high quality and quantitative EIAs are to be produced.

ACKNOWLEDGEMENTS

The FAP 16 team members acknowledge the sincere and spontaneous cooperation and assistance received from the villagers and the elites of the Surma-Kushiyara study area during the field surveys. The experience and the wisdom of the people of the project area cannot be underestimated. The help and assistance of government and nongovernment organizations and individual officials were invaluable. The team wishes to thank in particular the Deputy Commissioner and Additional Deputy Commissioner (Revenue), Sylhet; Director, Soil Resources and Development Institute; Executive Engineer, Department of Public Health Engineering, Sylhet; Executive Engineer, Public Health Engineering, Zakiganj Upazila; Executive Engineer, Local Government Engineering Bureau, Sylhet; Executive Engineer, Local Government Engineering Bureau, Zakiganj Upazila; Superintending Engineer, Bangladesh Water Development Board, Sylhet; Executive Engineer, Hydrology Directorate, Zakiganj; Executive Engineer, Hydrology Directorate, Kanairghat; Upazila Nirbahi Officers and their associates in Zakiganj, Kanairghat and Beanibazar; Upazila Chairmen and their associates in Zakiganj, Kanairghat and Beanibazar; Officials of the Geological Survey of Bangladesh; Dhaka Meteorological Department, Dhaka and Friends in Village Development of Bangladesh.

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ABBREVIATIONS/ACRONYMS

BBS	-	Bangladesh Bureau of Statistics
BWDB	-	Bangladesh Water Development Board
cm	-	centimeter
DPHE	-	Department of Public Health Engineering
DSSTW	-	deep set shallow tube well
EPWAPDA	-	East Pakistan Water and Power Development Authority
EUS	-	Epizootic Ulcerative Syndrome
FCD/I	-	flood control drainage and irrigation
FPCO	-	Flood Plan Coordination Organization
g	-	gram
h	-	hour
ha	-	hectare
HTW	-	hand tube well
HYV	-	high yielding variety
IEC	-	important environmental component
ISPAN	-	Irrigation Support Project for Asia and the Near East
km	-	kilometer
m	-	meters
M^3/s	-	cubic meters per second
MCA	-	multicriteria analysis
meq	-	milliequivalent
mg/l	-	milligram per liter
mm	-	millimeter
O & M	-	operation and maintenance
PRA	-	participatory rural appraisal
RRA	-	rapid rural appraisal
STW	-	shallow tube well
t	-	tonne
Tk.	-	taka

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
Baniya	-	A local term meaning sudden onrush of water from overspill and through dyke breaches which causes extensive damage to crops, vegetation, livestock and property
Baor	-	Ox-bow lake
Barga	-	Share cropping
Bari	-	A homestead consisting of a number of households in which the residents are related to one another usually by kinship
Barsha	-	Normal seasonal flooding
Beel	-	A natural depression, the bottom of which normally remains wet throughout the year
Boro	-	Rice grown during *rabi* season
Bungari	-	A local name for smuggling
Dadan	-	Advance sale of crops before harvesting
District	-	An administrative unit comprising a number of *Upazilas* in the charge of a Deputy Commissioner
Doon	-	An indigenous irrigating appliance used for lifting surface water for irrigation from a height of less than a meter
Haor	-	Water body formed in the monsoon season by the inundation of several beels under one continuous water body
Jalmahal	-	A leased out water body
Kathi	-	A local weight unit of paddy, equivalent to 16.74 kg. of paddy
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 temporary flood-protection shelter made of bamboo on higher platform
Mirajdar	-	A local name for *Jalmahal* lease holder
Mouza	-	The smallest revenue unit
Monsoon	-	Period of rain starting in June and ending in October
Pahari Dhol	-	A local term for *baniya* or flash floods
Rabi	-	Winter season (November through February)
Taka	-	Name of Bangladesh currency
Union	-	Smallest administrative unit of the Local Government
Upazila	-	An administrative unit comprising a number of Unions

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Chapter 1

INTRODUCTION

1.1 Environmental Impact Assessment within the Flood Action Plan

Environmental considerations are of prime importance in the long-term planning and development of resource use in Bangladesh (Hoque *et al.* 1990; IUCN 1991) and more so in the Bangladesh Flood Action Plan (World Bank 1991). The requirement to fully consider environmental and social concerns in Flood Action Plan (FAP) development stems initially from concerns raised at the 1989 G7 Summit Meeting in Paris. At that meeting it was determined that any actions taken to alleviate flooding problems in Bangladesh be technically, economically, environmentally and socially sound. The environmental concern was placed in more substantial terms following the Second Conference on the FAP in Dhaka in March 1992 where donors agreed that all FAP projects should be subjected to Environmental Impact Assessments (EIA). The EIA is also a requirement in the draft Bangladesh Environment Preservation Ordinance of 1989.

All five regional study components of the FAP[*1] plus the priority pilot projects, such as the compartmentalization project, must address environmental and social factors in both the prefeasibility and feasibility stages of project development. These various regional and pilot projects are responsible for conducting the respective EIAs. A set of guidelines to direct the EIA process has been produced (ISPAN 1992a) and are intended to establish 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 to provide assistance in conducting EIAs according to the guidelines is in preparation in two volumes : volume 1 is in draft form (ISPAN 1992b) and volume 2 is expected in early- to mid-1992.

Environmental planning is addressed within the FAP at two levels : prefeasibility and feasibility. At the *prefeasibility* level, potential projects are defined by the regional study components within regional plans to reduce flood damage, improve drainage and (for some areas) provide for irrigation. At this level of initial environmental examination investigators screen environmental and socioeconomic concerns. This level of investigation is covered in the EIA guidelines, but case studies currently are *not* being undertaken due to constraints on time and resources. At the *feasibility* level, projects are identified and assessed in terms of engineering design, environmental and socioeconomic impacts, and economic evaluation. The EIA is a component of the overall project feasibility planning and evaluation, and provides the basic environmental and socioeconomic impact information for the overall project evaluation. Feasibility level EIA is also detailed in the EIA guidelines and case studies at this level *are* being undertaken. This report is the first of one of these EIA case studies.

The Guidelines for Project Assessment (FPCO 1992) require evaluation at one or more of three

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*1 **North West (FAP 2), North Central (FAP 3), South West (FAP 4), South East (FAP 5) and North East (FAP 6)** levels: economic values for preference or, failing this, a quantification of the impacts in some form or, failing this, a description of the expected impacts. It has been the custom in most countries to restrict EIAs to quantitative, qualitative, and other information and data pertaining to impacts and benefits. Economic and financial evaluation of impacts and resource losses is typically performed in a separate cost-benefit analysis. The case study presented here has adopted this procedure and thus presents impacts in quantitative and qualitative form only.

1.2 Objectives of EIA Case Studies

A variety of EIA guidelines, manuals, methods, techniques and philosophies are in current use, many of them by FAP donor and executing agencies. The purpose of the EIA guidelines and manual developed specifically for the FAP (ISPAN 1992a, 1992b) is not to duplicate these documents but rather to pull together the most applicable procedures and methodologies and to combine them with local knowledge. Such a process is intended to produce procedures that are appropriate to the special needs of the FAP as well as to environmental resource management requirements in Bangladesh.

The purpose of EIA case studies is to:

- Test EIA methodologies, approaches and procedures under the environmental, social and institutional conditions prevailing within the FAP;
- Provide a basis for practical training of local professionals and technicians in EIA methods and approaches.

Case studies are a valuable approach in that they consider FAP projects under typical Bangladesh environmental, social and institutional conditions. Documenting and analyzing the positive and negative experiences of conducting a typical FAP project's EIA identifies the strengths and weaknesses of the approaches and methods outlined in the current guidelines and manual.

EIAs undertaken as part of case studies conform to the following steps as described in the draft EIA Guidelines (ISPAN 1992a):

- Identification of problem and management objectives
- Definition of project interventions and alternatives
- Definition and analysis of project actions
- Field reconnaissance
- Definition of study area
- Development of people's participation
- Development of conceptual model of the environmental resource system and the interactions with proposed interventions
- Identification of important environmental components
- Selection of environmental and socioeconomic indicators
- Field data collection programs
- Data analysis
- Impact analysis

- Development of mitigation proposals and environmental management programs
- Development of environmental and socioeconomic monitoring programs.

1.3 Criteria for EIA Case Study Selection

The following criteria have been developed to identify potential projects for EIA case studies:

- Regional: Covering as much environmental variation and as many physical, ecological and social factors as possible

- Project type: Covering as many FAP-type interventions as possible, including flood control, drainage, irrigation, water management and flood proofing procedures

- Stage of project development: Projects should be conceptually developed enough that the principle features and structural characteristics are identified and characterized in terms of location, size and operating intentions. Projects should not be currently in operation since this precludes testing of predictive methodologies, development of mitigation strategies and use of people's participation as devices in impact assessment.

- Extent of available information: The more baseline information available the more effective an EIA will be.

1.4 Surma-Kushiyara EIA Case Study

Informal discussions held with the North East Regional Study (FAP 6) in mid-1991 made it evident that the Upper Kushiyara Project was a potential candidate project case study. The project was studied in the early 1960s (EPWAPDA 1965, 1967) and again in 1972-73 (SARM Associates 1973), and provided valuable background and trend information. The present project has been named the "Surma-Kushiyara Project" to distinguish it conceptually from the earlier Upper Kushiyara Project.

Subsequent to the selection and initiation of the Surma-Kushiyara project as a case study, it was learned that a major dam is presently under construction at Tipaymukh on the Borak River in India. This structure, when completed, is likely to alter substantially the flow regime in both the Kushiyara and Surma Rivers, and hence the project concept used and the assessments made in this case study are probably redundant. However, the objective of the exercise is to test EIA methodologies and approaches only, and in this sense the present study is still valid.

Two project concepts were provisionally developed by FAP 6 to provide a basis for the FAP 16 EIA case study. They are subject to modification as the northeastern regional study progresses and more hydrological and topographic data become available, particularly to address the flow changes induced by reservoir formation in India. A third option - improved drainage only, was discussed in initial meetings but not included as a project to be assessed because it required more detailed engineering assessment of its long-term feasibility. Within the FAP full accounting will eventually be made of non-structural options to be employed in conjunction with any structural measures: these had not been identified for the project area at the time of the case study. Thus, any conclusions presented in this report are tentative and are made for the purpose of the case study only. They do not necessarily represent interpretations and conclusions to be made when the full feasibility report for the project area is presented by FAP 6. The Surma-Kushiyara case study was undertaken from July 1991 through June 1992 (Figure 1.1).

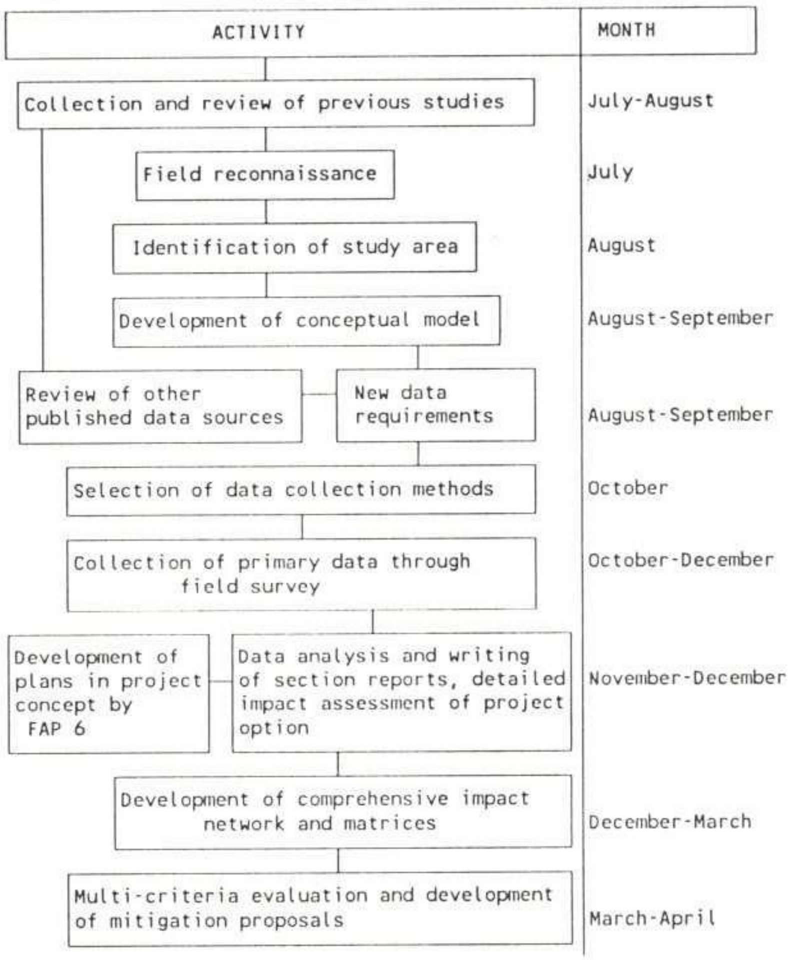


Figure 1.1. Progress of the Surma-Kushiyara EIA Case Study.

As a case study, the Surma-Kushiyara EIA is necessarily incomplete. It was not given a full regional level prefeasibility assessment in which the major environmental and social issues would have been outlined. Such issues have been outlined to some extent by the previous studies on the Upper Kushiyara Project, although these were relatively weak in social impact assessment and in many environmental areas. No non-structural options for overcoming flood damage problems had been developed. The EIA was conducted *without* intensive interactions between design and planning engineers, and the environmental and socioeconomic study team. In a feasibility study this interaction is essential to develop an efficient and acceptable project design. The EIA ends with a summary of the major environmental and social impacts which would normally link to the main feasibility report. In such a report the environmental and social impacts would be entered into the multicriteria analysis and be ranked along with project costs, benefits and other impacts to provide a decision-making framework for the project. The report provides initial input material to the Environmental Management Plan (EMP), but doe not produce a detailed EMP which would require extensive interactions between design engineers, the environmental team and the local communities. Figure 1.2 indicates the position of an EIA as it should appear in the overall project feasibility study framework.

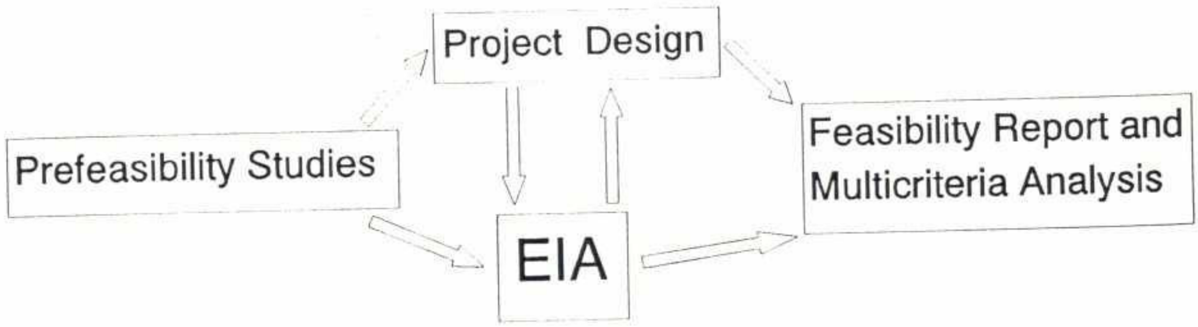


Figure 1.2. Relationship of EIA prefeasibility and feasibility studies.

Chapter 2

PROJECT DEFINITION

2.1 Outline of Problem and Management Objectives

Phase 1 of the Surma-Kushiyara Project covers a gross area of 39,000 ha in the northeastern corner of the Sylhet district (Figure 2.1). The area lies between latitude 24° 30' and 25° 92' North, and longitude 92° 09' and 92° 30' East. The project area is bounded by the Surma River to the North and East, and by the Kushiyara River up to the outfall of Karati Khal to the South. A proposed embankment from the outfall of the Karati Khal to the Surma River forms the western boundary.

The project area is a saucer-shaped alluvial plain. The Surma and Kushiyara Rivers both overflow into the project area during the premonsoon, monsoon and even post-monsoon seasons. The land along the banks of the rivers are relatively high and slope toward the middle of the project area with a gradient varying from 0.4 to 0.9 m/km. A natural depression in the center, running between and approximately parallel to the Surma and Kushiyara Rivers, is connected by several well defined khals (Figure 2.2).

Most of the khals taking off from the Surma and Kushiyara Rivers have either silted up or closed over the past years. Exceptions are Jaigirdar Khal, Shikar Mohammad Khal and Teli Khal from the Kushiyara River, and Kakura Khal from the Surma River. Regulators have been constructed at the off-take of Rahimpur and Sunam khals.

The principal drainage outlet for the project area is Sada Khal which traverses the saucer-shaped basin as a continuation of the Rahimpur Khal. The drainage outlet originates from the Kushiyara River at the southeastern part of the project (Figure 2.1). The principal drainage outlet has 13 different names at different locations inside the project area and is known as the Karati Khal at the outfall to the Kushiyara River (Chapter 3).

An embankment, not built to proper section, exists along the left bank of the Surma. Another improperly built discontinuous section exists along the right bank of the Kushiyara. Every year these embankments are breached, sometimes more than once in the same year. In 1991 there were 23 breaches in the Kushiyara embankment and 13 in the one along the Surma. In addition to the breaching, the area is subject to heavy rainfall. The rain water and consequent flooding enters the project area by overtopping the embankments and by flowing through the existing khal openings, seriously flooding the area. As a result, crops, homestead vegetation, livestock, and household property are damaged.

The flooding situation is further aggravated by drainage congestion. Khals do not drain during high river stages, and many are so nonfunctional that they do not drain for prolonged periods even when river stages are low. In addition, there is considerable siltation downstream of the Charkhai-Sheola Road, leaving the bed of the Karati Khal near the outfall silted up. All these factors hamper drainage and lead to water stagnation and lack of flashing inside the project area.

River bank erosion is also a problem at several locations. The four most prominent problem sites are at Amalshid, the bifurcation point of the Surma and Kushiyara Rivers, and at Bhuyiamura, Hydraboud and Ujirpur on the right bank of the Kushiyara. Midstream of the Kushiyara is considered the international boundary. The banks erode from the Bangladesh side and accrete on the Indian side, resulting in a territorial loss for Bangladesh.

Flooding is common and causes significant damage to crops, property and homestead vegetation two to three times each year. Boro, aus and broadcast aman rice are damaged by flash floods during the premonsoon season. Transplanted aman rice is damaged during monsoon floods, and often again during post-monsoon floods and consequent drainage congestion. Livestock, terrestrial wildlife and some fish species, e.g. catfish, are lost during floods. These losses and damage are a continuous misery to the people living in the project area.

In summary, the major water resource management problems facing the Surma-Kushiyara area are:

- Frequent flash flooding
- Seasonal flooding of severe magnitude in some years
- Widespread drainage congestion
- Extensive siltation of canals.

2.2 Alternative Project Considerations

The Surma-Kushiyara Project forms part of the North East Regional Study (Flood Action Plan study component FAP 6) that will prepare an overall regional plan emphasizing water management. FAP 6 is due to start working at the project level in 1992. Discussions with the FAP 6 team have affirmed that the Surma-Kushiyara Project will be studied in due course of time.

To facilitate the FAP 16 EIA case study, FAP 6 did preliminary work on the project concept. There are considerable variations in the project concept compared to earlier feasibility study reports.

The project was first studied in 1964 by the Upper Kushiyara Study Team, a component of the Directorate of Schemes of the then East Pakistan Water and Power Development Authority (EPWAPDA) and the results published in an interim report (EPWAPDA 1965) and a feasibility report (EPWAPDA 1966). The recommended plan proposed that flood embankments be constructed along the left bank of the Surma River and the right bank of the Kushiyara River. Improving the existing natural drainage channels and placing a drainage regulator on the Sada Khal where it crosses the Charkhai-Sheola Road was also suggested. The report indicated, however, that if the regulator was put at the outfall of Karati Khal it would work more efficiently due to greater water level differences. Also proposed were three pumping units for irrigation facilities at Amalshid, Kanairghat and Andu on the Surma and Kushiyara Rivers.

In 1973 the feasibility report was revised and updated (SARM Associates 1973). The recommended plan differed from that in the 1966 report in the extent of flood protection, drainage and irrigation areas, cropping patterns and the irrigation system layout. And, instead of the earlier proposed three pumping units, only two were proposed at Rahimpur and Chiralbag for irrigation facilities.

In February 1985, the Sylhet Operation and Maintenance (O&M) Circle of BWDB prepared a three-phrase preliminary report on the Surma-Kushiyara Project. Phase 1 of this project uses the same boundaries used by the previous Upper Kushiyara Project, and in essence, simply renames the earlier study. Differences from previous plans of development include:

- Four drainage sluices are called for at Rahimpur Khal, Jaigirdar Khal and Karati Khal along the Kushiyara belt, and at Sunam Khal along the Surma belt
- The proposed pumping plant could be moved to Pillakandi and constructed over the Senapati Khal
- A proposed pumping station along the Surma belt would be constructed over the Naya Khal near Patramati.

The latest proposal by the BWDB includes the following:

- Bringing the embankment along the left bank of the Surma River to proper section
- Constructing a proper setback continuous embankment along the right bank of the Kushiyara River
- Constructing regulators at the off-takes of the Jaigirdar and Teli khals from the Kushiyara River, and the Kakura Khal from the Surma River
- Provide about 1.6 km of silt clearance on the Surma River near Amalshid
- Protect the river bank at Amalshid and Bhuiyamura
- Construct 20 pipe sluices.

The present project concept establishes the western project boundary at the outfall of the Karati Khal to the Kushiyara River, and extends the Kushiyara embankment from that point north to connect with the Surma embankment. The possibility of connecting the Surma and Kushiyara Rivers through gated regulators is also being studied by FAP 6. Two options are being studied by FAP 6. The first comprises the following components:

- Bringing the embankment along the left bank of the Surma River to proper section for full flood control
- Constructing a full flood protection embankment with a proper setback distance along the right bank of the Kushiyara, possibly using the Zakiganj-Sheola Road now under construction, and extending the embankment to the outfall of the Karati Khal, finally connecting it with the Surma embankment
- Re-excavating drainage channels and constructing regulators at the off-take of Karati Khal, Jaigirdar Khal and Teli Khal from the Kushiyara River, and Kakura Khal from the Surma River.

This option is similar to the latest proposal prepared by the Bangladesh Water Development Board (BWDB). The BWDB proposal differs in that it recommends the project boundary be extended to the outfall of the Karati Khal. It also recommends draining water out to the Surma and Kushiyara Rivers through at least four khals with regulators instead of using one drainage outlet through the Sada Khal.

An alternative includes all components listed above, except that it proposes using the present alignment of the existing Kushiyara embankment for constructing a submersible embankment, instead of constructing a new full flood protection embankment with proper setback distance. In this case, the feasibility of developing irrigation facilities also will be studied.

Design alternatives do not as yet include improvement of drainage only (without substantial construction of embankments) or non-structural options such as flood proofing and enhancing the flood damage mitigation strategies already practiced to some extent by the local communities. At the time of execution of this case study, these measures were not well defined, and have not been included as options for study. It is expected that they will be included at the stage where the Surma-Kushiyara project is studied and evaluated as a potentially viable project.

The following options are thus addressed in the EIA case study:

- Option 1: The future scenario without any further development (Figure 2.2). Needs to be replaced by a map showing existing infrastructure.
- Option 2: Flood control and drainage with embankments for controlling all types of floods (Figure 2.3).
- Option 3: Submersible embankments along the Kushiyara River, drainage improvements and some irrigation (Figure 2.4).

2.3 Project Components

Table 2.1 summarizes the specific project components likely to be developed under one or more of the development options being considered. These are neat known in detail since the Surma-Kushiyara Project is not in a detailed engineering planning phase at this time. The project components are assumed on the basis of best judgement from the available information.

Table 2.1. Components of alternative proposals for the Surma-Kushiyara Project and their environmental effects

1. Preconstruction (planning, exploration and study) phase
   a. Land, topographic and benchmark surveys
   b. Hydrological and climatic surveys and instrumentation
   c. Land use and natural resource inventories
   d. Socio-economic surveys
   e. Land acquisition
   f. Construction of temporary access roads

Table 2.1. Continued.

2. Construction phase
   a. Land acquisition
   b. Temporary structures and land occupation
      - storage and godowns
      - staff and labor camps
      - garages and parking sites
      - canteens and kitchens
      - waste and garbage disposal sites
      - water handling and storage facilities
   c. Excavation of all main drainage canals

2. Construction phase
   d. Reconstruction work on existing embankments along the Surma and Kushiyara rivers
      - labor mobilization
      - soil taking and borrow pit construction
   e. Construction of hydraulic structures
      - four drainage sluices (most likely at Rahimpur, Jaigirdar, Karati and Sunam khals)
      - four pumping stations (most likely on Senapati and Naya khals)
      - regulators at the off-takes of several khals, including Jaigirdar, Teli and Kakura Khal.
      - pipe sluices (approximately 20)
   f. River bank protection works at Amalshid and Bhuiyamura.

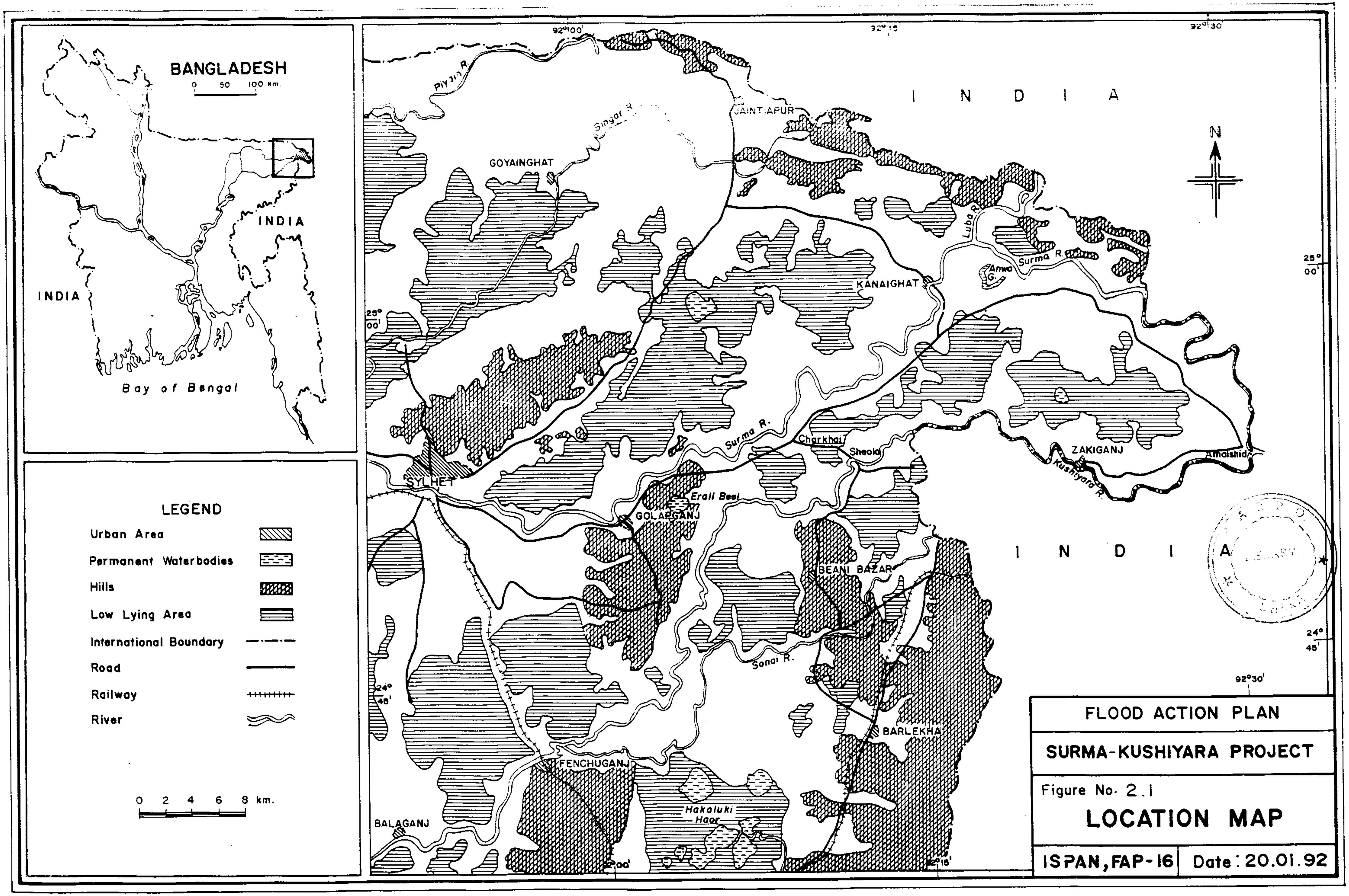
3. Operation and maintenance phase[*1]
   a. Project O & M
      - embankments
      - sluice gates
      - regulators
      - drainage channels
      - irrigation canals
   b. Agricultural development
      - institutional development
      - agricultural extension and credit
      - seed, fertilizer and pesticide acquisition, storage and application
      - irrigation
      - establishment and operation of cooperatives, resource user, community educational and project support programs

*1 Assuming effective maintenance of embankment facilities

Table 2.1. Continued

c. Environmental management[*2]
- monitoring and evaluation
- land reclamation

[*2] It is assumed that there will be no project abandonment phase as the embankments will have to be permanently maintained



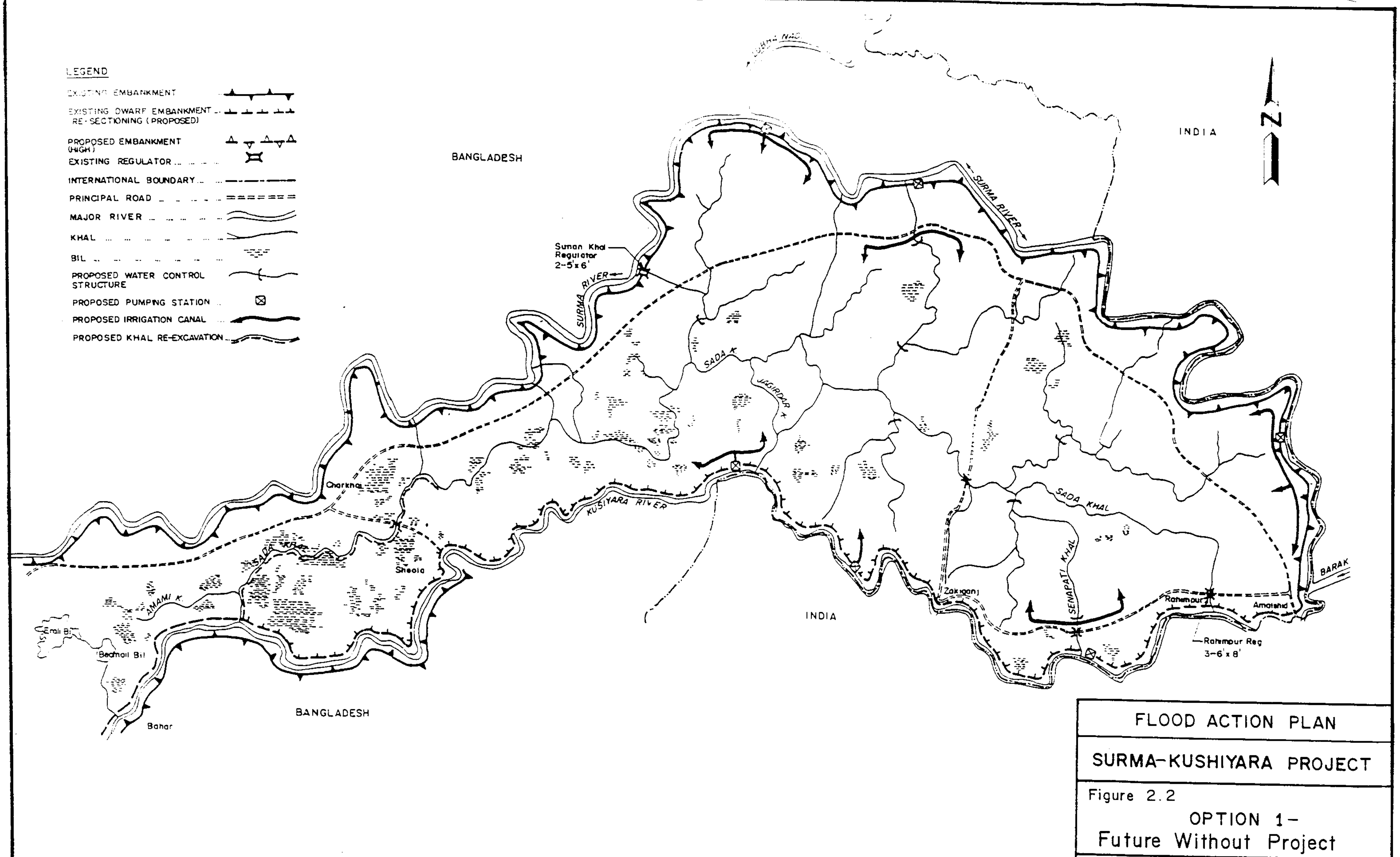
FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure No. 2.1

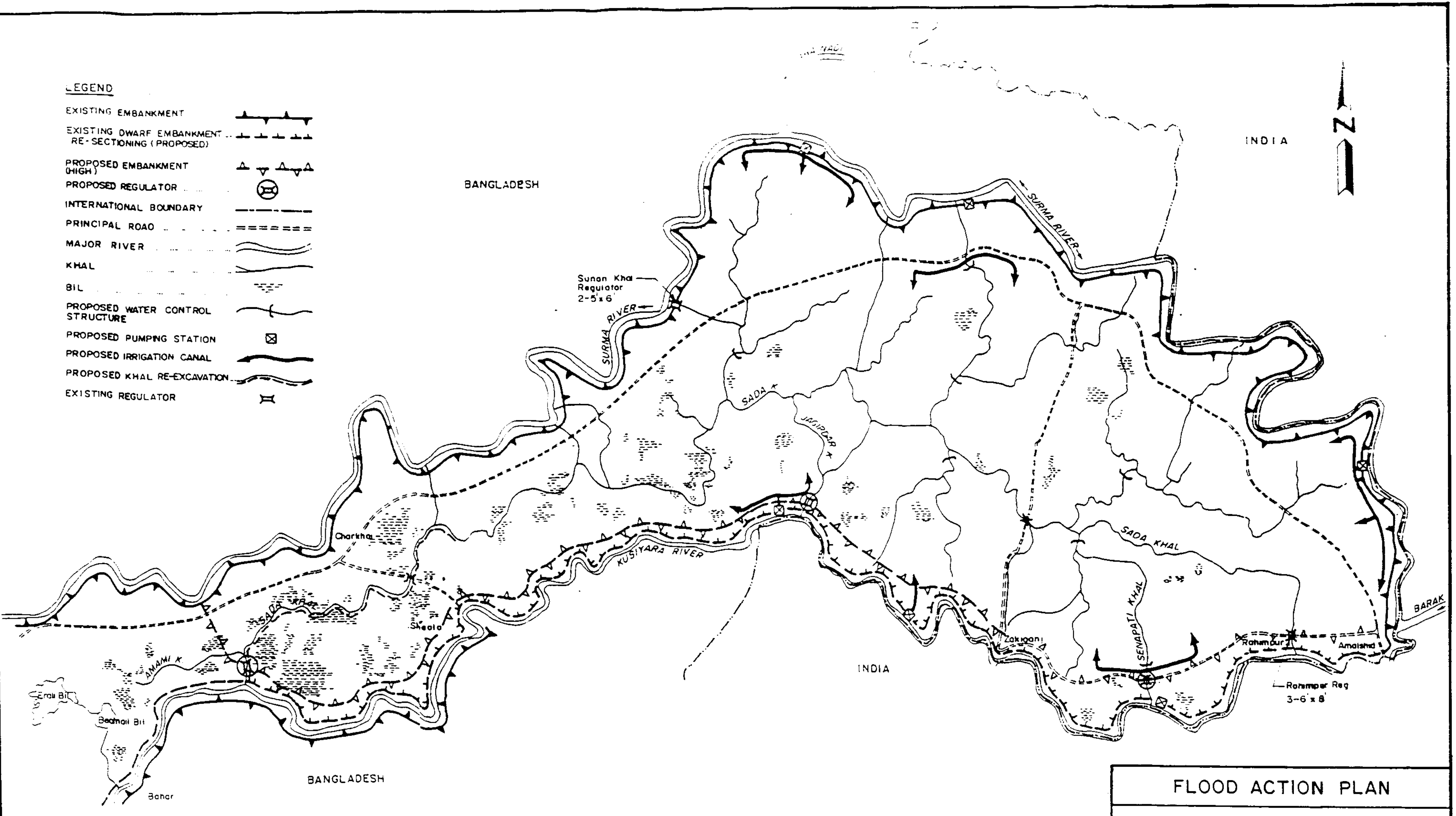
LOCATION MAP

ISPAN, FAP-16 | Date: 20.01.92



SOURCE: FAP-6

FLOOD ACTION PLAN	
SURMA-KUSHIYARA PROJECT	
Figure 2.2 OPTION 1- Future Without Project	
ISPAN, FAP-16	Date: Jan, '92



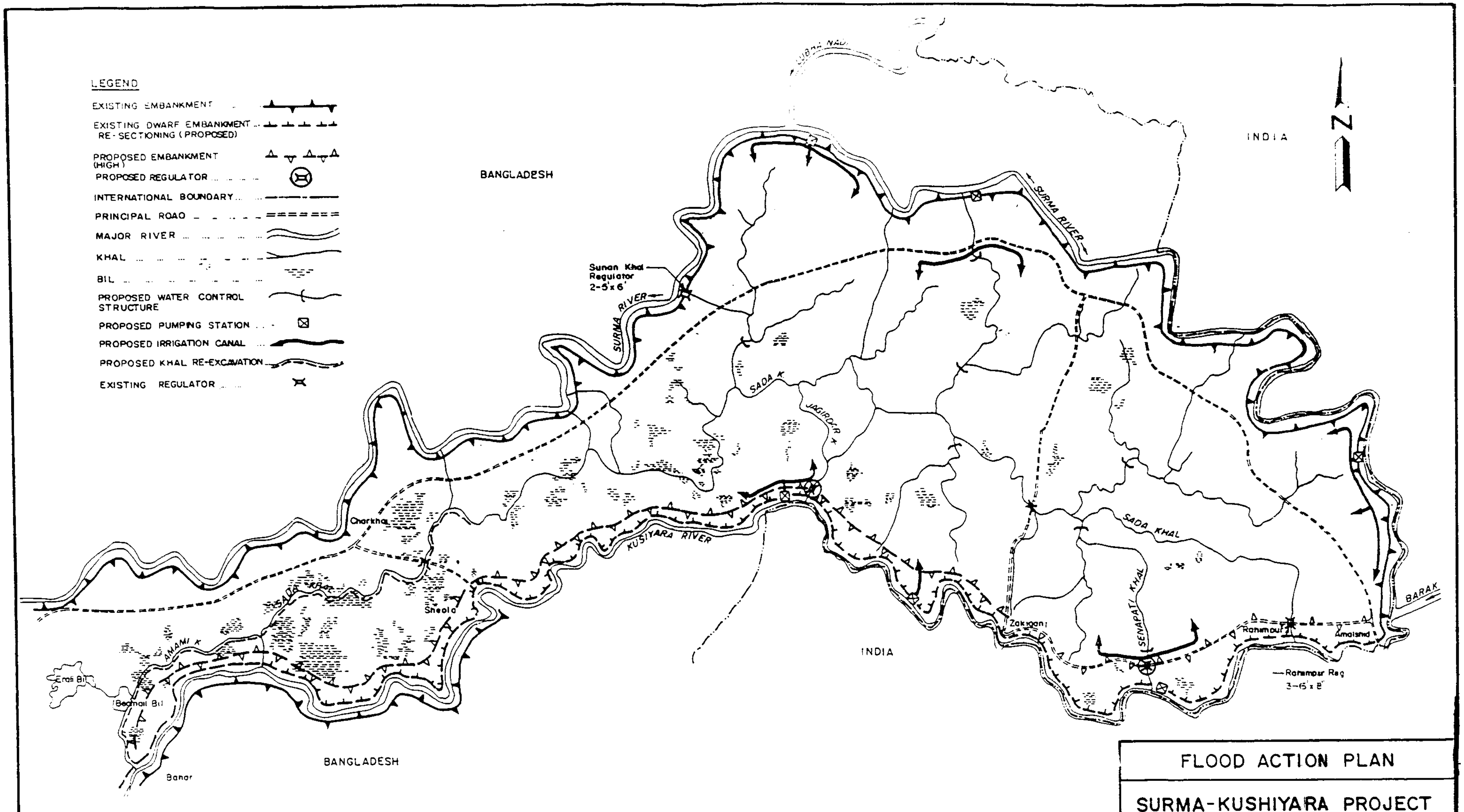
FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure 2.3 OPTION 2 - Full Flood Protection

ISPAN, FAP - 16 | Date: Jan '92

SOURCE: FAP-6



SOURCE: FAP-6

FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure 2.4
OPTION 3 -
Partial Flood Protection

ISPAN, FAP-16 | Date: Jan '92

Chapter 3

METHODS

Data for the EIA case study were collected from both primary and secondary sources. The main sources of secondary data were published reports on earlier studies of the Upper Kushiyara Project (EPWAPDA 1965, 1966, 1967; SARM Associates 1973), published inventories and reports by government ministries and other institutions (BBS 1985, 1989, 1990; MPO 1985, 1986a, 1986b, 1986c, 1987) and unpublished reports and data (Department of Public Health Engineering (DPHE), Bangladesh Water Development Board (BWDB)). Field data collection was done from 14 October to 28 October 1991 and extended through November and December for social issues and some fisheries, wildlife and water quality data collection.

3.1 Review of Previous Project Studies

All available BWDB and FAP 6 reports and documents on Phase 1 of the Surma-Kushiyara Project were collected and reviewed. These included early feasibility study reports (EPWAPDA 1965, 1966, 1967; SARM Associates Ltd. 1973), a prefeasibility report on the North East Rivers (SARM Associates 1973), and documents and correspondence from the BWDB Operations and Maintenance Division (Sylhet). Available data on hydrology included extremes of water level and discharge at designated stations for the Kushiyara (Amalshid and Sheola) and the Surma (Kanairghat) rivers from 1951 to 1990, a frequency analysis of the river stage and discharge for various return periods, a design discharge of the rivers for various return periods, and aquifer information from boreholes along the periphery of the project. Data on water quality included chemical analysis of samples from the Kushiyara, and sediment concentration analysis of the Kushiyara and the Surma. Because it was important to collect current information on different social categories for the socio-economic portion of the EIA, previous project studies were used as general background information only.

Previous studies on the project area were found generally deficient in information on fisheries, wildlife and social aspects.

3.2 Field Reconnaissance

After preliminary discussions with the FAP 6 team, FAP 16 team members made a reconnaissance visit to the proposed project area in July 1991. The areas visited included the bifurcation point of the Surma and Kushiyara Rivers, erosion points and possible impact areas. Two regulators were found, one on Rahimpur Khal and one on Sunam Khal. Observations made during the field reconnaissance confirmed that the proposed project met most of the criteria for selection as a case study area. Crop damage due to both flash and seasonal flooding, siltation, drainage congestion, erosion, conflicting social interests and other problems were noted. Based on discussions with various groups it appeared that local people had an interest in the project.

3.3 Identification of Study Area

The study area includes the project and impact areas (Figures 2.2, 2.3 and 2.4). The project area is the land between the Surma and Kushiyara Rivers beginning at the bifurcation point of the Borak River at Amalshid and extending to the outfall of Karati Khal into the Kushiyara River. The area covers the whole of Zakiganj Upazila, Purbo and Paschim Dighirpar Unions of Kanairghat Upazila, and Charkhai and Sheola Unions of Beanibazar Upazila of Sylhet district. The impact area of the proposed project includes an area on the right bank of the Surma near the Lubha River confluence and both sides of the Kushiyara up to Hakaluki Haor. The study area was necessarily confined to the Bangladesh side of the Surma and Kushiyara rivers, although it was recognized that impacts could potentially extend to the Indian side.

As noted later, off-site impacts were not addressed in this EIA case study. Downstream effects of the project could possibly extend to Fenchuganj, but probably would not be measurable further south than Hakaluki Haor which receives most of the discharge from the project area.

3.4 Selection of Important Environmental Components (IECs)

Following a review of the available reports, the initial field reconnaissance of the study area which included consultation with potentially affected groups in the area, and an initial phase of field data collection, a set of IECs was selected. These were either resources of particular value to communities within the project area, ecological components responsible for perceived functioning of the floodplain ecosystem, or processes which are responsible for the maintenance and functioning of such components and resources. IEC's were selected as representing the water resources, agricultural, fisheries, wildlife, homestead vegetation and socio-economic sectors of the project area.

3.5 New Data Requirements

A review of available information revealed that existing data on hydrology, soil and agriculture were adequate but needed updating. Data on fisheries, wetlands, wildlife, social aspects, homestead vegetation and livestock were either missing or incomplete and were identified for collection in the field study phase.

3.6 Field Data Collection

Many regional and local areas in Bangladesh for which FCD/I projects are planned have a shortage of quality secondary data. In addition, this EIA case study faced time and budget constraints, typical of such assessments, which limited the use of extensive quantitative survey methods and data analyses. Methods used in the study were thus primarily of a survey nature and include extensive use of Rapid Rural Appraisals (RRA) and Participatory Rural Appraisals (PRA). Mapping of the study area was carried out from a number of sources, notably:

- SPOT image taken on 1 January 1990
- A 1963 5-feet interval contour map (BWDB)
- A 1963 1-feet contour map (BWDB)

- Field maps prepared by study team members.

3.6.1 Area Familiarization

Before field data were collected, FAP 16 team members visited the study area to become familiar with it. Through the reconnaissance process the team developed a traverse sampling procedure for selecting areas according to flood levels, embankment location, river erosion, siltation, and water quality in rivers, khals, beels and tubewells.

3.6.2 Traverses

Because the case study is multidisciplinary in nature, common sample areas and similar sampling procedures were needed. The basis for sampling the area was a set of six traverse lines (Chapter 5 for location), selected on the basis of the physiographic pattern displayed on the soil association map. Each traverse line was planned to cut across ridges and basins and to represent land types of the area. The traverse lines were set eight to nine km apart and usually ran north to south. Each traverse included high and low impact areas for data collection. The team members moved in groups along the traverses, but deviations were made whenever field observations indicated such a requirement.

3.6.3 Water Resources

During 1990 and from January to September 1991, various monthly data on maximum, minimum and average water levels of the Kushiyara River at Amalshid and Sheola, and of the Surma River at Kanairghat were collected from the BWDB. The distribution of the area's hand tube wells were provided by the Department of Public Health Engineering (DPHE) for the same time frame.

Questionnaires were used to collect quantitative and qualitative data from the field. Quantitative data included:

- Water flow in khals and beels during various months
- Flash and seasonal flood time, depth, duration and frequency
- Breaching points of dykes and embankments
- Sources of domestic water and availability during seasonal changes.

Qualitative data included:

- History of flood related problems for the last 10 years
- Sedimentation of canals and beels
- Present flood control problems and their effects
- People's view on flood problem and the proposed projects.

3.6.4 Land Resources

Sample locations were selected along each traverse line according to land type, i.e., highland, medium highland, medium lowland and lowland. In addition to obtaining land resource information from groups of farmers, households on different land types along the traverse lines were interviewed on the basis of the following farm sizes:

- Small farms 0.02 to 1.00 ha
- Medium farms 1.01 to 3.03 ha
- Large farms more than 3.04 ha
- Landless.

Information was collected from local farmers on the inundation level of the crop field, frequency of flooding, month(s) of flooding and flooding duration. Data on existing cropping patterns by land type, extent and magnitude of crop damage, and the level of agricultural input use with corresponding yields were collected through a structured questionnaire. Data on livestock, homestead vegetation and forestry, along with assessment of flood damage in each sector, were also collected during the household surveys. People's perception of flooding problems and the proposed interventions were recorded.

3.6.5 Biological Resources

The main biological studies in the project area were related to identification and characterization of the main habitat types, and rapid field surveys of the principal benthic, macrophytic, fish and wildlife communities.

3.6.5.1 Water Quality Analyses

A Hach portable water testing kit was used to test the following nine parameters which are closely related to biological activities:

- Dissolved oxygen
- Chloride
- Ammonia
- Nitrite nitrogen
- Carbon dioxide
- Ferric iron
- Total hardness
- pH.

Turbidity of water was judged by visual observation and classified as follows:

- High turbidity
- Moderate turbidity
- Low turbidity
- Clear.

Water testing sites were located on each of the various types of water bodies: beels, canals or rivers. Samples were taken in October and again in December, 1991. Water samples from beels and canals were taken from the surface at a distance of 1-2 m from the bank; those from the rivers were taken 30 cm below the surface. Five water samples were taken from each of the major rivers and two from each type of water body. A single test for each parameter were done at each sampling site.

3.6.5.2 Benthos

Zoo- and phytoplankton samples were collected from the various water bodies using a plankton net. The net was trawled at different water depths to obtain a large variety of plankton species. Plankton were examined under a compound light microscope at both low (10 x 10) and high (40 x 12.5) magnification. Plankton were identified according to the key prepared by Alfred *et.al* 1973. Benthic invertebrates were collected along the shoreline by hand picking and with the use of push nets.

Blue-green and green algae were identified under a microscope using an identification key. Some macro algae, e.g. *Spirogyra* were identified by direct physical examination. Some red-colored algae blooms were both visually inspected and identified under a microscope.

Aquatic macrophytes were classified into four major groups:

- Growing along wetland margins
- Submerged
- Rooted emergent
- Free floating.

3.6.5.3 Open Water Capture Fisheries

Depending on the area elevation curve and water levels the total project area has been classified into the following fishery habitat categories:

- Permanent wetlands (W_0) which remain inundated throughout the year.
- Seasonal wetlands which are inundated for less than a year. Based on land type and period of inundation, these are sub-divided into:

  W_1: Flooded lowland, inundated from April to November, peak water levels from 1.8 to 3.0 m

  W_2: Flooded medium lowland, inundated from April to October, peak water levels from 0.9 to 1.8 m

  W_3: Flooded medium highland inundated from May to September, peak water levels up to 0.9 m.

Field information was collected at sites along the traverse lines. Knowledgeable fishermen were selected for interviewing at the same sites. Fish species were identified during catch and sales at the sites. Fish harvest data were analyzed to derive unit area production for each type of water body. Fish production data for each major habitat type were obtained from upazila fishery officers and from fishermen and leaseholders.

Fish were classified into four groups:

- Carps
- Catfishes
- Snakeheads
- Miscellaneous

Field data collection sources included:

- Catch during fishing, during spot sales (sale in fishing area) and during local market studies (special study)
- Household fish consumption (special study)
- District and Upazila fishery officers
- Lease holders
- Subcontractors.

Information was collected on the following aspects:

- Identification of species
- Abundance/availability (special study)
- Micro and macro habitats
- Fish and fishing problems related to management (socioeconomic study), systems and techniques, seasons (special study), and fishing areas
- Fish diseases
- Abundance and species diversity in local fish markets.

3.6.5.4 Closed Water Culture Fisheries

Information on culture fishery activities collected, from Upazila fishery officers and local pond owners, include:

- Number of ponds
- Number of ponds under fish culture
- Cultured species
- Sources of fish fry
- Culture fishery management
- Annual fish production
- Marketing
- Constraints of culture fisheries.

3.6.5.5 Wildlife

The wildlife study considered habitat, a list of species and the role of wildlife in the environment. Information was collected on the following:

- Habitat types and distribution
- Plant species composition in different land-types
- Utilization of habitats by wildlife
- The study also considers wildlife's sensitivity to environmental changes, especially a change in the ratio of land to water.

Total wildlife habitat was divided into terrestrial and aquatic. The terrestrial portion of the project area is mainly occupied by homestead vegetation, but also includes agricultural lands, crops, fallow and roadside vegetation.

The terrestrial portion of the study considered the following factors as they relate to plant species:

- Dominant species
- Species distribution by canopy
- Ecotone and land use
- Species composition on edge
- Cause of habitat conversion and destruction.

Wildlife species in the area included amphibians, reptiles, mammals and resident and migratory birds, and were classified as:

- Commercially important wildlife
- Agricultural pests
- Endangered species
- Indicator species.

Birds of the study area were identified and observed with the help of binoculars and some were recorded on film. Pictorial guide field books were used for identification and confirmation.

The assessment of negative and positive impacts on wildlife by the proposed project includes discussion on the following:

- Food habits by species
- Ecological niche of wildlife
- Wildlife habitat conversion and destruction
- Movement and migration times, routes and obstructions
- Effects of a change in the land to water ratio
- Role of wildlife in the study area, including control of insects and rodents, and supplying organic fertilization
- Critical environmental conditions for wildlife.

The study of aquatic ecosystems considered water quality, wetlands, waterfowl and migratory birds. The wildlife species, and factors affecting them, were the same studied as in the terrestrial ecosystem study. Distribution and abundance of migratory birds were also observed.

3.6.6 Human Resources

The method used for social data collection was Participatory Rural Appraisal (PRA) which is a development of the RRA approach[*1] in which rural people are involved in investigation, presentation and analysis. Through informal structured discussions with individuals, social groups and key local people, PRA pinpoints local issues and how they are perceived. The PRA initiates the process of local, active involvement which is necessary to the planning and development of sustainable FCD/I projects.

The social team comprised male and female members. They selected 8 high impact subzones following the traverses and characterized by:

- Seasonal flooding
- Flash flooding
- Erosion
- Water logging and drainage congestion.

Subzones were selected with the help of key informants. One of the sub-zones was located outside the project area, but inside the impact area. Table 3.1 indicates the characteristics of the high impact subzones (Chapter 5 for location map).

A total of 23 villages were visited in the selected subzones. More villages were visited in subzone 1 since this area is more seriously affected by flash flooding and has a larger number of fishing communities. The main social groups identified in the selected villages were:

- Agricultural laborers
- Capture fishing households
- Professional fishermen
- Boatmen
- Boat builders
- Petty traders
- School teachers
- Farmers (large to marginal)
- Landless
- Women from above groups, including female heads of household.

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*1 Rapid Rural Appraisal (RRA) is an investigative technique in which interviews with local knowledgeable people (i.e. key informants) in selected locations are the main component. The method was developed in the late 1970s following the realization that there are many biases which impede outsider contact with rural poverty (Chambers 1983). RRA is an inexpensive, timely and effective method of gathering information and has been used and refined over the last two decades.

Table 3.1. Characteristics of High Social Impact Sub-zones in the Project Area.

Subzones	Traverse Line	Upazila	Union	Villages	Features
1	1	Zakiganj	Khalachara	9	SF,FF.WL*
2	1	"	Khalachara/Kajalshar	5	SF,FF,E
3	2	Kanairghat	Dighirpar	2	SF,FF
4	2	"	Luxmiprasad West**	1	SF,FF
5	3	Zakiganj	Barohal	2	SF,FF,WL
6	4	Beanibazaar	Charkai/Sheola	3	SF,FF,WL
7	4	"	Sheola	1	SF,FF,WL,E

* SF=seasonal flood, FF=flash flood, WL=water logging, E=erosion.
** Outside project area but inside impact area.

Also included were those whose land is erosion prone or water logged and those who have lost their land through erosion.

A list of key questions was prepared and, using an interview guide, informal discussions were conducted with individuals and groups from different social categories. Discussions focused on occupation, livelihood, quality of life and local issues. In particular, views and opinions were elicited on flooding, water logging and erosion. Suggestions on how to remedy such problems were also recorded.

Time restraints prevented prearranged meetings, but efforts were made to talk with at least one person from each social category in every village. Because speaking with occupants of poor households was top priority, one substandard *"bari"* (homestead) in each village was selected for interviewing. This approach led to discussions with five to 15 people from roughly the same economic level. Local leaders, influential people, and local NGOs were also consulted. Information also was collected from officers stationed at the Upazila using RRA techniques.

3.7 Impact Analysis

The objective of impact analysis is to evaluate the impacts of the various project options on water, land and human resources, compare them to changes likely to occur in the absence of the project, and to integrate the results into the project planning process.

The steps for impact analysis were as follows:

Step 1: A series of IECs were selected for each major environmental and social resource or component.

Step 2: Three separate networks for each individual resource section were developed. The first considered the interdependent relationship of environmental and socioeconomic conditions in a series of sequential phases. The other two networks considered the post-project conditions of sequential relationships for interventions for the two project options.

Step 3: Using the end-points of the networks developed in Step 2 plus other data generated for individual sections, four effects matrices were developed to identify impacts at four phases of the project, namely: planning and surveys; construction; operation and maintenance; and post-project.

Step 4: The major impacts of the project options were extracted from the above matrices, summarized and compared.

Step 5: Verbal descriptions of impacts were developed.

Step 6: An assessment of impacts was made according to an 11-point scale (ISPAN 1992a).

Step 7: The major impacts were evaluated as far as possible, based on the information available. This was a link to the multicriteria analysis (MCA) required for full project feasibility evaluation.

Step 8: Mitigation measures and an environmental management plan were developed.

Chapter 4

IMPORTANT ENVIRONMENTAL COMPONENTS

A number of important environmental components (IECs) have been selected for the purpose of conducting an EIA within the Surma-Kushiyara project area. IECs chosen were either resources of particular value to communities within the project area, ecological components responsible for perceived functioning of the floodplain ecosystem, or processes which are responsible for the maintenance and functioning of such components and resources.

4.1 Hydrology

Since the hydrological cycle is so predominant in determining the nature and distribution of resources within the project area (and indeed within all of Bangladesh), the IECs have been considered in terms of the seasonal hydrological constraints and determinants, e.g. flooding, soil moisture, etc. The basic hydrological cycle within the project area is displayed graphically in Figure 4.1, and the IECs within each of the major resources groups are arrayed in biological calendars in Figures 4.2 through 4.6.

The hydrological determinants within the project area are strongly seasonal in nature. These include:

- River discharges
- Ground water levels
- Rainfall
- Flash flood frequency
- Seasonal flood frequency
- Incidence of drainage congestion resulting from flooding
- Occurrence of sedimentation resulting from flooding
- Frequency of bank erosion.

Rainfall is a primary driving force governed by the climate and weather patterns in the region. River discharge, ground water levels, frequency of flash and seasonal floods, sedimentation and drainage congestion are very closely linked to rainfall patterns and to each other, and any intervention affecting one will have consequent effect on others. Bank erosion is a function of receding water levels and discharges. It is noticeable that whereas flash flood as an event is easily identified in the pre-monsoon season (April-May), it is not similarly perceptible in the post-monsoon season. The hydrological calendar (Figure 4.2) displays effectively the dry season differences in water discharge and water level between the Kushiyara and Surma Rivers. The Surma has more extreme flows than the Kushiyara. Any unusual event during the summer

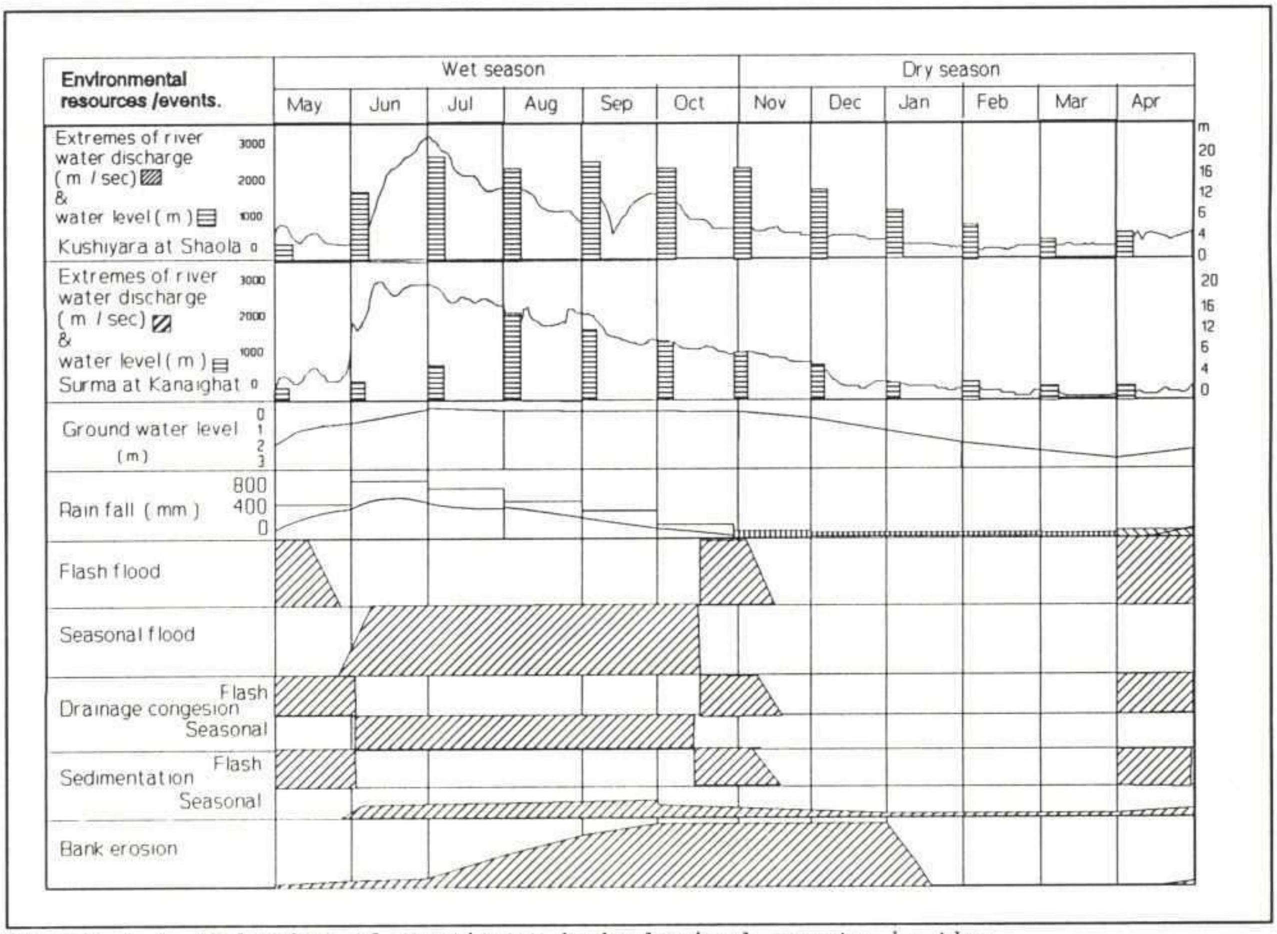


Figure 4.1. Calendar of prominent hydrological events in the Surma-Kushiyara project area.

monsoon, i.e. early or late flash floods or seasonal floods, will likely be the cause of disruptions in the various cycles. The severity of disruption will depend on the timing, duration, intensity and extent of the event.

4.2 Agriculture

Crop diversity in the project area decreases from higher land types to lower land types (Figure 4.2). Rabi crops are grown on the highest land type. B. and T. aus and T. aman are characteristic of higher land types, but give way to B. aman and boro at the lower elevations. Thus kharif-1, kharif-2, and rabi/boro crops are fine-tuned to land types and flooding frequency and duration. If the latter are changed due to interventions, agricultural practices will change with increased demand on irrigation water.

Use of farm labor is related to the diversity and number of agricultural crops grown on a particular land type. Both high and medium high lands have 3 months of lean period each, whereas medium low land has 4 months and low land has as much as 6 months of lean season when no farm labor is used. These 6 months are divided into two periods: 5 months from June to October, and 1 month in February. If the fisheries calendar (Figure 4.4) model is compared to the agricultural calendar (Figure 4.2) it is seen that fishing in floodplain and canals more or

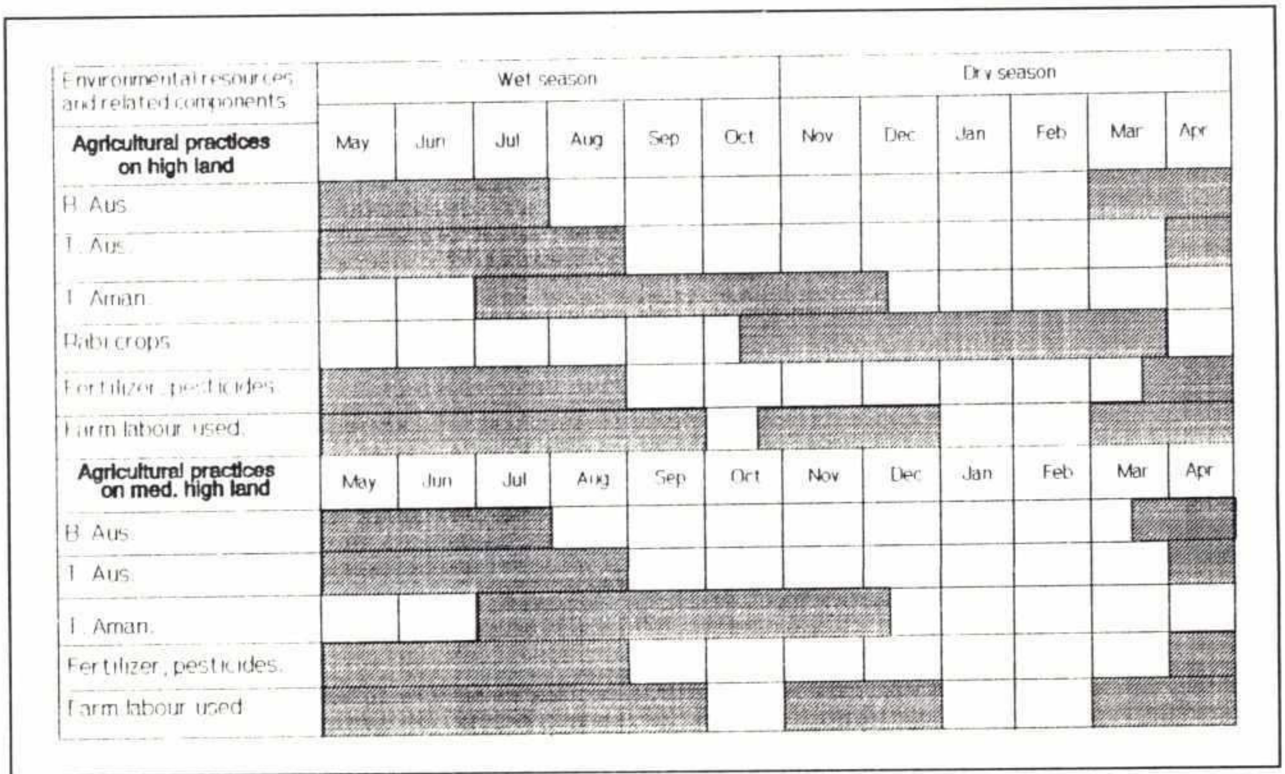


Figure 4.2. Agricultural resource calendar for the Surma-Kushiyara project area (Figure continued on next page).

less coincides with the lean period of agricultural employment. The FCD/I intervention could potentially remove fishing activity in the floodplain and canals during the farm labor lean season, thereby creating an imbalance in the general survival strategy of the farm laborers.

Surface water irrigation at present is related chiefly to boro cultivation on medium low to low land during December to March. This coincides with the dry season when water level and discharge in both Surma and Kushiyara are low and ground water level also declines to the minimum. Any increase in HYV Boro will increase the seasonal pressure on all available surface water for irrigation.

4.3 Cultivated and Noncultivated Vegetation

The Surma Kushiyara project area is devoid of any forest, but is rich in homestead, roadside and marshy vegetation. The model depicts activities as well as vegetation cycles. Sprouting of bamboo shoots, cane and patipata, and fruiting of betel nuts and banana ratoons are parts of vegetative cycles of critical importance. All vegetative cycles start in March with the early showers associated with Nor'westers. Roadside vegetation and homestead plantations start only when the monsoon is quite advanced. The summer vegetation cycle starts with the early monsoon showers and ends in August when the seasonal cycle of winter vegetables starts. Winter vegetables are dependent on irrigation water from homestead sources.

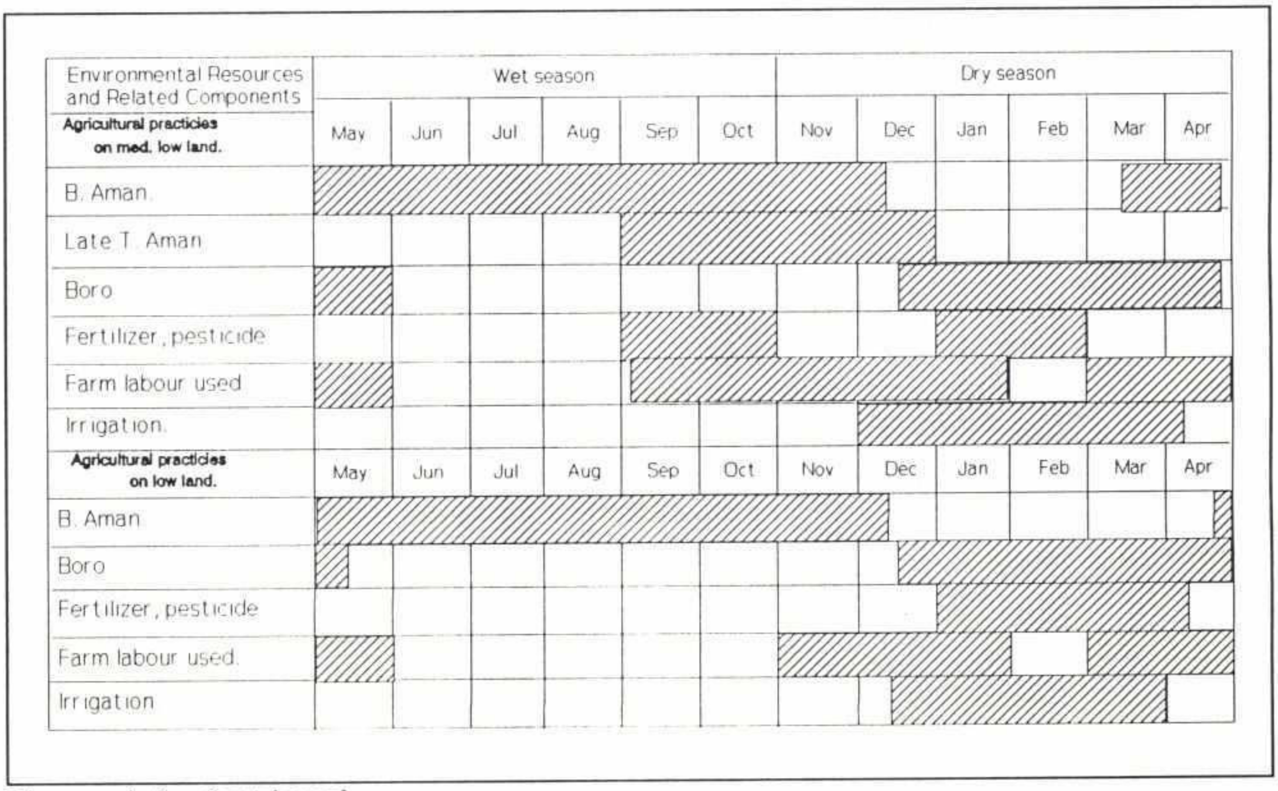


Figure 4.2. Continued.

4.4 Fisheries

Fisheries in the project area, in common with most floodplain areas in the country, follow a four stage cycle during a year:

- Spawning migration (to rivers for major carps, to flood plain for resident species)
- Spawning (major carps in flowing rivers, resident species in flood plains)
- Grazing dispersal (to the floodplain for all the species)
- Return to permanent water bodies (major carps to rivers, resident species to Beels)

There are three ways in which the proposed FCD/I projects can potentially have adverse effects on the annual cycle:

- By closing and/or restricting migration paths during spawning and/or return migration
- Restriction on grazing habitat by reducing floodplain water area
- Reduced habitat area for return of resident species.

Fishing in the flood plains and canals, which also include most of the common property areas not leased out, takes place from May to January, after which fishing is mainly restricted to beels.

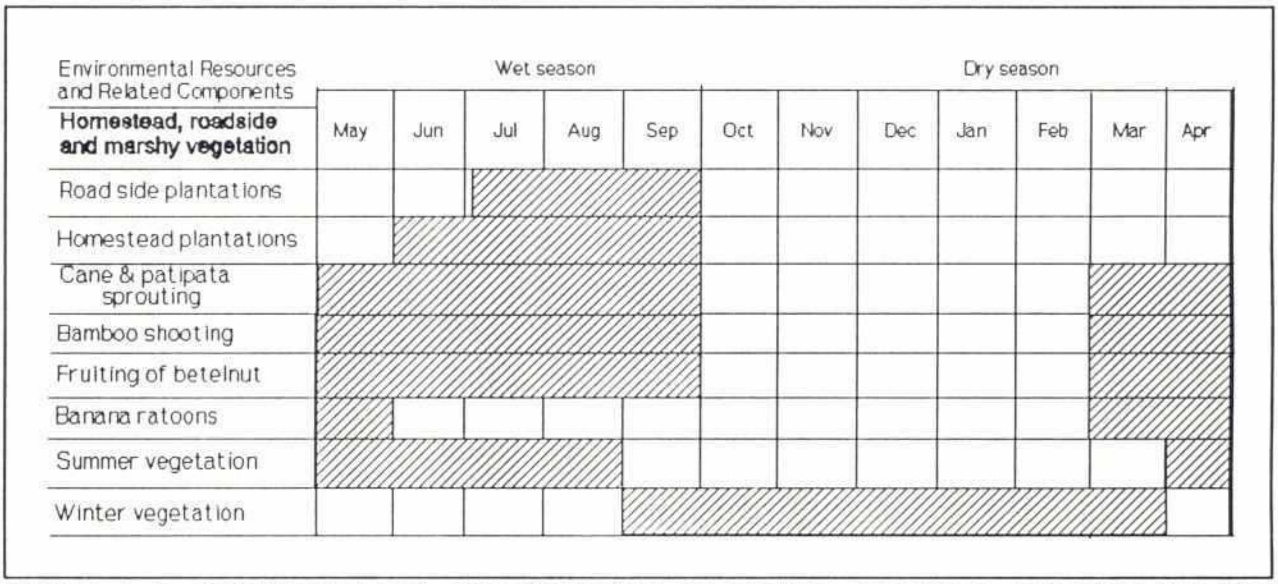


Figure 4.3. Cultivated and noncultivated vegetation resource calendar for the Surma-Kushiyara project area.

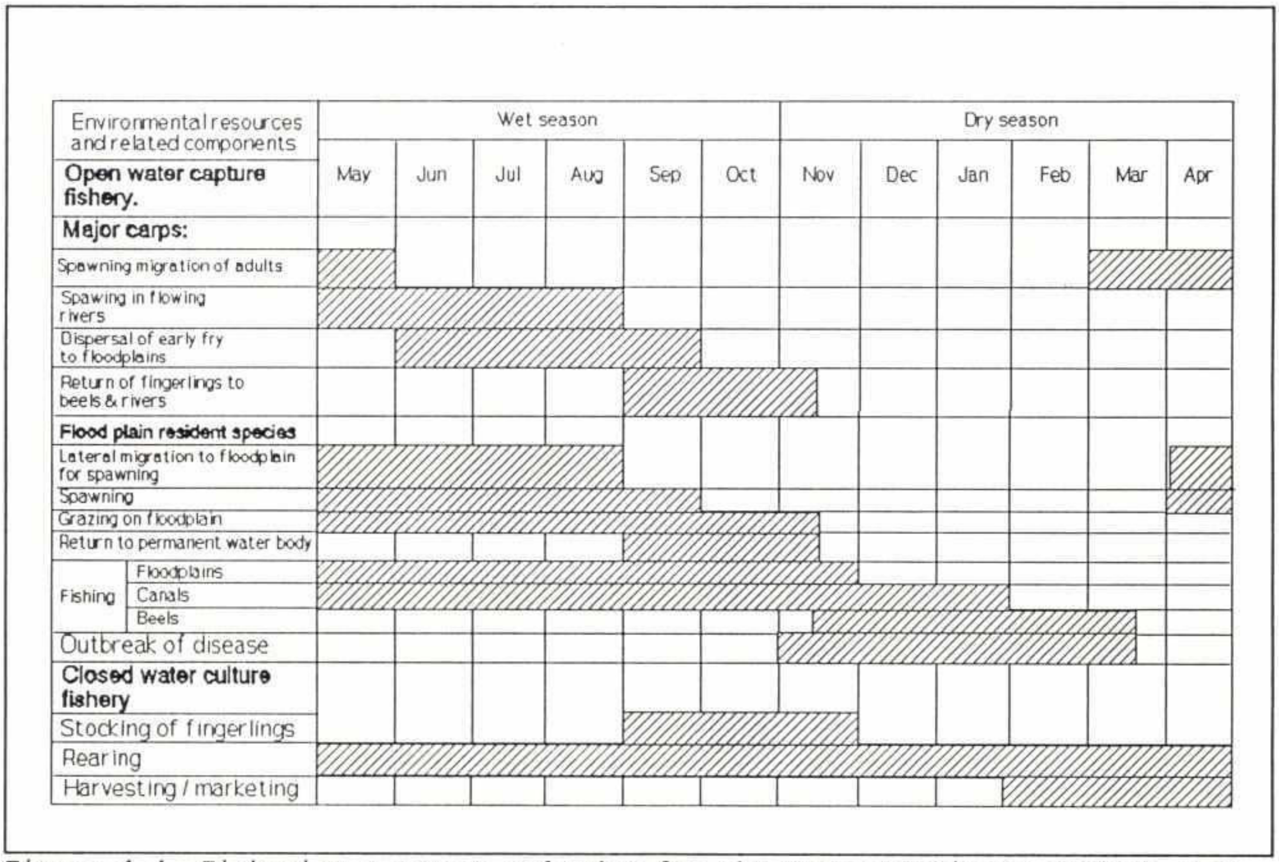


Figure 4.4. Fisheries resource calendar for the Surma-Kushiyara project area.

4.5 Wildlife

Breeding and migration of wildlife is very seasonal (Figure 4.5). Breeding seasons vary slightly between amphibians, reptiles, birds and mammals, but generally extend from March to September. Migratory birds arrive by the end of November and leave by the end of March. This is also the period when most of the hunting and trapping take place. Food damage by wildlife follows the breeding season. Embankment damage by rats also has seasonality and is limited to the period from mid-December to mid-April.

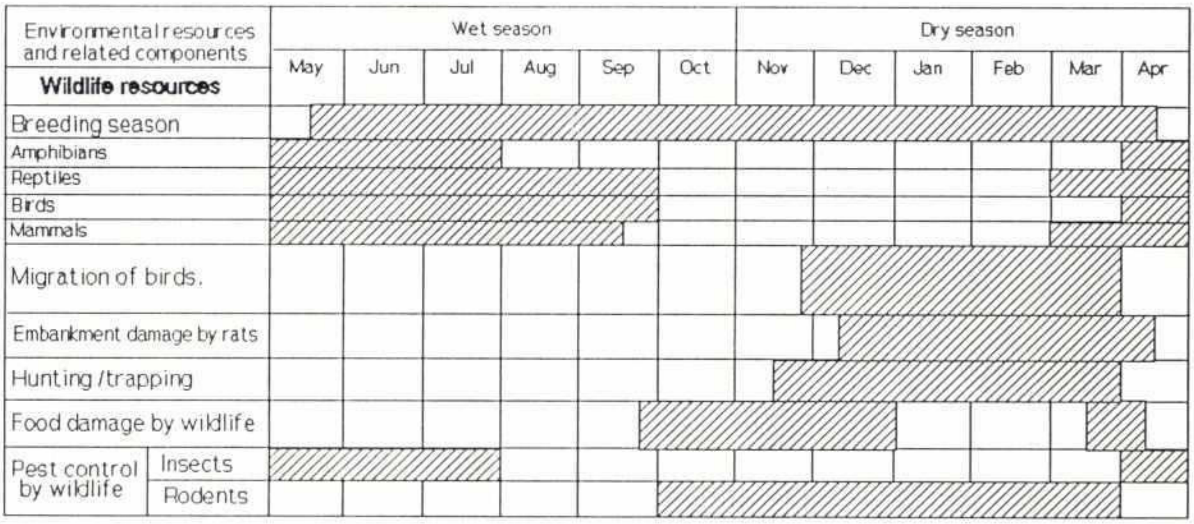


Figure 4.5. Wildlife resource calendar for the Surma-Kushiyara project area.

4.6 Human Resources

Four different aspects of human resources have been included in the calendar (Figure 4.6):

- Agriculture
- Capture fishery
- Culture fishery and
- Public health

Agriculture, capture fisheries and public health concerns are more seasonal than culture fisheries, which though paid employment, self employment, income and marketing, covers the whole calendar year. Agriculture has three distinct seasons, i.e. pre- and post-kharif and the rabi season. Similarly, activities around capture fishery extend from October to March. Water borne diseases also show distinct seasonality in their main occurrence, i.e. pre-monsoon and during monsoon, with a gap in between. Disease vectors are prevalent from mid monsoon to late winter, i.e. from September to February.

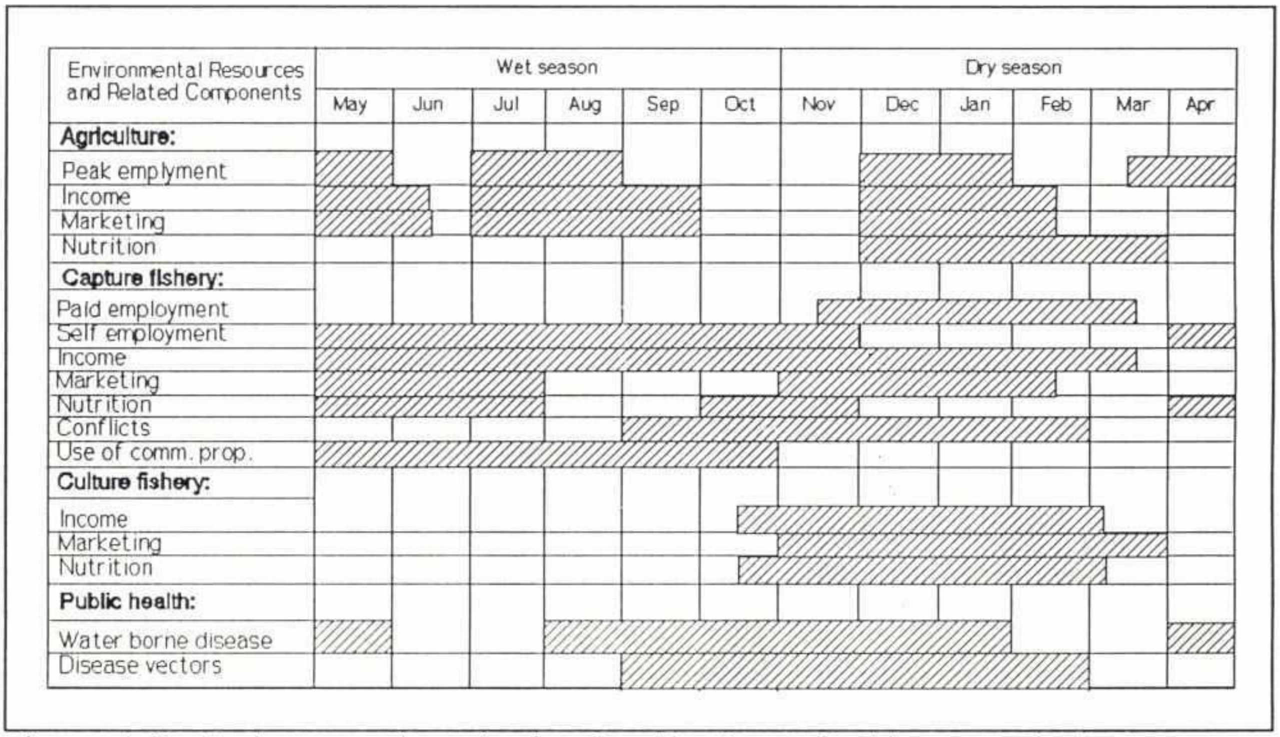


Figure 4.6. Socio-economic calendar for the Surma-Kushiyara project area.

Chapter 5

DESCRIPTION OF THE EXISTING ENVIRONMENT

5.1 Climate

Although Bangladesh is a small country, there is a wide range of spatio-temporal variation in the distribution pattern of climatic elements. Classified on the basis of temperature efficiency and precipitation effectiveness, the Surma-Kushiyara project area falls in the tropical prehumid zone. The temperature efficiency index and precipitation effectiveness index for the project area are 134 and 216 respectively.

5.1.1 Temperature

The highest temperature in the project area was recorded as 40.6^{0}C in May and the lowest was 8.9^{0}C in December and February. The maximum mean daily temperature, taken in April, was 32.4^{0}C and the minimum mean daily temperature, taken in January, was 12.2^0. The range between the maximum and the minimum mean daily temperatures in January varies from 25.2^{0}C to 12.2^{0}C, and in May it ranges between 31.1^{0}C to 22.8^{0}C (Table 5.1).

Table 5.1. Climatological data for the Surma-Kushiyara project area.

	Temperature^0 C								
Month	Max	Mean Daily Max	Mean	Mean Daily Min.	Min	Rel. Hum %	Day Light per day hrs	Sun shine hrs	Light %
January	28.3	25.2	18.7	12.2	9.4	76.9	10.8	8.8	81
February	32.2	30.1	20.4	14.2	8.9	70.9	11.3	9.0	78
March	36.7	31.0	24.2	17.4	12.8	63.8	12.0	8.4	72
April	38.9	32.4	27.2	21.9	16.7	75.0	12.8	7.5	55
May	40.6	31.1	26.9	22.8	18.3	83.5	13.4	6.8	48
June	35.0	30.6	27.8	24.7	21.1	87.7	13.7	3.5	31
July	40.0	31.9	28.8	25.9	23.9	89.5	13.6	4.1	35
August	35.0	31.2	28.2	25.2	23.3	89.5	13.0	4.4	38
S'tember	35.0	31.3	28.1	24.9	21.7	87.5	12.3	4.6	45
October	35.0	30.4	26.6	22.7	18.3	87.3	11.6	7.5	52
November	31.7	28.8	19.7	13.5	12.8	81.0	11.0	9.0	75
December	28.9	26.0	19.7	13.5	8.9	79.9	10.6	7.8	76
Annual	40.6	29.9	24.9	20.2	8.9	81.0	--	7.0	59

Source: Meteorological Department (1902-1990)

5.1.2 Rainfall

Rainfall records at individual stations are available in time periods ranging from 25-85 years. Data for Sylhet and Lalla Khal have been maintained since 1905. The general trend of spatial distribution pattern (Figure 5.1) shows that rainfall gradually increases from South to North. Average annual rainfall within the project area ranges from 3600 mm along the Kushiyara River to about 4800 mm along the Surma River. Average annual rainfall in the East at Zakiganj is 3744 mm; in the West at Sheola 4082 mm and in the North at Kanaighat 4734 mm.

5.1.2.1 Monthly Mean Rainfall

The highest mean monthly rainfall for all stations in and around the project area was recorded in June. The next highest were recorded in July, August and May, respectively. The lowest mean monthly rainfall was recorded in December (Table 5.2).

Table 5.2. Mean monthly and annual rainfall in Surma-Kushiyara (mm).

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9.2	36.5	101.4	397.1	514	916.5	747.2	555	282.2	198.7	53.7	30.2	3833.7

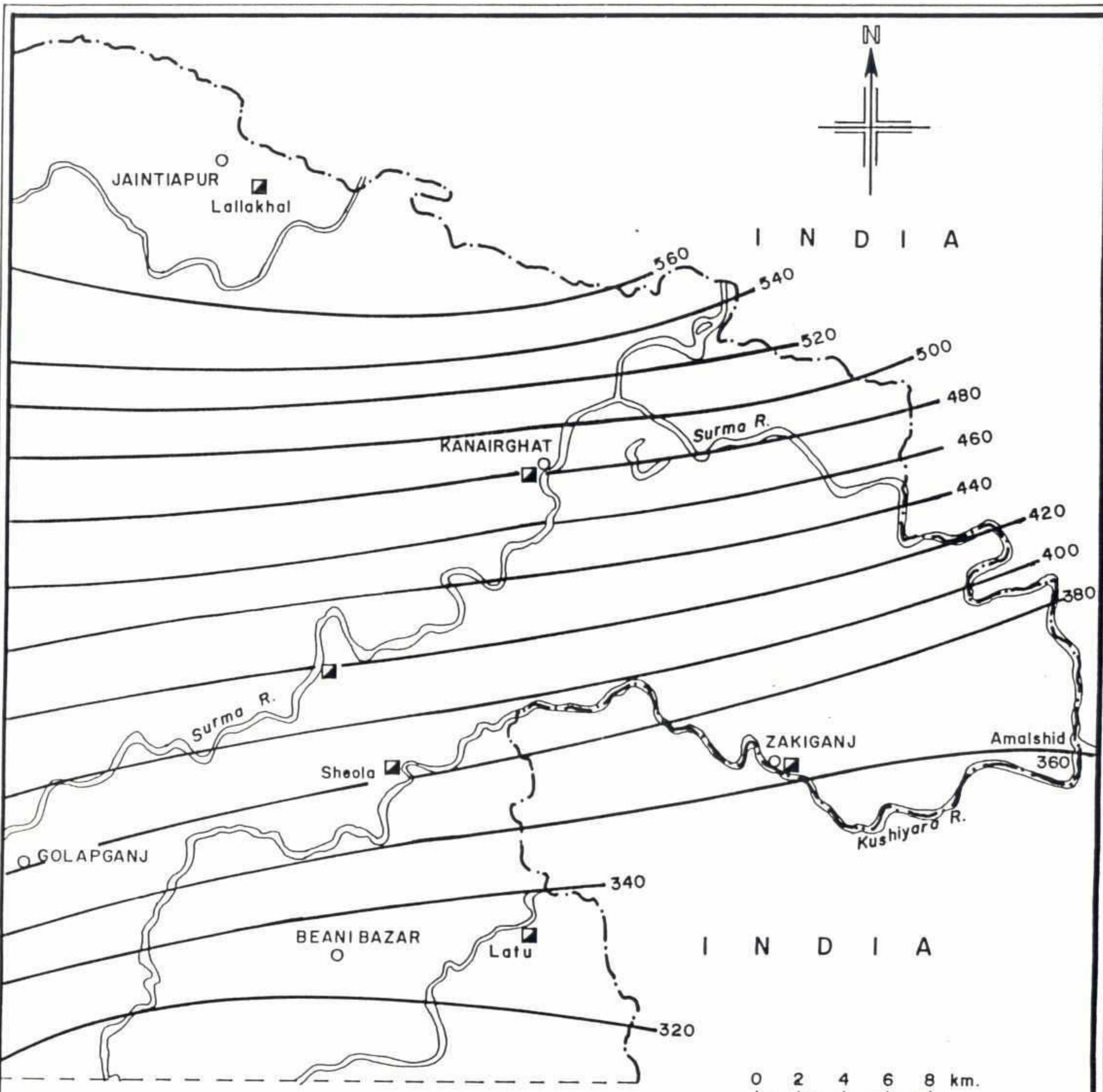
5.1.2.2 Maximum Rainfall Analysis

Frequency analyses were made to determine the mean (2.23 yearly probability), 5, 10 and 20 year maximum, two-day rainfall. These analyses were used to estimate drainage requirements. Table 5.3 shows a two-day maximum rainfall frequency analysis for Zakiganj and Sheola stations.

Table 5.3 Maximum two days rainfall recurrence interval and percent chance in Surma- Kushiyara project area.

		Rainfall Quantity (mm)	
Year	Percent Chance	Zakiganj	Sheola
1.01	99	144.02	87.84
1.05	95	160.49	137.69
1.11	90	172.55	164.97
2	50	237.72	264.63
2.33	43	249.93	278.88
5	20	303.18	333.15
10	10	345.48	370.01
20	5	384.80	400.93
50	2	433.96	436.25
100	1	469.72	460.17
200	0.5	504.51	482.28
500	0.2	549.51	509.37
1000	0.1	582.83	528.53

Source: WARPO (1990)



LEGEND

INTERNATIONAL BOUNDARY
UPAZILA HEADQUARTER
RAINGAUGE STATION
RIVERS
ISOHYETS IN CENTIMETERS

Source : MPO/HARZA, 1986

FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure 5.1

ISOHYETAL MAP

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5.1.2.3 Rainfall Variability

Variability greatly affects rainfall efficiency. Variability parameters including coefficient of variation and inter-quartile ranges are used in climatic indices to show the comparative utility of land areas for agricultural purposes. The parameters indicate to what degree a rainfall occurrence is typical of a specific area and period. During the premonsoon period (March-May) in the project area variability is highest during March when variability is 45 - 50 percent. During April variability is as low as 25 percent and then increases to 40 percent in May. The lowest variability occurs during the monsoon (June - October) when the area receives more than 80 percent of its total rainfall. Variability in this season ranges between 18 and 25 percent except during October when it is about 35 percent. However, overall variability fluctuation is minimal in the project area.

5.1.3 Humidity

The mean monthly percent distribution of relative humidity is presented in Table 5.1. The data were collected at the meteorology station at Sylhet, located 35 m above mean sea level. The mean monthly relative humidity varies from 63.8 percent in March to 89.5 percent in July and August. These readings are based upon three daily recordings at 6 a.m., 9 a.m. and 6 p.m. local time.

5.1.4 Day Length and Hours of Sunshine

Table 5.1 presents the mean monthly sunshine hours compared to daylight hours. Sunshine occurs during 31 percent of the daylight hours in June, compared to 81 percent in January. The annual mean is 59 percent. Sunshine hours range from 4.3 hours in June to 8.8 hours in February. The annual average is 7 hours.

5.1.5 Evapotranspiration

The most accessible station producing evaporation data is at Sylhet where records have been maintained since 1961. Average monthly evapotranspiration is shown in Table 5.4.

Table 5.4. Average monthly evapo-transpiration (mm) in Surma-Kushiyara project area.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1.80	2.64	3.88	4.35	4.44	3.80	3.98	3.98	3.59	3.38	2.47	1.75

Source: FAO (1988)

5.1.6 Wind

Mean monthly average wind speeds for the project area is shown in Table 5.5.

Table 5.5. Average monthly wind speed (km/h) in project area.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.4	2.8	5	6.0	5.0	5.4	5.6	5.0	3.7	2.4	1.9	1.9

Source: Meteorology Department (1988)

5.1.7 Agro-climatic Evaluation Using AEZ Climatic Data Base

Annual moisture regime in the project area which indicates the seasonal periods covering information on duration, begin date and end date for agricultural purpose are presented in Table 5.6.

Table 5.6. Generalized moisture characteristics of kharif growing period.

Kharif Growing Period		Kharif Humid Period			Rabi Growing Period	
Days	Period	Days	Period	Excess rain fall(mm)	Days	Period
280-290	27 March 6 January	195-210	10 Apr. 3 Novem	3000- 4500	135 150	3 Nov. 25 Mar.

Source: FAO (1988)

5.2 Water Resources

5.2.1 River Systems and Geomorphology

The hydrology of the project area is influenced by the Barak, Lubha, Surma and Kushiyara River Systems. A schematic diagram of these river systems is presented in Figure 5.2. The rivers' general morphological characteristics are summarized below.

5.2.1.1 Barak River

The Barak River has a drainage basin of about 26,000 km^2, most of which is located in India. The upper portion of the catchment is hilly with mountains reaching to about 2400 m above sea level. The river descends to less than 30 m as it enters into the flood plain. It enters Bangladesh at Amalshid in the Zakiganj Upazila of the Sylhet District after running some 400 km from the source. It bifurcates at Amalshid into the Surma to the North and into the Kushiyara river to the south. Figure 5.3 shows the bifurcation details of the Surma Kushiyara bifurcation.

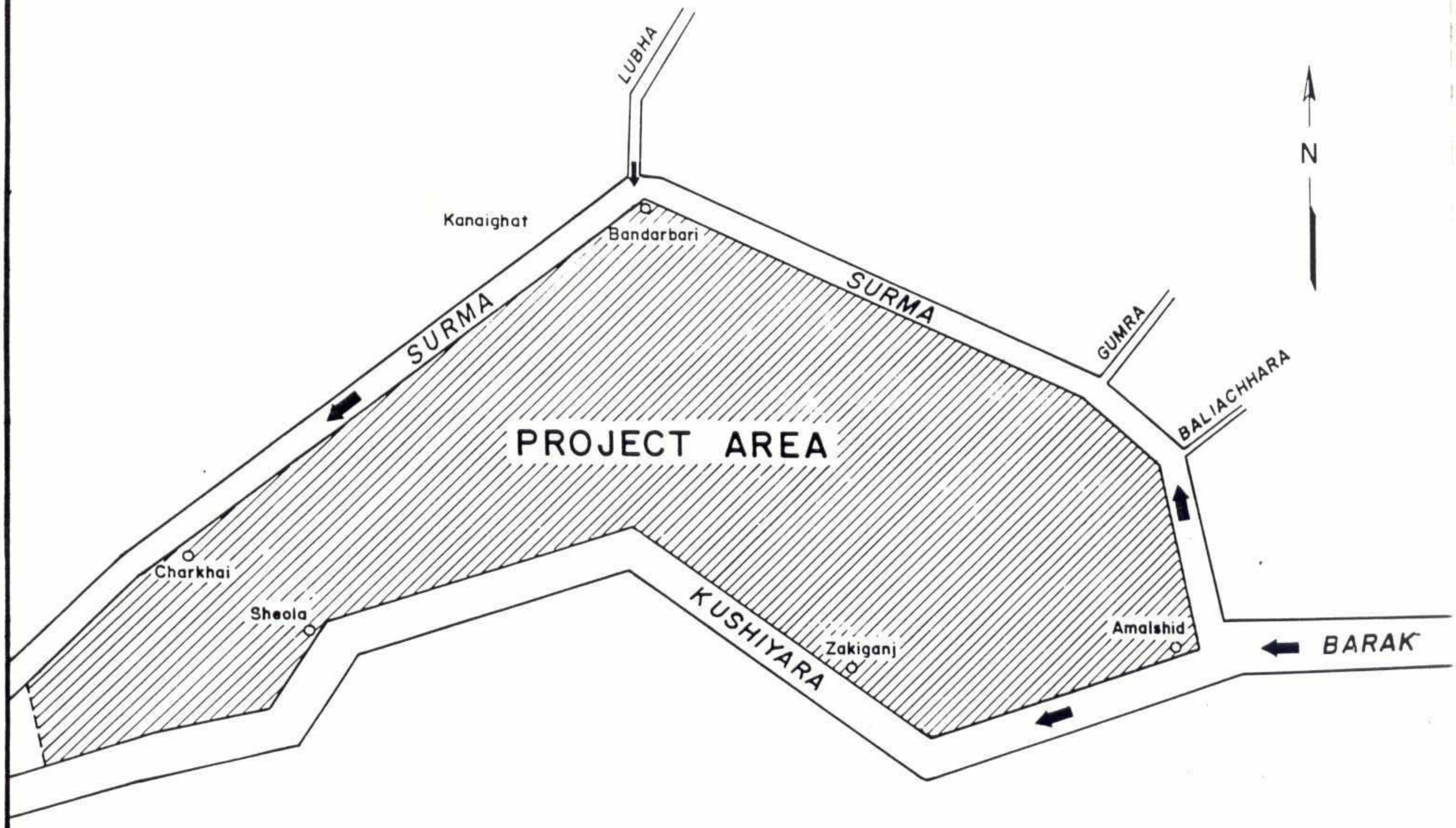
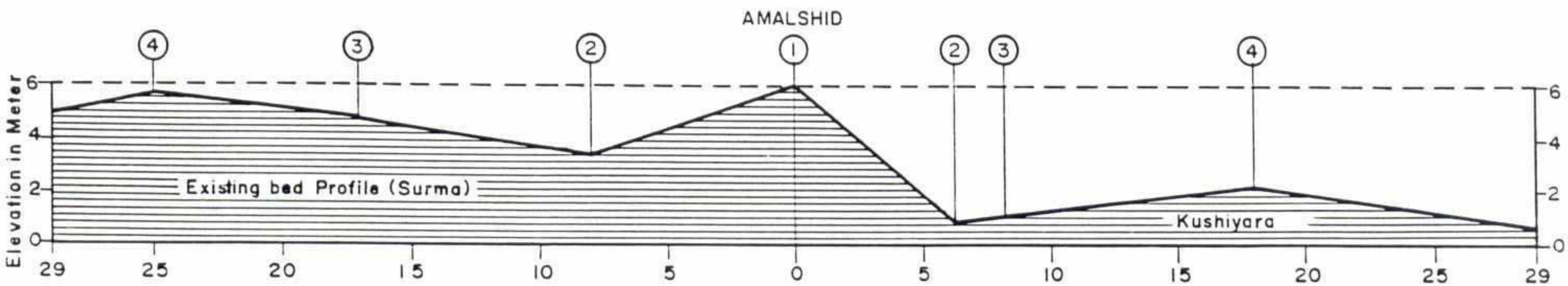
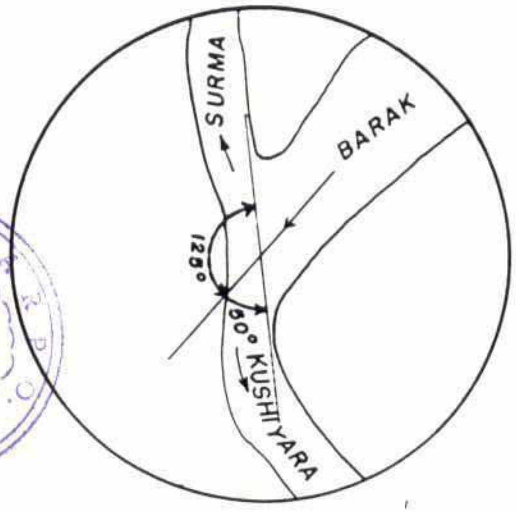


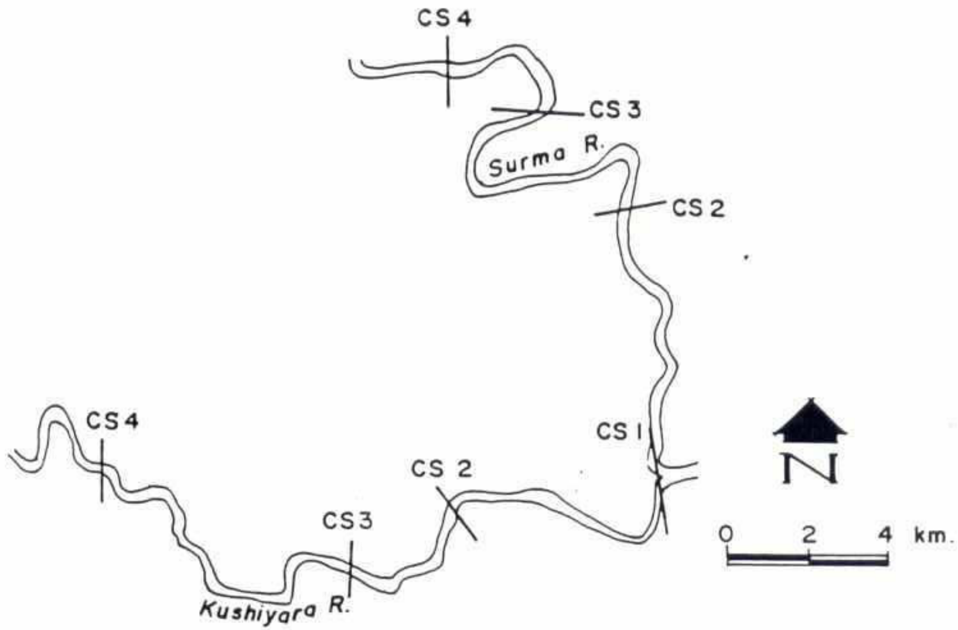
Figure 5.2. Schematic Diagram of the River System of the Project



THALWEG PROFILE



BIFURCATION DETAIL
(Not to Scale)



Location of Cross-Sections

Figure 5.3 Surma-Kushiyara Bifurcation

Source: WAPDA, 1966

5.2.1.2 Lubha River

The Lubha River is the principal tributary to the Surma. The drainage basin is about 850 km^2, most of which lies in India. The river is about 50 km long. It originates in the Cachar Hills of Assam and meets the Surma at Bandarbari about 40 km downstream from Amalshid. The river is steep, and flow is rapid and turbulent as it falls towards the flood basin. It is, however, almost flat in the last 7 km where bank spills are fairly frequent. Compared to the Barak River basin, the influx of the Lubha flow is very rapid and flashy due to the size and hilly nature of its catchment. The Surma flows are sometimes reversed when the Lubha is fully flooded.

5.2.1.3 Surma and Kushiyara Rivers

The Surma and Kushiyara Rivers are the bifurcated channels of the Barak River from Amalshid. The Surma has an average slope of 50 mm/km from Amalshid to Kanaighat. The Surma River is approximately 150 m wide at bankfull stage. It is 11 m deep at Amalshid, then decreases to 8.3 m at the junction of the Lubha. From Lubha, the river bed falls for the next 16 km downstream, lowering to 13.8 m below the bank level. The Surma above the Lubha towards Amalshid is not significant and carries only a small portion of the Barak flow. The Kushiyara river is approximately 150 m wide when full and the average depth is about 12 m. The Surma and Kushiyara meets near Habiganj beyond the project area and ends to Bay of Bengal in the name of Meghna.

5.2.1.4 Other Tributaries

The Gumra and the Balichara Rivers join the Surma between Amalshid and the outfall of the Lubha. These two tributaries have a combined catchment area of about 200 km^2 but pass through a large flood plain before draining into the Surma and do not greatly influence the project area.

5.2.1.5 Longitudinal Profile

The lengths and slopes are based on the bank level's natural top and are approximately as follows (BWDB 1986):

- Amalshid-Sheola: 35 km at 0.10 m/km
- Sheola-Fenchuganj: 41 km at 0.06 m/km

Historical trend of river stage shows that 10-year high-water levels are up to 1.5 m above the average natural bank level top. Two-year high-water levels reach approximately the bankfull level.

5.2.2 Flooding

In the northeast region of Bangladesh, where the project is located, floods occur earlier than in the western part of the country (Brammer 1988). While flooding is common in the project area, the depth and duration of floods vary from place to place. The primary reasons for flooding in the project area are high rainfall, over bank spills and flat river gradients.

In this report, the term *"normal flood"* refers to the usual seasonal submergence of land during which neither crops nor property are damaged. The period of seasonal flood is usually from June to October. *"Disastrous flood"* refers to flooding that is potentially dangerous to crops or property. A *"flash flood"* is one that occurs suddenly and rapidly. In addition, a flash flood occurs either earlier or later than normal flood season and is extremely dangerous. The period is usually April and May for early and late October and November for late flash floods. A normal flood often occurs in the project area when incessant rains cause a rise in the water level. Villagers call this type flooding "barsha" and do not consider it harmful. The overtopping of the Kushiyara and the Surma results in a sudden onrush of water. The villagers call this type flooding "*bannya*" or "*pahari dhol*," and it results in severe damage to crops and property. It is termed a "flash flood" if it occurs in April, early May or late October and November, and is called a "disastrous flood" if it occurs from June to September.

The annual peak flooding stage occurs most often in June. Stage hydrographs dated 1959 to 1964 reveal that early flash floods occur in March, April or May, and late ones in October and November. Flash floods occurred in Kushiyara in late March 1961, April 1961, and early May 1961 and 1964. Stage hydrographs of the Kushiyara and Surma Rivers for 1959, 1961, 1962 and 1964 are shown in Figures 5.4 and 5.5.

The frequency of seasonal disastrous floods also has increased. According to local people disastrous floods are occurring every two year now and normal seasonal floods inundate the medium lowland and lowland areas. The area remains under water from June to October. Flood waters begin to recede in September, but late rains and flash floods often keep the land inundated until November. For example, in 1991 a late flood by rains kept water levels high until November. Seasonal floods also inundate medium highland and highland when river stage and discharge are very high.

The 1991 flash flood was one of the worst in history and compares with extreme flooding that occurred in 1928, 1955 and 1988. During the 1991 flood about 80 percent of the project area was affected. Many areas not prone to flooding were covered in one to two meters of water for more than a week.

5.2.3 Surface Water Hydrology

5.2.3.1 Kushiyara River

The Kushiyara River has three gauge stations: Amalshid, Sheola and Fenchuganj (Figure 5.6). The first two are within the project, but the Fenchuganj station is outside and downstream of the project. Table 5.7 shows extreme water levels and discharge at the designated stations from 1951 to 1990. Table 5.8 shows the monthly extreme water level for the year 1990 and 1991. The river reached its highest stage of 14.3 m at Sheola on 18 June 1959 and its lowest stage of 3.9 m on 8 March 1973.

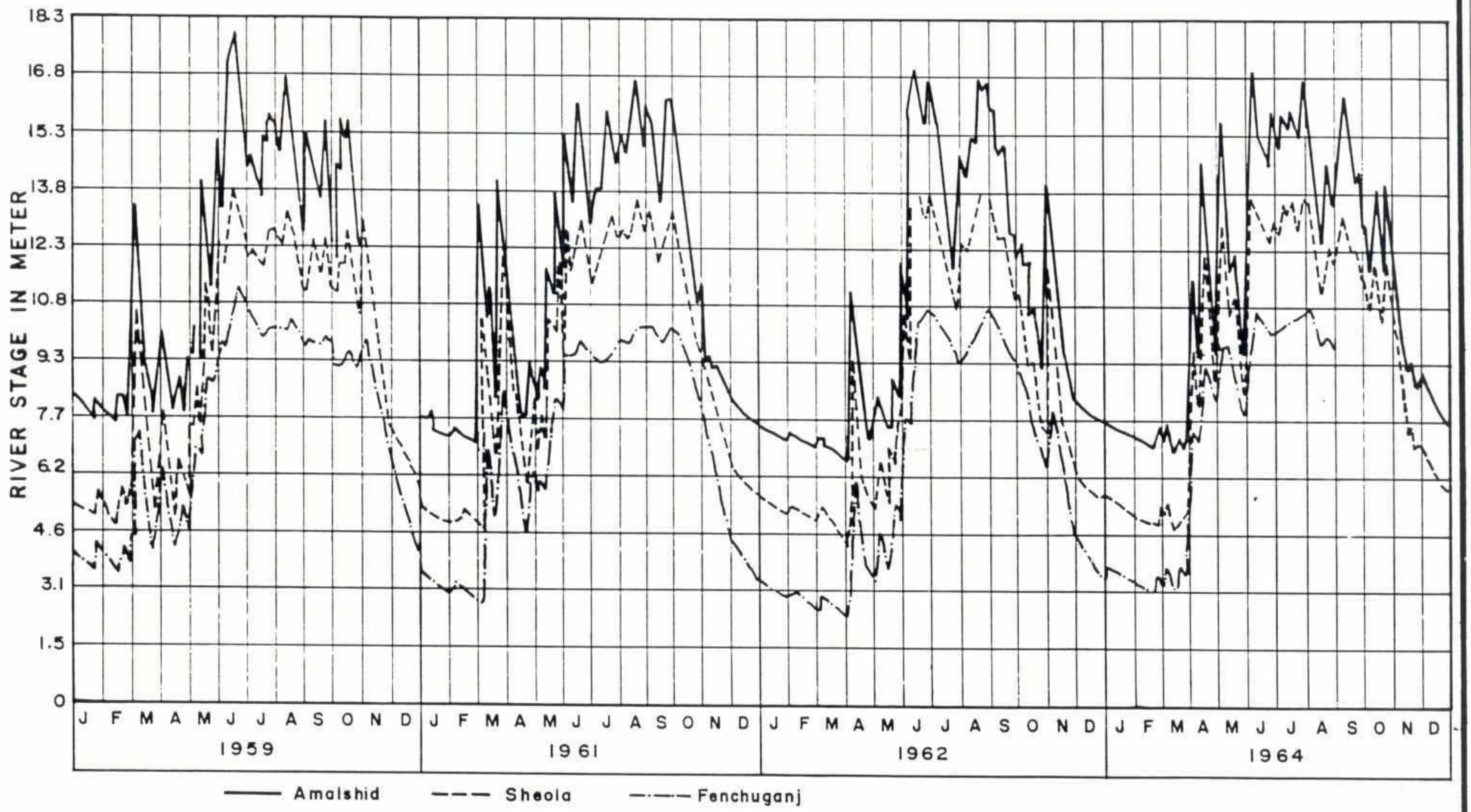


Figure 5.4 River stage hydrograhs of the Kushiyara River, 1959, 1961, 1962 and 1964

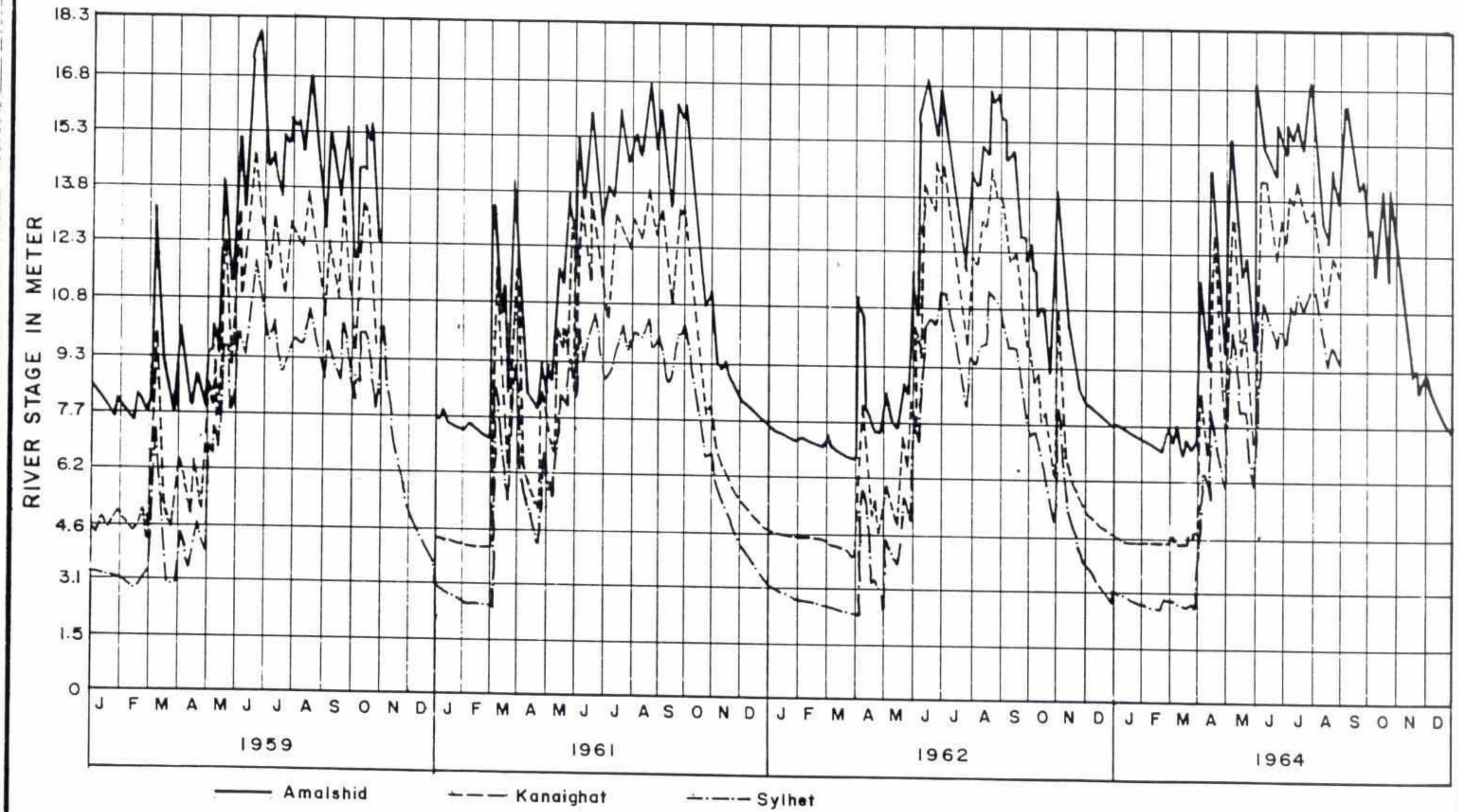
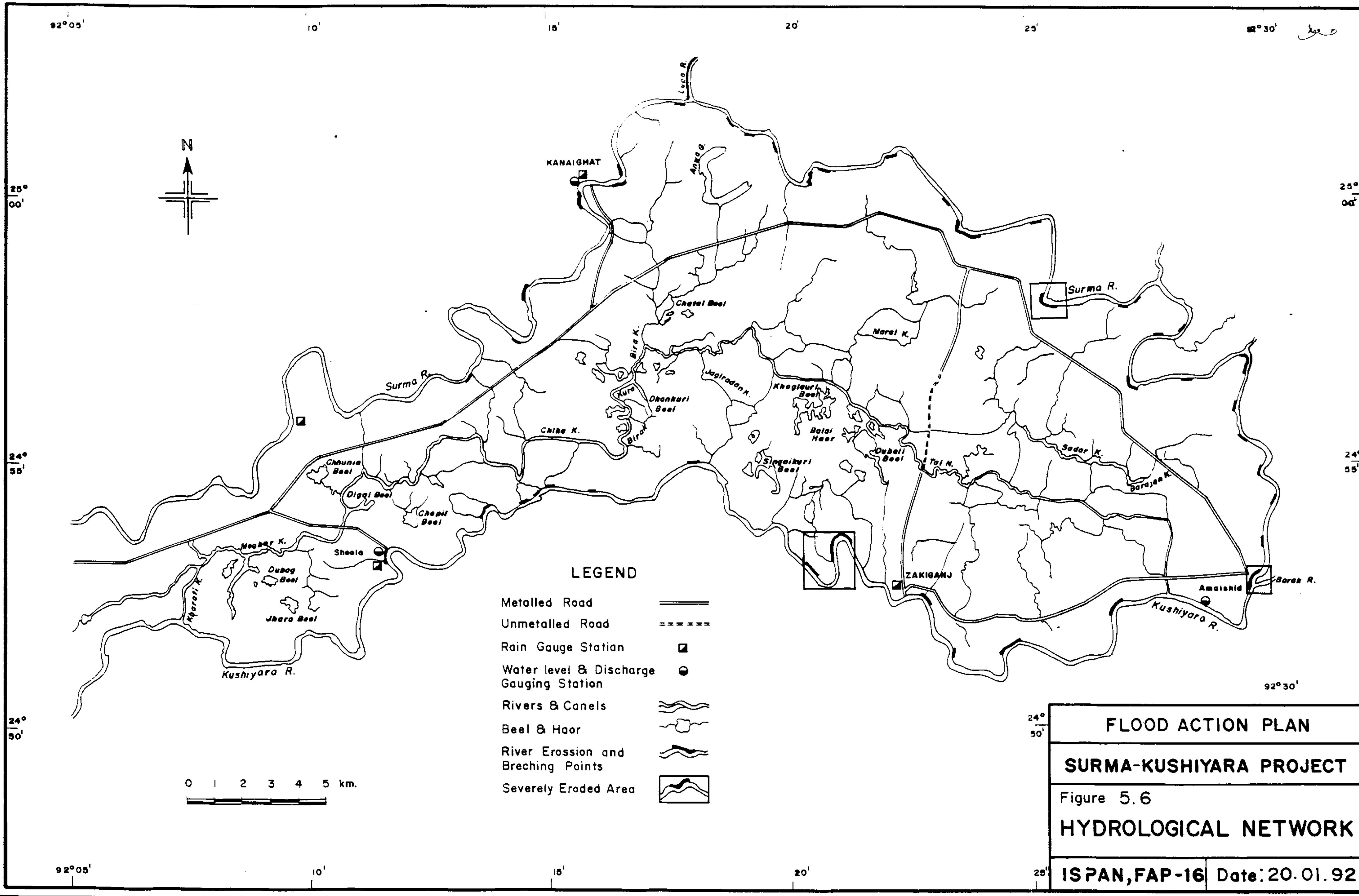


Figure 5.5 River stage hydrographs of the Surma River, 1959, 1961, 1962 and 1964



FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure 5.6

HYDROLOGICAL NETWORK

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5.2.3.2 Surma River

The Surma River has two gauge stations: one within the project area at Kanaighat, and the other downstream and outside the project area at Sylhet. Table 5.9 shows the river's extreme water levels and discharge at the two stations from 1951 to 1990. Table 5.10 shows the monthly extreme water level for the year 1990 and 1991 at Kanaighat station only.

Table 5.7. Maximum and minimum water levels (m) and discharge (m^3/s) in the Kushiyara at Amalshid, Sheola and Fenchuganj for the period 1951-1990.

	Amalshid		Sheola		Fenchuganj	
	Water Level	Dis-charge	Water Level	Dis-charge	Water Level	Dis-charge
Maximum	18.00 (18 June-'59)	N.A	14.3 (18 June '59)	2970	11	N.A
Minimum	5.9 (8 Mar-'73)	N.A	3.9 (8 Mar'73)	25	2.1	25.5

Table 5.8. Extremes of water levels (m) of the Kushiyara River in 1990 and 1991 at Amalshid and Sheola (figures within parentheses indicate date of occurrence).

Year	Level m	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Amalshid													
1990	Maxi-mum	N.A	N.A	10.4 (27)	15.7 (24)	15.1 (17)	17.3 (10)	17.9 (13)	17.3 (17)	17.0 (27)	14.9 (14)	9.8 (1)	8.8 (29)
	Mini-mum	N.A	N.A	6.8 (18)	10.4 (1)	9.6 (13)	13.8 (1)	14.8 (26)	13.3 (31)	12.3 (5)	14.7 (8)	8.5 (30)	7.7 (31)
1991	Maxi-mum	8.1 (7)	10.9 (6)	7.8 (13)	8.5 (13)	17.9 (10)	16.9 (19)	16.4 (1)	16.4 (19)	16.8 (26)	N.A	N.A	N.A
	Mini-mum	7.1 (31)	10.9 (5)	6.7 (27)	6.7 (21)	10.8 (1)	14.7 (2)	12.1 (3)	13.5 (2)	13.8 (13)	N.A	N.A	N.A
Sheola													
1990	Maximum	N.A	N.A	N.A	N.A	12.4 (17)	14.0 (10)	13.9 (3)	14.1 (18)	13.9 (29)	13.7 (1)	10.0 (9)	7.0 (23)
	Minimum	N.A	N.A	N.A	N.A	8.6 (19)	12.2 (1)	12.8 (26)	12.0 (31)	11.0 (6)	8.8 (3)	6.9 (30)	6.0 (31)
1991	Maximum	6.6 (8)	7.5 (7)	6.1 (14)	11.5 (5)	14.2 (10)	13.8 (15)	13.6 (1)	13.6 (14)	13.8 (27)	13.1 (16)	N.A	N.A
	Minimum	5.5 (31)	5.3 (25)	5.0 (1)	5.5 (1)	6.9 (2)	12.8 (31)	10.8 (31)	11.1 (1)	12.0 (13)	10.0 (26)	N.A	N.A

Table 5.9. Maximum and minimum water level (m) and discharge (m^3/s) of the Surma River at Kanaighat and Sylhet. Reporting period: 1951-1990.

	Kanaighat		Sylhet	
	Water Level	Discharge	Water Level	Discharge
Maximum	15.3 (10 May 1991)	2480	12.0	2990
Minimum	3.2 (1958)	2.3	1.7	2.8

Table 5.10. Extremes of water levels (m) of the Surma in 1990 and 1991 at Kanaighat. Figures in parentheses indicate date of occurrence.

Year	Level m	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	Maxi-mum	N.A	N.A	N.A	N.A	12.2 (31)	14.8 (7)	14.2 (13)	14.7 (12)	14.9 (28)	14.1 (1)	8.5 (9)	5.5 (23)
	Min-imum	N.A	N.A	N.A	N.A	7.3 (13)	11.9 (1)	12.4 (26)	11.5 (31)	9.9 (6)	7.0 (31)	5.4 (30)	4.7 (31)
1991	Max-imum	5.0 (8)	5.6 (7)	4.6 (17)	10.3 (6)	15.3 (10)	14.2 (20)	13.6 (6)	13.5 (5)	14.6 (26)	N.A	N.A	N.A
	Min-imum	4.5 (31)	4.1 (26)	4.3 (29)	4.4 (1)	5.8 (1)	12.4 (2)	9.8 (30)	12.0 (31)	11.8 (31)	N.A	N.A	N.A

Table 5.11. Maximum, minimum and mean flow (m^3/s) of wet season in the Kushiyara River and Sada Khal.

	Kushiyara River	Sada Khal
<u>Period 1952-63</u>		
Maximum	2400	4000
Minimum	800	490
Mean	1570	1830
<u>Period 1970-76</u>		
Maximum	2200	570
Minimum	2130	250
Mean	2160	350

Source: Northwest Hydraulics (1986)

5.2.3.3 Sada Khal

The Sada Khal is located in the southern part of the project area and is known by 13 different names at various locations originating as Rahimpur Khal at the Southeast part of the Kushiyara. It is fed by many small canals that flow from the Kushiyara and Surma Rivers. Sada Khal's highest recorded flow was 4000 m^3/s on 4 August 1964 at a stage of 12.9 m (Northwest Hydraulics 1986).

Examination of reported discharges for the Kushiyara River and the Sada Khal near Sheola for the years 1952 to 1963 and 1970 to 1976 indicate a substantial reduction of Sada flows and an(Northwest Hydraulics 1986). Possible reasons include canal closures that reduced the number of Surma River spills, dike and road construction, and canal sedimentation of the Rahimpur and other Khals. Table 5.11 shows the annual maximum flows of the Kushiyara and Sada Khal.increase in Kushiyara flows.

5.2.4 Characteristics of Flood Flows

The Barak-Surma-Kushiyara system has a large drainage area and a large flood plain storage capability. The system's flood hydrography characteristics include long periods of rise and fall, and overlapping effects of successive rainstorms. Such characteristics produce sustained high flows for weeks or months. A typical seasonal discharge hydrograph for the Kushiyara River at Sheola is shown in Figure 5.7.

Stage hydrographs of Kushiyara river show that rising water levels in April and early May cause flash floods. Water usually recedes for 15 - 60 days after the flash floods with occasional recurrences. The actual flooding season begins in June. From 1973 to 1983 the bankfull stage at Amalshid and Sheola exceeded in 1983. From 1984 to 1991 the bankfull stages were exceeded three times in 1987, 1988 and 1991.

The 1973 Upper Kushiyara Project report included river stage frequency analysis for the Kushiyara at Amalshid, Sheola and Fenchuganj, and for the Surma at Kanaighat and Sylhet. Chow's extreme probability treatment and curve fitting by the least square method was used. The MPO has updated the data with an analysis by Log Pearson Type III for various recurrence intervals. The latest analysis by MPO in 1988 is shown in Table 5.12.

Flood discharge records for the Kushiyara River at Sheola and for the Surma River at Sylhet were analyzed in the 1974 report because these two stations had comparatively long record periods. The records were updated by MPO and the analysis of the data by Log Pearson Type III is presented in Table 5.13.

5.2.5 Low Flows

Low flow frequency analysis for 1- and 10-day mean minimum flows in April from 1951 to 1990 was made and is shown in Table 5.14. The analysis is of the Surma at Kanaighat and the Kushiyara at Sheola at 90 percent frequency. This data is used to compute irrigation water

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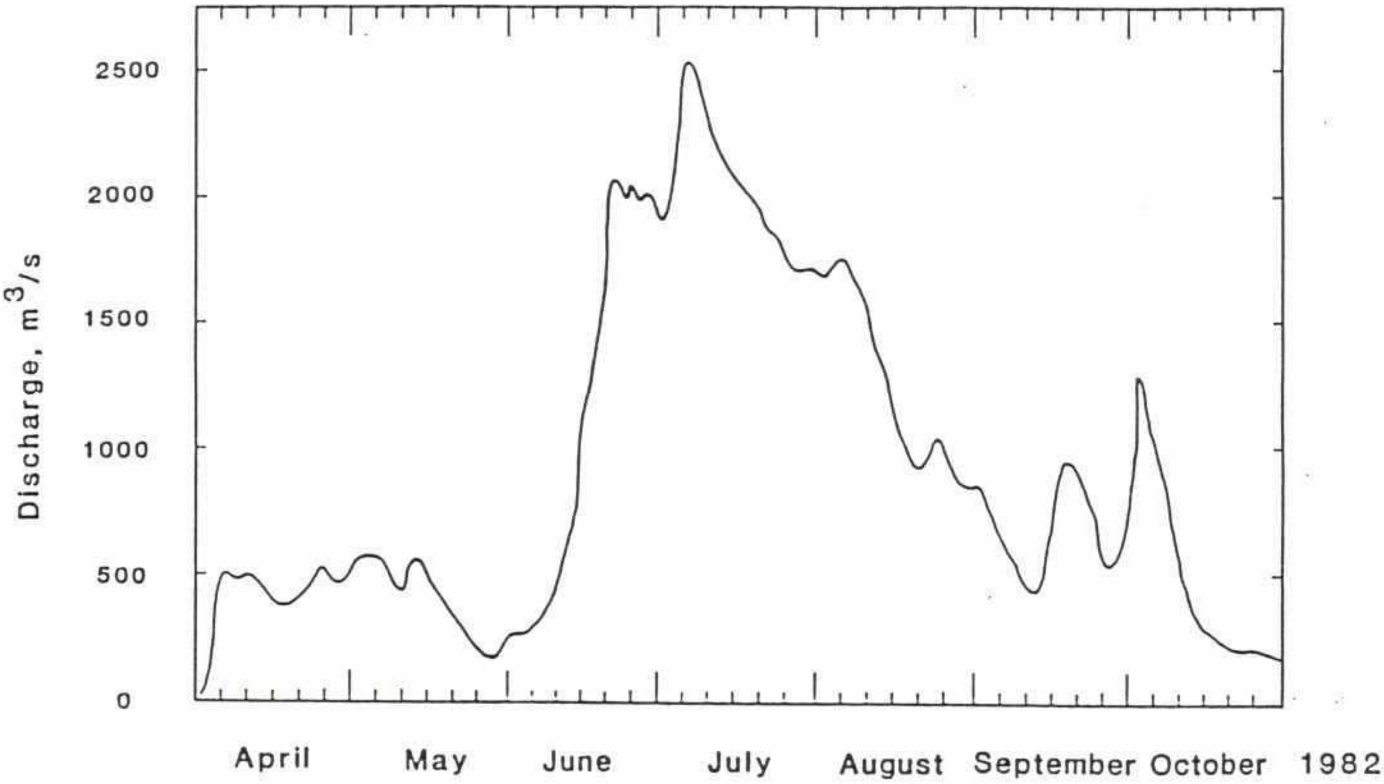


Figure 5.7 Typical seasonal hydrograph for Kusiyara River at Sheola.

Table 5.12. River stage-frequency analysis for different return periods at designated stations (Stage in m).

Analysis Period (Years)	Barak at Amalshid 1962-88	Kushiyara at Sheola 1964-88	Kushiyara at Fenchuganj 1947-71	Surma at Kanaighat 1952-71	Surma at Sylhet 1959-88
5	17.6	14.0	10.5	14.4	11.5
10	17.7	14.1	10.8	14.6	11.7
20	17.8	14.2	11.2	15.0	11.8
50	17.9	14.3	-	15.5	12.0
100	18.0	14.4	-	-	12.0
200	18.0	14.4	-	-	12.1
500	18.1	14.5	-	-	12.2

Source: MPO (1988)

Table 5.13. Flood discharge-frequency for different return periods for the Kushiyara and Surma at designated stations in m^3/s.

River Stations Analysis period (Years)	Kushiyara Sheola 1964-88	Surma Kanaighat 1969-87	Surma Sylhet 1964-87
5	2530	2380	2270
10	2690	2500	2370
20	2820	2600	2440
50	2940	2740	2510
100	3010	2800	2550
200	3080	2900	2580
500	3140	2960	2620

Table 5.14. Estimated minimum low flows (90 percent frequency, m^3/s) in the Barak, Surma and Kushiyara Rivers in April (numbers in parenthesis indicate percentage of total flow).

River	1-day Mean Minimum	10-day Mean Minimum
Barak	27.9(100%)	35.4(100%)
Surma	2.4(9%)	4.3(12%)
Kushiyara	25.5(91%)	31.1(88%)

supply for the project.Table 5.14 shows that 90 percent of the Barak's dry season flow runs into the Kushiyara and 10 percent into the Surma. This distribution is evidenced by the Kushiyara's higher slope in river bed. From the bifurcation point for 6 km the river bed of the Kushiyara is much deeper than the Surma. Its bed slope is 100 mm/km compared to the Surma's 50 mm/km. Also, more erosion takes place along the Kushiyara, promoting more flow into its waters and less into the Surma.

Possible surface water sources for irrigation are the dry season water flows of the Surma in the northeast and the Kushiyara in the south. A statistical analysis of dry season low flows is given at Table 5.15.

5.2.6 Drainage

The project area contains many wetlands and depressions that retain water most of the year and present complex drainage problems. The primary natural drain for the area is Rahimpur Khal. It assumes the name Sada Khal as it joins the Kushiyara through the Karati Khal. Due to high bed levels in the Surma and Kushiyara rivers and heavy siltation of the khals, gravity drainage out of the study area appears to be restricted to the months from mid-October through March. There are seven recognizable khals on the Kushiyara's right bank between Amalshid and Sheola that allow high flow to enter the project area when stages are almost bankfull. These khals have bed levels of about 3 m below the top of the riverbank and are connected through various beels

Table 5.15. Water availability (m^3/s) of the Kushiyara and the Surma in dry months at different frequencies in m^3/s.

	Kushiyara River at Sheola			Surma River at Kanaighat		
	50%	70%	90%	50%	70%	90%
January	65.1 +	56.6 +	48.1 +	4.8 +	4.4 +	4.1 +
	70.8 *	62.3 *	53.7 *	5.4 *	4.8 *	4.7 *
February	53.7 +	42.5 +	28.3 +	3.5 +	3.1 +	3.0 +
	56.6 *	42.5 *	34.0 *	4.1 *	3.5 *	3.2 *
March	45.3 +	34.0 +	25.5 +	3.4 +	2.8 +	2.4 +
	50.9 *	39.6 *	31.1 *	3.8 *	3.3 *	2.7 *
April	65.1 +	39.6 +	25.5 +	8.5 +	4.3 +	2.4 +
	79.2 *	50.1 *	31.1 *	28.3 *	11.3 *	4.3 *

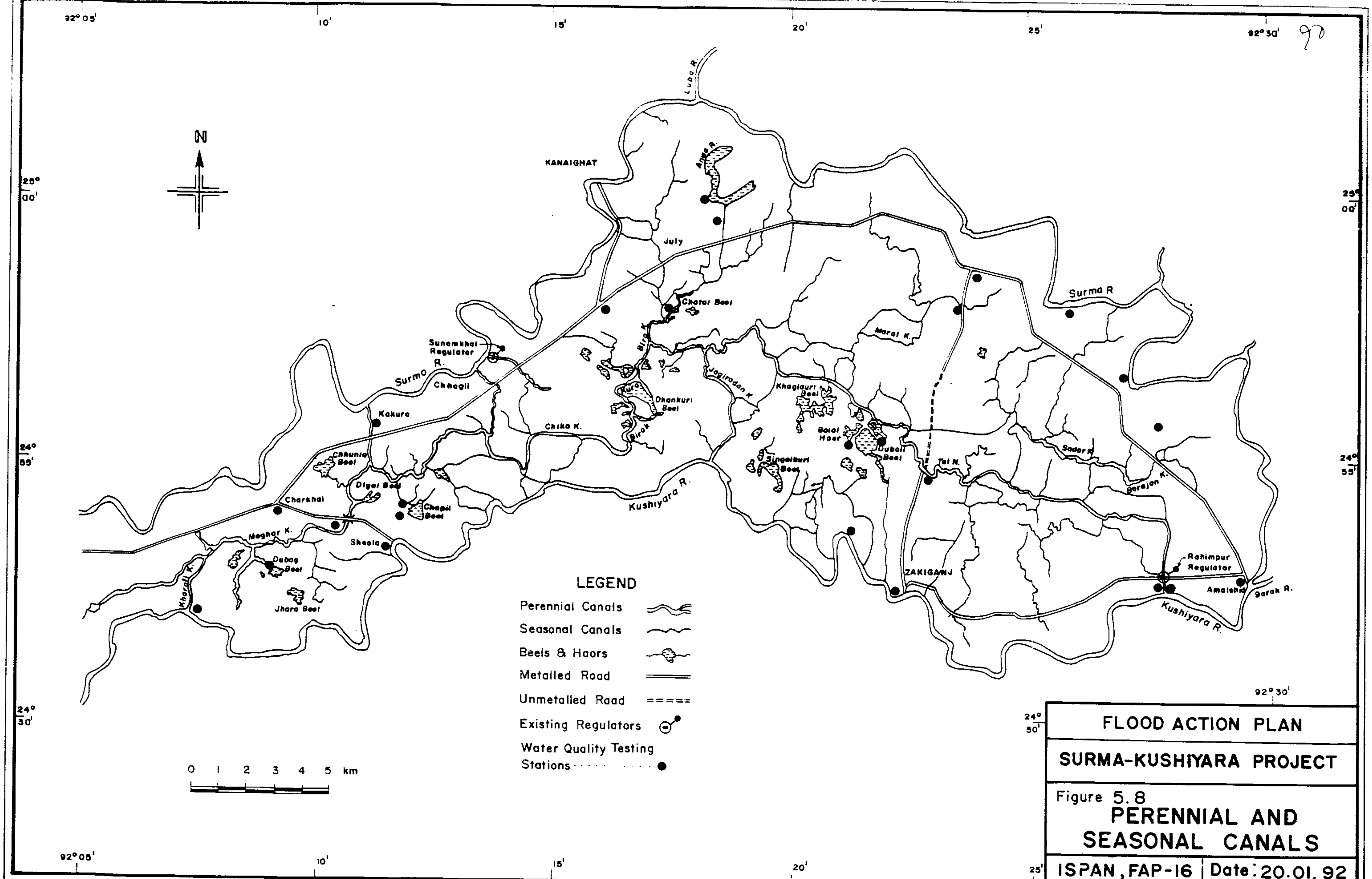
+ Discharge of one day minimum
* Discharge of ten-day mean minimum

and khals to Sada Khal. There are five khals from the Surma, most one of which have silted and closed. There are also smaller khals from the Kushiyara and Surma that connect to the central khal system. Figure 5.8 shows the perennial and seasonal Khal of the project area. Water levels in the Surma and the Kushiyara are higher than those of the project area during most of the wet months and hence drainage to river does not occur in that period.

5.2.7 Sedimentation

Limited data on suspended sediment concentrations at Manumukh and Sherpur (Northwest Hydraulics 1986) suggests that loads are relatively modest for the Kushiyara. The highest concentration reported is 2300 ppm at Sherpur from a discharge of 2300 m^3/s. Sediment transport does not appear to be dominant or important in flood protection design. There is some sediment deposition in the lower Kushiyara during late monsoon season due to reduced velocity. Kushiyara water taken between Zakiganj and Sheola in mid October contained sediments and was quite turbid. The Surma River is also quite turbid and contains sediments during flood times.

Various khals and beels have silted up causing drainage congestion - these include Senapati Khal,



FLOOD ACTION PLAN

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Figure 5.8
PERENNIAL AND SEASONAL CANALS

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Dubail Beel, Muskendar Khal, July Beel, Shiker Mohal Khal, Urban Beel, Baiyur Khal and Rahimpur Khal.

5.2.8 Erosion and Breaching

Erosion and breaching occur along both the Kushiyara and Surma, but is more pronounced along the Kushiyara because of more gradient and higher velocity than that of the Surma. For example, the village Bhuiyamura used to stand about 3 km down west of Zakiganj, but erosion along the Kushiyara has destroyed it. It is estimated that over the last 30 years, 3 km of land was lost due to erosion at the village Bhuiyamura. Field observations in October 1991 confirm that the area is still eroding.

During 1991 erosion occurred at 14 different locations along the Kushiyara. Erosion was most serious at Amalshid in Barathakuri Union, Bhuiyamura and Hydrabond in Kholachara Union, and Ujirpur in Birsree Union. In addition, the Barak River's northern bank is eroding at Amalshid.

Severe erosion occurs in March, April, September and October with the rise and fall of water levels. Between October and December 1991, severe erosion occurred at Amalshid Village. Figure 5.8 gives the erosion and breaching spots of river banks.

5.2.9 Ground Water

Seven exploratory bore holes were drilled along the north and eastern periphery of the project area in 1965 to assess ground water hydrology (EPWAPDA 1966). Sediment deposits observed at that time were predominantly fine textured soils and clays. Five of the holes had no potential, one had limited potential and one (at Bara Takri) had good potential for development.

The most recent review of groundwater resources in the regional area (Mott MacDonald 1990) indicates the area generally has moderate potential for future groundwater development (Table 5.16).

Over 2000 hand tube wells (HTW) were installed by 1990 in the area by DPHE. Interviewers discovered that most HTWs provide adequate water during the dry months of March and April. Many, however, are not in operating condition.

5.2.10 Water Quality

Previous studies in the project area did not consider surface water or groundwater quality in any detail and reported the results of only one sample from the Kushiyara River (EPWAPDA 1967, Table 5.17) at Manumukh, and sediment concentration analysis of suspended sediments at eight locations on both the Kushiyara and Surma (Table 5.18). The results are presented in Tables 5.19 and 5.21. The water was rated suitable for irrigation and was classified as low saline sodium water. Sediment quantity was low (EPWAPDA 1966).

Table 5.16. Potential of groundwater resources potential in the Surma-Kushiyara project area.

	Date	Depth (m)	Discharge (l/s)
Exploratory wells:			
Kanairghat	Aug 1988	91	
Zakiganj	Apr 1988	88	
Beanibazar	Jun 1987	73	
Production Wells:			
Kanairghat	Sep 1988	122	60
Zakiganj	Apr 1988	79	58
Beanibazar	Jul 1987	82	44

Tube Well Potential:	Presently Drilled			Potential Command Area (ha)	Potential Cultivable Area (ha)	Cultivable Area Irrigable from DTWs (%)
	DTWs	STWs	LLPs			
Kanairghat	3	1	0	40,366	24,403	46
Zakiganj	3	0	0	26,591	17,869	51
Beanibazar	9	4	8	23,807	17,926	49

Source: Mott MacDonald (1990)

Table 5.17. Chemical analysis of sample water of the Kushiyara River at Manumukh.

Date collected	31 December 1960
pH	8.2
Spec. Cond. @25^{0}C micromhos/cm	173
Total Dissolved Solids (mg/l)	139
Calcium (Ca^{++})	0.4
Magnesium (Mg^{++})	6.2
Sodium (Na^{+})	14.5
Soluble Iron (Fe+++)	0.13
Bicarbonate (HCO_3^-)	98.00
Carbonate ($CO_3^{=}$)	2.04
Chloride (Cl^-)	3.00
Sulphate (SO_4)	16.00
Nitrate (NO_3)	0.11
Fluoride (F-)	0.0

Table 5.18. Sediment concentration analysis of suspended sediment samples of Kushiyara and Surma rivers.

Name of River	Name of Station	Date of Collection	Water level (PWD) ft.	Discharge cfs	Sampling position *	Surface velocity ft/s	Sampling Depth ft	Sediment concentration in ppm
Kushiyara	Karati Khal	23.9.65	36.41	8,948	240'	1.66	3	684
"	"	"	"	"	"	"	16	686 +
Surma	Atgram	23.9.65	41.51	12,035	200'	1.53	2	452
"	"	"	"	"	"	"	21	470
"	Kanairghat	26.9.65	38.24	20,117	220'	2.43	2	227
"	"	"	"	"	"	"	22	226
"	Charkhai	27.9.65	36.35	21,267	200'	2.00	2	507 +
"	"	"	"	"	"	"	26	572

+ Trace of fine sand in the sediment'
* LEW in sampling position stands for Left Edge of Water

Table 5.19. Water quality in different sources of water in Surma-Kushiyara project area, October 1991.

	River					Canal					Beel		Tubewell	
	Barak Amal-shid	Kushi-yara Zakiganj	Kushi-yara Rahim-pur	Kushi-yara Sheola	Surma Manik-pur	Sada Khal	Sadir Khal	Kakura Khal	July Khal	Tal Nadi	Dubail Beel	Chatal Beel	Char Khal Bazar	Rahim-pur
Diss. Oxy. mg/l	7	8	5	7	8	6	8	6	8	7	8	10	<1	
Sod. Chlor. mg/l	50	25	37.5	25	25	37.5	25	37.5	37.5	37.5	25	33.5	100	
Ammon. mg/l	0.3	0.1	0.7	0.5	0.5	0.7	0.2	0.6	0.8	0.4	0.5	0.7	>2.4	>2.4
Nitrite mg/l	0.02	0.02	0.02	0.02	0.02	0.01	0.02	-	0.02	0.07	0.01	0.01	-	-
Carbon Diox. mg/l	15	10	15	15	15	7	10	10	5	5	7.5	5	65	-
Ferric iron mg/l	0.8	1	0.6	0.8	0.8	0.8	1	0.8	0.6	2	1	0.2	2	5
Alkali mg/l	34.2	35	57.3	27.4	35	27.4	20.5	20.4	20.4	34.2	20.5	17.1	153.1	-
Hardness mg/l	34.2	34.2	51.3	34.2	35	17.1	17.1	34.2	34.2	34.2	17.1	17.1	68.4	119.7
pH	6.6	6.4	7.4	7.2	6.8	6.5	6.7	6.9	6.6	7.3	6.8	7.4	7	6.5

Table 5.20. Water quality in different sources of water in Surma-Kushiyara project area, December 1991 (all parameters measured in mg/l).

	River					Canal			Beel			
	Barak Amal-shid	Kushi-yara Sh-eola	Kushi-yara Rahimpur	Kushi-yara Zakiganj	Surma Atgram	Karati	Tal Nadi	Chatal Beel	Andu Beel	Dubag Beel	Septi Beel	Dubail Beel
Diss. Ox-ygen	10	9	10	10	12	8	10.5	8	9	9	9	8
Sod. Chlor.	19	15	15	15	15	15	15	37.5	18	11.2	7.5	15
Ammonia	0.3			0.4		0.3		0.5	0.7			
Nitrite						0.07			0.02			
Carb. Dioxide	5	15	20	10	10		10	4	4	5	4	12.5
Alkali	68	62	62	55	62	68.4	31	21	21	41	31	14
Hardness	68.4	68	68	68	60	60	34	17.1	10	34.2	17.1	17.1
pH	7.3	6.8	7.8	7.4	8	7.5	7.3	8.2	7.2	6.8	7.2	6

Table 5.21. Water quality analyses of groundwater in Surma-Kushiyara project area.

Upazila	pH	TDS mg/l	EC uS/cm	Ca mg/l	Na mg/l	Fe mg/l	B mg/l	Alk mg/l	Cl mg/l	SO4 mg/l	NO3N mg/l	PO4 mg/l	CO3 mg/l
Zakiganj	7.0	359	580	88	105	12.6	0.01	279	32	0.01	0	5	
Kanaighat			260	8	31.2	28.1	0.01	153	31	0	0	0.01	69
Beanibazar	6.5	74	125	5	20.2	10.5	0.01	56	7	0.01	0	15	25

Source: Mott MacDonald (1990)

Table 5.22. Standard values for water quality in Bangladesh for various uses.

Parameter/ Determinants	Unit	Drinking Water	Fishery Water	Irrigation Water
Alkalinity	mg/l	NYS	70-100	NYS
Ammonia (NH_3)	mg/l	0.5	0.25	3
Carbon Dioxide (CO_2)	mg/l	NYS	6	NYS
Chloride (Cl)	mg/l	150-600	600	600
Dissolved Oxygen	mg/l	6	4-6	5
Hardness ($CaCo_3$)	mg/l	200-500	80-120	NYS
Iron (F_e)	mg/l	0.3-1	NYS	NYS
Nitrite (No_2)	mg/l	<1	0.03	NYS
pH		6.5-8.5	6.5-8.5	6.0-8.5
TDS	mg/l	1000	NYS	2000

NYS: Not yet standardized.
Source: Dept. Environment

Table 5.23. Water quality: suitability of water from rivers, canals, beels and tubewells of Surma Kushiyara project.

Parameter mg/l	Tolerance Limit	B.desh Stand.	Aver. River	Suitability D	Suitability F	Suitability I	Aver. Canal	Suitability D	Suitability F	Suitability I	Aver. Beel	Suitability D	Suitability F	Suitability I	Aver. Tube well	Suitability D	Suitability F	Suitability I
Nitrates		<1 (D)	0.02	√	√	√	0.02	√	√	√	0.01	√	√	√	--	√	√	√
Iron	5	1	0.8	√	√	√	1	√	√	√	0.6	√	√	√	3.5	x	√	√
Sod. Chl.	1000	600	33	√	√	√	35	√	√	√	29	√	√	√	100	√	√	√
Hardness		250	38	√	√	√	24	√	√	√	17	√	√	√	94	√	√	√
pH	6.5 -9.2	7	6.9	√	√	√	6.7	√	√	√	7.1	√	√	√	6.8	√	√	√
Diss. Oxy.	2-10	-	7	√	√	√	7	√	√	√	9	√	√	√	--	√	√	x
Alkalinity		700-100(F)	34	√	√	√	20.4	√	√	√	18	√	√	√	158	√	√	√
Carb. Diox.		6	14	√	x	√	7	√	x	√	6	√	√	√		√	x	√
Ammonia		0.5(D)	0.4	√	x	√	0.5	√	x	√	0.6	√	x	√	>2.4	x	x	√

D = Drinking
F = Fishery
I = Irrigation

√ Suitable
x Unsuitable

Ten water samples from rivers, seven each from canals and beels and two from tube wells were analyzed in October and December 1991 (Tables 5.22,5.23). Figure 5.8 indicates the location of the samples. The analyses, althopugh incomplete, give some indication of water quality for domestic, fishery and irrigation uses. Results of 1990 ground water tests at Zakiganj, Kanaighat and Beanibazar (Mott MacDonald 1990) are given in Table 5.21. Table 5.22 shows water standards and limits for domestic, fishery and irrigation uses (DOE 1991). Using data found in these tables, water quality in the project area is summarized as in Table 5.23.

- Dissolved Oxygen (DO): DO is satisfactory (5-10 mg/l) for drinking, fishery and irrigation purposes. It averages 7 mg/l in rivers and canals and 9 mg/l in beels. The Bangladesh standard for drinking is 6 mg/l; for fisheries, 46 mg/l; and for irrigation, 5 mg/l.

- Sodium Chloride (NaCl): NaCl ranges from 25 to 50 mg/l in surface water and 100 mg/l in groundwater. The Bangladesh standard is 150 to 600 mg/l for various uses.

- Ammonia (NH_3): NH_3 content ranges from 0.1 mg/l to 0.8. mg/l. The groundwater contains more than 2.4 mg/l which exceeds allowable limits of 0.5 mg/l for domestic use, 0.25 mg/l for fisheries and 3 mg/l for irrigation use.

- Nitrite (NO_2): NO_2 content averages 0.02 mg/l in rivers and canals and 0.01 mg/l in beels. Tal Nadi, a canal in the central part of project, shows a high content of nitrite (0.07 mg/l).

- Carbon dioxide (CO_2): Dissolved CO_2 averages 14 mg/l in rivers, 7 mg/l in canals and 6 mg/l in beels. These values are very high and toxic to fish. Discharge of industrial wastes in the Barak River may be a possible reason for such high content of carbon dioxide.

- Iron (Fe): Fe content averages 0.8 mg/l for rivers, 1 mg/l for canals and 3.5 mg/l for ground water. The iron content is satisfactory in surface water, but in groundwater it exceeds the Bangladesh standard (0.3 to 1 mg/l) and is close to tolerance limits (5 mg/l) for domestic use.

- Alkalinity: Alkalinity averages 34 mg/l for rivers, 20 mg/l for canals, 18 mg/l for beels and 158 mg/l for ground water. These levels are considered satisfactory for various uses.

- Calcium Carbonate ($CaCo_3$): $CaCo_3$ content, a measure of water hardness, averages 38 mg/l in rivers, 24 mg/l in canals, 17 mg/l in beels and 94 mg/l in groundwater. These levels are well below the Bangladesh standard of 250 mg/l for drinking water.

- pH: The pH value averages 6.9 for rivers, 6.7 for canals, 7.1 for beels and 6.8 for groundwater. These averages are interpreted as slightly acidic to neutral for rivers, canals and ground water, and are neutral for rivers, canals and ground water, and are neutral to slightly alkaline for beels.

The main characteristics of surface and ground water are summarized as follows. Surface water is generally turbid, while ponded water is somewhat clearer. Black oily lumps are seen coming from the Barak River from an industry situated in India. Local people along the Kushiyara River claim that the water becomes black colored in winter when the flow is reduced, and that fish are smelly and taste bad. Groundwater does not taste good and some tubewell water has a very high iron content (10 mg/l at Amalshid hydrology site). Further investigations are necessary to assess the reasons for this.

Iron and carbon dioxide levels are high, and the latter levels are potentially toxic to fish in rivers and canals, but only marginally toxic in beels. The iron content of groundwater makes it unsuitable for drinking purposes. The pH is acidic to neutral in general and is suitable for drinking and fisheries. In general the drinking water situation is dismal. Surface water is unsuitable for drinking. People prefer tubewell and pond water, but the latter is highly contaminated by microbes.

5.3 Land Resources

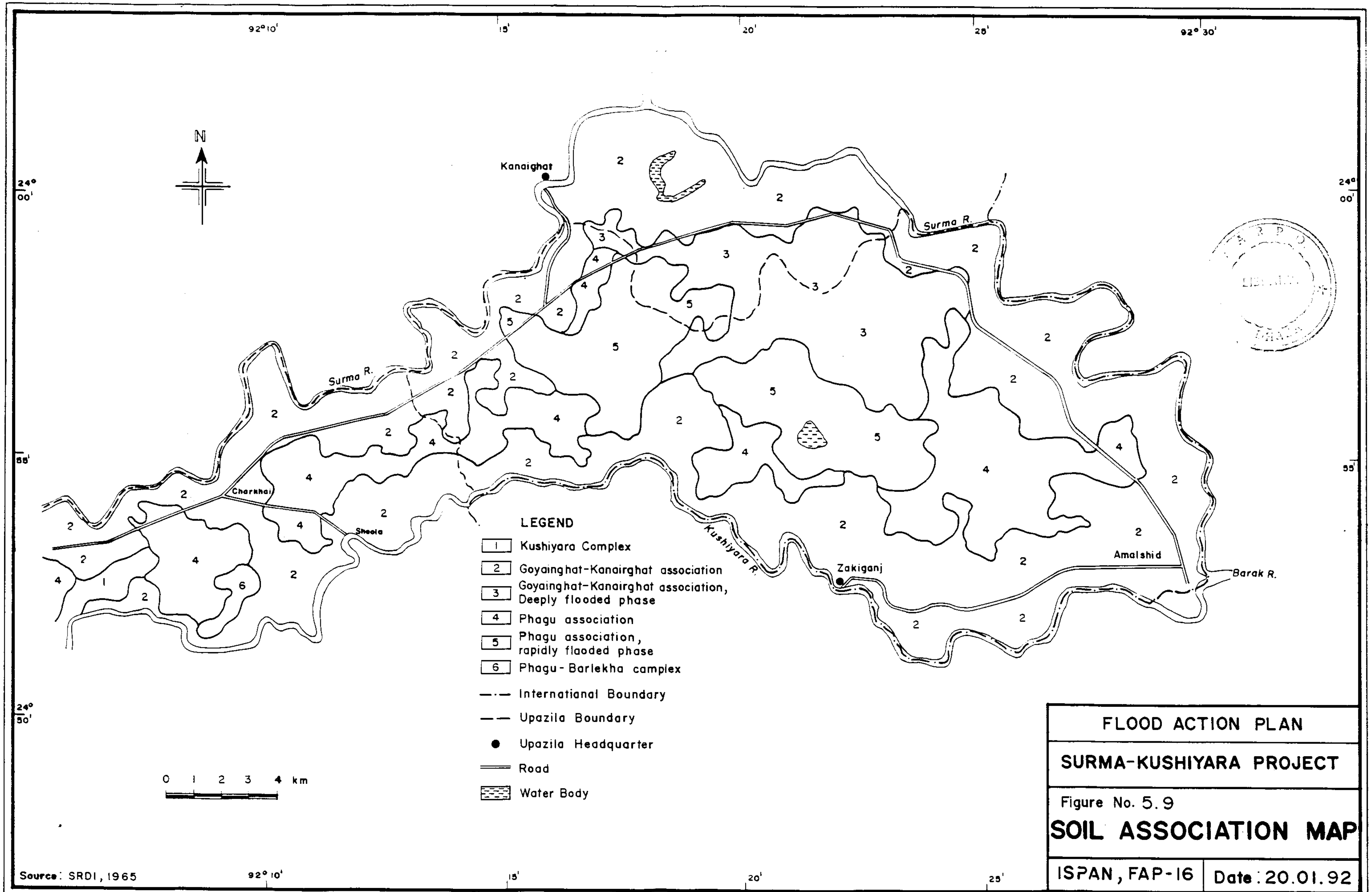
5.3.1 Soils and Topography

Soil surveys of the area were used to evaluate soil potentials, to decide the best use and kind of development for the various type of soil and to determine soil constraints on agricultural development. This was also used for describing the soils of the areas and their relationships to the topography and hydrology. Soil surveys were done in 1964 by the EPWAPDA (now BWDB) and updated in 1973 by SARM Associates Ltd. The soil map prepared by SARM is similar to the soil association map prepared by the Soil Resource Development Institute (reconnaissance soil survey report of Sadar and Moulvibazaar subdivision of Sylhet district). The entire project area is covered by six soil associations.

5.3.1.1 Soils

Soils in the project area were developed in alluvial sediments laid down by the Surma and Kushiyara Rivers. Because both rivers originate from the Barak River, parent materials of the soil are similar. Eight soil series have been identified so far. Areas and percentages of the soil series are given in Table 5.24. These soil series are mapped in soil association to show their relative distribution in the project area (Figure 5.9).

Heavy clay soils occur in the deeply flooded basins and cover about 5691 ha (20 percent) of the cultivated area. Silty clay soils occur on low, smoothed out ridges and edges of basins, and cover about 7277 ha (26 percent). Silty clay loams are found primarily on ridges on about 10,462 ha (37 percent) while medium texture soils (loam to silt loam) occupy the highest topographical positions and cover about 4400 ha (16 percent).



FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure No. 5.9

SOIL ASSOCIATION MAP

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Table 5.24. Areas of soil series in the Surma-Kushiyara project.

Name	Area (ha)*	Percentage
Balaganj	3483	12.5
Goyainghat	10462	37.6
Kanaighat	7277	26.2
Kushiyara	917	3.3
Phagu	5204	18.7
Terchibari	487	1.7
Total	27830	100.0

Data source: BWDB (1974)
*Area as determined in 1974 studies. Additional soil series mapping was not undertaken for this EIA.

Fine texture soils (silty clays and clays) are poorly to very poorly drained, grey to dark grey in color and have low available moisture holding capacity. Moderately fine textured (silty clay loam) and medium textured (silt loam) soils are olive brown to grey in color, imperfect to poorly drained and have high to moderately high available moisture holding capacity. The natural fertility of these soils is moderate and they are capable of producing fairly good crops with very little fertilizer. Agricultural production, however, can be increased by applying mixed fertilizers.

The physical and chemical characteristics of each soil series and relationships to topography are shown in Figure 5.10.

5.3.1.2 Land Type

The project area is subjected to seasonal flooding of varying depths and duration. On the basis of the surface inundation by normal flood, four land type classes have been identified in the project area by following standard classification of AEZ.

- Highland: Land above normal flood level
- Medium highland: Land seasonally flooded up to 90 cm deep
- Medium lowland: Land seasonally flooded between 90-180 cm deep
- Lowland: Land seasonally flooded more than 180 cm deep.

Major soils of the area occupy more than one land types, so these soils have been sub-divided at phase level to incorporate land type characteristics for agricultural use. Exceptions are Kushiyara and Terchibari series which occur on highland and lowland respectively.

5.3.1.3 Land Capability

Land capability classification groups soils to indicate relative suitability for sustained common agricultural production. The classification described here was developed by the Soil fig 5.9

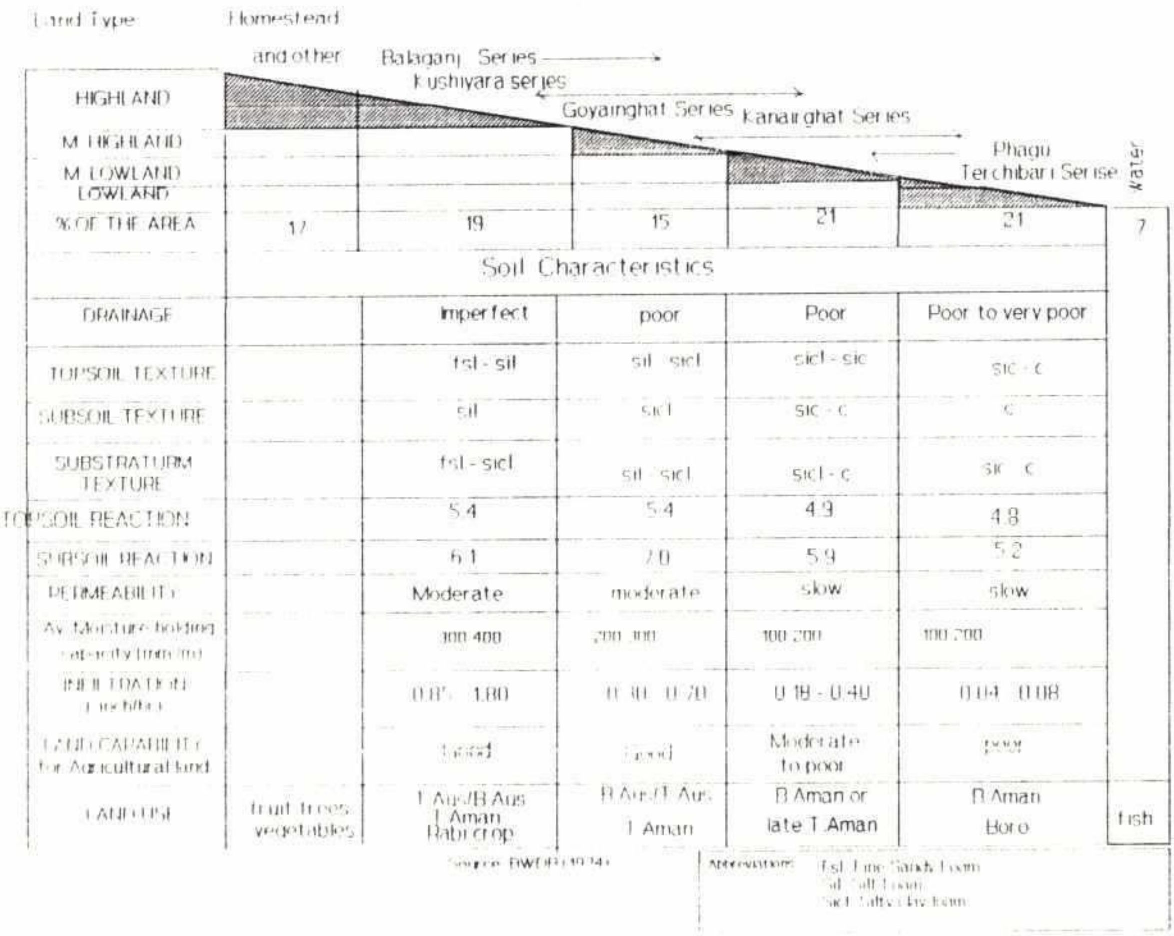


Figure 5.10. Relationship of soils to topography and hydrology in the Surma-Kushiyara project area.

Resources Development Institute to suit the agricultural conditions of Bangladesh and is similar to the U.S. Soil Conservation Service classification system. Highest class soils are most effective for agriculture use. In successive lower classes, effectiveness drops and more effort is needed to produce high crop yields.

The project area has good agricultural land of about 45 percent of cultivable area and major soils are highland and medium highland phases of Balaganj, Goyainghat and Kanaighat series. More than 50 percent of the arable land is poor to moderate agricultural land occupying lowland and medium lowland phases of Phagu, Kanaighat, Terchibari and Goyainghat series. Each land capability class and its percentage of the total cultivable area is shown in Table 5.25.

Table 5.25. Areas of land capability classes: Surma-Kushiyara project area.

Land Capability Class	Area (ha)*	Percentage
Good agricultural land	12604	45.3
Moderate agricultural land	2827	10.1
Poor agricultural land	12399	44.6
TOTAL	27830	100.0

Source: SARM Associates (1973)
* Area as determined in 1973 studies

5.3.1.4 Physical Limitation for Agricultural Improvement

Agriculture is limited in the project area by deep flooding, rapidly rising flood waters, poor soil drainage, wetness of the basin soils in the early part of the dry season. Agriculture is also limited by the heavy consistence of basin soils that make cultivation difficult with traditional country ploughs.

5.3.1.5 Sediment Analysis

During 1991 fresh sediments were deposited during flash floods. Samples of such sediments were collected from the surface of the topsoils of Kushiyara and Balaganj soil series. The samples were analyzed in the laboratory of Soil Resources Development Institute for major and minor soil nutrients. Results revealed that both samples are acidic and coarse, and that organic matter and nitrogen are low compared with the national average (Table 5.26). Both samples contained moderate levels of calcium and magnesium, but potassium is high. The samples were high in micronutrient sulphur, boron, copper and manganese, and very high in iron and zinc.

5.3.2 Agriculture

Crops, cropping patterns, cropping intensity, production and agricultural limits of the Upper Kushiyara Project were described in two feasibility reports (EPWAPDA 1966, SARM Associates Ltd. 1973). The EPWAPDA study gathered information on crop damage primarily by interviewing farmers in the field. Major cropping patterns were broadcast aus followed by transplanted aman (32 percent) in higher areas and single crop of transplanted aman (30 percent) in the lower areas (Table 5.27). Single crop of broadcast aman (7 percent) and boro (3 percent) were the other minor cropping patterns. Cropping intensity was 92 percent and annual cereal production was 27,000 tons in a cropped area of about 32,000 ha. About 14,000 ha of cropped land was damaged by flood with yield losses of 12,000 tons.

SARM Associates Ltd. (1973) described flooding as a continual menace to area, farmers reported that flooding was responsible for major crop losses. A land use survey also was conducted in early 1972 to determine which crops were grown in the area. The major

Table 5.26. Analytical results of fresh sediments.

Sample	Sand (%)	Silt (%)	Clay (%)	Text-ure	pH	OM (%)	meq/100gm Soil				Microgram/ml soil					
							Ca	Mg	K	N	S	Bo	Cu	Fe	Mn	Zn
E-1*	49.0	46.0	5.0	Sandy loam	6.0	0.6	3.0	2.0	0.7	10	23	1.8	4.0	570	39	32
E-2·	78.6	19.4	2.0	Loamy Sand	5.9	0.4	2.1	1.7	0.8	10	33	1.4	3.0	450	26	18

* Sediment from topsoil of Kushiyara series along the Surma River

· Sediment from topsoil of Balaganj series near the Kushiyara River

Table 5.27. Land use in the Surma Kushiyara project area in 1964 and 1973.

Land Use Class	1964		1973	
	Area(ha)	Percent	Area(ha)	Percent
Non-arable Land				
Cultivated Fallow	607	2.04		
Homestead and Orchards	5110	17.18	3272	10.23
Permanent Water	657	2.21		
Roads, Rivers etc.	648	2.18		
Thatching Grass	141	0.47		
Bamboo Bushes, thatching grass and pasture			742	2.32
Roads, Schools, mosques, graveyard etc.			337	1.05
Ponds, ditches, and other permanent water bodies.			2125	6.65
Total:	7163	24.08	6476	20.25
Arable Land				
Aus - T.Aman	9769	32.84	10,585	33.11
T.Aman on flood damaged land of B.Aman	9013	30.30	1870	5.85
Broadcast Aman	2279	7.66	9956	31.15
Boro	1038	3.49	1356	4.24
Seed Beds	233	0.79	167	0.52
Linseed	178	0.60		
T.Aman	71	0.24	46	0.14
B.Aus - Rabi Crops			405	1.27
T.Aus (HYV) - T.Aman			364	1.14
Seed Bed - Rabi Crops			688	2.15
Seed Bed - T.Aman			59	0.18
Total:	22,581	75.92	25,496	79.75
Grand Total:	29,744	100.00	31.972	100.00

Source: BWDB (1966) and SARM Associates (1973)

cropping pattern was single broadcast aman which occupied over 30 percent of the project area (Table 5.29). The next most important cropping pattern was broadcast aus followed by transplanted aman (24 percent). Next in importance was transplanted aus followed by transplanted aman (10 percent). Boro (4 percent) was grown on low pockets especially in the beel area, although beels were supposed to be an irrigation source. Rabi crops were grown in minor areas (3 to 4 percent). Cropping intensity was 144 percent in a cropped area of about 36,000 ha. Annual cereal production was 42,000 tons.

5.3.2.1 Land Types

Different land types were charted by superimposing relevant water level data on the area elevation curve (Table 5.28). Areas occupied by homesteads, orchards, roads and permanent water bodies were deducted to identify the net area available for crop production. Distribution of land types are shown in Figure 5.11.

5.3.2.2 Agricultural Land Use

Of the gross project area's 39,000 ha, about 29,700 ha are available for agricultural crop

Table 5.28. Land type distribution under pre-project condition in the Surma-Kushiyara project area.

Land Type	Total Area	Net Area available for Agriculture	Remarks
High Land	13,831 (35)	7,201 (24)	6,630 ha under Homesteads, Orchards, Roads etc. (17)
Medium High Land	5,954 (15)	5,954 (20)	
Medium Low Land	8,320 (22)	8,320 (28)	
Low Land	10,895 (28)	8,225 (28)	2,670 ha under permanent water bodies (7)
Total:	39,000	29,700	

Figures within parenthesis indicate percentage of the total area

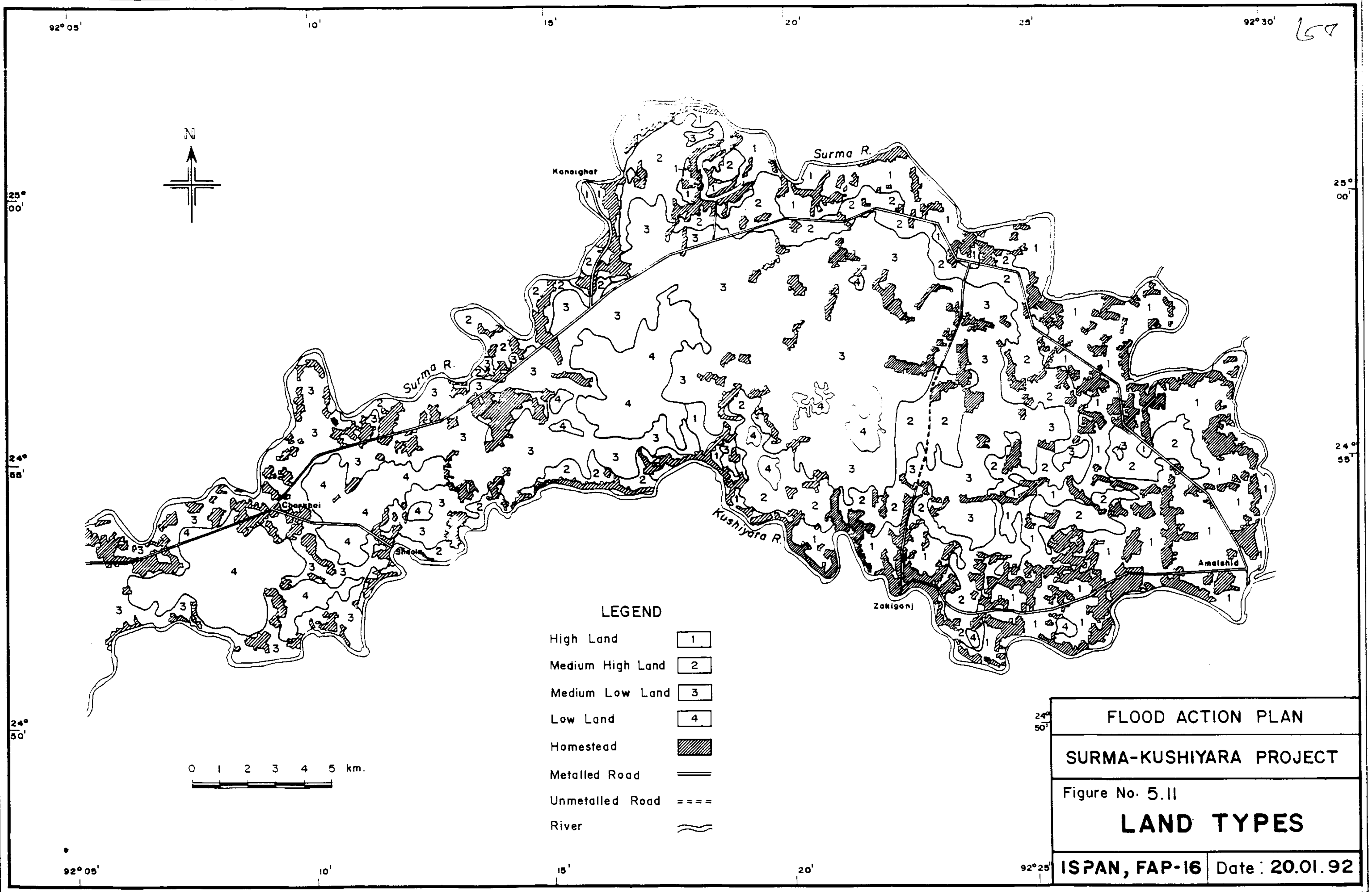
production. Homesteads, villages, roads and embankments occupy 6630 ha, while water bodies, including khals and perennial wet land, cover 2670 ha.

Most cultivated areas on high and medium-high land are double cropped. Single cropping is dominant in the medium-low and lowland areas. However, about 2 percent of medium-low and lowland cultivated areas cannot be cropped in any season because of unfavorable hydrologic conditions. The current cropping intensity is 144 percent.

5.3.2.3 Cropping Patterns

Currently, various varieties of rice are the primary crops grown during the three cropping seasons: kharif 1, kharif 2 and rabi. Aus rice, grown during kharif 1, followed by transplanted aman rice, grown during kharif 2, are the dominant rices found in highland and medium-highland areas. Non-rice crops cover only 3 percent of cultivated highlands, and are grown in the Rabi season after aus rice. Non-rice crops include potato, oilseed, chili and various vegetables. Single cropping prevails on medium-lowland and lowland. Cropping pattern details are presented in Table 5.29.

Local and high-yielding varieties (HYV) of aus rice are grown on 42 percent and 5 percent of the cultivated area, respectively, during kharif 1. Broadcast aman rice is sown on 23 percent of cultivated areas during kharif 1, but only 9 percent of this crop survives. Local varieties of transplanted aman rice is grown on about 54 percent of the cultivated area during kharif 2. The 54 percent includes areas where seedlings are transplanted after recession of flood waters that damage the broadcast aman rice. Also during kharif 2, HYV aman rice are grown on about 8 percent of cultivated land. Local and HYV boro rice are grown in lower elevations on 17 and 7 percent of cultivated areas respectively. It is apparent that local varieties of rice are dominant and that HYVs are restricted by floods and drainage congestion.



FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure No. 5.11

LAND TYPES

ISPAN, FAP-16 | Date : 20.01.92

Table 5.29. Cropping patterns under pre-project condition in the Surma-Kushiyara project area.

Land Type	Cropping Pattern Kharif-1	Kharif-2	Rabi	Area(ha) Under the Pattern	Cult.Area (%)
High Land	B.Aus(L)	T.Aman(L)	Fallow	2,520	8.48
	T.Aus(L)	T.Aman(L)	Fallow	1,440	4.85
	T.Aus(L)	T.Aman(H)	Fallow	360	1.21
	T.Aus(H)	T.Aman(L)	Fallow	1,080	3.64
	B.Aus(L)	T.Aman(H)	Fallow	720	2.42
	Seed Bed	T.Aman(L)	Fallow	360	1.21
	B.Aus(L)	Fallow	Rabi Crops	721	2.43
			Sub-Total	**7,201**	**24.24**
Medium High Land	B.Aus(L)	T.Aman(L)	Fallow	2,380	8.01
	T.Aus(L)	T.Aman(L)	Fallow	1,913	6.44
	T.Aus(L)	T.Aman(H)	Fallow	1,311	4.41
	T.Aus(H)	T.Aman(L)	Fallow	350	1.18
			Sub-Total	**5,954**	**20.04**
Medium Low Land	B.Aus(L)	T.Aman(L)	Fallow	1,030	3.47
	B.Aman(D)	T.Aman(L)	Fallow	4,080	13.74
	Fallow	T.Aman(L)	Fallow	830	2.80
	B.Aman	B.Aman	Fallow	1,660	5.59
	Fallow	Fallow	Boro(H)	500	1.68
	Fallow	Fallow	Fallow	220	0.74
			Sub-Total	**8,320**	**28.02**
Low Land	B.Aman	B.Aman	Fallow	1,110	3.74
	Fallow	Fallow	Boro(H)	1,645	5.55
	Fallow	Fallow	Boro(L)	4,940	16.63
	Fallow	Fallow	Fallow	530	1.78
			Sub-Total	**8,225**	**27.70**
			Grand Total	**29,700**	**100.00**

Table 5.30. Crop area and production under pre-project condition in the Surma-Kushiyara project area.

Crop	Area		Area		Production (t)	Production Lost (t)
	Normal	Damaged	Normal	Damaged		
B.Aus(L)	2,904	4,467	1.2	0.5	5,718	3,127
T.Aus(L)	2,472	2,552	1.5	0.8	5,749	1,787
T.Aus(H)	694	736	2.7	1.0	2,610	1,251
B.Aman	1,012	1,758	1.6	0.0	1,619	2,813
T.Aman(L)	6,155	9,828	1.8	1.0	20,907	7,862
T.Aman(H)	1,054	1,337	3.0	1.6	5,301	1,872
Boro(L)	3,155	1,785	2.0	1.0	8,095	1,785
Boro(H)	690	1,455	4.0	1.6	5,088	3,492
			Total Paddy:		55,087	23,989
Rabi Crop	721		1.0		721	

5.3.2.4 Crop Production

Because crops are frequently damaged by floods, average yields for each crop was estimated for normal and damaged condition. These conditions were recorded from the field and compared with regional average data of MPO (1986).

Total production was computed by adding production from normal areas with normal yield levels, and production from damaged areas with damaged yield levels (Table 5.30). A production loss figure was computed by deducting damaged yields from estimated normal yields. Current cereal production is 55,087 tons per year, based on 450 grams of cereal required per person per day, the annual paddy production requirement in the project areas is 64,000 tons. Thus there is a shortage of about 9,000 tons of paddy for the present population.

5.3.2.5 Crop Damage

Agricultural crops are damaged almost every year by flood. According to farmers, flash and seasonal flooding has become more frequent in the last 5-7 years. Flood water stands in the fields for long periods because drainage is poor. Transplanting aman and raising of seed beds for aman and boro is delayed by flooding. As a result, some lowlands and medium-lowlands lie fallow throughout the year. During April and May, flash floods often destroy the early growth of aus and broadcast aman. Boro crops are damaged at harvesting stage, especially the late maturing HYV crops. Farmers sometimes recover damaged aus by transplanting it later in fields of damaged broadcast aus. However, it is already common to grow transplanted aman or deep water transplanted aman in the field of the damaged broad-cast aman. But transplanted aman also suffers under both seasonal floods and late flash floods. Once the crop is lost, farmers try a second transplanting, continuing the recovery process until it is too late to grow transplanted aman. Crop damage data from 1967 - 1970 is presented in the 1973 feasibility report (Table 5.31). Existing damaged areas and current

Table 5.31. Estimated yearly crop damage due to floods in the Surma-Kushiyara project area.

Crop	Damaged Area(ha)/ Production lost in tons.	1967	1968	1969	1970	Average during 1986-90
B.Aus	Damaged Area (ha) Production lost (tons) Damaged Area(ha) Production	2,374 1,990 2	1,805 1,645 1	2,705 1,753 2	2,740 2,169 2	4,467 3,127
T.Aus	Damaged Area (ha) Production lost (tons)	1,539 1,263	1,373 992	1,717 1,259	1,512 1,132	3,288 3,038
B.Aman	Damaged Area (ha) Production lost (tons)	3,519 2,921	6,313 6,653	8,664 9,469	5,293 4,566	1,758 2,813
T.Aman	Damaged Area (ha) Production lost (tons)	11,736 12,082	10,905 6,518	11,129 6,917	8,223 4,478	11,165 9,734
Boro	Damaged Area (ha) Production lost (tons)	- -	- -	- -	- -	3,240 5,277
Total	Damaged Area (ha) Production lost (tons)	19,168 18,256	20,396 15,808	24,215 19,398	17,768 12,345	23,918 23,989

Source: SARM Associates (1973) and own observations.

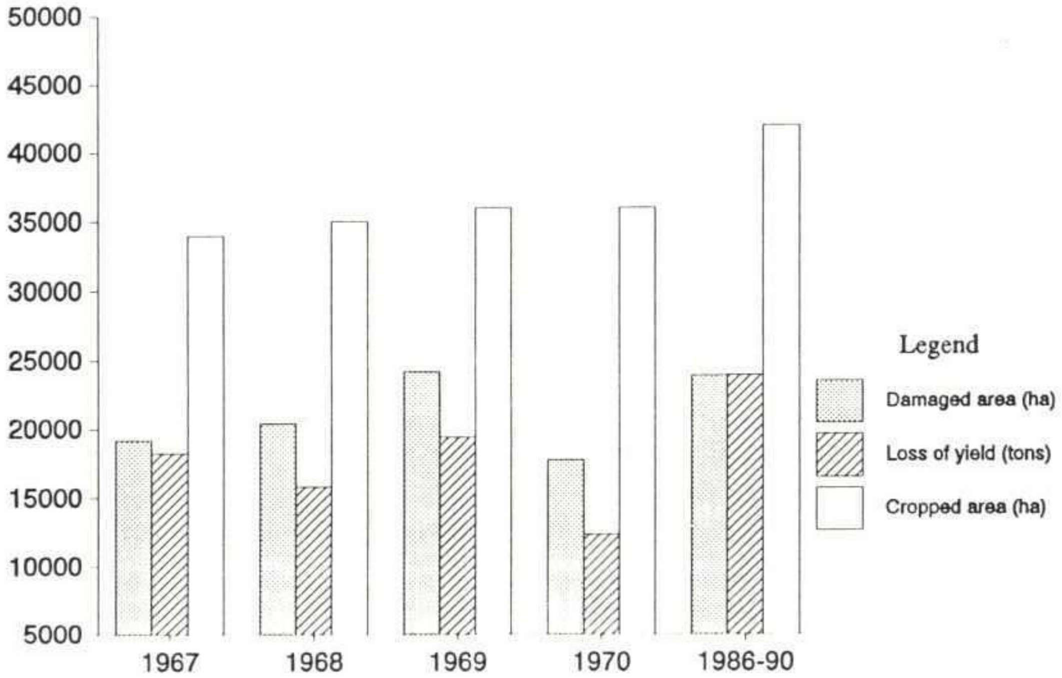


Figure 5.12. Extent of crop damage from flooding in Surma-Kushiyara project area. Data from SARM Associates (1973) and own observations.

Table 5.32. Input use level in different crops under pre-project condition in the Surma-Kushiyara project area.

Crop	Person Days	Animal Pair-Days	Seed (kg)	Fertilizers (kg/ha) Urea	TSP	MP	Pesticides (kg/ha)
B Aus(L)	136	42	100	7	5	2	0.0
T Aus(L)	155	53	25	14	12	8	0.0
T Aus(H)	165	55	25	41	33	18	0.0
B Aman	115	42	100	0	0	0	0.0
T Aman(L)	155	44	25	15	11	8	0.0
T Aman(H)	165	46	25	28	24	16	0.5
Boro(L)	160	40	25	12	0	0	0.3
Boro(H)	205	42	25	40	30	20	0.5
Rabi Crops	95	35	1	6	5	3	0.0

yield losses were determined from field data. These figures represent average damage levels of the last several years (1985-90).

Current flood damaged areas are nearer to damaged areas of 1969 mentioned in the 1973 feasibility report (Figure 5.12). The most damage occurred in 1969, the least in 1970 and there was no flood in 1971 according to the feasibility report.

Aus, broadcast aman and HYV Boro were seriously damaged by flash floods in May 1991. The local boro was harvested before the flooding, but was damaged in its post-harvest stage later in May.

5.3.2.6 Agricultural Inputs

Current use of agricultural inputs is low in the project area (Table 5.32) for repeated loss of crops every year. Cow dung, other manures and pesticides are seldom used. Draft animals, such as bullocks and cows are ill-nourished and, therefore, not productive. Agricultural labor used for the crops grown in the areas are shown in Table 5.33.

5.3.2.7 Irrigation

Traditional irrigation practices are common in the project area. Conserved ponded water is transported by swing baskets and dones. Most local boro is grown on static water, so irrigation water is needed primarily for HYV boro rice. Current water use is outlined in Table 5.15.

Table 5.33. Agricultural labor requirements under pre-project condition in the Surma-Kushiyara project area.

Crop	Area	Person-Days per Hectare												
	(ha)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
B Aus(L)	7,371			31	30	30	25	15	5					136
T Aus(L)	5,024			10	40	30	15	15	25	20				155
T Aus(H)	1,430			10	40	30	20	20	25	20				165
B Aman	2,770				30	30	10					25	20	115
B.Aman(L)	15,983						10	40	30	20	10	25	20	155
T Aman(H)	2,391						10	40	30	25	15	25	20	165
Boro(L)	4,940	30	20	15	25	20						10	40	160
Boro(H)	2,145	30	30	25	25	25	20					10	40	205
Rabi crops	721	10	10	15	10							30	20	95
Total requirement: (000 Person-days)		220	170	515	747	595	515	949	749	509	265	607	665	6506

5.3.3 Forestry and Homestead Vegetation

Forestry and homestead vegetation are important in maintaining the environmental balance and play a significant role in the economic life of the people. Forestry and homestead vegetation were not studied in previous feasibility studies (EPWAPDA 1966, SARM Associates 1973) and were only briefly mentioned in recent North Central Regional Study (NCRS 1990). Forests in the study area consist of natural forests, tree plantations and homestead groves.

5.3.3.1 Natural Forests

Local people report that about two decades ago a few patches of natural forest and wood lots prevailed on khasland in the project area. These lands were usually situated in the highlands and are now privately owned and converted into cultivable land (as reported by local people). This deforestation denuded the area, exposing clay soils to erosion from flash floods and incessant rain water. Patches of cane, patipata, keya, ekur and other shrubs are found in privately owned lands, and along roadsides and canal banks.

5.3.3.2 Plantations

Land available and suitable for tree plantations is scarce in the area. As the majority of land is under cultivation or inundated, tree plantations are restricted to roadsides, homesteads, schools, mosques, Upazilas and union office campuses, Eidgah and graveyards.

Several species (Table 5.34) grow successfully in plantations along both sides of the Charkhai-Zakiganj Road and the Zakiganj-Atgram Road. Some existing flood control

Table 5.34. Dominant species in roadside plantations in Surma-Kushiyara project area.

Local Names	Scientific Names
Raintree	*Samanea saman*
Babla	*Acacia nilotica*
Sissoo	*Dalbergia sisso*
Koroi	*Albizia spp.*
Dholkolmi	*Ipomea spp.*
Arjun	*Terminalia arjuna*
Mehogini	*Swietenia spp.*
Aswatha	*Ficus religiosa*
Bat/Krishnabat	*Ficus benghalensis*

embankments (locally intervened) are planted with *Ipomoea* spp. but many were found without any plant, the reason could be either the full length of rows were not planted or the plantations were damaged or destroyed. The banks of most waterways are planted with cane, patipata, keya, ekur and hijal (scientific names given in Table 5.35). Roadside, embankment and bank plantations protect slopes against wave and runoff erosion, while producing fuel wood, fodder, poles, timber, mats, fruits and petty cash. Road plantations are considered public property, but management of these areas is unclear. It is also unclear

Table 5.35. Scientific names of trees, shrubs and vegetables of economic importance in project area (local names are alphabetically arranged).

Local Name	English Names	Scientific Names
Aam	Mango	*Mangifera indica*
Anarosh Arhhar	Pineapple	*Ananas sativus*
Arjun	Pigeonpea	*Cajanus cajan*
Aswatha	--	*Terminalia arjuna*
Ata/Sharifa	--	*Ficus religiosa*
Babla	Bullocks heart	*Annona squamosa*
Bansh	Indian acacia tree	*Acacia spp.*
Bat/Krishnabat	Bamboo	*Bambusa spp.*
Bel	Banyan	*Ficus benghalensis*
Beth	Woodapple	*Aegle marmelos*
Boroy	Cane	*Calamus spp.*
Chambal	Plums	*Zizyphus jujuba*
Chattim	--	*Artocarpus chaplasha*
Chalkumra	Seven leaf tree	*Alstonia scholaris*
Dholkolmi	Whitegourd	*Benincasa hispida*
Ekur	--	*Ipomoea spp.*
Dheras	--	*Eranthos ravanmae*
Gamari	Okra	*Hibiscus esculentus*
Gua	--	*Gumelina arborea*
Gub	Betelnut	*Areca catechu*
Hijal	Mangosteen	*Diospyros spp.*
Jam	--	*Barringtonia acutangula*
Jarul	Blackberry	*Eugenia spp.*
Jambura	--	*Lagestroemia speciosa*
Jhinga	Grapefruit	*Citrus grandis*
Kadom	Cucurbit. veg.	*Luff acutangula*
Kanthal	Cadamba tree	*Anthocephalus chinensis*
Kakrol	Jackfruit	*Artocarpus heterophyllus*
Keya	--	*Momordica cochinchinensis*
Khira	Screwpine plant Cucum-	*Pandanus odoratissimus*
Kola	ber	*Cucumis sativus*
Komola	Banana	*Musa spp.*
Korolla	Orange	*Citrus reticulata*
Kalo koroi/Shirish	Bittergourd	*Momordica charantea*
Lichu	Black koroi	*Albizia lebbeck*
Lubia	Litchi	*Litchi chinensis*
Mandar	Cowpea	*Dolichos lablab*
Mehogini	Coral tree	*Erythrina variegata*
Mistikumra	Mahageni tree	*Swietenia mahageni*
	Sweetgourd	*Cucurbita maxima*

Table 5.35 continued on next page -->

as to who is entitled to benefits from these plantations. This ill-defined situation has jeopardized sustainable uses and development of biomass and wood production.

5.3.3.3 Homestead Groves

Almost every rural household grows some trees, shrubs and herbs on and around homesteads for the supply of fruits, vegetables, timber, construction materials, fuelwood etc. Livestock populations are low in the project area and most of the available dung is used as manure. Jute and sugarcane are not cultivated, therefore some of the basic traditional sources of energy (BBS 1990) are not available in the area.

Table 5.35. Continued.

Local Names	English Names	Scientific Names
Mortha/Patipata	Matleaf	*Clinogyne dichotoma*
Narikel	Coconut	*Cocos nucifera*
Neem	Nim tree	*Melia azadirachta*
Panikodu	Bottlegourd	*Lageneria siceraria*
Pepe	Papaya	*Carica papaya*
Palm	Royal palm	*Alstonia scholaris*
Raintree	Raintree	*Samanea saman*
Sabriam	Guava	*Psidium guajava*
Sada Koroi	White koroi	*Albizia procera*
Shak/Danga	Amaranths	*Amaranthus spp.*
Sisso	Sisso	*Dalbergia sisso*
Shimul	Silk cotton	*Salmalia malabricum*
Shegun	Teak	*Tectona grandis*
Urri	Beans	*Vicia faba*

Households are dependent on homestead based trees, shrubs and crop residues for a period of six months; road sides, hill sides and eroded shrubs for three months and for about the rest three months people need to buy the fuel wood marketed mainly from nearby hill forests. An average size household (8.9 persons) with an average area of homestead (0.22 ha) consumes about 7 tons biomass annually from the homestead forests.

The current study revealed that homestead vegetation, and therefore household income, is greatly affected by flash flood enter by breaching, overtopping and of excess flow through existing open canals. About 35 - 40 percent of total homestead-based income is lost to flash flood damage annually. For example, betelnut trees, an important homestead cash crop, are seriously damaged by flooding. Table 5.37 shows that on an average each household possesses about 105 betelnut trees and the produce was valued over Tk. 8,000 annually i.e. each betelnut tree can fetch about Tk.80 annually.Flash floods destroy 10 - 20 percent of existing betelnut trees and almost 100 percent of the new seedlings are damaged. Those that survive usually do not produce optimum yields. Other important cash plants, e.g. bamboo, cane and mortha/patipata, also are damaged by flash and seasonal floods. In addition, the yields and growth of most fruit trees e.g. banana, jack fruit, mango, papaya, plum and grape fruits are hurt by flooding. Trees for fire wood and construction, material e.g. kadam, shimul and shirish, are also damaged by flooding. Surviving trees are often diseased, resulting in a yield and cash loss. Such tree damage occurs regardless of land type or distances from rivers and beels.

In the medium highland of the Gandhadatta Mouza very close to Kushiyara River the inundation level was about 100 cm, in the medium lowland of Kazalshar Mouza close to a beel the inundation was 160 cm and in the highland Charigram Mouza very close to the Surma River the inundation was about 50 cm in 1991. The inundation levels were very close to these figures in the 1989 floods. The depth and duration of flood water on the homestead is variable depending upon the land types, ranging from 45 - 170 cm above courtyard for 2 - 3 weeks in highland to medium-lowland.

Homestead species are planted according to economic importance. Table 5.38 lists

Table 5.36. Source and valuation of fuelwood periodically by homestead size, household size of different mouzas

House hold No.	Mouza	Homestead Size (ha)	Household Size (#)	Homestead Tree Mnds.	@Tk.30	Month	Homestead Shrub/ Crop Residues Mnds.	@Tk.20	Month	Roadside/Hillside Shrubs Mnds.	Tk.@15	Months	Purchase Mnds.	Tk@30	Months	Total (Tk.)
1.	Gandhadatta	0.17	11	66	2,000	3	70	1,400	3	70	1,000	3	40	1,200	3	5,600
2.	Gandhadatta	0.06	8	32	1,000	2	40	800	2	30	1,500	6	32	1,000	2	4,300
3.	Kajalsar	0.11	12	70	3,100	3	70	1,400	3	80	1,200	3	50	1,500	3	6,200
4.	Gandhadatta	0.2	11	50	1,500	2	20	400	1	-	-	-	198	5,940	9	7,340
5.	Gandhadatta	0.22	8	30	900	2	15	300	1	96	1,440	6	48	1,440	3	4,060
6.	Charigram	0.2	11	50	1,500	2	20	400	1	198	9,900	9	-	-	-	11,800
7.	Charigram	0.70	8	32	1,000	2	15	300	1	30	450	1	128	3,840	8	5,590
8.	Satpari	0.17	5	30	900	3	30	600	3	-	-	-	60	1,800	6	3,300
9.	Hatershar	0.22	5	60	1,800	6	60	1,200	6	-	-	-	-	-	-	3,000
10.	Natershar	0.22	9	108	3,240	6	110	2,200	6	-	-	-	-	-	-	5,440
11.	Sheola	0.08	10	120	3,600	6	120	3,400	6	-	-	-	-	-	-	6,000
	Average	0.22	8.9	58	1,867	3	52	1,127	3	45	1,408	3	50	1,520	3	5,695

Tk=Taka, Mnds=Maunds (1 maund=37 kg.)

Table 5.37. Household income from betelnut trees.

Household (No.)	Betelnut tree (No.)	Annual Income (Taka)
1	100	10,000
2	50	4,000
3	25	2,000
4	300	24,000
5	30	2,000
6	7	500
7	250	15,000
8	150	15,000
9	20	2,000
10	2000	16,000
11	20	2,000
Total	1152	92,500
Average	105	8,400

Average annual income per tree: Tk. 80.00

dominant, common and rarely grown trees, as well as shrubs and vegetables of the area. Old homesteads are covered in a diverse number of species with betelnut being the dominant cash crop. New homesteads which are found in comparatively low areas have little species diversity (Table 5.39). New homesteads usually are first planted in banana saplings and betelnut seedlings for shade, then followed with bamboo and others.

While new homesteads are being established, the young seedlings and saplings of banana, betelnut, coconut, jackfruit, litchi and bamboo are more susceptible to flood damage than those of old homesteads. Simultaneously, old homesteads lose their older trees to flooding, but have difficulty establishing new seedlings or saplings in the continual flooding. New homesteads in the project area are encroaching on croplands comprising high to medium low lands. Due to population explosion the potential crop lands are being converted to homestead.

5.3.4. Other Land Uses

About 6,630 ha (17 percent) of the project area are used for homesteads, roads and embankments. Homesteads are found primarily along the project area's periphery and on highlands and medium-highlands. Homesteads consist of houses, ponds, vegetation, cow sheds, graveyards and more. Every village has at least one mosque with a pond. Embankments and roadsides are currently used as grazing areas. Winter vegetables such as beans and cowpeas are grown along roadsides by adjacent residents. Other income-producing plants and trees grown along roadsides include keya (*Pandanus odoratissimuss*), ekur (*Eranthos ravanmae*), koroi (*Albizia spp.*), sisso (*Dalbergia sisso*) and babla (*Acacia spp.*).

Buildings such as offices, schools, madrasas, hospitals and markets are usually found in and around upazila and union headquarters. Urban areas exist only in Zakiganj Upazila headquarters. In addition, one or two brickyards were found, but no arable land is used for factories or industrial establishments.

5.3.5 Livestock

Commonly found livestock include bullocks, cows, buffalo, goats, chickens and ducks. Bullocks and cows are dwarf, unhealthy, inefficient in farm operations and low milk producers. Buffalo are more productive draft animals than cows and bullocks. Wet marshy land inside the areas provide desired environment to graze to collect their food. Current livestock and poultry populations for an average farm are shown in Table 5.40. Buffaloes, bullocks and cows (including milk cows) are used for farm operations. Draft animal power was 3.21 in 1962, 2.59 in 1973 and is currently 2.30 for an average farm size. The major reasons for this decline are flooding, shortages of feed and fodder, lack of grazing land, and diseases and epidemics.

5.3.5.1 Impact of Floods

Flash floods harm livestock more than do seasonal floods. When flood water inundates homestead courtyards it creates unhygienic situations that threaten the health of livestock. Animal shelters are poorly built, soggy and usually damaged in heavy downpours. Frequent flooding weakens livestock to the point they are ineffective as draft animals. Seasonal floods affect most homesteads, but they confine livestock inside the homestead for long periods between May and October. Livestock then depend upon stall feeding as seasonal floods reduce available grazing areas. In addition, poultry are often washed away in floods. The 1991 flash flood caused significant damage to livestock and poultry. Acute shortages of feed and fodder occurred after the flood, and some bullocks and cattle starved. Casualties rose with the outbreak of disease and epidemics. Livestock owners lost crops as well and were forced to sell cattle to maintain their families.

5.3.5.2 Feed and Fodder Shortages

Farmers report feed and fodder shortages are the most serious constraint in livestock production. Rice straw and bran, paddy byproducts, are the major feed source. Repeated floods destroy crops in the field, severely reducing the amount of straw and bran available for livestock. Animals are most affected during the monsoon when they must be stall fed. Small farmers cannot afford feed from the markets. Instead, they collect various types of aquatic weeds such as helencha (*Enhydra flactuanus*), lalkashuria (*Bergia capensis*), janglidhan (*Hygroryza aristata*), golamethi (*Cyperus tagetiformis*) and water hyacinth (*Eichhornia crassipes*) for feed. Rarely, however, are these feeds of improved nutritional value. Stall feeding is not as difficult for medium and large farms as they spend between Tk. 2,000 and 10,000 annually for feed from the market.

5.3.5.3 Grazing Areas

Except for a few areas along roadsides, grazing land is difficult to find in the project area. Few cattle and bullocks graze throughout the year. In the past, khas lands were used for grazing,

Table 5.38. Homestead trees[1], shrubs[1] and vegetables[1] of economic importance in the Surma-Kushiyara project area

Types of Vegetation	Dominant	Common	Rare	No Longer Cultivated due to Flood Susceptibility
Trees and Shrubs	Gua (Betelnut[2]) Kola (Banana[2]) Bansh (Bamboo[2]) Beth (Cane[2]) Mortha (Patipata[2]) Koroi Kadam Hijal Keya	Ata Aam (Mango) Jambura (Grapefruit) Jam (Blackberry) Jarul	Kanthal (Jackfruit[2]) Narikel (Coconut[2]) Sabriam (Guava) Gub Lichu (Litchi[2]) Boroy (Plum) Royal palm Satim Gamari Mandar	Komola (Orange[2]) Chambol[2] Shegun (Teak[2]) Neem[2] Bel (Wood apple[2])
Vegetables	Uri (Beans) Lubia (Cowpea) Mistikumra (Sweet gourd) Chalkumra (White gourd) Panikodu (Bottle gourd)	Jhinga[2] Chichinga[2] Kakrol[2] Pepe (Papaya[2]) Khira (Cucumber[2])	Korolla (Bitter gourd[2]) Dharas (Okra[2])	

[1] Scientific names are listed in Table 5.35
[2] Considered by villagers to be most susceptible to flood damage.

Table 5.39. Selection of dominant and common tree and shrub species over time in settlement area.

Homestead Mound Prior to House Construction	New Homestead <5 years old	Old Homestead >5 years Old
1. Dholkalmi	1. Kola (Banana)	1. Gua (Betelnut)
2. Ekur	2. Gua (Betelnut)	2. Bansh (Bamboo)
3. Arhhar (Pigeonpea)	3. Bansh (Bamboo)	3. Mortha (Patipata)
	4. Mortha(Patipata)	4. Aam (Mango)
	5. Kadam	5. Kadam
	6. Koroi	6. Koroi
	7. Aam (Mango)	7. Jambura
	8. Jambura (Grapefruit)	8. Kanthal (Jackfruit)
	9. Bet (Cane)	9. Ata
		10. Jam (Blackberry)
		11. Jarul
		12. Hijal
		13. Beth (Cane)

but these lands have been cropped. Grazing improves in November when major crops are harvested. Most of these lands remain fallow through February, providing needed grazing areas.

Table 5.40. Livestock of an average farm of Surma-Kushiyara project.

Types of Livestock	1972	1991
Buffalo	0.06	0.12
Bullock	1.92	1.18
Working Cow	0.61	0.41
Milk Cow	-	0.59
Steer and Idle Cow	0.51	1.06
Goat	0.32	0.29
Chicken	3.19	4.94
Duck	-	1.70

5.3.5.4 Disease and Epidemics

Livestock disease and epidemics are a major problem for farmers. Foot and mouth disease is endemic in the area. Diarrhoea is a common disease during flood season. Pneumonia, throat diseases and parasites are other common problems. Chickens frequently die from Newcastle (Ranikhet) Disease. Buffalo are more disease resistant than cattle. Treatment facilities are inadequate and small farmers cannot afford veterinary services. Medium and large farm holdings generally spend between Tk. 200 and 500 per year on veterinary services.

5.4 Biological Resources

5.4.1 Open Water Capture Fisheries

The study area is rich in vast open water capture fisheries resources. Its many beels, haors, canals and huge areas of seasonally flooded lands are good habitat for open water capture fisheries. Besides open water resources, there are also about 9,000 ponds and small ditches that are unused or under used for fish production.

About 65 percent of the study area is covered by wetlands of which 7 percent are perennial wetlands and 58 percent seasonal wetlands that provide diversified fish habitat (Figure 5.13). About four percent of all people in the study area are fully employed in fishing activities almost year-round (Upazila Fishery Officers, pers. comm.). In addition, many people fish at the subsistence level for about six months of the year.There are several different types of wetlands in the study area and they are classified according to their water retention period (Table 5.41)

- Permanent wetlands (W_0): Areas that are under water throughout the year.
- Seasonal wetlands (W_1-W_3): Areas that are under water for less than a year.

Depending on water levels and inundation period, seasonal wetlands are classified into the following three groups:

- Flooded Lowland (W_1): Water levels vary between 1.8 and 3.0+ m during high flooding periods.
- Flooded Medium Lowland (W_2): Water levels vary between 0.9 and 1.8 m during high flooding periods.
- Flooded Medium Highland (W_3): Water levels rise to 0.90 m during high flooding

periods.

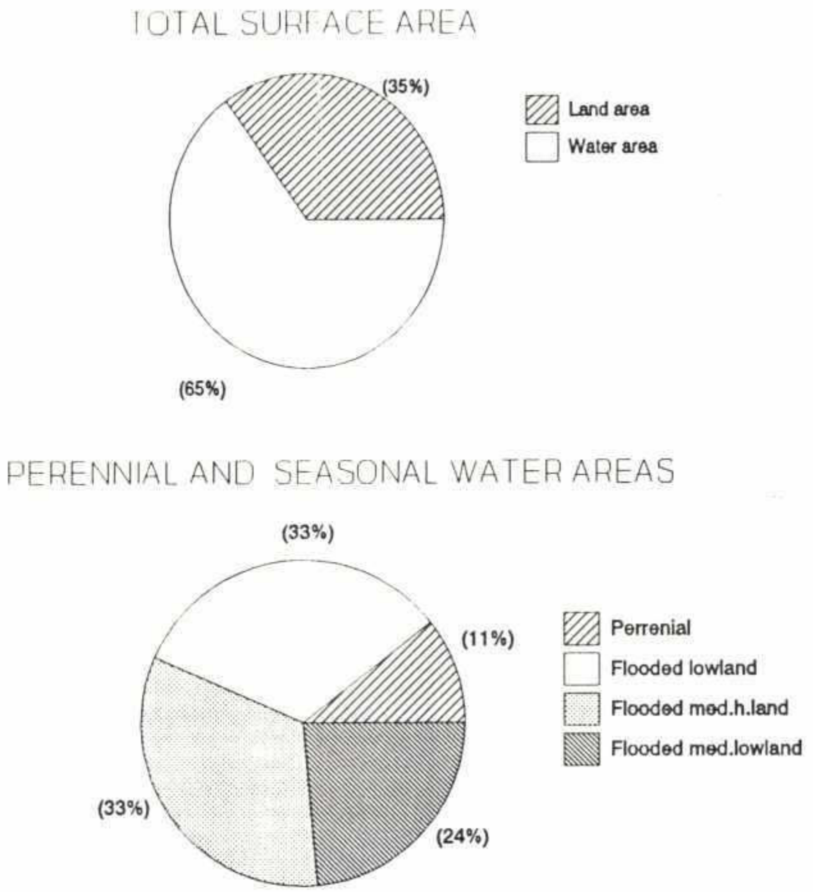


Figure 5.13. Distribution of perennial and seasonal wetlands in the Surma-Kushiyara project area.

Table 5.41. Wetland Areas within the Surma-Kushiyara project area.

Wetland type	Code	Area (ha)	Fishery Areas(%)	Total Area (%)
Perennial wetlands	W_0	2,670	10.6	7
Seasonal wetlands				
Flooded lowlands	W_1	8,225	32.7	21
Flooded Medium lowlands	W_2	8,320	33.0	22
Flooded Medium highlands	W_3	5,954	23.7	15

The study area is located in a high rainfall zone in which rain accumulates in a central depressed basin. At the onset of the monsoon in May/June, wetland areas gradually increase, peaking in size and area in August/ September. During a maximum flooding situation, water levels reach 0.9 m in medium highland areas and about 3 m in lowland areas. The rains connect isolated wetlands areas into large water bodies (Figure 5.14).

From June to September in most years rain water does not drain out to the rivers because of high water levels in the rivers. Water from the Surma and Kushiyara Rivers enter the project area through seven major canals: Kakura, Chagli, Sonam, Rahimpur, Jaigirdari, Napit and Karati canals. Water also enters by overtopping both river banks and breaching of dykes along the rivers of Surma and Kushiyara. (Figure 5.8). About 60 - 70 percent of the area is under water during normal flooding situations. Raised canal beds at the confluence of the Surma and Kushiyara restrict drainage which prolong water retention in flood plains and beels. Water levels in the two main rivers are very variable and can change rapidly from one day to the next, with resulting differences in efficiency and direction of drainage. Restricted drainage allows more time and area for fish for feeding and growth but on the other hand hampers migration of fish from flood plains to the rivers.

The flood water begins to recede in September or October, and in October the channel of the receding water changes from the central depressed basin to rivers through Khals. Water flows through the Kakura, Sunam and Chagli Khals to the Surma River and through the Karati, Jaigirdari, Napit and Rahimpur Khals to the Kushiyara River. By the end of November, flooded medium high-and medium lowlands (W_2 and W_3) are dry. In lowland areas (W_1), people dam water until December for boro cultivation. The wetlands again become isolated from one another in December and remain so until April/May.

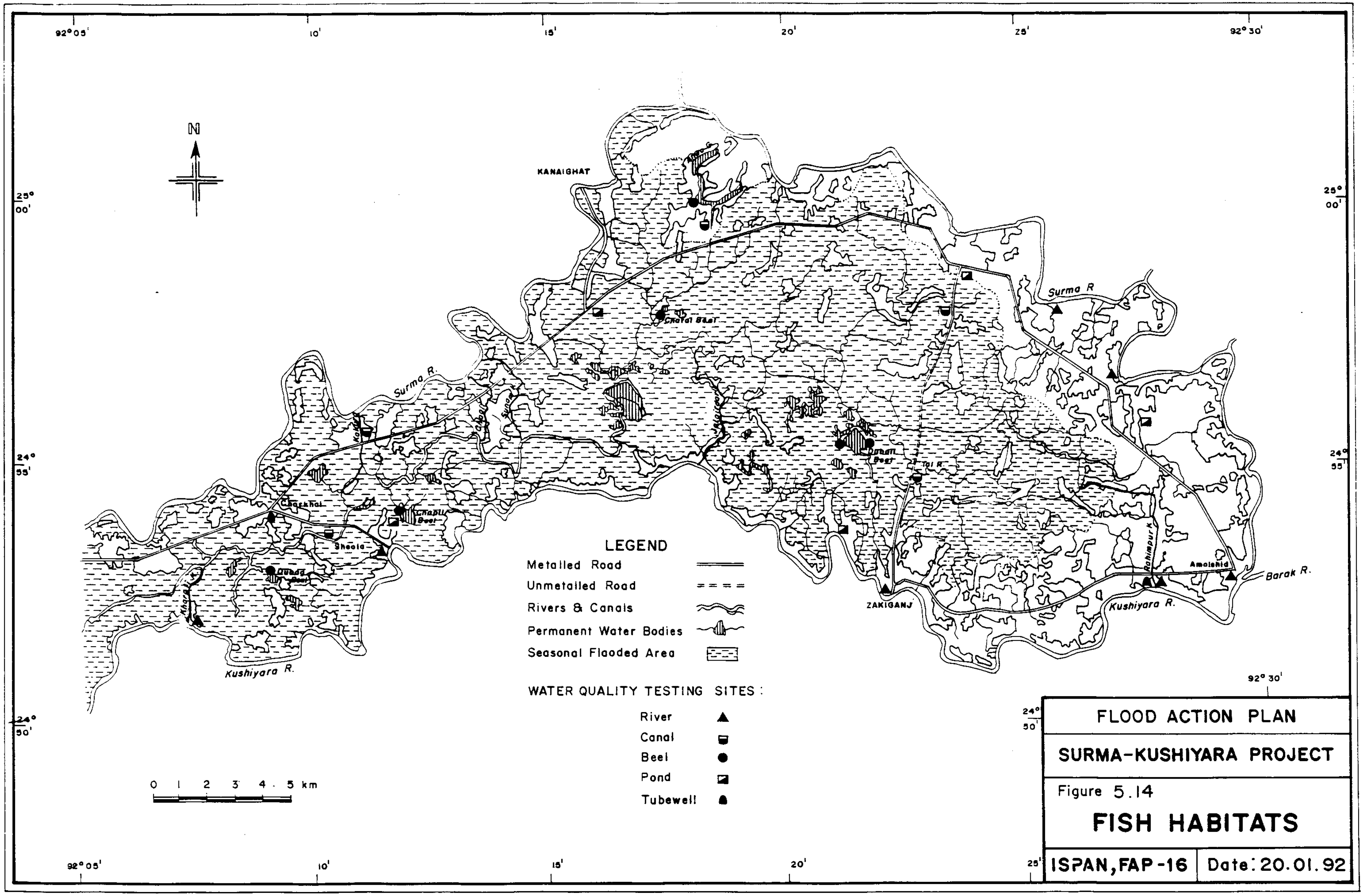
Some selected water quality parameters were monitored during the study period and the data are presented in the hydrological portion of this report. The water quality was found suitable for fish, however, seasonal and diel variations should be monitored to establish the overall water quality conditions of the wetlands.

Most of these wetland, open water resources (jalmahals) are owned by the government and are leased for fishing to local people for one to three years. Details of the jalmahal leasing system are described in section 5.5.

Wetland areas are used primarily for the following purposes:

- Wetlands are primarily used for fishing, and when the area is completely inundated, almost everyone will fish. Common people, however, are not allowed to fish in the leased water bodies. So, from April to November, it was observed that most villagers fish at the edge of flooded lands mainly for family consumption. Commercial fishermen also use the area during this period. But, from November to March fishing is confined to the perennial wetlands that are controlled by lease holders.

- Wetlands provide habitat for large numbers of resident and migratory birds as



92° 05'
10'
15'
20'
25'
92° 30'
25° 00'
24° 55'
24° 50'
N
KANAIGHAT
Surma R.
Surma R
Kushiyara R.
Barak R.
ZAKIGANJ
Amalshid
Sheola
LEGEND
Metalled Road
Unmetalled Road
Rivers & Canals
Permanent Water Bodies
Seasonal Flooded Area
WATER QUALITY TESTING SITES :
River
Canal
Beel
Pond
Tubewell
0 1 2 3 4 5 km
FLOOD ACTION PLAN
SURMA-KUSHIYARA PROJECT
Figure 5.14
FISH HABITATS
ISPAN, FAP-16
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well as other wildlife.

- Wetlands provide irrigation for boro crops.
- Wetlands home macrophytes that are used as green manure, fuel, cattle feed and human food.
- Wetlands provide avenues of transportation, and therefore communication, during the wet season.

5.4.1.1 Macrophytes

People of the area informed that about 15-20 years prior to the study the wetlands were infested with many varieties of aquatic macrophytes. The current overall macrophyte population of the area, however, is not abundant. Relatively large quantities of macrophytes were observed in the beels than canals and other water-bodies (Table 5.42).

5.4.1.2 Phytoplankton, Zooplankton and Macroinvertebrates

Planktonic populations were investigated only on a qualitative level. A small number of phytoplankton species were observed during the study. High turbidity is one possibility for the low numbers. Zooplankton populations were more abundant than phytoplankton. Seasonal observations are needed to determine seasonal numbers and distribution of planktonic populations. A list of plankton is shown in Table 5.43.

A large population of mollusks was found in the study area (Table 5.44).

5.4.1.3 Fish Species

Approximately 56 species of fish were observed in different wetland areas during the case study. Predator fish (boal, aair, foli) are caught more often than other species. In addition to finfish, 2-3 species of small fresh water prawns were also observed.

Six species of carp, 14 species of catfish, 3 species of snakehead and 33 miscellaneous species, of which chapila was most dominant, were observed in wetland habitats (Table 5.45).

5.4.1.4 Breeding and Migration

Early rains, flooding, temperature and water levels influence the spawning of all freshwater fish. During the monsoon months fish migrate from inside the project area to outside rivers, and vice-versa, through canals and over-spilled flood waters.

Shallow flood plains provide important habitat for fish. Decomposed vegetation, wildlife and domestic animal dropping, and allochthonous nutrients carried in flood waters support rapid growth of fish food organisms. The flood plains, therefore, provide a suitable environment for spawning, feeding and growth of most species that spend their early life in the rich flood plain

Table 5.42. Aquatic macrophytes observed within the Surma-Kushiyara project area, October 1991

Bangla name	Scientific name	Remarks
Lal kashuria	*Bergia capensis*	Cattle food, grows along beel margins
Ram karalla	*Ottelia alismoides*	Local people consume fruit part
Kachuripana	*Eichhornia crassipes*	Low populations may be due to last flash flood
	Hydrilla verticillata	Submerged vegetation-low population
	Monochria hastata	Grows along beel margins
	Aponageton spp.	Used as buffalo food
	Hygroryza aristata	Grows throughout beel areas, main food item of buffalo
	Cyperus tagetiformis	Grows along beel margins, beels, good cattle feed
Halencha	*Enhydra fluctuans*	Used for human consumption
Kalmi	*Ipomoea aquatica*	Used for human consumption
Dholkolmi	*Ipomoea fistulosa*	Grows at the edges of beels & lowl-ands used as fuel wood

Table 5.43. Plankton observed in waters within the Surma-Kushiyara project area, October 1991.

Plankton:	Remarks
Phytoplankton: *Oscillatoria* *Pediastrum* *Navicula* (Diatoms)	Low population
Volvox	Low population, small colonies
Chlamydomonas	Found in Sada Khal, Chatal Beel & in small water bodies
Spirogyra	Minimum numbers have been found
Microcystis	Bloom covering a large area of Dubail Beel. Secretes toxic
Zooplankton:	substances to other algae.
Vorticella spp. *Cyclops* *Daphnia* *Brachionus spp.*	Form colonies in waters of higher quality. Dominant crustacean found throughout project area. Large numbers in Sada Khal.

eventually move, with the receding water, to perennial water bodies such as rivers, beels and canals.

Major carps use canals and rivers as migration routes and spawning areas, but use flood plains as nursery and feeding grounds. The spawning migration of major carps take them from beels and boars to rivers during the early monsoon (March through May). They search for suitable

Table 5.44. Macroinvertebrates observed in Surma-Kushiyara project area, October 1991.

Bangla name	Scientific name	Remarks
Shamuk	*Pila globosa*	Common food for domestic and migratory ducks
Jhinuk	*Lamellidens marginalis*	
Jhinuk	*Unio spp.*	
Gura kecho	*Tubifex spp.*	Food for bottom feeding fish
Kecho	*Pheretima posthuma*	
Jok	*Hirudo medicinalis*	Ectoparasite on cattle and humans

Table 5.45. Fish species observed in Surma - Kushiyara study area, October 1991.

Groups	Family	Zoological Name	Local Name
Carps	Cyprinidae	Catla catla	Catla
		Labeo rohita	Rui
		Labeo clabasu	Calbaush
		Labeo gonius	Gonia
		Cirrhinus mrigala	Mrigal
		Cirrhinus reba	Tatkini
Catfishes	Clariidae	Clarias batrachus	Magur
	Siluridae	Wallago attu	Boal
		Ompok bimaculatus	Kanipabda
		Ompok pabda	Pabda
	Heteropneustidae	Heteropneustes fossilis	Singi
	Schilbeidae	Ailiichthys punctatus	Baspata
		Psedudeutropius atherinoides	Batasi
		Eutropiichthys vacha	Bacha
	Bagridae	Rita rita	Rita
		Mystus aor	Aair
		Mystus tengara	Bajari Tengra
		Mystus vittatus	Tengra
		Mystus cavasius	Gulsha
	Sisoridae	Bagarius bagarius	Bagair
Snakeheads	Channidae	Channa marulias	Gajar
		Channa striatus	Shol
		Channa punctatus	Taki
Miscellaneous fish species	Cyprinidae	Salmostoma phulo	Fulchela
		Esomus danricus	Darkina
		Chela laubuca	Chepchela
		Rasbora daniconius	Darkina
		Amblypharyngodon mola	Mola
		Rohtee cotia	Dhela
		Puntius chola	Chalapunti
		Puntius ticto	Titpunti
		Puntius sophore	Punti

Table 5.45 continued on next page

Table 5.45 (Cont.)

Groups	Family	Zoological Name	Local Name
	Cobitidae	Nemachilus spp. (2 species)	Balichata
		Acanthophthalmus pangia	Panga
		Botia spp. (2 species)	Rani
		Lepidocephalus spp. (2 species)	Gutum
	Notopteridae	Notopterus notopterus	Foli
		Notopterus chitala	Chital
	Clupeidae	Gudusia chapra	Chapila
	Mastacembelidae	Macrognathus aculeatus	Tara Baim
		Mastacembelus armatus	Baim
		Mastacembelus pancalus	Guchi Baim
	Anabantidae	Colisa sota	Boicha
		Colisa fasciatus	Khalisha
		Anabas testudineus	Koi
	Gobiidae	Glossgobius giuris	Bele
	Nanidae	Nandus nandus	Meni
	Pristolepidae	Badis badis	Napit
	Centropomidae	Chanda nama	Chanda
		Chanda ranga	Lal chanda
		Chanda beculis	Chanda
	Tetrodontidae	Tetrodon spp.	Potka
	Belonidae	Xenentodon cancila	Kakila

areas in flowing rivers out side the project area and complete their spawning from May to August. Their spawn and early fry drift through the rivers and are laterally dispersed onto the flood plains. Snakeheads feed on small fish, fish larvae, frogs, tadpoles and insects. Other miscellaneous fish also feed on plankton, periphyton, benthic invertebrates, fish and insect larvae, and detritus found in wetland habitat. Feasibility reports on the Upper Kushiyara Project indicate that major carp do not breed in the rivers and haors, but local fishermen report that they do find fry and fingerlings there. It is possible, therefore, that carp may breed in the upper reaches of the rivers in India.

Other flood plain species (catfish, snakehead and miscellaneous fish) breed in stagnant water, they migrate toward inundated flood plains for spawning, feeding and early growth. Some catfishes (i.e. *M.aor*) breed in rivers, they migrate towards rivers with receding water during late monsoon, their early fry again immigrate to flood plain for feeding and growth in early monsoon. The spawning period of all these species range from April to October. A fish spawning calendar is presented in Figure 5.15.

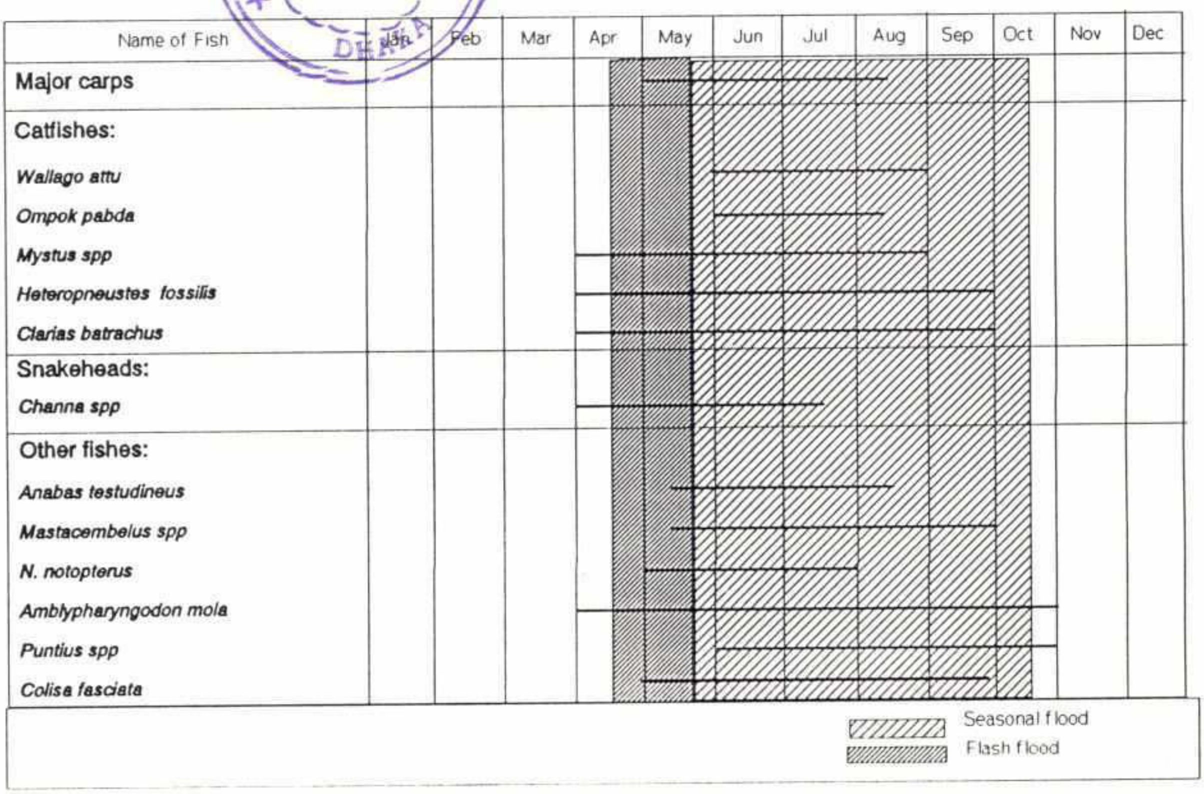


Figure 5.15. Breeding Calendar for Fishes in the Surma-Kushiyara Project Area

5.4.1.5 Feeding

Carp feed on plankton, periphyton, benthic invertebrates and detritus found in the various strata of the water column. Catfish prefer small fish, fish larvae, frogs, tadpoles, small shrimp, aquatic insects, insect larvae, plankton, detritus and decaying organisms.

5.4.1.6 Disease

Many fish species found in beels and canals suffer from Epizootic Ulcerative Syndrome (EUS). In particular, shol, gojar, taki, baim, puti and tengra were affected by the disease. The disease first occurred in Bangladesh in 1988 and since then, it outbreaks every year during winter months (November-March). The actual causes of EUS have not been identified. However, virus and bacteria have been identified from affected fishes. Low alkalinity is thought to be a factor. It is thought that the outbreak of EUS may be the result of an unbalanced relationship between fish population, pathogens and the environment.

5.4.1.7 Limitations

The exiting wetland management system is ineffective. It appears that the authority's objective is to lease the wetlands and collect revenues instead of managing for biological and resource improvement. Fishing by dewatering of permanent beels every year is causing

reduction in fish stock in the area. Siltation of beel beds and abstraction of water for irrigation are reducing fish habitats and making the fish vulnerable to natural and fishing mortality. Siltation of canal mouths inhibit spawning migration of various fish species. Fishing in canals (i.e. Kakura Khal, July Khal, etc.) during early monsoon impede brood fishes to migration spawn in flood plains.

5.4.1.8 Previous Development Impacts

A 1907 map of the study area showed it to be rich in a healthy wetland system. A network of canals, originating from the Surma and Kushiyara Rivers, crisscrossed the study area. Those canals together with many perennial beels provided suitable habitat for diversified fish species. Morphological changes, brought on by both natural and human intervention, occurred over many years. These changes, such as silting, sluice gates at Rahimpur and Sunam khals the closure of canal openings (Babur Khal, Senapati Khal etc.), dyke construction, pesticide use, overfishing and the draining of water bodies attributed to a gradual degradation of wetland habitat, and, consequently, the decline of fish production and species diversification.

5.4.2 Closed Water Culture Fisheries

There are about 3275 big and small ponds in the project area covering 256 ha. Of these ponds, 2531 (196 ha), 374 (31 ha) and 370 (30 ha) are located at Zakiganj Upazila, Kanaighat Upazila and Beanibazar Upazila respectively. In addition, there are about 6000 small water bodies and ditches in the area suitable for fish production. It was reported that most of ponds retain water round the year.

Despite the number of ponds, pond-fish culture is not practiced by pond owners or villagers as it is in other parts of the country. The following problems seem to substantiate this lack of interest:

- Recurrent annual flooding inundates almost every pond in the area.
- People prefer fishing in the abundant beels, canals, rivers and seasonally flooded areas rather than raising fish in ponds.
- Rich harvests from open water capture fisheries ensures availability of local supply of fish at less cost.
- Fish seed supplies are inadequate and costly.
- There is little technical fish culture knowledge.
- There is no motivation, nor technical or credit support, offered by the Department of Fisheries (DOF) and other agencies in the project area.

A few pond owners do culture fish at a traditional level; they stock only with fingerlings. Other activities such as eradicating unwanted fish (predator and weed fish), liming, manuring, feeding, and regular monitoring of fish health and growth are ignored by all but a few. The current status of fish culture is better termed as "fish keeping" rather than as fish farming

5.4.2.1 Pre-stock Management

Pre stocking management involves pond preparation during which unwanted fish are eradicated. Then the pond is limed and manured. Almost no pond owners follow any pre-stocking management. They simply stock ponds with fingerlings without eradicating unwanted fish and applying lime and manure.

5.4.2.2 Stocking Management

After preparation, the ponds are stocked with various fish species. Most ponds were not stocked in 1991 because of flooding. And, in 1990, stocking was not properly done. In most cases ponds were over stocked. In two ponds, carp fingerlings were stocked at a rate of 30,865 per hectare. The standard farmers (recommended by the Department of Fisheries) stocking rate is between 6,000 and 7,500 per hectare. The size of stocked fingerlings was small, varying from 3 to 8 cm. Only in one pond, at Zakiganj, were the fingerlings larger. About 30 percent measured 15 cm.

Three species of major carps are stocked in most of the project area ponds. In a few ponds, exotic carps, such as silver carp and common carp, are stocked. No definite stocking ratio was followed by pond owners. In most cases, catla *(Catla catla)* constituted 50 to 70 percent of the stocked species, while rui *(Labeo rohita)* and mrigal *(Cirrhinus mrigala)* made up the rest in equal proportions.

Pond owners purchase fingerlings from fish seed hawkers who collect fish fry from fry raisers at Madar Khal village under Zakiganj Upazila as well as from distant fish seed farms located outside project area. There is no government fish Seed farm in the project area.

5.4.2.3 Feeding and Manuring

The pond owners usually do not apply any feed or manure in fish ponds. Only the very wealthy can afford oil cake and rich bran for fish feed, and then, only on an irregular basis.

5.4.2.4 Monitoring

There is no regular monitoring of fish health and growth, but most pond owners report that fish growth rate is not satisfactory and that fish disease is common. The survival rate of fish, as reported by farmers, is less than 50 percent. The low survival rate is due to overstocking of small fry, the presence of predator and weed fish, and the absence of feed and manure.

5.4.2.5 Production and Marketing

Pond fish production is low (400 to 800 kg/ha/year) compared to other areas of the country. Fish are not harvested on yearly basis because most pond owners prefer to keep fish in ponds for several years. Usually, contract fishermen harvest and sell pond fish. These fishermen usually receive 20 to 30 percent of either the produce or the cash equivalent.

5.4.3 Wildlife

A total of 125 species of wildlife, including a number of endangered and threatened species, were identified in the project area from October to December 1991. The wildlife of the project area comprised 67 terrestrial species and 58 water-dependant species. There were 29 migratory and 68 resident bird species.

5.4.3.1 Terrestrial Habitats

In wet months about 35 percent of total project area remains as terrestrial habitat (Figure 5.16). It increases up to 93 percent in the dry season. There is no land defined as natural forest within the project area. Extensive and diverse stands of homestead trees form village forests. Depending on vegetation and land type, the wildlife habitats can be divided into four groups :

- Homestead vegetation
- Agricultural crops
- Open (fallow) land vegetation
- Road side vegetation

Homesteads, orchards and roads covered 17 percent of the total lands of the project area (Figure 5.11) compared to 1.88 percent for the whole of Bangladesh. Older homesteads have diversified plant species composition, while newly constructed homes have mainly selected plant species (e.g. banana). All the species are distributed throughout the project area. Vegetation occurs along the rivers in thin linear strips, and is scattered along the roads confined to the highland areas). Vegetation of the medium highland and medium lowlands is more irregularly distributed.

Homestead forests comprise two main types. *Edge plants* grow from the nearest agricultural field or from small wetlands and ponds. Grass, Ekur, Son and some bush plants are the first to occupy homestead edges. These plants, combined with cane, mortha, mander, babla and chattim, form a dense ecologically rich edge. *Inside plants* such as koroi, bamboo, aam, jam, supari, bel, hijal, jarul, kadom, sisu, shimul and shegun are the main inside plants of older homesteads. Banana and some other plants occur in new homesteads. Distribution of terrestrial wildlife within the various canopies in study area is shown in Figure 5.16.

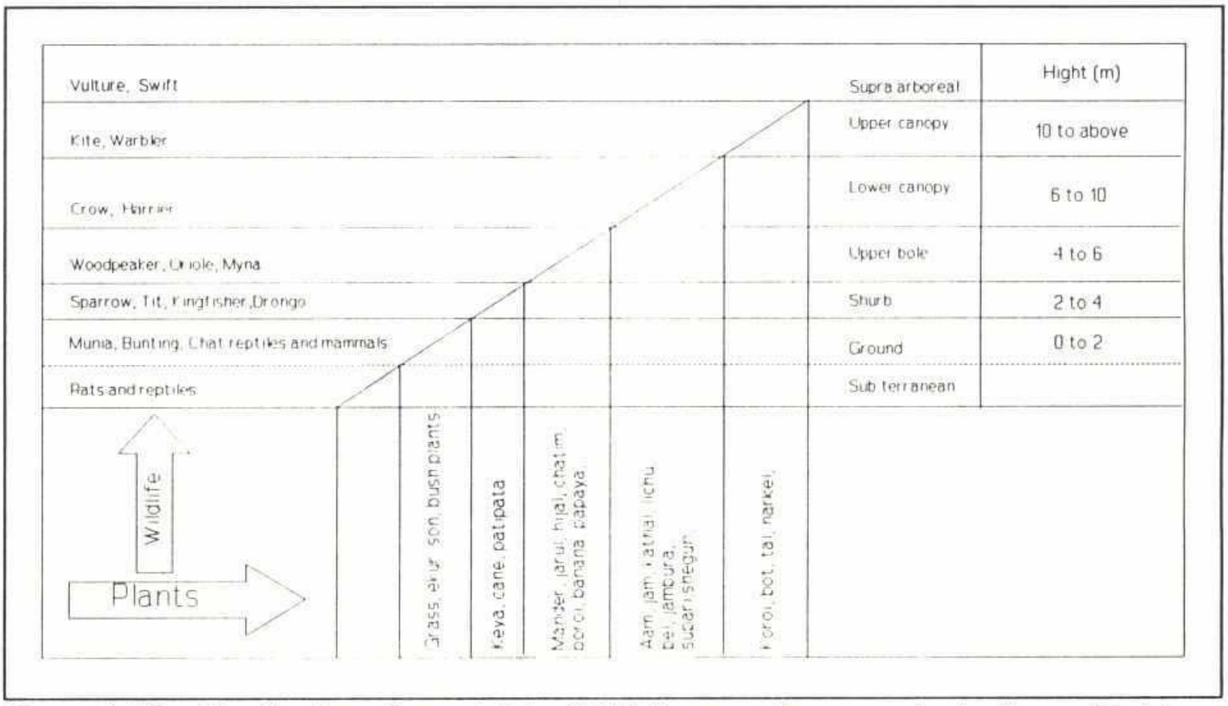


Figure 5.16. Distribution of terrestrial wildlife in vegetation canopies in Surma-Kushiyara Project Area.

Agricultural lands cover about 76 percent of the total lands of the project area. Different varieties of rice are dominant. Banana, papaya, cucumber, brinjal, beans are the next most abundant coverage. Some seasonal vegetables are cultivated close to the homesteads and on the canal banks. Three species of rats, munia, sparrows and common myna are the main grain eating wildlife. Seed beds provide shelter for rats, while field bunds constitute the best shelter for rats in dry months.

About 6-7 percent of total land area is open fallow land, covered by grasses of different types. These are used as grazing for cattle. Parts of the lowlands (boro lands) which are not under cultivation by poor land owners (because these crops are damaged by flood almost every year) becomes fallow land. In the central part of the project area dholkolmi covers these type of lands after 2-3 year without cultivation. If these plants are allowed to grow for 2-3 years the land becomes unsuitable for cultivation. Grass varieties grow very fast but often do not survive because of water shortage. Some of these lands are not utilized by farmers. Other plant species occurring in lowlands include *Cyperus* spp., *Mariscus* spp., *Polygonum* spp., *Hygrophila* spp. and *Enhydra fluctuans*.

Rain trees occur as main road side plantation. Keya (thorny bush) grows along the road side where water is available. Koroi, sisoo, jarul are the common road side trees, while keya, dholkolmi and grasses are the principle herbaceous species.

Koroi (rain tree) is the dominant species among the large trees within homesteads and provides the most canopy habitat for woodland birds. Many of these birds build their nests in these trees. Betelnut is the common plant used by pied myna for nesting. The pied myna is well known in the study area for controlling populations of ear-cutting caterpillar (agricultural pest). Bamboo gives shelter to some habitat-specific birds such as the long tailed nightjar (a nocturnal insect eating bird) and the rat snake which has an important role in controlling rat population. Herons build colonies on bamboo near Septi Beel. Blackberry provides food and nesting support to many birds (crow, tree pie, etc). From November to March wild, fig trees give fruit and nesting support for different species of myna, robin, tree pie, dove, pigeon, barbet and other birds. Kites usually nest in Satim trees. Wood apple is the most suitable tree for common myna, tailor bird and house sparrow for building nests. House crow nests in mango trees. Manders tree is preferred by pied myna for building nests. Cane and morta provides good shelter for groups of small birds and the crow pheasant. Shawra gives shelter to owls and owlets. Coconut is uncommonly used by jungle crow for nesting. Palms are rare plants in the project area, and provide habitat for *Buya*. The edge plants provide habitat to warbler, chat, munia, tailor bird, babbler and other small birds. Munia and some bush birds nest in roadside keya bushes.

5.4.3.2 Wetland Habitats

Wetlands provide the basis for the highest biodiversity in the study area and are classified into two major types:

- Permanent wetlands (W_0) where water remains throughout the year e.g. canals, rivers, beels etc. (Figure 5.17).

- Seasonal wetlands (W_1-W_3), where water remains part of year. Depending on seasonal water level rise and the area covered, the seasonal wetlands have been classified as indicated in Figure 5.17.

Large beels (e.g. Dubail Beel), smaller beels (e.g. Septi Beel) and some canals (e.g. Tal nodi) provide permanent wetland habitat for wildlife. These beels are different from each other because of water quality, macrophytes (Table 5.42), plankton species (Table 5.43), macro-invertebrates (Table 5.44), fish composition (Table 5.45) and presence of wetland-dependant wildlife.

Seasonal wetlands (W_1-W_3) provide habitat for resident wildlife and breeding habitat for resident water birds. In different seasons wetlands provide food (e.g. macrophytes), shelter (e.g. Jacana) and breeding support to wildlife. From mid-April to October about 65 percent of total land becomes wetland. From November to December it is reduced to 50 percent, from December to mid-January 28 percent and up to mid-April it becomes 7 percent of the total land of the project area.

5.4.3.3 Wildlife Species and Population

A total of 5 species of amphibians, 13 species of reptiles, 97 species of birds and 10 species of mammals were recorded within the project area during the case study period.

a. Amphibians

Cricket frogs are very common throughout the study area in all types of water bodies. Bull frogs are low in number because of hunting and seasonality. Tree frogs were observed in road side dholkolmi plants close to water (Table 5.46).

Table 5.46. Amphibians identified in Surma-Kushiyara project area, October-December 1991.

Bangla name	Common name	Scientific name	Remarks		
Sona bang	Bull frog	*Rana tigrina*	T/C	R	I
Kotkoti bang	Cricket frog	*R. cynophyctis*	C	R	I
Kuno bang	Toad	*Bufo melanostictus*	C	R	I
Gecho bang	Tree frog	*Racophorus* sp	UC	R	I
Koti bang		*R. limnecharis*	C	R	I

C=Common, UC=Uncommon, E=Endangered, T=Threatened, R=Resident, M=Migratory, I=Insectivorous, P=Piscivorous, G=Granivorous, A=Predator, MO=Mollusks/Crustaceans, F=Fructivorous, V=Aquatic vegetation, O=Others.

b. Reptiles

Monitor lizards and skinks are seen close to water bodies. Water snakes are common in wetlands. Dog faced water snakes were observed to be quite abundant, although they are more commonly found in estuarine and low salinity areas. Rat snakes and cobras are reported by the local people to frequent homesteads. Banded kraits are reported close to water bodies. Other species noted are listed in Table 5.47.

c. Birds

A total of 97 species of birds were identified/observed in the Surma-Kushiyara project area during the case study period (Table 5.48). Of these 58 were aquatic, 67 terrestrial, 29 migratory, 68 resident and 3 endangered. Fifty-two open bill storks, an endangered species, were observed near Chatal Beel. These birds are easily disturbed by hunters and farmers. Grebes, cormorants, herons, stork, ducks, jacanas and waders were observed from the early part of the day (before to just after sunrise). The terrestrial birds of open lands, agricultural fields and homestead forest were observed during the day. Due to frequent disturbance by hunters it was difficult to approach close to many birds. Openbill storks and migratory ducks were observed to be highly sensitive to human activities. Ducks (common teal, shelduck, pintail, garganey, shoveler) frequent beels, while waders (snipes, stilt, lapwings, plovers, sandpipers) are abundant in lowlands and beel margins. Grey headed lapwings are abundant. Large egrets and grey herons are found in Dubail Beel only. Highest number of ducks are seen in lowlands near Shahbagh (430-450 pintails, 12 pair of shelducks). Wood cock are common in lowlands and beels. Fish eating kites, harriers and eagles are adjusted to human activities.

Migratory ducks utilize lowlands (boro fields) of the project area in the early period of migration. In early December the preparation of boro land starts and the birds move topermanent wetlands. These wetlands were highly disturbed by fishermen.

Table 5.47. Reptiles identified in Surma-Kushiyara Project Area, October-December 1991

Bangla name	Common name	Scientific name	Remarks[*1]		
Terrestrial: Kochop	Tortoise	*Kachuga tecta*	C	R	P
Tiktikee	Wall lizard	*Hemidactylus*	C	R	I
Tokkhok	Gecko	*Gecko gecko*	UC	R	I
Roktochosa	Garden lizard	*Calotes spp.*	UC	R	I
Angila	Skink	*Mabuya carinata*	C	R	I
Kalo gui	Monitor lizard	*Varanus bengalensis*	T/UC	R	I/A
Daraj sap	Rat snake	*Ptyas mucosus*	UC	R	A (rats)
Gokhra sap	Cobra	*Naja naja*	UC	R	A/P
Shonkhine	Banded krait	*Bungarus fasciatus*	UC	R	A (snakes)
Aquatic: Sona gui	Yellow monitor lizard	*Varanus flaviscens*	T/UC	R	P/A
Dora sap	Checkered keelback water snake	*Xenochrophis piscator*	C	R	P
Matia sap	Common water snake	*Enhydris enhydris*	C	R	P
Bora sap	Dogfaced water snake	*Cerberus rhynchops*	C[*2]	R	P

*1 See Table 5.46 for key to remarks codes.
*2 Exceptional observation of this estuarine species in the project area.

d. Mammals

Indian civets, small mongoose and foxes are confined to the densely planted homesteads. Pug marks of fishing cats and otters were seen in Dubail Beel. As informed by the local fishermen, the populations of otter and rats were increasing due to the concentration of Dholkolmi. Bandicoot rats were observed in boro seed beds. At Amalshid where the river Barak divides into Surma and Kushiyara a population of Gangetic dolphin (about 10-15) were observed throughout the study period. As informed by the local fishermen, dolphins move up and down stream in dry months probably due to high pollutants coming from Indian industries. Table 5.49 lists all mammals known to occur in the study area.

5.4.3.4 Migration

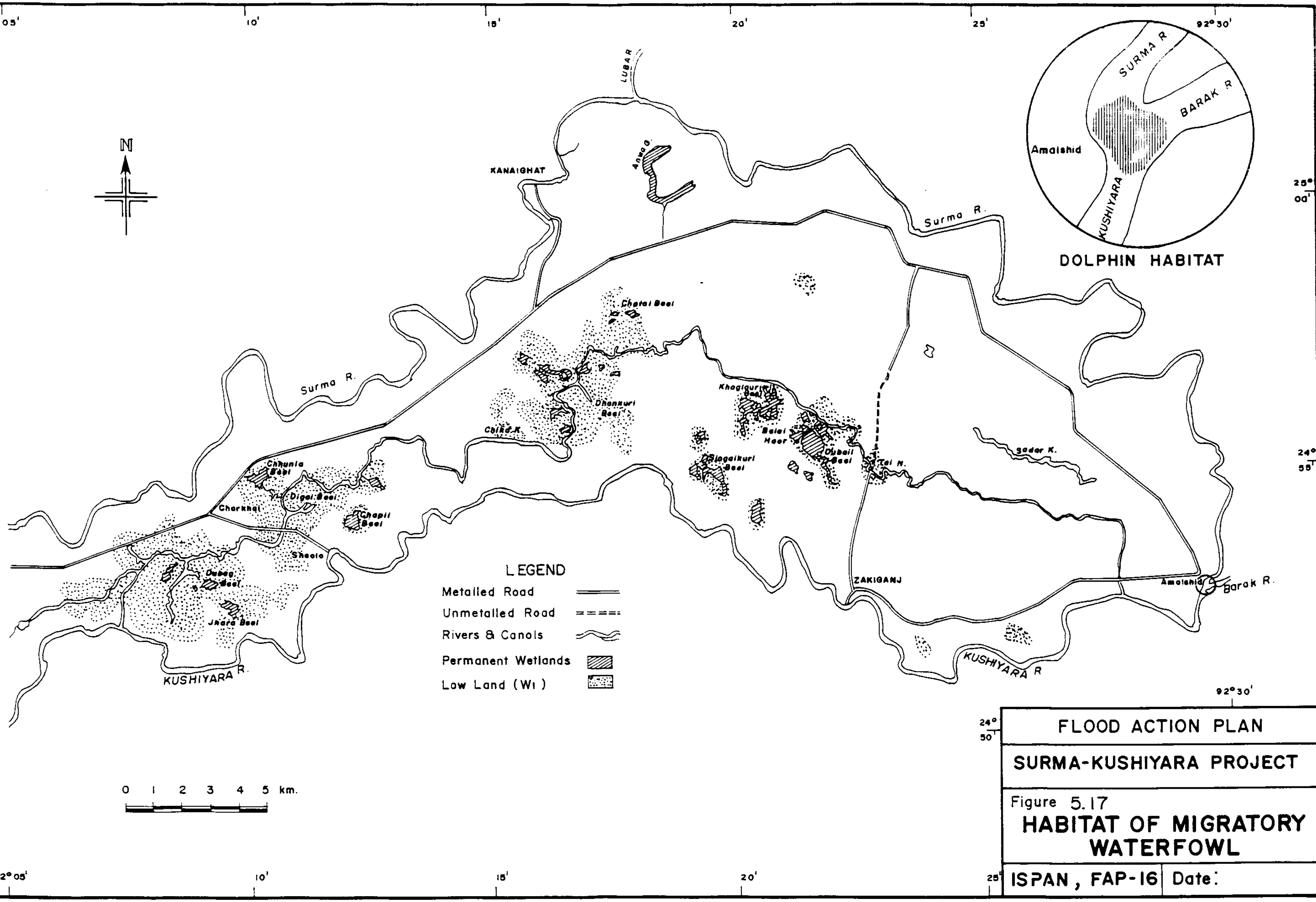
Shrikes, swallows, chats and some flycatchers were observed to arrive with in the project area as first phase migratory birds in early October. From the month of December grebes, ducks, harriers, waders started to settle on the low lands and permanent wetlands (Figure 5.18). Geese

Table 5.48. Birds Identified in Surma-Kushiyara Project Area, September-December 1991

Bangla name	Common name	Scientific name	Remarks[*1]		
Terrestrial:					
Bhuban cheel	Black kite	*Milvus migrans*	C	M/R	I/A
Sowkoon	Vulture	*Gyps bengalensis*	T/C	R	O (scavenger)
Tilla baz	Crested serpent eagle	*Spilornis cheela*	C	R	A
Baz	Shikra	*Accipiter badius*	UC	R	A
Lal ghughu	Red turtle dove	*Streptopelia tranquebarica*	UC	R	G/F
Tila ghughu	Spotted dove	*Streptopelia chinensis*	C	R	G
Teya	Parrakeet	*Psittacula krameri*	C	R	G
Chok galoo	Hawk cuckoo	*Cuculus varius*	UC	R	I
	Plaintive cuckoo	*Cacomantis merulinus*	UC	R	I
Kokil	Koel	*Eudynamys scolopacea*	UC	R	I
Lokhipacha	Barn owl	*Tyto alba*	UC	R	A
Bhutum pacha	Spotted owlet	*Athena brama*	C	R	A
	Ruby throat	*Erithacus calliope*	UC	M	I
Nishi chor	Night jar	*Caprimulgus macrunus*	UC	R	I
Hud hud	Ashy swallow shrike	*Cypsiurus balasiensis*	C	M	I
Sui chora	Bee eater	*Merops orientalis*	C	R	I
	Dusky leaf warbler	*Phylloscopus fuscatus*	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
Nilkotho	Roller	*Coracias bengalensis*	C	R	I
Hupu	Hoopoe	*Upupa epops*	C	R	I
	Lineated barbet	*Megalaima lineata*	UC	R	F
Boshonto baure	Coppersmith barbet	*Megalaima hacmacephala*	C	R	F

Table 5.48. Continued.

Bangla name	Common name	Scientific name	Remarks		
Kat thokra	Golden back woodpecker	*Dinopium javanense*	C	R	I
Abbabil	Common swallow	*Hirundo rustica*	C	M	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	Mag pie 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 (Ag-pest)
Kalo munia	Blackheaded munia	*Lonchura malacca*	C	R	G (Ag-pest)
Mautushi	Sun bird	*Nectarinia asiatica*	C	R	O (nector)
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 (Ag)
Harichacha	Tree pie	*Dendrocitta vagabunda*	C	R	I
Pati kak	House crow	*Corvus splendens*	C	R	O (scavenger)
Dar kak	Jungle crow	*Corvus macrorynchos*	C	R	O (scavenger)
Bhat salik	Common myna	*Acridotheres tristis*	C	R	G
Go salik	Pied myna	*Sturnus contra*	C	R	I
Gang salik	Bank myna	*Acridotheres ginginianus*	C	R	I/G
Jhuti salik	Jungle myna	*Acridotheres fuscus*	C	R	I



FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure 5.17

HABITAT OF MIGRATORY WATERFOWL

ISPAN, FAP-16 | Date:

Table 5.48. Continued.

Bangla name	Common name	Scientific name	Remarks		
Chorui	House sparrow	*Passer domesticus*	C	R	G
	Paddy field pipit	*Anthus novaeseelandiae*	C	R	I
Babui	Buya	*Ploceus philippinus*	UC	R	G
Aquatic:					
Pancowri	Little Cormorant	*Phalacrocorax carto*	C	R	P
Goair	Darter	*Anhinga rufa*	T/UC	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
Lal bok	Cinnamon Bittern	*Ixobrychus cinnanmeocus*	UC	R	I/P
Kani bok	Pond Heron	*Ardeola grayii*	C	R	P/I/MO
Nol bok	Grey Heron	*Ardea cinerea*	T	R	P
Chonkho cheel	Brahminy kite	*Haliaster indus*	C	R	P
Shamuk khor	Openbill stork	*Anastomus oscitans*	E	R	MO
Bali hash	Large whistling teal	*Dendrocygna bicolor*	E	R	P
Bali hash	Lesser whistling teal	*Dendrocygna javanica*	C	R	P
Bali hash	Common teal	*Anus crecca*	C	R	P
Gargany	Gargany	*Anus querquedula*	UC	M	V
Langa	Pintail	*Anus acuta*	C	M	V
Choto duburi	Little grebe	*Podiceps ruficollis*	T/C	R	V
Lal duburi	Rednecked grebe	*Podiceps griseigena*	UC	M	V
Jhuti duburi	Greater crested grebe	*Podiceps cristatus*	UC	M	V
	Shoveller	*Anus clypeata*	UC	M	V
Chokha Chokhe	Shelduck	*Tadorna ferruginea*	UC	M	V (algae)

Table 5.48. Continued.

Bangla name	Common name	Scienmtific name	Remarks		
Mechopacha	Brown fish owl	*Bubo zeylonensis*	E	R	P
Kura	Grey headed fishing eagle	*Icyhthophaga ichthyaetus*	T/C	R	P
	Marsh harrier	*Circus spilonotus*	C	M	P/O (Frog, snake)
	Pied harrier	*Circus melanoleucos*	C	M	O/P(Frog)
Jal pipi	Bronzewinged jacana	*Metopidius indicus*	C	R	V/G
Kalo pipi	Coot	*Fulica atra*	UC	R	V/G
Hot titi	Redwattled lapwing	*Vanellus indicus*	C	R	V/Seed
Holud titi	Yellow wattled lapwing	*Vanellus malabaricus*	C	M	V/MO
	Greyheaded lapwing	*Vanellus cinereus*	C	M	V/MO
	Little ring plover	*Charadrius dubius*	C	M	V/MO
	Pin tail snipe	*Gallinago stenura*	C	M	V/MO
	Fan tail snipe	*Gallinago gallinago*	C	M	V/MO
	Woodcock	*Scolopax rusticola*	C	M	V/MO
	Blackwinged stilt	*Himantopus himantopus*	UC	R	A/O (Frog)
	Common sandpiper	*Tringa hypoleucos*	C	M	V/MO
	Wood sandpiper	*Tringa glareola*	C	M	V/MO
	River turn	*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

Table 5.48. Continued

Bangla name	Common name	Scientific name	Remarks		
	Yellow wagtail	*Motacilla flava*	C	M	MO
	Yellowheaded wagtail	*Motacilla citreola*	C	M	V

*1 See Table 5.46 for key to remarks codes.

Table 5.49. Mammals Identified in Surma-Kushiyara Project Area September-December 1991

Bangla name	Common name	Scientific name	Remarks*1		
Boro badur	Flying fox	*Pteropus giganteus*	UC	R	F
Badur	Bat	*Megaderma lyra*	C	R	I
Shial	Fox	*Vulpes bengalensis*	C	R	O/A
Kattas	Civet	*Viverina malaccensis*	C	R	A
Mecho bagh	Fishing cat	*Felis viverrina*	E	C	P
Beje	Mongoose	*Herpestes edwardsi*	C	R	A
Indur	Rat	*Bandicota bengalensis*	C	R	G (Ag-pest)
Ud biral	Otter	*Lutra lutra*	C	R	P
Sehsu	Gangetic dolphin	*Platanista gangetica*	C (Kushiyara)	R	P
Metho indur	Bandicoot rat	*Bandicota indica*	C	R	G (Ag-pest)

*1 See Table 5.46 for key to remarks codes.

are the last migratory birds that comes to the project area. A large group of birds known as locally migratory birds accompany the migratory birds. Kites, eagles, storks, cormorants, common teal, whistling teal, cotton teal, herons, egrets, jacanas, water hens and a group of waders were observed along with the migratory birds during the study period. Migratory birds started to return from the project area from early march as reported by the local knowledgeable people and hunters. Some resident birds (e.g. lesser whistling teal) are observed to accompany the migratory birds in dry season in large flocks. They also migrate locally from Barisal and adjacent areas.

5.4.3.5 Food Behavior

Most wildlife in the study area are insectivorous and about 40 percent consume agricultural pest insects. Predators play a beneficial role by consuming rats. The food consumption groupings of wildlife in the project area are shown in Figure 5.19. More than 80 percent of total wildlife of the study area consume items which are not consumed by the local people.

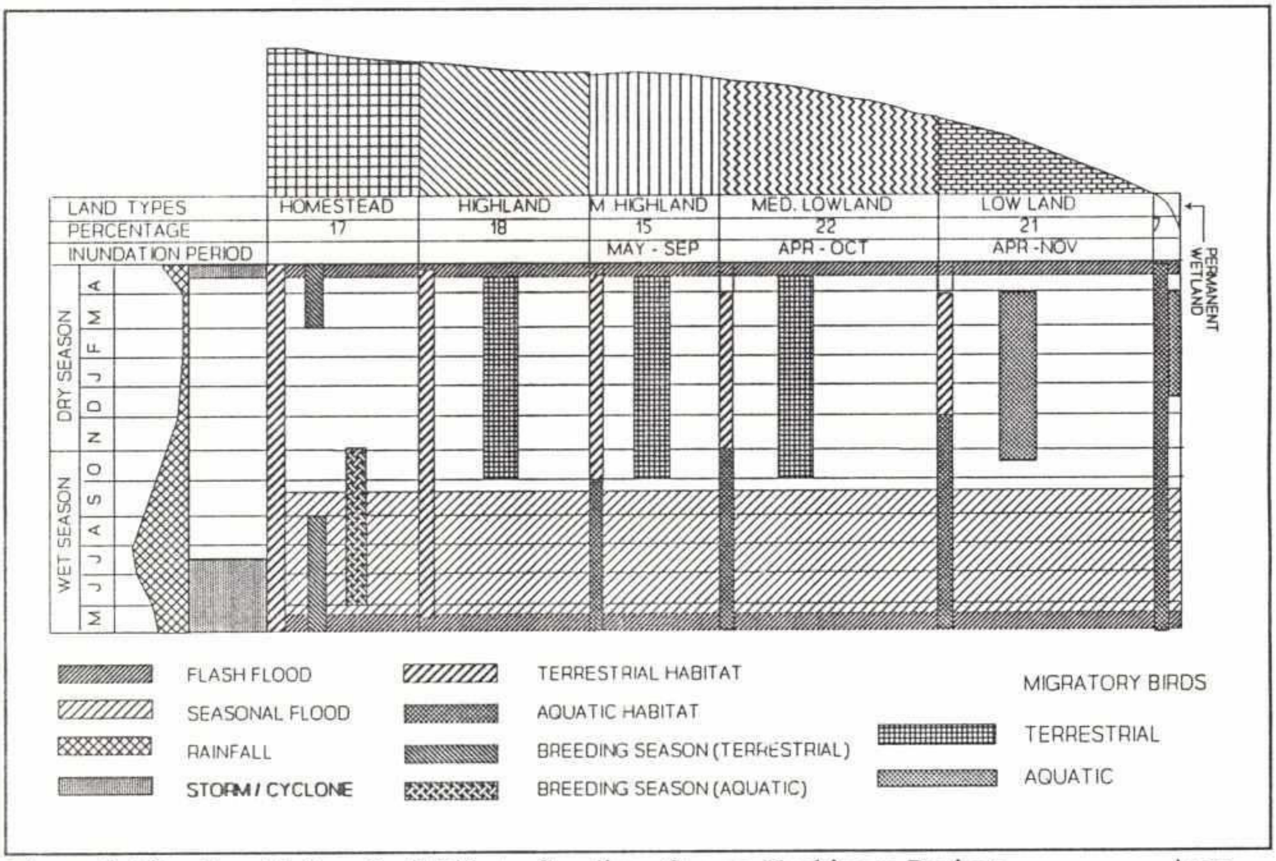


Figure 5.18. Sensitivity of wildlife to flooding, Surma-Kushiyara Project Area

5.4.3.6 Breeding

Cricket frogs breed from April to August. These amphibians breed in any type of water, specially in small pits. Bull frogs breeding season ranges from May to July. Water snakes breeds from November to June. Dog faced water snake breeds from March to August. Cobras and krait breed from April to August. Skinks breeds From May - July. Monitor lizards lay eggs from mid-April to October. Cormorants, herons, storks, water hens and some local waders breed from May to September. The kites, eagles and vultures breed from October to April. The land birds (dove, myna, barbet, cuckoo, bee-eater, kingfisher, etc) breed from February to September. Rats breeds almost through out the year. The relationship between wildlife breeding season and flood (Figure 5.20) shows that the breeding of terrestrial wildlife is affected by flash flood. Flash floods also benefit man as they are the natural control measure for rat populations.

5.4.3.7 Utilization of Wildlife

People of the study areas capture frogs for consumtion from April through September. Although the export of frogs has been banned for the past three years, frogs are regularly extracted and

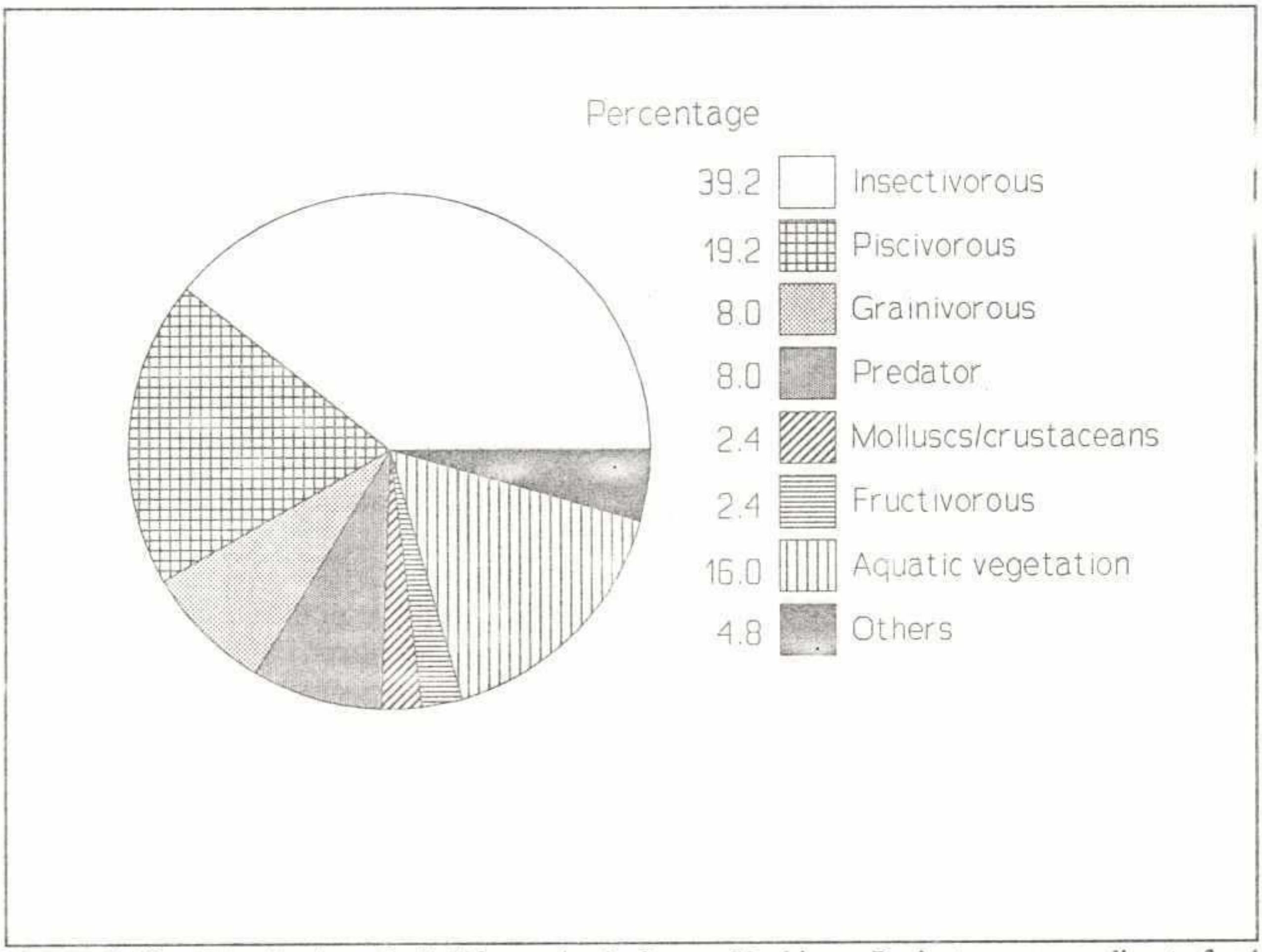


Figure 5.19. Distribution of wildlife species in Surma-Kushiyara Project area according to food habits

passed to India. A frog purchase center was observed in Ratanganjbazar. Killing of lizards for their skins was also reported by the local people. Large numbers of people from Sylhet and other parts of the country hunt birds from November to March. Egrets, doves, herons and waders are killed by air guns. Large egrets, storks, larger waders and duck are killed by fire arms. Trapping of swallows and ducks was also observed. The shooting of birds by fire arms causes the highest damage, both due to mortality and disturbance due to noise.

5.4.3.8 Endangered and Threatened Species

Fishing cats, openbill storks, brown fish owl and greater whistling teal are listed as endangered wildlife species. They are all water dependant. Nine other species - vulture, darter, grey heron, rednecked grebe, grey-headed fishing eagle, two species of monitor lizard, bull frog and the little grebe are listed as threatened wildlife species; seven of them are water dependant.

5.4.3.9 Wildlife Pests

Some wildlife act as agricultural pests, causing damage to crops in different stages of cultivation

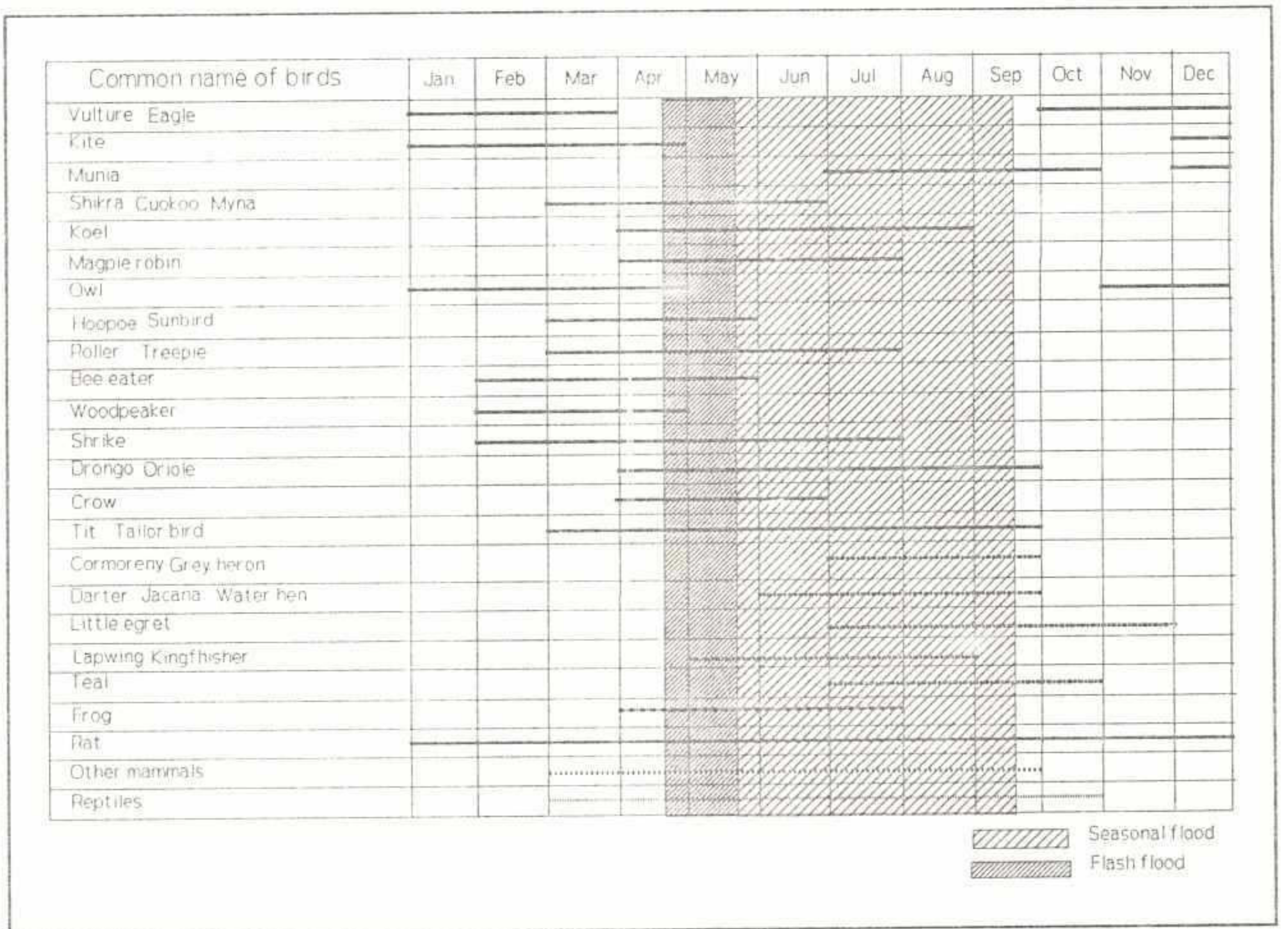


Figure 5.20. Wildlife breeding seasons in relation to flooding, Surma-Kushiyara Project Area.

or harvest. These include Indian field rats, bandicoot rats and house rats among the mammals, and spotted munia, blackheaded munia, rose-ring parakeet and barheaded geese among the birds. As informed by the local farmers 5-7 percent of the total crops were damaged by rats and 2-4 percent were damaged by birds. Among the birds the munia cause the highest damage. Rats damage dikes and embankments, specially in flooding season.

For controlling birds (munia) just before harvesting, people use sound made by empty metal containers and rope. Rats are more difficult to control: poisons such as Endrin are used occasionally but are generally not effective. Trapping is found to be more effectiveness. Due to the magnitude of flooding in 1991, the population of rats was comparatively low, according to local farmers. Nothing can be done for controlling the geese as these consume crops at night.

5.5 Human Resources

5.5.1 Population and Communities

The total population of the project area given in the 1981 census was 217,690. Of those 110,206 were male and 107,480 were female (Table 5.50). About 3.9 percent of the district population live in the project area which comprises 3.1 percent of the district. There is a

Table 5.50. Total Area, Households and Population of the Project Area by Union and by Mouza

Name of Union	Area in sq. km	No. of Mouzas	No. of Villages	No. of Households	No. of Males	No. of Females	Total Population	Density per sq/km
Barohal	43.40	14	31	3238	11023	10735	21758	501
Birosri	28.98	19	32	2535	8971	8550	17521	605
Kajalshar	38.87	20	20	3144	9148	8718	17866	460
Khalachara	31.78	10	42	3215	9050	9002	18052	568
Zakiganj	15.36	11	28	3154	9778	8978	18756	1221
Sultanpur	24.60	9	44	2943	9017	9257	18274	743
Barathakuri	23.92	10	30	2945	7966	8227	16193	677
Kashkanakpur	18.58	6	16	2216	6936	6690	13626	733
Manikpur	40.30	26	43	3466	10766	10412	21178	526
Zakiganj Upazila								
Purba Digirpar	32.90	31	31	1949	5621	5512	11133	338
Paschim Digirpar	25.14	19	29	1868	5625	5577	11202	446
Kanaighat Upazila								
Charkhai	36.65	25	46	2769	9177	8956	18133	495
Sheola	29.52	14	15	2070	7128	6870	13998	474
Beanibazar Upazila								
Total :	390.00	214	407	35512	110206	107480	217690	558

Source: BBS (1985, 1989) and Upazila Office)

significant variation in population densities between highland and lowland areas. Population density is 558 persons/km^2, compared to 445 persons/km^2 in the Sylhet District. Although the project area is more densely populated than other areas of the district, it is less densely populated than the national average which is 605 persons/km^2 (BBS 1985). The exponential growth rate is 3.2 percent and the total population in 1991 was estimated to be 290,000.

In 1984 there were 35,512 households in the project area and the average household size was 6.1 (Table 5.50) compared to 6.0 for the district and 5.7 for the nation (BBS 1985). There are only seven tribal households in the project area (BBS 1985), but none are living near the banks of either the Surma or Kushiyara rivers. Muslims constitute nearly 83 percent of the total population, while Hindus, both caste and scheduled caste, constitute 17 percent compared to 12.1 percent nationwide (BBS 1990). There are virtually no Christian or Buddhist communities in the project area.

There are 407 villages distributed in 214 Mouzas. Mouza boundaries are fairly clear, marked by paddy fields, plots, homesteads, and cultural sites. Village boundaries are not clear as one village fades imperceptibly into the next. Villages, however, are a geosocial entity to which villagers have a strong affiliation. In any discussion relating to flooding, erosion, waterlogging and drainage congestion, villagers immediately refer to problems of their respective villages.

Settlements are mostly concentrated along the side of river banks in a linear-linking pattern. Settlement along beels and haors is primarily circular, but is dispersed in the highlands. Highland houses are built in small clusters, often several hundred yards from another house. Homesteads or residential areas are usually located on higher mounds above the normal flood level. Betelnut trees, bamboo and various indigenous plants usually grow in these settlements. Different types of fruit trees and vegetables also are grown in and around homesteads.

Travel into the project area originates in Sylhet town either on paved roads or on river transportation. Inside the area are the Zakiganj-Atgram, Shahbag-Kanaighat and Charkhai-

Sheola roads as well as many village paths that crisscross the area and intersect khals, beels and swamps. During severe flooding, when lowlands are inundated, the area transforms into small islands. Small boats then become the primary transportation mode. At other times, people either walk or use local transportation. In Kanaighat Upazila, boats provide primary transportation throughout most of the year.

Of the 34 market centers in the area, Kaliganj, Chagli, Zakiganj, Kanaighat and Beanibazar are the largest (Figure 5.21). A few government offices and educational institutions are located near these large markets. These centers are effective meeting places because they are geographically and socially central to some 50 to 60 villages and because they are an important link between villages and urban society. The five large markets meet almost daily, while smaller ones meet twice a week.

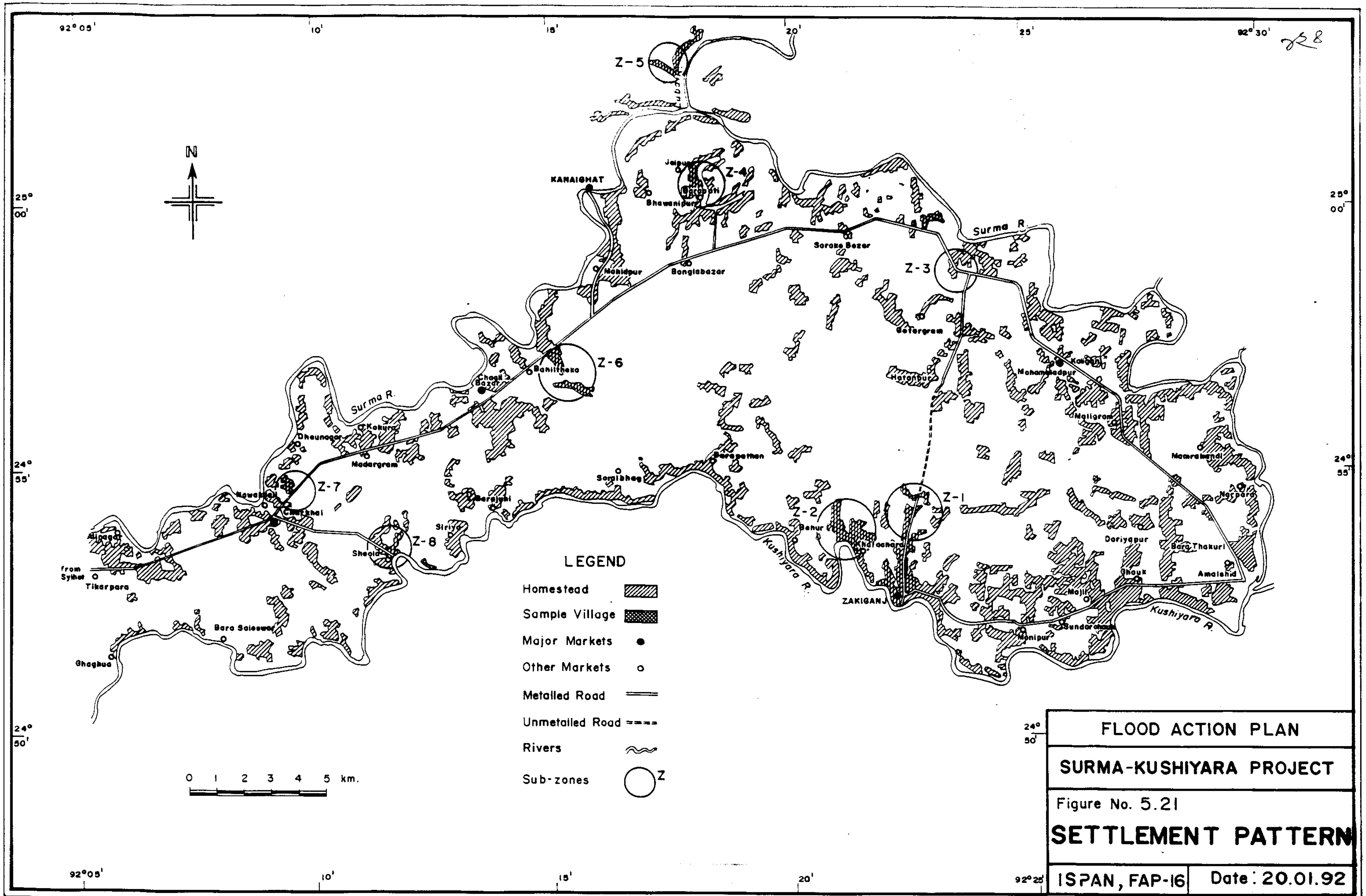
5.5.2 Livelihood and Subsistence

5.5.2.1 Agriculture

About 85 to 90 percent of the population depends directly or indirectly on agriculture as their main source of livelihood. Rice is the main food crop and betelnut the main cash crop. There is no factory or industry in the project area and, hence, few job opportunities exist outside agriculture. All the usual government services are available in the Upazila headquarters and in the five large market areas.

Agriculture employs many men and women, although women are only minimally involved in the labor market. Fishing, the principal occupation of nearly six percent households, is the second most important occupation. Only a few households derive their livelihood from employment in the public sector. Businesses, including petty trading and shop-keeping, constitutes the main occupation of a very few people.

Despite the importance of agriculture, villagers believe it has stagnated. Low agricultural productivity, an inequitable and retrograde land system, and flooding severely hamper development for the area. Farmers cannot afford and do not have access to many modern cultivation techniques and methods. Use of fertilizers (mostly urea, 5 to 6 kg per 0.11 ha or 1 kear) are limited and pesticides are often not finally available. Crops are mostly irrigated by traditional



FLOOD ACTION PLAN

SURMA-KUSHIYARA PROJECT

Figure No. 5.21

SETTLEMENT PATTERN

ISPAN, FAP-16 | Date: 20.01.92

methods e.g. *seuti* and *doon*. Irrigation by power pumps and deep tubewells is rare.

Family members are the primary laborers and crops are grown primarily for family consumption. Wage laborers are hired during peak season (January, March, July, August and December), but rarely other times of the year. Most of the landless and land-poor remain unemployed outside the peak season. The majority of the poor are employed as day laborers on large and medium farms. The daily wage varies between Tk. 40 and 60 (without food) during the peak season, and between Tk. 25 and 35 (with food) during the lean season. It is also common for laborers to be paid in advance for their work. Four to five days advance pay for peak season labor will bring Tk. 100.

While the area has an abundant labor supply, increasing poverty and population growth prevent the agricultural sector from absorbing the growing labor force. This situation is further compounded by a lack of non-agriculture employment opportunities. Only a few people are engaged in boat-making, carpentry and manufacturing work. Very few women are in the labor force and their non-agricultural income-generating activities are also extremely limited. Women generally do not work in the field.

5.5.2.2 Fisheries

Fishing-related activities employ about 11,400 people in catching, selling and trading in Zakiganj Upazila. According to the Upazila Fishery Officer, there are 1032 households (4 percent) in Zakiganj Upazila involved in fishing as a primary occupation, and many more are engaged in part time fishing to supplement income and to provide food for the family. In addition, some people participate in a specific type of fishing only once or twice a year. Most fishermen use different types of fishing nets, gears and small boats in their trade.

Most fishing takes place in open waters such as haors, baors and khals. But some closed water culture fishing is done in ponds, tanks and ditches. According to the Upazila Fishery Officer, there are about 80 *jalmahals* and nearly 9000 ponds, tanks and ditches in the project area. Sixty of the 80 *jalmahals* cover up to 8 ha and the rest are larger. The *jalmahals* and adjacent inundated flood plains are the main source of open water fishery. There are no large spawning grounds within the project area, but there are some mini-hatcheries in Khalachara Union which provide fry for pisciculture.

Fishing occurs year round, but the peak season is between November and February when water of beels and haors recede. During rainy season (April to July), fishermen fish on the edge of flooded beels and haors. But they are often frightened away, however, by hired guards known as parials. Parials are hired by those who hold the lease to the water body, the *mirajdar*.

Many villagers, including fishermen, report that Parials prevent them from fishing even in the inundated plains adjacent to the beels and haors. The Parials not only take away fishing nets and other equipment but physically assault fishermen if they have fish in their possession. Sometimes fishermen are taken to the *mirajdar's* home and held captive for several days. The fishermen are allowed to go if they declare they will not fish again in the inundated plains where they were caught.

Traditionally, fishermen used to fish freely in various khals, beels and water bodies but now believe fishing as a vocation is uncertain, partly due to a reduced number of free fishing areas and partly to the rising costs of fishing equipment. A fishing boat and nets costs nearly Tk. 3000 - 4000, much more than most fishermen can afford.

In addition, if a fisherman wants to legally fish on the edge of flooded beels, haors and khals, he must pay the *mirajdar* between Tk. 200 and 300 per month. Similar rules also apply to fishing in large canals and rivers. Rates vary according to size and location of the spot.

There are few places, therefore, where fishermen can fish freely. Under the *Jalmahal* leasing arrangement, any area up to 1.2 ha should not be leased, but should remain under the Union Parishad Chairman's management for use by the common people. In reality, however, the Union Parishad Chairman often leases areas under 1.2 ha to close associates. Beels and *jalmahals* between 1.2 and 8 ha are managed by a committee headed by the Chief Executive of the Upazila, while those more than 8 ha are leased by a district level committee headed by the Additional Deputy Commissioner (Revenue).

Jalmahals usually are leased for an initial period of three years, but frequently are extended up to 12 years. There is a 25 percent leasing rate increase provision to be considered after each three years of a lease. Lease holders petition, however, for an extension of old rates on pleas of excessive flooding, siltation and decreasing numbers of fish. If the extension is not granted, the petitioner takes the issue to the court. The cases run for several years and if the court grants an injunction for status quo, the lease holder will continue leasing at the old rate. Thus, the government loses higher revenues until the case is settled.

Fishermen Cooperative Societies are supposed to get preference in leasing *jalmahals*. They are usually, however, allotted to individuals outside the fishing community. Field studies reveal that most of large beels and haors, such as Balair Haor, Andhu Beel, Chunia Beel and Dubail Beel, are leased to large land owner-cum-businessmen who live away from the area. Many of the lease holders are Chairmen or Members of the Union Parishad. Fishermen cooperatives often exist in name only and are controlled by the rural rich who favor non-professional fishermen.

Under the existing system, the Bangladesh Department of Fisheries is involved in leasing only and not in enforcement of leasing rules. Although the law does not allow year-round fishing in the *jalmahals*, the lease holders often fully drain the area by erecting temporary bandhs or barricades and then catch all the fish. Such action creates irrigation problems resulting in conflicts with agriculturalists and reduction in fish populations.

According to the Upazila Fishery Officer, the project area was abundant in fish resources 10 years ago. Now fish availability and the supply of fish has been reduced because of the following:

- About 30 to 35 percent of beels and haors are silted up due to excessive flooding and sedimentation.
- Population pressures have turned many areas adjacent to beels and haors into

agricultural fields.

- Over fishing, harvesting undersized fish and loss of fish habitat are reducing fish numbers.
- Unregulated and indiscriminate fishing, including the use of "current nets" (very fine mesh made of nylon thread placed against water flow for trapping fish fry and fingerlings) by non-professional fishermen, is reducing the number of fish.
- Fish diseases and water pollution threaten fish.
- A lack of culture fisheries and fish stocking facilities prevent restocking.
- Lack of interest in aquaculture slows fishery development.
- The lack of a systematic development plan for *jalmahals* and various water bodies slows fishery development.

There are two important fish marketing channels: One is when fishermen sell directly in the local market, and the other is when the lessee sells directly to their favored intermediaries. The intermediaries use two or three middlemen in the process which help them earning profits with practically little or no physical labor and transportation cost involved in fish marketing. During fishing season (November through January), temporary wholesale fish markets are opened near fishing sites. At these sites, genuine fishermen buy some fish from the lessees and then sell them in the local market at a nominal profit margin (Tk. 3 - 4 per kg).

About 60 percent of the catch, especially the larger fish, is transported by middlemen to India and exchanged for rice, sugar, spices, clothes, medicines etc. a business known locally as bungari. The lessees and their intermediaries, thus, make substantial profits compared to their actual investment.

5.5.3 Gender Relations

Due to increasing landlessness, poverty and migrating males the position of women in Bangladesh has undergone some changes in recent years. A far greater proportion of women are involved in the labor market and in on- and off-farm income generation than in the past. This trend is much less apparent in the Surma-Kushiyara case study area, which is characterized by conservative cultural values, strong religious feeling and a continuing commitment to family and kinship ties. Seclusion of women is maintained, and with few exceptions women carry out their traditional roles as wives and mothers.

Other than a few poor women involved in domestic work and about 25 widowed women working for the CARE Road Maintenance Program (RMP), very few women are in the labor force. Even women who head their households survive by taking assistance from their neighbors. Women are not employed on Upazila embankment maintenance or drainage improvement schemes under the Food for Works Programme. In addition, women in the area do not appear to benefit from post-harvest work, such as rice husking. Although commercial rice mills in local markets are on the increase, the movement of rice from India appears to be the main reason. Some poorer women stated that they would like paid employment, but that there is none available.

Women's mobility is limited and their tasks confined to the homestead. Even fuel is mostly collected by men and children. Their involvement in homestead production is limited, but some plant vegetables and rear poultry for consumption or sale. Betelnut and banana are a major source of income, but women are not involved in planting trees. Managing of homestead tasks is done by both husband and wife, but because women do not go to the market, men control family finances. Women say that they would do more home gardening, poultry and livestock raising, if constant flooding did not damage vegetables and livestock. Neither they nor their husbands are receiving the benefits of extension services, such as poultry vaccination and veterinary services.

Few women in the study area own land or engage in active income generation other than limited making or mending of fishing nets and equipment, and mat-weaving. Due to lack of purchasing power, there is little local demand for craft products. *"Patipata"*, the plant used to make mats, abundant ten years ago in the homesteads, is particularly susceptible to flood damage, and now has to be bought in the market.

Grameen Bank, operating in four Unions of Zakiganj Upazila, is providing credit to landless women's groups for poultry, fishing equipment, and handicrafts production. As a first-time one-year loan women receive Tk.2,500-3,000 and have to repay at the rate of Tk 50-60 per week. A woman can expect Tk.12 per day from selling eggs, if she has about a dozen chickens or ducks. Grameen has flexible repayment arrangements after natural disasters and give advice on how to manage poultry during floods. Grameen staff also assist with record keeping.

The literacy rate for women is probably less than 10 percent compared to 20 percent for men. Nevertheless, there has been some improvement in female education. Ten years ago few girls went to school. Now at Primary School level the enrolment of boys and girls is almost equal. In Zakiganj Upazila out of 19,928 students at primary level, 10,928 (55 percent) are boys and 9,031 (45 percent) are girls. Village women said that all but the poorest sent both boys and girls to school. However, because the national dropout rate of girls in primary school is more than twice compared to that of boys, no firm conclusions on levels of attendance can be reached without further investigation. (Task Force 1991)

Superstition and religion are the primary reason most girls are withdrawn from education at puberty. Very few attend Secondary School. There are very few professional women, most of whom are involved in primary school teaching. For example, 20 of the 40 female primary school teachers in Zakiganj Upazila are local women.

Although a considerable nutritional deficiency exists among the poor, it appears that girls in the project area are not as discriminated against in terms of access to food and medical care as in other areas of the country.[1] This is borne out by the male/female ratio population figures. The most likely reasons for low ratios of females in the population are neglect of infant daughters and high maternal mortality. The 1981 Census shows that the male/female ratio of the population In Zakiganj Upazila is 103 males to 100 females, compared to 106 males to 100 females in Bangladesh as a whole (BBS 1985).

Average age of marriage, proportion of marriages registered, and rate of divorce and abandonment, are key indicators of women's status and quality of life. The divorce rate is also an indicator of social stability. The average age of marriage is 14-15 for girls and 18-20 for boys. As in other areas, poorer families suffer from having to pay high dowries. Although for a poor family dowry consists only of gifts, such as household goods and furniture, payment is difficult. However, the majority of Muslim families, even in remote areas, register their daughters' marriages. The amount of dower to be paid by the husband is recorded and registration acts as a safeguard against marriage breakdown.

Research has shown there is a positive correlation between poverty and incidence of divorce and abandonment in times of food scarcity among the poorer classes (Chaudhury and Ahmed 1980). The fact that the families try to protect their daughters' legal rights to some extent, taken together with the maintenance of strong religious values and the extended family system in the area, may explain the low divorce rate of approximately 5 percent and the fact that the incidence of violence against women and abandonment of women are comparatively low.

It is unlikely that the officially recorded 20 percent of Zakiganj families said to be using temporary or permanent contraception, are actually using it. Average household size is 6.1, a figure greater than the national average. (Section 5.5.1.) Some women said that they were aware of family planning (FP) but had no access to contraceptive supplies and FP services. Family planning services suffer from inadequate staff and housing. There are three understaffed Union Health and Family Welfare Centers operating in Zakiganj Upazila (3 more are under construction). Only two have family welfare visitors (FWV). Upazila FP Officers said that recruitment of Family Planning staff is problematic. Women do not come forward because such employment is regarded as unacceptable in a conservative community.

Likewise, maternal and child health care provisions are inadequate due to staff shortages and lack of medical supplies. Women forgo services, or the family forbids them to seek help, in favor of traditional beliefs. Fifty percent of those who do attend prenatal clinics drop out after the first visit. The problem is worsened by the shortage of FWVs who play an important role in training traditional birth attendants (TBA). There are not enough trained FWVs and TBAs to aid rural women who typically bear children too early, too frequently and too closely spaced.

Another key indicator of women's status is their decision making role in the family. Women in the area hold a subordinate but not insignificant position in family decision making. Most women said that they were always consulted in family decisions, but the final decisions were

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*1 A recent UNICEF survey of Bangladesh showed that 59 percent of girls and 56 percent of boys suffered chronic malnutrition, while 10 percent of girls and 7 percent of boys suffered acute malnutrition (UNICEF 1987).

made by their husbands or male relatives. Only 2 groups offered a different response. In one village women said that they were not consulted at all and, in another, a widow living with her brother said she made all household decisions.

In general, the sociocultural environment restricts women's mobility, but appears to offer them some protection. This may not, however, hold true for the 2 Unions of Khanaighat Upazila, also a conservative area. In these 2 unions it is said that only 2 percent of girls go to school. The average age of marriage for girls is 12-15 and 25-28 for men. Divorce is reported to be 35 percent among the poorer classes, and remarriage and polygamy are common. An Upazila Officer reported that 20 percent of court cases involved rape.

The reasons for this very different picture in two Unions may be that many young men migrate abroad looking for work. This inevitably leads to disruption of family life. Also poverty undoubtedly plays a role in polygamy. The proportion of teenage girls to eligible young men is high. In communities where marriage breakdown is common and females are seen as a burden, the family does not have to pay dowry for their daughter's second or third marriage. Nonetheless, the labor of second and third wives is undoubtedly of economic benefit to the husband's household.

Although women in the case study area are not involved in the gathering of fuel outside the homesteads, it is obviously a matter of concern to them when fuel is scarce. A major source of fuel for landless and marginal families in some areas is *dholkolmi*, a plant which grows abundantly on the edge of water bodies. But the burning of this plant is said to cause respiratory problems. In those areas where this plant is not available households have to buy fuel from the market. This is a major item of expenditure for poor households. At the time of field work in late October some families were paying between Tk. 2-3,000 per month.

Women in the project area suffer particularly at times of flood. During the recent flash floods there was up to 4 feet of water in their houses. Many families had to leave their homes and take shelter on high ground, or built platforms to live on until the water receded. Women mentioned difficulties in living conditions and sleeping arrangements; lack of water, food, fuel and fodder inability to wash themselves or their clothes; serious illness and health risks, (one woman was in an advanced stage of pregnancy); lack of flood shelters and medical help; damage to houses; loss of animals, poultry, trees and vegetables. Some families lost everything including their homes. A whole village has eroded away over recent years and the displaced inhabitants, who were Hindu, emigrated. The women from this community were thus unavailable to describe their experience.

5.5.4 Land Ownership, Tenancy and Credit Relations

All land in the project area, excluding *jalmahal* and *khas* land, is privately owned and there is no notion of communal or corporate type of ownership. Very little common property resources are available. Even the khals, narrow streams and water bodies up to 1.2 ha which are supposed to be unleased are not available for use by the common people. Roadside common property resources are used mostly by the people whose lands are adjacent to the road. Land is considered as the most valued possession in the society. The larger the amount of land owned, the higher is the status of an individual.

The land ownership distribution pattern in the project area is less equal than in Bangladesh as a whole in that at one end of the scale there are few households who control much of the land, while at the other end there are many who either own little or no land at all. Table 5.51 presents data on the classification of households in Zakiganj Upazila according to land ownership and farm size distribution by operated area. Similar data on the four Unions of Kanaighat and Beanibazar Upazila could not be presented as they were not available. The data in Table 5.51 will, however, give an indication on the pattern of distribution of land ownership in the whole area, as Zakiganj Upazila constitute nearly 70 percent of the total project area.

Table 5.51. Distribution and Classification of Farm Sizes by Net Cultivated Area: Zakiganj Upazila.

Farm Size Grouping (ha)	Percent Households	Total	Total cultivated Area ha	Percent
Between .004 to .016 ha	13.3	3570	18.30	0.1
" .020 to .198 "	25.3	6807	171.27	1.0
" .202 to .400 "	11.2	3014	443.25	2.6
" .404 to .603 "	11.5	3069	1016.13	5.9
" .607 to 1.00 "	12.9	3460	2160.66	12.6
" 1.01 to 3.03 "	21.4	5753	8287.05	48.4
" 3.04 ha & above	4.4	1183	5030.66	29.4
Total	100.0	26856	17127.32	100.00

Source: BBS (1989)

It is evident from Table 5.51 that although there are few (only 4 percent) large land owners owning 3.04 ha and above, they command nearly 30 percent of the total cultivated area. On the other hand, a little over 74 percent of the households own between 0.004 and 1 ha and their farm land commands only 22 percent of the total cultivated area. It is further evident from the table that about 50 percent of the households own less than one half of a ha, but they claim only tenuous hold on the land. On the other hand, there are some large land owners owning over 12 ha in every village who exercise considerable political and economic power in the locality. The overall ownership pattern also shows the highest proportion of ownership of land by the large and medium land owners.

Thus, the distribution of land ownership in the project area is highly skewed. The Gini ratio (GR)[1] calculated from this ownership distribution provides an inequality coefficient of 0.59.

[1] The Gini coefficient or concentration ratio (CR) is the most popular measure of wealth/income inequality. The Gini coefficient is derived from the Lorenz curve, which shows the cumulative percentage relationship between land area and households.

The high degree of inequality is therefore evident. The Lorenz curve[1] in Figure 5.22 shows the degree of inequality in the distribution of land ownership in the project area.

As regards tenurial status of farmers, three distinct categories have been identified. They are: (1) owner-cultivator (one who cultivates his own land only), (2) owner-cum-tenant cultivator (one who cultivates his own land plus rent in some from others), and (3) tenant cultivator (whose entire holding is rented under different contractual arrangements). The exact number and percentage of households falling into each of the above mentioned categories could not be ascertained. However, the data obtained from the Upazila Agricultural Officer indicate that about 60 percent of the farmers are owner-cultivators, 30 percent are owner-cum-tenant cultivators, and only 10 percent are tenant cultivators.

This seems contradictory to the data presented in Table 5.51 as well as the data in the Feasibility Study of 1973. The Feasibility Study shows the same farmer category to be 82, 17 and 1 percent respectively. However, if the Upazila official level information could be compared with the Feasibility Study findings, then it would indicate that the percentage of owner-farmer categories have decreased, while the percentage of owner-cum-tenant and tenant farmer categories have increased within a span of last 18 years. This would support a trend towards some kind of polarization and marginalization process as well as a gradually deteriorating equity situation in the project area.

An active and non-formalized tenancy market exist in the project area with 'share cropping in or out' as the predominant form of tenancy, accounting for nearly 80 percent of the total rented land. The other type of tenancy arrangement is 'renting in or out' on payment of a fixed amount of rent to the land owner at the beginning of the cropping season. As elsewhere in Bangladesh, the small and marginal farmers are net leasers in of land, while large farmers are net leasers out. The contractual arrangement under both types of tenancy is fully verbal and is highly insecure.

Under share tenancy (locally called Bhagi) the contract is generally for one cropping season, but may extend further, with an agreement that the gross produce will be divided equally on a 50-50 basis (adha-adhi bhag) between the land owner and the tenant if the land is cultivated on a traditional method. But if the modern inputs, such as the chemical fertilizers and pesticides are purchased or pump irrigation is used on rental basis, then the gross product will be divided into three equal shares, the third share being given to the person who (land owner or tenant) pays for the input.

The system of renting in or out (locally called Pattani) is that under it the tenant has to pay a certain sum of money to the land owner irrespective of the output he produces on the land at any given season. The rent is generally fixed for one year and renewed in the subsequent year or years subject to the fulfillment of the conditions that the owner receives the cash in advance. The rental rate varies depending on the type, quality and location of the land. In the highland areas, the rent varies from Tk.1,000 to Tk.1,200 per 0.11 ha (or 1 kear, which is equal to 28

1 The Lorenz Curve is a graphic method of studying the degree of inequality in distribution of wealth and income. It is a cumulative percentage curve in which the percentage of items is combined with the percentage of other things as wealth.

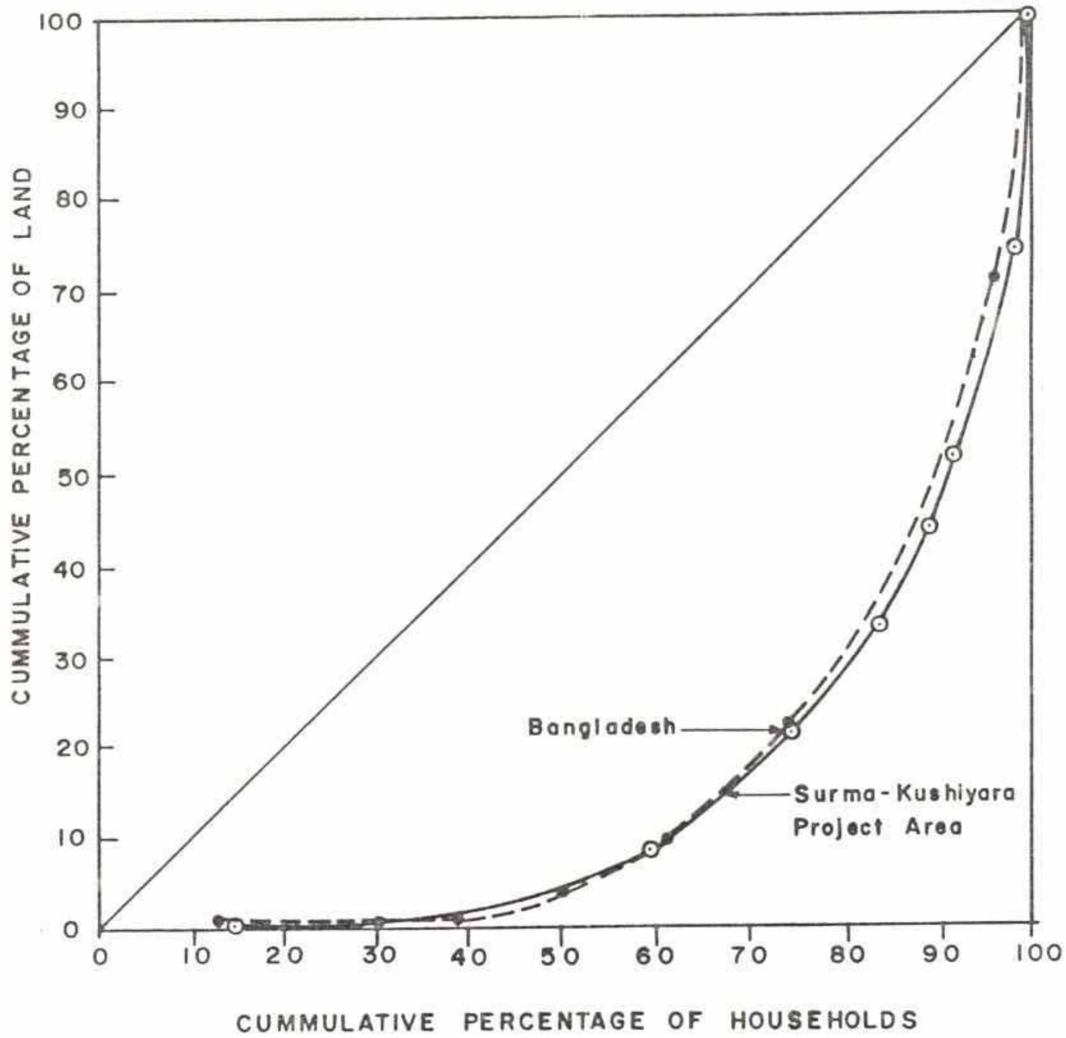

Figure 5.22 Lorenz Curve for the Surma-Kushiyara Study Area.

decimal), while in the low lands the rate varies between Tk.400 and Tk.600. The very best lands are rented out for Tk.1,500 to Tk.2,000 per kear where at least two crops can be grown. The large land owners generally rent out the medium and low lands on crop sharing or cash rental basis and cultivate the high lands by hired labor.

In the project area with all crops, except the little grown HYV paddy, the tenant provides all inputs (seed, cattle and labor). The main constraint to taking land on sharecropping and cash rental basis is access to draught power and credit. Most of the farmers who lack credit, they borrow money at a very high interest rate. For example, if Tk.100 is borrowed in the lean season, 2.5 kathi paddy (equivalent to 42 kg) is to be paid after harvesting of crops. This means that for every Tk.100 borrowed, the borrower has to pay Tk.250-300 within a period of 3-4 months. Advance sale of crops before harvesting (Dadan) is also done by small and marginal farmers at a very low rate of payment in distress situations.

Credit is obtained mostly from non-institutional sources than institutional sources. Institutional sources include Krishi Bank, Grameen Bank, BRDB cooperatives and some scheduled banks. Non-institutional sources comprise mainly of moneylenders, traders, shop-keepers and large land owners. There is no professional moneylender in the project area, but there are some households who combine money lending with other activities. Relatives, friends and neighbors often help each other by providing smaller loans (say Tk.50 - Tk.100) for which no interest is charged. But, for bigger loans, friends and relatives do charge interest on relatively softer terms with the understanding that the same will be reciprocated in the future.

Although there exist a land market in the project area, land is not exchanged freely as a commodity. Land is generally sold by small land owners in distress situations and is usually purchased by large and medium farmers. The price of land per ha varies from Tk.40,000 to Tk.55,000 for high land, Tk.15,000 to 25,000 for low land, and Tk.60,000 to 90,000 for homestead land. Five years ago the land prices were much higher. Now it is low primarily because of flooding, waterlogging and drainage congestion problems. Bandhak or mortgage of land also occurs at lower rates and land is mortgaged out primarily for family maintenance and debt repayment reasons. Under mortgage arrangement, the mortgagee gives a loan to the mortgagor against a collateral of land which the latter has the right to cultivate as long as the loan is not repaid. The usual rate of mortgage in the project area is Tk.5,000 to 8,000 per ha. The marginal and small farmers generally mortgage land for consumption, while the rich farmers to buy better land. The mortgage rate is also low due to flooding and waterlogging problems.

5.5.5 Distribution of Wealth and Equity

Land is the principal form of wealth in the project area, but its distribution is highly unequal. Data collected from two Union Parishad offices, namely Kajalshar and Khalachara, indicate that there are only 6-7 households in every village who control much of the land within the village, while on the other hand there are large number of households who either own very little or no land at all. In Kajalshar Union, for example, there are only 7 percent households who own nearly 50 percent of the land, while there are about 35 percent households who claim only a tenuous hold on the land. The percentage of landless household to the total households is also very high (nearly 50 percent). The preliminary findings of a Base Line Socio-economic Survey conducted in 1991 by FIVDB, a local NGO, in 22 villages of Kajalshar Union indicate the similar pattern of inequality in the distribution of land and other productive assets in the villages surveyed. Our discussion with the villagers also show that in every village there are only 5-6 households who own much of the land in that village. In Batoishail village of Barohal Union, there are, for example, 3-4 very large land owning families who control between 20 and 32 ha of cultivable land per family, which is roughly 40 percent of the entire land within that village.

This finding is consistent with the data presented in Table 5.50 which shows that only 4 percent of the total households in Zakiganj Upazila control nearly 30 percent of the land. The overall ownership pattern also shows the highest proportion (about 78 percent) of ownership of land by the large and medium land owners who constitute nearly 26 percent of the total households. Thus, a little more than a quarter of the households control above three-quarters of the land, while nearly three-quarters of the households (who own between .004 - 1 ha) command less than one-quarter of the total cultivated area. On the other hand, the number and Percentage of landless households to the total households is high. Nearly 40 percent of the total households in Zakiganj Upazila are landless in functional terms, if we consider functionally landless households as those households who own some land but no more than .20 ha (Table 5.51). This data is obtained from the 1983-84 Agricultural Census Survey of Zakiganj Upazila.

Although no detail household survey was conducted for this study, data collected from various social categories indicate that nearly 60 percent of the households are landless in both absolute and functional terms. Absolutely landless households are those households who do not own any land, either homestead or agricultural. Functionally landless households are those households who own some land but no more than 0.20 ha. In every villages we talked to villagers, especially the small and marginal farmers, we were told that their economic condition has worsened during the last 8-10 years. Given such a worsening situation, it would not be unreasonable to assume that a large number of households in the project area have become poorer day by day which eventually led to their increasing landlessness. Several reasons have been attributed by the villagers for their increasing poverty and landlessness. The most important among these are the selling of land in small bits to cover up economic loss due to flooding, waterlogging and erosion problems. Other reasons mentioned are family maintenance and debt repayment, which lend support to the depth and dynamics of poverty in the project area.

The implication of such a situation for the distribution of wealth and equity is fairly clear. A few large land owners who already own a disproportionate share of land are accumulating more and more of it, while the marginal and small farmers who own very little land are continuously losing parts of whatever small amount they have. This indicates that more and more households are joining the ranks of landless as time passes on. The problems of poverty and landlessness are further compounded by the fact that such an increase have not been matched by an increase in employment opportunities. Section 5.5.2 shows that there exist serious scarcity of employment in the project area. Furthermore, since practically little or no employment opportunities exist outside agriculture, the landless and land poor households are saddled in a situation where a slight misfortune, such as those caused by flooding or other natural calamities, could seriously jeopardize their chances of survival.

Additional evidence on the distribution of wealth and equity situation could be provided by looking at the patten of income distribution. But time did not permit to collect such data by household survey. Field level information, however, suggest that the distribution of wealth and (hence) income is far from equal. A significant concentration of income could thus be obvious since productive resources are concentrated in few hands. Inequality in the distribution of agricultural income could also be caused by an inequality in the distribution of land ownership. Since large land owners diversify their income in the sphere of exchange, their non-agricultural income from various sources such as business, shop-keeping, petty-trading and *jalmahal* leasing simply add to the process of larger concentration of income in their hands.

On the other hand, the large number of landless and land poor households who have little sources of income and hence very meager or no savings at all barely eke out a subsistence which is close to destitution. Majority of them depend on the large land owners for employment and for obtaining land on a sharecropping basis, which often binds the former to the latter in a situation of domination and dependency relationship. This relationship is expressed economically through the receipt and payment of rent and politically through patronage and clientelism, in which the large land owners operate as patrons and their single or several individual followers as clients. The dominant economic and political position of the patrons also affords them more of an opportunity to act as mediators or brokers between the village society and the larger polity.

5.5.6 Education and Awareness

Access to education is of primary importance in the development of any community, but there are a number of constraints to access in the Project area. These are 1) socio-economic, 2) socio-cultural, 3) institutional, and 4) physical. The level of functional literacy in the Project area is low. In Zakiganj Upazila the literacy rate is estimated to be about 15 percent for both sexes, 20 percent for male and 10 percent for female. The literacy rate recorded in the 1981 Census is 21.7 percent for both sexes (BBS 1985). If the current estimated figures are correct, there has been a marked decrease in literacy over the last ten years.

There is an awareness of the importance of education in the Project area. All social categories in the villages said that their children went to school, except for the very poorest. Nevertheless, the reality is that children make an important economic contribution to poor households. Although Primary Education is free, the cost of clothes for their children may be beyond the means of very poor families. At Primary school level enrolment of boys and girls is almost equal. (Section 5.5.3.) Non-attendance and drop-out rates are about 30 percent. Ten years ago few girls attended school, but now attendance of girls is said to be higher at primary level than that of boys.

A shortage of high schools and poverty are the major obstacles to attendance at high school. There are only 15 high schools in Zakiganj Upazila. Only about 50 percent of those who pass at primary level go on to high school and 50-60 percent of those who do attend high school drop out before completion. The higher involvement of girls generally ceases at puberty for superstitious and religious reasons, but the recent introduction of free schooling for girls from Class 6-8 is having an impact on attendance in the 10-12 age groups. Very few girls complete high school.

The general belief is that girls do not need education after 12 or 13 years old and parents disapprove of the co-education system. But there are exceptions and some parents are in favor of education, such as the wife of a medium farmer who proudly declared that all her daughters went to school and her eldest daughter had now reached Class 9. Those that complete their secondary education tend to become primary school teachers. Only 40 of the 297 primary school teachers in Zakiganj Upazila are women and only 20 of these are local women.

Shortage of staff is a matter of concern to local education authorities. For example, there are 113 primary schools in Zakiganj Upazila. About 19,928 children are enrolled, an average of 176 students per school. About 40 schools have only 2 teachers, so the Teacher-student ratio of 1 : 88 is high, even when the double shift system is taken into account. School buildings are insufficient in number, existing accommodation needs repair, and furniture and equipment is lacking, so the educational environment is far from ideal.

Lack of communications during the monsoon season is a problem near the *Haors*, and in Biresri and Kazalshar Unions, and children do not regularly attend school. In one village in Barahol Union, parents talked of the difficulties children face getting to school. The school being a mile from the village, "the children have to swim to go to school".

Non-formal adult education is absent in the case study area, although the NGO, FIVDB, is carrying out a baseline in Kazalshar Union with a view to establishing a comprehensive human development programme there. Awareness of those who have received a minimum of formal education may be extremely uneven. Highly developed knowledge of environmental resource management may exist side by side with almost total absence of knowledge of the environment in other aspects. For example, on the one hand, farmers maintain a traditional form of cropping practice well suited to survival in a flood prone area, and are quick to respond after flooding with appropriate measures to rehabilitate their crops. On the other, there is no understanding of the relationship between contaminated water and disease, so insanitary habits continue and basic measures for safeguarding health are not practiced.

The reason for this disparity may be that rural people's knowledge is gained from direct observation, while microscopic infections and the spread of disease are more difficult to comprehend (Chambers 1983). In rural communities where illiteracy is high, superstitious beliefs play an important role in daily life, particularly for women, and may have profound implications for their health and wellbeing (Blanchet 1984). But illiteracy is not the same as ignorance. In group discussions, it was apparent that poor villagers have a very clear understanding of local power structures, and the mechanisms by which the rich and influential control and manipulate natural resources for their own benefit.

5.5.7 Health and Sanitation

The field study indicates that the project area conforms to national seasonal trends for diarrhoeal and respiratory diseases. Typically both types of illness 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 mentioned in virtually all villages visited in relation to flash flooding and post monsoon periods. Helminthiasis (infection by parasites of the worm type) is also common in the monsoon season. Surveillance is required to confirm the annual pattern in the project area to understand the role of rainfall and flooding in determining the incidence of disease.

Contaminated water is the primary cause of water-borne diseases, such as diarrhoea. There is roughly one drinking pump to 14 households or 85 people in the Project area. This implies that a number of families have either no access or limited access to safe water. This was confirmed during village level discussions. In 3 out of 10 group discussions where this question was raised, women said that they faced problems of access to safe drinking water. In one village it was said that there was no drinking pump; in another, that there was a pump, but that it was far away; and in a third access was limited by the family who owned it.

Existing pumps are may be for communal use or privately owned. Access to those pumps which are privately owned by better off families may be denied. Pumps may be located in the grounds of mosques, where woman do not go. Households which have limited access to safe water use pond water for drinking and domestic purposes. Surface water is subject to contamination by human and animal wastes and is totally unsuitable for drinking. Women who use pond water are generally not aware of the importance of boiling. Those who are aware often cannot do so because of lack of fuel.

The problem becomes acute during flash floods. Those without boats or the resources to make rafts often have no access to tubewells. Water from submerged tubewells is contaminated. In the most recent flash floods many families either took shelter on high ground or lived on platforms, and remained there for, 2 to 3 weeks. They were unable to store sufficient water for this length of time. In one location where flooding was extremely severe the entire village had to take shelter on the main road. People drank flood water, and we were told that 50 people had died from diarrhoeal and other diseases.

Lack or inadequacy of medical facilities is a matter of concern to many women, both in general and during flood emergencies. In 2 out of 3 villages visited which had access to a health center or complex, lack of confidence in the service was expressed by women. The fact that emergency medical teams had not reached them during the recent flash flood was raised by 4 out of 10 groups of women.

Groundwater is of very poor quality because of the high iron content. It does not appear that the industrial wastes discharged into the Barak River is polluting pond water at present, but if the present trend continues, chemical pollution may contaminate surface water in future.

Anopheles philippiensis, the principal malaria-carrying mosquito has been identified within the project area during research carried out under the FAP 16 Vector Disease Special Study Program. *Anopheles aconitus*, very recently identified as a malaria vector has also been found in Kanaighat Upazila. Both species were recovered in the November. Kanaighat Upazila Health authorities are aware that malaria is health problem. Malaria is prevalent during the monsoon season.

The location of these vectors within the project area is clearly troubling. Household spraying with DDT (in itself harmful) would be required as a mitigation activity should breeding sites increase as a result of an embankment. Mitigation against malaria may require substantial investments in improving the government's capacity to respond to increased vector populations.

Sanitation facilities in the Project area correspond to the national picture. Traditional habits of defecation are still being practiced. In Zakiganj Upazila only 1,000 out of about 30,000 households have water-sealed latrines, despite efforts locally to promote low-cost latrines. The transportation charge of nearly Tk.200 is a factor in the low take-up rate. Entrenched social attitudes may be difficult to change.

Parasitic diseases, such as hookworm and roundworm, are caused by lack of adequate means of sewage disposal, with consequent faecal contamination of soil. Infection is transmitted from the soil by penetration of the larvae through the skin. Helminthiasis is common in the area and is contributing to the overall poor health and nutritional deficiency of the local population.

The level of Public Health provision in the area is extremely low for the size of the population. According to the 1981 Census, in Zakiganj Upazila there is one doctor, one bed and one clinic available for every 27,204; 5,265 and 81,612 persons respectively. (BBS 1985) Family Planning and Maternal and Child Health Care provision is inadequate due to lack of staff, infrastructure and medical supplies. For example, although there are Health Complexes serving the Upazila towns, there are very few Union Health Centers for the outlying areas. (See Section 5.5.3) Child Immunization is estimated by health authorities in Zakiganj to about 33 percent and Primary Health Education is being undertaken in schools and madrasas.

5.5.8 Food and Nutrition

The findings of various studies on maternal and child nutrition in rural Bangladesh show that food intake and nutritional status varies according to crop cycle (BIDS 1990). Unsurprisingly, results show that incidence in malnutrition is higher among mothers and children from poorer households. These findings provide evidence to support the thesis that malnutrition is related to poverty. But nutritional deficiency is not entirely dependent on socio-economic status. Factors such as proper feeding practices and absence of infections -factors which relate to the physical environment, (availability of safe water, sanitation, medical facilities etc.,) - gender of the child, and level of education of the mother also play an important role (BIDS 1990). Thus, nutritional status is determined by a variety of complex factors which are generally related to level of education and awareness, and the ability of a household to access resources.

There appears to be less disparity in the nutritional status of boys and girls than in other areas. (See Section 5.5.3.) Normally in rural areas the food intake of pregnant women is governed by superstition. The FAP 16 Special Study on the Bio-diversity of Fisheries is currently undertaking a household consumption survey. This study will provide data on the distribution of food within the family, and the nutrition of expectant or nursing mothers and children under 2 years over the course of one year. Any disparity in food consumption on the basis of gender will be reflected in the findings.

The nutritional trend conforms to that normally found in rural areas. Average food intake is said to be 1,500 calories, which is well below the average requirement.[1] Nearly 90 percent of the population of the Project area are dependent on agriculture for their primary source of livelihood. The seasonal pattern of nutritional deficiency related to crop cycle is one of marked malnutrition during the monsoon season, when there is less availability of protein and vegetables. Nutritional deficiency heightens during the pre-harvest *lean season* in October or November and reoccurs in the *lean season* in March or April. The landless and land poor suffer most at these times.

The pre-harvest *lean season* in the Project area coincides with the late Flash Flood. Field work was carried out in the latter part of October just after a severe late flood and prior to the Aman harvest. Households from all social categories, apart from the very rich, suffered food deprivation during the floods, and then because of flood losses had to borrow money at high rates of interest or sell land to buy food. Some groups of landless and land poor described their condition at that time as near starvation.

A number of nutritious foods, such as vegetables, fruits, poultry and livestock products can be produced in the homestead. But the common consumption pattern reveals a lower intake of vegetables than in other areas. The major constraint on the cultivation of vegetables is repeated flood damage. Moreover, pulses an important source of protein, are very little cultivated locally.

For the population of the area the flood plains are an important environmental resource. Although there has been a reduction in capture fisheries for several reasons. There has been a depletion of natural fish stocks due to population pressure and blockage of fish migration by closing of major khals (Section 5.4.1.). Moreover, traditional fishing rights have been seriously undermined. Capture fishing in water bodies and adjacent flood plains is now strictly controlled by leaseholders (Section 5.5.2.2). Overfishing has intensified as large scale operators maximize their catches. The methods of traditional fishermen are environmentally sustainable. But the practice of leaseholders is to drain the water bodies to gain the highest possible yield, which is damaging to natural fish stocks.

Nevertheless, indigenous varieties of fish either caught or bought in the market are an important source of protein to many households. The FAP 16 Special Study is carrying out a pilot study in the case study area. Initial findings suggest that a large variety of species are captured and consumed locally by poor families from the onset of the floods until late November. The pilot study of school children indicates that locally caught fish are the primary source of food protein.

The peak capture fishing season is when the flood water is receding at the end of the monsoon. Access is determined by the degree to which flooded areas surrounding water bodies are controlled by local leaseholders. This varies from locality to locality. But many households regard capture fishing as their ancestral right, and despite risk of harassment or assault, fish secretly. From December capture of fish is reduced in part due to strict enforcement of leases and the

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*1 The minimum per capita caloric intake per day recommended by the Food and Agriculture Organization (FAO) is 2150 calories. (BIDS 1990) drying up of crop land and canals. In some areas fishing for home consumption continues throughout most of the year. The drying of fish and prawns commonly occurs. This ensures the nutritional benefits from local fishing are extended several months. Fish are also sold at area markets and by fish sellers going door to door.

While further information is needed on the price of fish compared to other principal sources of food seasonally, there are indications that the price of a kg of small fish during the peak capture fishing season is less than a kg of rice. In Kanaighat Upazila prior to the Aman harvest the price of locally caught fish in the market was Tk. 4-6/kg, whilst that of rice was Tk. 11/kg. Furthermore fishing is an important source of employment activity in some areas.

Nutritional benefits from these natural resources appear to modify the normal trend of seasonal nutritional deficiency, particularly in the post-flood and pre-harvest *lean period*. Thus capture fisheries plays an important role in cushioning the affects of poverty in the area. Long term impact assessment of seasonal consumption of fish in 13 Mouzas is under way as part of a FAP 16 Special Study Project[1].

5.5.9 Flooding and Local Communities

Baniya or *Pahari Dhol*, and *Barsha* are the names that villagers give for the two types of monsoon floods. *Baniya* occurs with heavy runoff from the foothills of Assam in April and May. *Barsha* occurs with incessant rainfall. The former is the shortest in duration, but causes extensive damage to crops and property. Many villagers consider the latter beneficial for productive crops and for soil fertility.

The villagers' perception that *Baniya* floods are worse than *Barsha* floods differs from some other areas of Bangladesh. Their fears are understood, however, when examining the devastation of the May 1991 *Baniya*. It was the worst flood that most villagers had seen. Older villagers compared it with a 1928 flood, but said the May 1991 Baniya was worse. The Sylhet BWDB office estimates that the May 1991 flood inundated about 80 percent of Zakiganj Upazila, 77 percent of Kanaighat Upazila, and 80 percent of Beanibazar Upazila. In some places flood depth ranged from 1.2 to 1.8 m (4 - 6 feet) for 8 - 10 days.

The flood damaged 100 percent of the broadcast aman, 76 percent of transplanted aman and 99 percent of the boro crop as well as seedbeds in Zakiganj, Kanaighat and Beanibazar Upazilas. The flood severely affected 80 percent of the villages. During floods people take shelter on higher grounds, camps and school compounds, and build macha to protect their families, livestock and other belongings. Standing crops are also damaged by seasonal flooding and drainage congestion. According to villagers, drainage congestion has increased during the last five to six years because of the outlet blockage of major khals; unplanned construction of roads, culverts and other infrastructures; and siltation. Consequently, about 25 percent of the area remains congested even during the dry season. Nearly 70 percent of the total area in six Unions (Khalachara, Barohal, Manikpur, Sultanpur, Birosri and Kajalshar) of Zakiganj Upazila remain waterlogged for five months (June through October). March and April rainfall also waterlog

1 Nutritional consequences of biodiversity in fish.

these Unions. In Charkhai Union, four villages (Pallyshasan, Mohanpur, Nauerchak and Kumrai) remain waterlogged for almost 12 months and 30 villages for six to seven months.

Such flooding and consequent waterlogging creates a severe erosion problem. Erosion continues throughout most of the year, but the most serious occurs in October and March. In Sheola Union at Sheola Bazar, Digholbag, Balinga, and Shaleshwar Bazar more than 10 ha of land has already eroded into the Kushiyara River. Erosion also occurs along the Surma and Kushiyara Rivers at 14 different points in Zakiganj Upazila: Bhaktipur, Rahimpur, Manikpur, Pillyakandi, Saiddabad, Gangajal, Rarai, Maizkandi, Baroban, Madarkhal, Baropathor, Chak, Zamdahar, and areas adjacent of Zakiganj town.

The most serious erosion in Zakiganj Upazila occurs at Amalshid in Barathakuri Union, Bhuiyamura/Hydrabond in Khalachara Union, and Ujirpur in Birosri Union. Field studies suggest that during the last 10 years about 200 ha of agricultural and homestead land have eroded in Zakiganj Upazila. Of that 200, 45 ha has eroded in Amalshid and nearly 60 ha in Bhuiyamura/ Hydrabond. This is further supported by a 1991 BWDB estimate that between 1960 and 1991 a total of 250 ha of land in Bhuiyamura and 100 ha in Amalshid eroded into the Surma and Kushiyara.

Erosion in Ujirpur and Madarkhal villages has displaced 15 households and partially affected as many as 50 households during the last 15 years. The entire village of Suprakandi, near Bhuiyamura, eroded away over the last 15 years, displacing all of its inhabitants. Erosion contributes not only to the process of landlessness but also to the loss of national territory.

The project area has no flood forecasting or Early Warning System (EWS), or strong erosion-protection measures. Many villagers believe that at the rate at which erosion is occurring, the map of the area, and probably of the country as well, will need to be redrawn.

5.5.10 Hazard Risks

The study area is subject to a wide variety of geophysical and man-made hazards. Out of all the hazards in the project area, flood is a recurrent and most frequent and devastating event. The Surma-Kushiyara project area is situated in the north eastern corner of the Sylhet district, which is within the zone of heaviest rainfall and prone to earthquakes which are further aggravated by anthropogenic factors. The seasonal pattern of hazard risks and their consequences in the Surma-Kushiyara project area is shown in Figure 5.23.

The study area is subject to the following types of hazards:

- Flash and seasonal flood
- Bank erosion and territorial loss
- Embankment/Dike breaching
- Hailstorm
- Cyclone/Tornado/Thunderstorm
- Sedimentation
- Water Stagnation

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- Degraded water quality
- Pests/Dholkolmi (Ipomoea)

Field observations revealed that the flood hazards and bank erosion are recurrent events in the project area. The nature, extent, duration and frequency of hazard risks and damage largely depends on land level. Flood affected area, duration, percentage of affected homesteads and people in the project area are indicated in Table 5.52. The types of loss or damage in terms of financial and social point of view can be categorized by direct or indirect and tangible or non-monetary (Table 5.53).

The average damage for a certain flood event which may be equalled or exceeded once in a period of 50 year project life has been estimated based on the expectancy of the extreme probability and the discharge-probability relationship (D=f (Q) curve). Here, damage (D) is the function (f) of total discharge for any flood event (Q). Table 5.54 shows the computation of average annual damage for different flood events (SARM Associates Ltd. 1973).

Hazard risks due to flash flood are most severe in the eastern part of the project area along the Surma-Kushiyara bank. Poor and landless people (this class constitutes 60 percent of the total households) along the river banks are vulnerable group, who losses their home and other properties substantially (See Human Resource Section).

5.5.10.1 River Bank Erosion and Embankment Breaching

River bank erosion and embankment breaching are observed in both Surma and Kushiyara. Erosion is more severe along the Kushiyara, particularly at Amalshid where the Barak's

Table 5.52. Extent of Flooding in Surma-Kushiyara Project Area in 1991.

Land Type	Area in ha (%)	% Homesteads Affected by Flash Floods	% Homesteads Affected by Seasonal Floods
High Land	13,831 (35)	80	50
Medium High	5,954 (15)	85	70
Medium Low	8,320 (22)	100	80
Low Land	10,895 (28)	100	100

Source: Field observations, October 1991.

bifurcation takes place and at Bhuiyamura of Kholachhara union. In 1991, there were 23 breach points along the Surma dike and 34 along the Kushiyara dike as reported by the local BWDB and Upazila Parishad officials. Dike breaching by location and area along the Surma-Kushiyara and their consequences are described in the Water, Land and Human Resources sections.

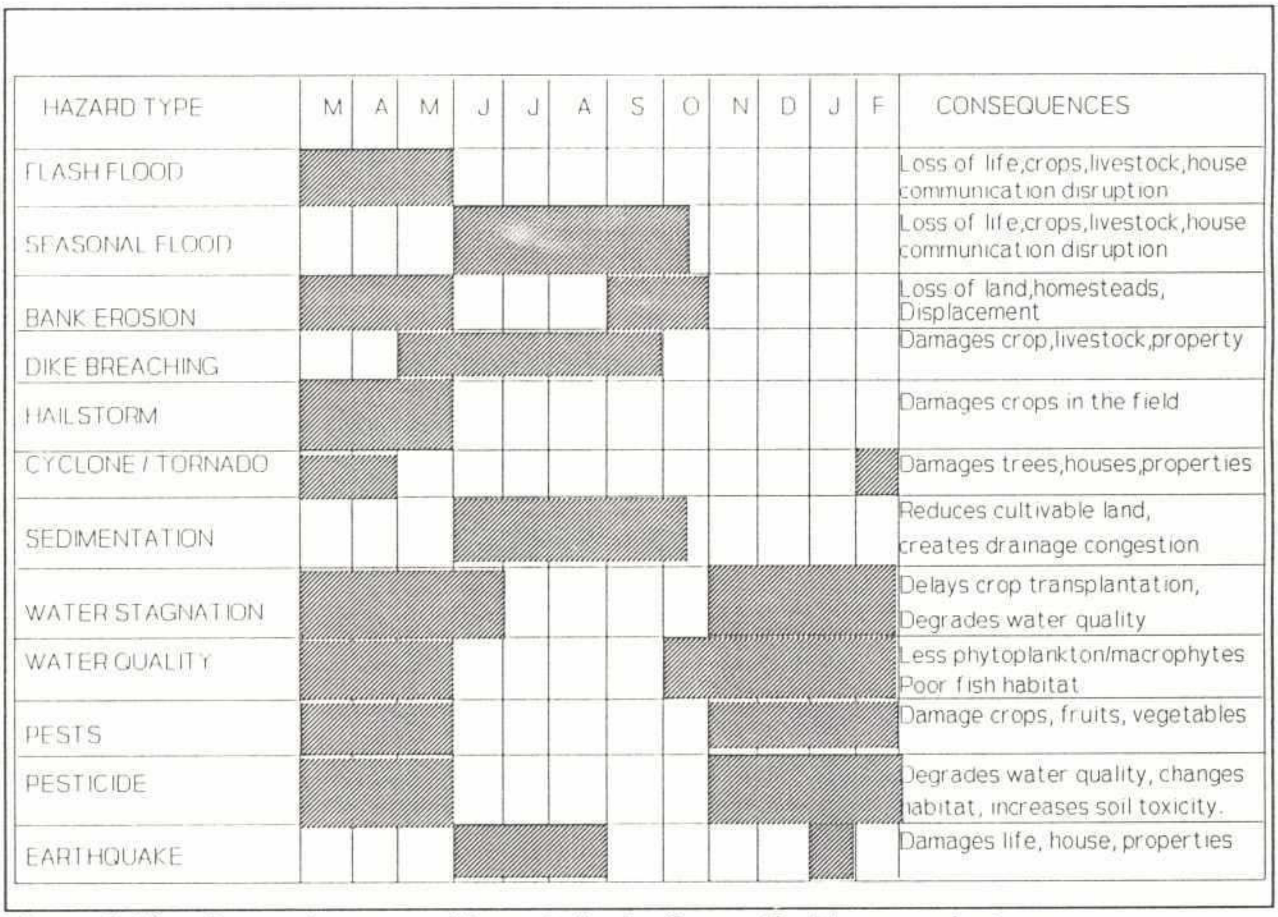

Figure 5.23. Seasonal pattern of hazards in the Surma-Kushiyara project area.

Table 5.53. Types of Damage due to Flood Hazards

Type	Tangible	Non-monetary
Direct	House Damage Crop Damage Livestock/Poultry loss Homestead Vegetation loss	Loss of life Malnutrition Water Stagnation Epidemics
Indirect	Transport disruption Loss in Trade/Business Unemployment/Loss of income.	Household disruption/displacement Education/Health service disrupted Change in habitat

5.5.10.2 Earthquakes

The Surma-Kushiyara project area lies in the zone of relatively high seismic activity of the country. The present zoning subdivides the country in three zones. According to Geological Survey of Bangladesh the basic seismic coefficient for the project area is 0.08. Coefficient for other two zones are 0.05 and 0.04 respectively, which indicates that the project area is potentially subject to higher risk due to earthquakes. Here earthquake shocks with maximum

Table 5.54. Average Annual Damage for different Flood Events (in millions of Taka)

Flood Event in cfs	Probability	Average Damage per Event (millions of taka)	Average Annual Damage (millions of taka)
597,700	0.002	28.00	0.56
554,700	0.004	27.80	0.56
521,900	0.023	27.65	0.65
478,900	0.040	27.40	1.10
407,600	0.100	21.65	2.17
350,000	0.200	22.40	4.48

Source: SARMS Associates (1973)

intensity of IX of Modified Mercalli Scale is possible. The major earthquakes that have affected the area are : 10 January 1869; 14 July 1885; 12 July 1897; 3 July 1930 and Assam Earthquake on August 15, 1950 directly affected the area. From British period this area officially has to follow special Building Act to reduce the earthquake hazard. Most of the earthquakes happened during the peak monsoon period. Consequently, if there is any flood control structures, it is potentially susceptible to damage due to earthquake which may result catastrophe situation.

5.5.10.3 Hailstorms

There is no official record or study of crop and property losses due to hailstorms. During field survey it is estimated that about 3 to 4 percent of the crop production in the project area is lost annually through the hail hazard. People of the project area reported that economic impact of hailstorm is localized but severe. Hail damage is usually considered a function of hailstone size, but the total damage from a hailstorm often results from high winds and torrential rains, as well as the physical impact of the hail itself. Hailstorm generally occurs during pre-monsoon period.

5.5.10.4 Other Hazards

During field observations other minor hazards identified were cyclones/ tornadoes, siltation, water logging, water quality, pests, crop disease and Dholkolmi (*Ipomoea* spp). Cyclone tracks pass through the project area but they rarely occur. Siltation is a hazard for the areas between Sada Khal and Karati Khal where drainage congestion is observed and affects its catchment area. As most of the inlet canal mouths are closed and internal drainage condition is not good as well water quality of the source water of the Barak river is also degraded which enters during flood is responsible for bad water quality in terms of pH, turbidity, hardness, content of dissolved oxygen, aquatic vegetation, and availability of macro- and phytoplankton inside the project area (See Water Resource and Biological Sections).

Chapter 6

PEOPLE'S PARTICIPATION

6.1 Background

There has been little meaningful grassroots participation in the planning and design of FCD and FCD/I projects to date. Historically, local views were sought on a random basis by BWDB executive engineers during field reconnaissance at the project identification stage. A proposal was formulated and the feasibility study initiated without further popular involvement. The beneficiaries were left to form their own views and response patterns to project implementation in the course of time. The commitment of local people to project aims, and their potential involvement, were not seen as priorities to be pursued within the project framework. The FAP 12 studies on completed large scale FCD and FCD/I projects found that there had been virtually no popular participation in the projects investigated (Hunting Technical Services 1991).

More recently, following pressure from donors, local participation was introduced into small scale water control projects in the form of Local Project Committees (LPCs). Pre-project meetings are now organized at sub-project sites with the aim of setting up LPCs involving beneficiaries. At pre-project meetings the project concepts are presented, expected benefits and impacts are explained, and beneficiaries have the right to comment and criticize.

Beneficiaries participation is now regarded in BWDB and in the donor community as the major strategy for improving operation and maintenance (O & M) of small scale flood control structures. The O & M is the primary responsibility of the LPCs and they are seen as a means of ensuring active involvement by beneficiaries either in cash and, or labor contribution to the O & M of the completed works. The role of planning, design and construction deficiencies in hampering effective O&M are also recognized.

An O & M Mission evaluation report on the Second Small Scale FCD/I Project comments that although pre-project meetings serve a valuable purpose as a means for initiating and encouraging beneficiary and local government interest in proposed projects, the meetings serve a limited purpose in the area of obtaining serious inputs from beneficiaries to project planning and design; a significant increase in effort and resources would be required to achieve significant improvements in this area (Northwest Hydraulic Consultants 1991)

Under the present system, pre-project meetings are convened by the Upazila Chairmen and organized by local Upazila staff. The LPCs are chaired by the Upazila Chairman, and made up of Union Chairmen, Upazila Officers, BWDB Engineers and some local farmers and fishermen selected by the Upazila Chairman from his own supporters. The LPCs are thus dominated by the rich and powerful. In this situation it is unlikely that landless fishermen and marginal farmers feel free to speak their views. Women, who constitute 50 percent of the target populations, are also agents and beneficiaries of small scale water management projects and should be involved in pre-project meetings and the organization of LPCs. As in many development projects, however, Women in Development (WID) perspectives are included as an after-thought at a stage when the organization of pre-project Meetings and LPCs are virtually complete (Northwest Hydraulic Consultants 1991)

If local meetings and committees are to be the medium for the involvement of different socio-economic groups in project assessment, planning and design, then time and effort has to be put into building appropriate procedures and representative structures. Education and motivation will be needed for both project staff and target group if people's participation is to be institutionalized. Developing a participatory approach to water management planning is a long and gradual process, which should be initiated at the earliest opportunity from the Project Identification Stage onwards.

6.2 Aims and Objectives of the Participation Process

The key to achieving the long term sustainability of FCD/I water management projects is the active participation of local people at all stages of project design and implementation. The overall aim of the participation process is to avoid imposed solutions and ensure that affected groups are involved in shaping project interventions. Interested organizations, particularly reputable Non-Government Organizations (NGOs) working in the area, should also be consulted. Public consultation and participation should be integrated into all phases of EIA procedures from pre-feasibility studies to monitoring arrangements.

The people's participation process aims to achieve the following objectives:

a. Provide affected groups with the opportunity to have a voice in the exploration, planning and implementation of FCD/I project interventions, appropriate involvement in the construction and operation of projects, and participation in the project monitoring program. These groups would then have an interest in the success of the project, to:

b. Obtain local knowledge, information and ideas relating to the development of the project plan, including views on the implications of project design. Involvement of local people in assessing likely project impacts is particularly important for helping to anticipate unexpected outcomes and side-effects,

c. Uncover potential social conflicts arising from project interventions early, so that they can be minimized through negotiation and education,

d. Initiate and develop appropriate programs to enable affected groups to participate in the construction, operation and post-project phases.

Care should be taken that issues of concern to affected groups are adequately addressed in an open manner. Failure to address conflicts of interest may jeopardize the sustainability of the project.

6.3 Approach

The primary objective of the social impact assessment component of the Surma-Kushiyara EIA was to pilot an approach to field investigation that would enable primary data collection from the different categories of people likely to be affected by the project interventions. The method chosen was informal discussion with individuals and groups from different social categories using a structured interview guide. Special attention was given to the rural poor, religious minorities and women. Ethnic groups were not present in the highly flood-affected areas selected for field work. The analytical framework, selection procedure, data collection and field work have been described in detail in Chapter 3.

The main social groups identified in the selected villages were:

- Agricultural laborers
- Capture fishing households
- Professional fishermen
- Boatmen
- Boat builders
- Petty traders
- School teachers
- Farmers (large to marginal)
- Households whose land is erosion prone or waterlogged
- Landless (including households which have lost their land through erosion)
- Women from the above categories, including female heads of household.

The period of field work for the case study was only 20 days, so the time frame did not allow the compilation of stratified village lists or the organization of pre-arranged meetings. Impromptu discussions with disadvantaged socio-economic groups resulted from entering a *bari* where the standard of housing was poor. This was generally sufficient to generate the spontaneous participation of people in the vicinity. Discussions were thus generally conducted with people from a mix of occupational categories. The aim was to involve different social groups at the problem definition stage.

During discussions, different social groups were asked about the local agrarian structure, their occupations and livelihoods, and local issues of concern to them. Groups were encouraged to express their perceptions, responses and views on types of flooding and flood-related features, e.g. normal seasonal floods, flash floods, erosion and water logging. Groups were asked about their experiences during and after the severe late flood which occurred in late September-early October of the year prior to the field work. Opinions were sought on the kind of remedial measures the groups thought appropriate.

Consultation with Upazila officers, elected representatives and an NGO operating in one Union took place both prior to and during field work.

6.4 Participation Context

The participation context was defined as:

- The degree to which different groups were prepared to participate;
- The level of education and, or awareness required to help people participate; and
- The best way to reach different social groups with respect to their specific location and level of organization.

All individuals and groups interviewed were found to be very responsive and open in discussion with the team. Many were illiterate but had strong views regarding the sources and impact of different types of flooding, which social groups were the worst sufferers, and which were less affected. For example, villagers said that the majority of farmers in the area suffer from flooding but the poor suffer most. Large landowners owning above 9 ha land are not very much affected because they are in a position to diversify their income. The villagers appeared to have a sound understanding of the network of power relations operating in the locality, the processes tending to increase landlessness and poverty, and the systems for controlling natural resources that were traditionally regarded as common property. Most importantly, villagers expressed clear opinions on remedial measures to be taken in relation to flooding.

Lack of education did not appear to be an intrinsic obstacle to participation during village or mouza level discussions on project ideas, provided that the meetings involved people from similar socio-economic and occupational categories. On the other hand, involvement of very poor people in more formal representative structures e.g. project committees would require substantial inputs in the way of orientation and confidence-building.

No firm conclusions can be drawn at this stage with regard to the degree that poor villagers would be prepared to participate in self-help programs for embankment and structure maintenance. A possible example is Bhuiyamura Village which is subject to severe erosion resulting in two-thirds of the village being washed away over a period of 3 years and many of the remaining households losing substantial amounts of land. Villagers there have been repairing the dyke voluntarily and have even resorted to using soil taken from their own homesteads.

Information from a number of local sources indicate that about 25 percent of embankments breaches are non-made. Breaching problems of the Surma Embankments are greater than that of the Kushiyara. Intentional breaches arise from two causes:

- By large farmers to promote siltation of their low lands; and
- By farmers of various land holdings to drain their lands.

Discussion with those involved in embankment breaching was not possible within the time frame, but involvement of large landowners in the project participation process is essential.

There is no organizational short-cut to access to the majority of landless and land poor. Distrust of elected representatives was a common factor in all discussions with ordinary villagers. Alleged mismanagement and misappropriation of funds and relief goods were the major reasons for dissatisfaction. Traditional forms of village organization, e.g. the *Samaj* or *Reyai*, are dominated by local influential. Bangladesh Rural Development Board (BRDB) cooperatives are few and are used by the rich as a method of obtaining funds. Cooperation from the Upazila and Union Parishads is essential for village research, and the village or neighborhood *Samaj* is an important point of contact, but grass roots participation in planning needs to be developed independently. Social scientists cannot rely on official bodies or local notables to organize popular participation.

The NGOs are currently regarded by donors as an important channel for reaching the rural poor. The NGO Friends of Village Development in Bangladesh (FIVDB) has recently started working in Kazalshar Union. The organizational basis for participation through NGO-sponsored small group formation is limited in the project area.

6.5 Peoples Perceptions of Flooding and Views on Remedial Measures

Villagers' perceptions of floods are described in Section 5.5.9. Table 6.1 presents systemized information obtained through group discussions at village level on people's perceptions of floods and flood related features. The findings should be seen as indicative rather than representative, since although the villagers interviewed came from a range of different social and occupational categories, their views may not be entirely representative of the views of the villagers as a whole.

The term Seasonal floods in the table corresponds with the Bengali word, *Barsha*, or normal seasonal inundation, and flash floods with the Bengali word, *Pahari Dhol*, or sudden onrush of water (Section 5.5.9)

There were group discussions in 23 villages in total. Flash floods were defined as a problem by villagers for their village in all discussions. Water logging was also seen as a problem in 8 villages, erosion in 8 villages, and seasonal floods in only 7 villages. Mostly villagers were of the view that normal seasonal flooding was good for the crops.

An embankment on either the Kushiyara, the Surma or on the outfall of the Luba were the preferred measures in 9 villages. An embankment + improved drainage was favored in 7 villages, and an embankment + improved drainage + irrigation in 4 villages. Two villages wanted an embankment + irrigation, and 1 wanted improved drainage only.

Villagers were overwhelmingly in favor of implementation of flood control measures on either the Kushiyara or Surma Rivers. The need for strong, well built embankments reinforced with boulders were mentioned in nearly all discussions. Embankment of the Lubha outfall was also requested in affected villages. Improvement of the drainage system was raised in over half of the discussions. A number of specific suggestions were made as regards of re-excavation and opening of canals, and location of sluice gates. Other needs outlined were improved communications, and provision of tubewells and medical facilities.

Since group discussions were the major means of obtaining a range of information, the time

Table 6.1. People's Perceptions of Flooding and Related Concerns in Surma-Kushiyara Project Area.

Upazila/Union/Village	Trav line	Perceived Problems				Preferred Measures			
		Seasonal Floods	Flash Floods	Water-logging	Erosion	Embank-ment	Improved Drainage	Irri-gation	Other
Zakiganj									
Khalachara	1								
Khalachara			√	√		√			
Namargram			√			√	√		Sluice gate
Hamindpur		√	√	√		x	√	√	
Bhuiyamura			√		√	√			
Hydrabond			√		√	√			Surma river dredging
Amalshid			√		√	√			Lubha & Surma dyke
Madrakhal			√		√	√			
Tarapur			√			√			
Sheikhpara			√		√	√			
Kadamtala			√	√		√	√		
Narasingpur		√	√			√			
Bondapara						√	√		Sluice gate Shikarband
Kajalshar	1							√	DTW/HTWs, med.fac's & dredging
Charigram			√		√	√	√	√	
Baroban			√		√	√		√	
Barohal	3								
Batoishal		√	√	√	√	√		√	Better comm'ns:TWs; reexcavation of Teli and Sunam khals
Baliteka		√	√	√	√	√	√		
Beanibazar									
Charkhai	4								
Nateswar		√	√	√		√	√		Sluice gate on Napit, Kakura
Natewarchak			√	√			√		and Karati khals, re-excav'n
Seola	4								of Sada, Karati & Siber khals
Deuonagar (north)			√		√	√	√		
Dattagram			√	√		√	√		

Table 6.1. Continued.

Upazila/Union/Village	Trav line	Perceived Problems				Preferred Measures			
		Seasonal Floods	Flash Floods	Water-logging	Erosion	Embank-ment	Improved Drainage	Irri-gation	Other
Kanaighat									
Dighirpur	2								
Dabadhanir mati		√	√			√	√		Link canal with Andu and Surma
Julai			√			√			Open Juli Khal outlet
Luxmiprasad west	2								
Luxmiprasad west		√	√			√		√	Improved communications

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available for in-depth discussion of each topic was necessarily limited. The question of the possible motivation of the very poor in favoring large-scale earthworks because it would provide employment was not addressed. Although on one occasion this was volunteered as the reason for preference.

Though the discussion outcomes in Table 6.1 represent the views of villagers on perceived problems and preferred measures in relation to their own village, on several occasions erosion was mentioned in villages which were not erosion-prone. This shows an awareness of the magnitude of the problem, and that breaching of dykes at erosion points has direct consequences for their village.

One major local conflict regarding flood protection was uncovered during field work in Kanaighat Upazila. This conflict related to the recent construction of dyke blocking Amri Khal, a tributary of the Lubha River. This dyke benefitted villagers in the village of Luxmiprasad West, but the village of Luxmiprasad East on the other side of the Lubha was severely flooded as a result. So the villagers there took matters into their own hands, crossed the river by boat and attempted to breach the Amri Khal dyke. Fighting broke out between the people from the two villages and the protagonists were unsuccessful. In any event the dyke breached naturally, temporarily resolving the matter. During the discussion in Luxmiprasad West villagers requested reconstruction of the Amri Khal dyke, but if implemented a serious conflict would undoubtedly result.

The social team was in a position to only establish an initial contact with a limited number of people from different social categories in highly flood affected locations in the case study area. Follow-up is needed to establish a meaningful participation process.

A series of meetings would enable presentation of Project Concepts, facilitate comment and discussion of alternatives, and would be particularly important for planning the exact location of structures, e.g. sluice gates, regulators, bridges and culverts, with the help of local knowledge. This process would also allow for negotiation between different groups to resolve local conflicts of interest.

Chapter 7

ENVIRONMENTAL IMPACTS

7.1 Network Analysis

Figures 7.1 to 7.20 summarize the expected sequence of hydrological and related events which would occur under the three scenarios, i.e. without any project development, with the development of full-flood protection and submersible embankments. The major differences between the three scenarios relate to the hydrological changes expected from implementation of full-flood embankment construction and maintenance which have significant implications for flood- and drainage-related events and resources affected by them, including wetlands, fish access and changes in cropping patterns and damage.

Appropriate quantification of impacts was a difficult task in the case of the Surma-Kushiyara project area due to the lack of long-term trend data for many resources and the relatively short period of time devoted to field data acquisition.

7.2 Description of Impacts and Potential Mitigation Measures

7.2.1 Water Resources

7.2.1.1 Future Without Project

If the project is not built, the hydrology and geomorphology of the area are expected to continue in the current trend of sedimentation, erosion, periodic flooding, breaching, erosion and channel shifting. Both flash and seasonal floods would continue. Flash floods occur every year but severe ones recur every three years. Devastating seasonal floods have 5 year return periods. The frequency of flash and disastrous seasonal floods during the last 10 years suggests that such flooding might occur more often in the future.

River beds would rise slowly and breaching would continue along the banks. Sediments would enter the project area, raising canal and beel beds. Sediments that are not removed would ultimately close more canals and aggravate drainage congestion. Because the rivers are presently higher in elevation than the saucer-shaped project area during the whole wet season, rainfall would continue to accumulate in the central depressions and contribute to drainage congestion. This situation is expected to continue to cause agroecological changes. Land would continue to be lost due to river erosion and scouring. Because the erosion is more pronounced on the right bank of the Kushiyara, there would be more territorial loss for Bangladesh. The river already has shifted 5 km inside Bangladesh at Bhuyamura village. The last 30 years of discharge data indicates that the Surma River flow has decreased while the Kushiyara River flow has increased. The bed slope of the Kushiyara is deeper than the Surma's and more erosion occurs on the Kushiyara. These trends are expected to continue.

The present groundwater situation is not expected to change measurably in the near future.

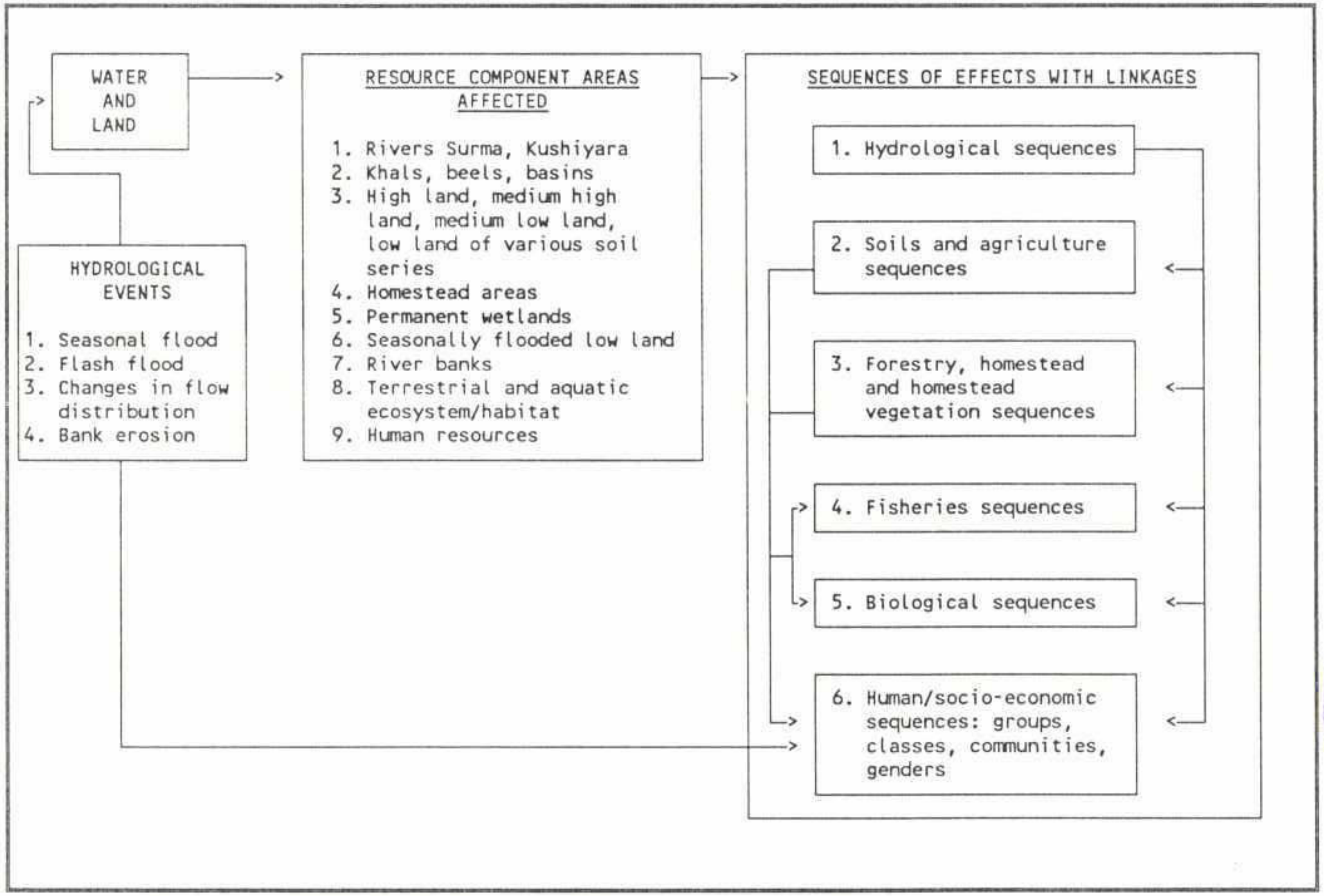

Figure 7.1. Cause and effect sequences: Surma-Kushiyara area without project development

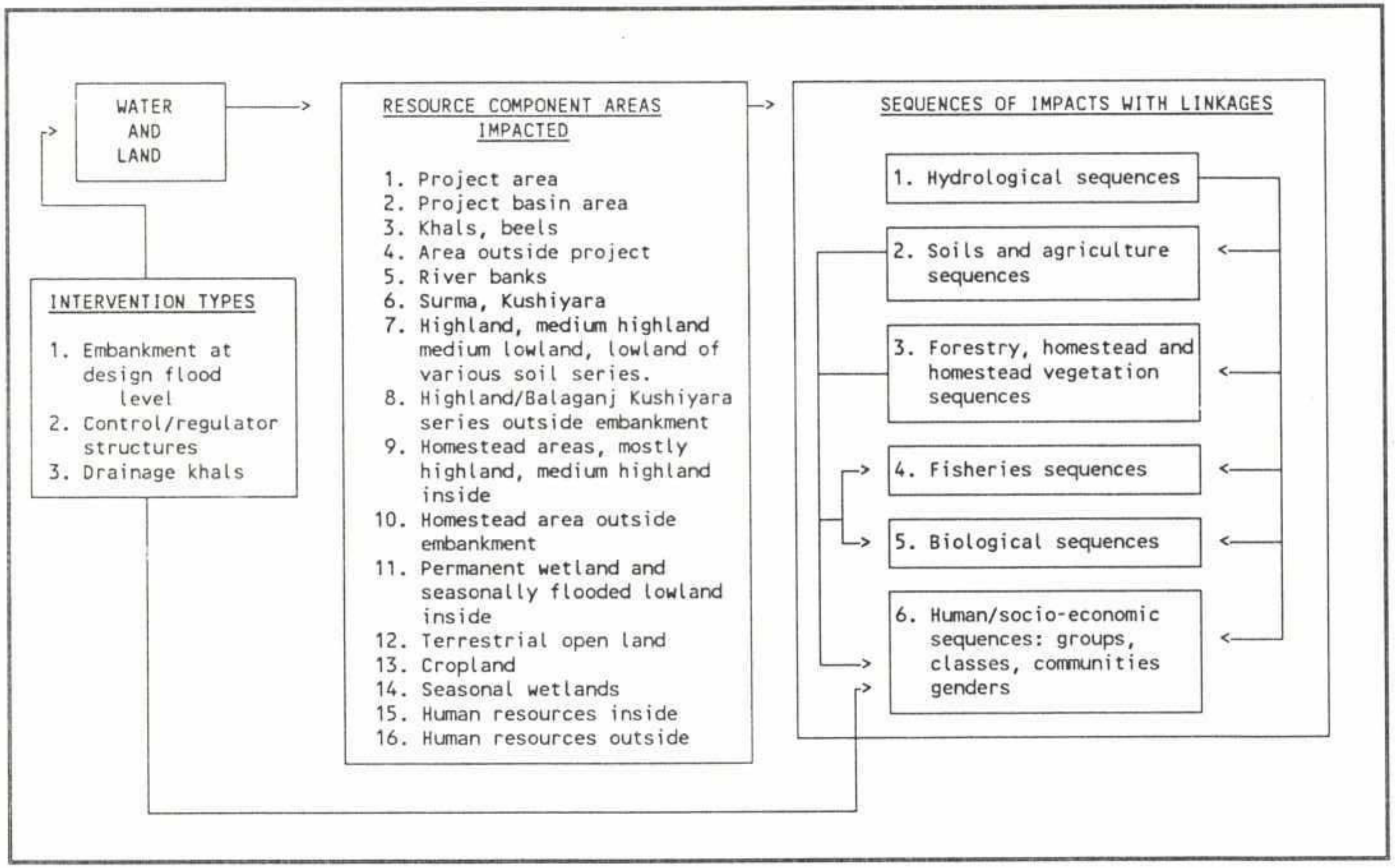

Figure 7.2. Cause and effect sequences: Surma-Kushiyara area with full-flood protection

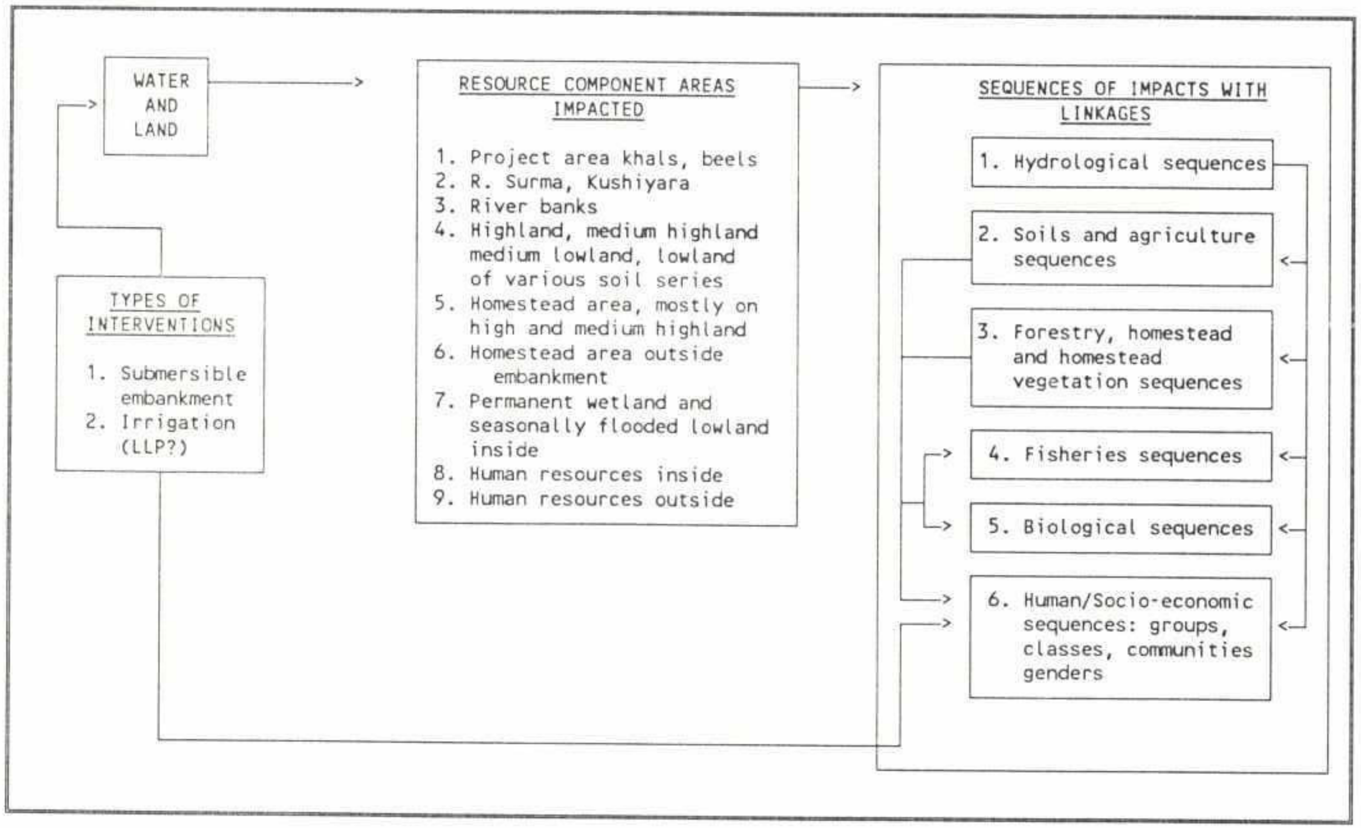

Figure 7.3. Cause and effect sequences: Surma-Kushiyara area with submersible embankments

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EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT	SEQUENCES	
		I	II	III
FLASH FLOOD	Project area Khals and Beels	Drainage congestion	Water Stagnation	Deterioration of Water Quality
	Project area khals and beels	Sedimentation and Raised Khals and Beel beds	Slow drainage	Water Stagnation
SEASONAL FLOOD	Project basin area (Khals and Beels)	Drainage Congestion	Water Stagnation	Deterioration of Water Quality
		Sedimentation and raised canal and beel beds	Slow drainage	Water Stagnation
CHANGE IN FLOW DISTRIBUTION	Surma and Kushiyara	Reduced flow in Surma	?	?
		Increased flow in Kushiyara	?	?
BANK EROSION	Surma and Kushiyara	Loss of land	Territorial loss	?
			Loss of homestead and homestead resources Loss of agricultural land	?

Figure 7.4. Expected hydrological effects in absence of project development: Surma-Kushiyara area

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES I	II	III
EMBANKMENT AT DESIGN FLOOD LEVEL	Project area	No Flash Flood	No Drainage Congestion	No Water Stagnation
			No Sedimentation	
	Surma, Kushiyara /Outside project area	Loss of gradient		
		Increased natural Irrigation development	Increased demand on surface water	
	Project basin area (Khals and beels); Medium low land	No Seasonal Flood by bank overflow	Reduced Drainage Congestion	Reduced water stagnation
			Reduced Surface Water Level	Reduced Surface Water area
		Increased natural irrigation development	Increased demand on surface water.	
	Outside project area	Higher stage in rivers	Possible flood in lower areas outside	
	River banks	Increased erosion/scouring	Widening of river width	Threat to embankment

Figure 7.5. Expected hydrological impacts with full flood protection: Surma-Kushiyara Project Area.

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
SUBMERGIBLE EMBANKMENT IRRIGATION	Project Area khals and beels	Reduced and delayed flooding from flash flood	Reduced drainage congestion	Reduced Stagnation
			Reduced sedimentation	Improved Drainage
		Reduced seasonal flooding	Reduced drainage congestion	Reduced Stagnation
			Reduced sedimentation	Improved Drainage
		Increased irrigation	Increased demand on river water	
	Surma and Kushiyara	Reduced gradient		
	River banks	Increased erosion/ scouring		

Figure 7.6. Expected hydrological impacts with submersible embankments: Surma-Kushiyara Project Area

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EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT	SEQUENCES	
		I	II	III
FLASH FLOOD	Highland: Balaganj Kushiyara Series	Loss of Aus, T.Aman	Loss of crop production	
		Fresh sediment	Addition of soil nutrient	Possible increased soil fertility
			Damage to crops	Loss of crop production
		Bank erasion	Loss of good agricultural land	Loss of crop production
		Breach of dykes	Loss of Aus, T.Aman	Loss of crop production
	Medium High land: Goyainghat Series	Loss of Aus, T.Aman	Loss of crop production	
		Fresh sediment	Addition of soil nutrient	Possible increased soil fertility
		Breach of dykes	Loss Aus and T.Aman	Loss of crop production
	Medium Low land: Kanairghat Series	Loss of B.Aman and Boro	Loss of crop production	
	Lowland/Phagu Terc-hibari Series	Loss of B.Aman and Boro	Loss of crop production	
SEASONAL FLOOD	Medium Lowland/ Kanairghat series	Loss of B.Aman and Late T.Aman	Loss of crop production	
	Low land/Phagu Terchibari Series	Loss of B.Aman	Loss of crop production	
NORMAL FLOOD	Medium Lowland/ Kanairghat Series	Biological fixation of nitrogen	Increased soil fertility	
	Low land/Phagu Terchibari Series	Biological fixation of nitrogen	Increased soil fertility	

Figure 7.7. Expected impacts to soils and agriculture in Surma-Kushiyara area in absence of project development

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
DRAINAGE CON-GESTION	Medium Lowland/ Kanairghat Series	Delayed transplantation of late T.Aman	Increased fallow land	Loss of crop production
	Lowland phagu Techibari series	Loss of B.Aman	Increased fallow land	Loss of crop production

Figure 7.7. Continued

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			
		I	II	III	IV
EMBANKMENT AT DESIGN FLOOD LEVEL	Highland; Balaganj Kushiyara Series	No flash flood	No damage to Aus, T. Aman	Increased crop/ HYV production	Increased use of fertilizers, pesti-cides
			Increased area of highland	Possible loss of organic matter	Reduced soil fertility
				Increased HYV area	Increased Crop production
			No sediment deposition	Reduced deposition of soil nutrients	Probable reduction in soil fertility
	Medium highland/ Goyainghat Series	No flash flood	No damage to Aus, T.Aman	Increased crop/ HYV production	Increased use of fertilizers, pesticides
			Increased area of Medium highland	Increased T.Aman area	Increased crop production
			No sediment deposition	Reduced deposition of soil nutrients	Probable reduction in soil fertility

Figure 7.8. Expected impacts to soils and agriculture from full flood protection: Surma-Kushiyara Project Area

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EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT	SEQUENCES		
		I	II	III	IV
	Medium Lowland/ Kanairghat Series	No flash flood	No damage to T.Aman and B.Aman	Increased crop production	Increased crop production
	Low land; Phagu Terchibari Series	No flash Flood	No damage to Boro	Increased HYV area	Increased use of Fertilizers, Insecticides
			Decrease of lowland	Reduced cropped area	
	Medium Low land; Kanairghat Series	Reduced frequency of Seasonal flood	Reduced damage to T.Aman, B.Aman	Increased crop production	
		Decreased area of medium lowland	Reduced cropped area under T. Aman, B. Aman	Reduced crop production	
		Reduced period of inundation	Reduced biological fixation of nitrogen	Probable reduction in soil fertility	
	Highland/ Balaganj Kushiyara series Outside the embankment	Increased water level of flash flood/ confinement effect	Loss of Aus and T.Aman	Loss of crop production	

Figure 7.8. Continued.

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT	SEQUENCES		
		I	II	III	IV
SUBMERGIBLE EMBANKMENT IRRIGATION	Highland/Balaganj Kushiyara Series	Reduced frequency of flash flood	Reduced damage of Aus and T.Aman	Increased crop production	
		Availability of Irrigation water	Reduce deposition of soil nutrients	Probable reduction in soil fertility	
			Introduction of Boro (HYV?)	Increased crop production	
			Seepage loss in irrigation canals	Damage to rabi crops	Loss of crop production
				Water stagnation?	
	Medium Highland/ Goyainghat Series	Reduced frequency of flash flood	Reduced damage to Aus and T.Aman	Increased crop production	
			Reduced deposition of soil nutrients	Probable reduction in soil fertility	
		Availability of Irrigation Water	Introduction of Boro (HYV?)	Increased crop production	

Figure 7.9. Expected impacts to soils and agriculture from submersible embankments: Surma-Kushiyara Project Area

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
	Medium Lowland/ Kanairghat Series	Reduced frequency of flash flood	Reduced damage to B. Aman	Increased crop production
		Delayed flash flood	No loss of Boro	Increased crop production
		Reduced frequency of seasonal flood	Reduced damage to T.Aman and B.Aman	Increased crop production
		Availability of irrigation water	Increased Boro (HYV?) area	Increased crop production
				Increased use of fertilizers and pesticides
	Lowland/Phagu Terc-hibari Series	Delayed flash flood	No loss of Boro	
		Availability of Irrigation water	Increased Boro (HYV?) area	Increased crop production
				Increased use of Fertilizer, insecticide/ pesticide
		Increased water logged area	Loss of cropped area	Reduced crop production

Figure 7.9. Continued

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT	SEQUENCES		REMARKS
		I	II	III	
FLASH FLOOD	Homestead area, mostly on High and Medium High Land	Damage to Betelnut, Patipata fruit tree and other homestead tree species	Loss of yield	Scarcity of fruits, Pati materials, fuel, fodder and construction materials	Poorer economy
			Inability to sustain new seedlings		
		Damage to Summer vegetables	Scarcity of Summer vegetables	Malnutrition loss of petty cash	Blindness, rickets, skin diseases
		Damage to stored/ Unthreshed grain	Scarcity of food	Famine/starvation	Ill health and diseases
		Soil erosion	Damage to houses	Cost of repair	
			Damage to trees, and plants; summer vegetables	Reluctance for further plantation/ vegetation	Scarcity of food, fuel and fodder
		Damage to houses, livestock/ poultry shelter	Loss/reduced livestock and poultry products	Loss of petty cash, problem for ploughing	Constraint of cash expenditure
			Reduced drought power		reduction in yield

Figure 7.10 Expected impacts to forests, homesteads and homestead vegetation in Surma-Kushiyara area in absence of project development

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			REMARKS
		I	II	III	
EMBANKMENT AT DESIGN FLOOD LEVEL	Homestead area, mostly on Highland Medium High land inside embankment	No damage to homestead trees, plants and vegetables	Increased food and income from homestead trees, plants and vegetables	Improved diet and nutrition increased petty cash	Improved economy
		No damage to houses and household property	Saved repair cost	Assurance of security increased output	Improved living standard
			Construction of homestead in lower land types	Increased homestead production Increased risk of loss in extreme events	
	Homestead area outside embankment	Increased damage/losses to homestead, homestead trees, plants, poultry etc.	Scarcity of fodder Environmental imbalance outside the embankment	Increased risk of tidal surges affecting embankments Increased soil erosion out side embankment	Increased poverty and poor health

Figure 7.11. Expected impacts to forests, homesteads and homestead vegetation from full flood protection: Surma-Kushiyara Project Area

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EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			REMARKS
		I	II	III	
SUBMERGIBLE EMBANKMENT: IRRIGATION	Homestead area, mostly on High and Medium High land inside embankment	Reduced frequency of flash flood	Reduced damage to homestead trees, plants and vegetables, poultry	Increased homestead income improved income	Improved general health
		Reduced duration of flash flood	Reduced damage to homestead; trees, plants and vegetables, poultry	Increased homestead output/ income	Improved nutritional status
		Delayed flash flood	Organized evacuation/ storage precaution	Reduced poverty	
		Reduced/No soil erosion	Reduced/No damage to houses, homestead vegetation	Reduced cost of repair and replantation	
	Homestead area outside embankment	Increased damage/loss to homestead, homestead trees, plants, poultry etc.	Reduced homestead output/income	Increased cost of repair, replantation and poverty	

Figure 7.12. Expected impacts to forests, homesteads and homestead vegetation from submersible embankments: Surma-Kushiyara Project Area

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			
		I	II	III	IV
FLASH FLOOD	CAPTURE FISHERIES Permanent wetland and seasonally flooded lowland	Wetland bed raised due to siltation	Reduced fish habitat	Inhibit migration of major carps in early monsoon	Reduced major carp production
		High water turbidity	Temporary reduced primary productivity	Reduced fish productivity . .	
			Fish health hazard		

Figure 7.13. Expected impacts to capture fisheries in Surma-Kushiyara area in absence of project development

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			
		I	II	III	IV
EMBANKMENT AT DESIGN FLOOD LEVEL	Permanent wetland and seasonally flooded lowland inside	Seasonal wetland greatly reduced	Reduced fish habitat. Possible destruction of spawning ground	Reduced fish population and species diversity	
		Inhibit migration of fish/fish fry from/to rivers/beels	Reduced population of major carps	Reduced capture fishery production	Increased culture fisheries in the long term
			Reduced fish stock replenishment		
		Stoppage of allochthonous inputs with floodwater	Decreased productivity of the wetland		
		Increased application of pesticide for agriculture	Fish health hazard		
	Rivers Surma Kushiyara; Outside Project	Possible stoppage of spawning/feeding migration of major carps from/to rivers and beels	Possible reduced population of major carps outside		

Figure 7.14. Expected impacts to capture fisheries from full flood protection: Surma-Kushiyara Project Area

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EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			
		I	II	III	IV
SUBMERGIBLE EMBANK-MENT IRRIGATION	Permanent wetland and seasonally flooded lowland inside	Reduced fish habitat by area and by time due to protection from flash flood	Inhibit spawning migration of major carps from beds to rivers outside	Reduced population of major carps inside	Reduced fish production
	Rivers Surma Kushiyara outside	Inhibit spawning migration of major carps from beels to rivers outside	Reduced population of major carps outside	Reduced fish production outside	

Figure 7.15. Expected imports to capture fisheries from submersible embankments: Surma-Kushiyara Project Area

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			
		I	II	III	IV
FLASH FLOOD	Terrestrial	Partial loss of burrowing mammals	Raptors food shortage	Temporary local migration	Increased rat population next season
		Surviving mammal population take shelter in dykes	Helps dyke weakening/ breaching		
		Death of immature otter population	?	?	
		Loss of partial breeding potential of woodland granivorous bird spp.(due to boro loss)	?	?	
		Adverse effect on pied Myna population	Increased population of ear-cutting caterpillar next season	Rabi/Boro crop affected	
	Aquatic	Probable reduced aquatic macrophytes	Probable reduced fish spawning ground		
			Probable reduced fish shelter material		
			Reduced feed/fodder for Livestock		

Figure 7.16. Expected impacts of biological resources in absence of project development: Surma-Kushiyara Project Area

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EVENT/ INTER-VENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
			Reduced migratory bird next season	Reduced aquatic ecosystem productivity
		Decreased phyto- and zooplankton	Decreased fish population, especially major carp	
SEASONAL FLOOD	Aquatic	Decreased phyto- and zooplankton	Decreased fish population, especially major carp	

Figure 7.16. Continued

EVENT/ INTERVENTION	RESPIRE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES			
		I	II	III	IV
EMBANKMENT AT DESIGN FLOOD LEVEL: REGULATORS	Terrestrial open land	Increased area of seasonal open land	Increased terrestrial bird population	Increased biological pest control	
	Crop land	Increased area of cropland	Increased insect population	Increased insectivorous bird population	Possible decrease in bird population due to possible over use of insecticide
	Seasonal wetland	Reduced area of seasonal wetland	Reduced total wetland quality	Reduced water bird population	Reduced wetland productivity due to reduced bird dropping
			Reduced population of frogs and M.lizards	Increased population of insects and rats	Increased crop damage
			Rats and M.lizards easier to catch due to confinement		Possible embankment damage

Figure 7.17. Expected impacts to biological resources from full flood protection or submersible embankments: Surma-Kushiyara Project Area

EVENT/ INTERVENTION	RESOURCE COMPONENTS EFFECTED/IMPACTED	EFFECT/IMPACT	SEQUENCES		
		I	II	III	IV
FLASH FLOOD AND SEASONAL FLOOD	Human Resources	Reduced agricultural income and food security	Increased poverty, inequality and landlessness	Increased under employment	
				Increased distress sale mortgage	
				Increased concentration of wealth and income	
				Poorer households more affected	
		Reduced homestead production and biomass	Chronic shortage of biomass and fuel		Increased deterioration in the general quality of life
		Reduced consumption and increased nutritional deficiency	?		
		Reduced employment and income earning opportunities	?		
		Increased loss of cultural sites and heritage (land erosion)	?		

Figure 7.18. Expected impacts to human resources in Surma-Kushiyara area in absence of project development.

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EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/ IMPACTED	EFFECT/IMPACT	SEQUENCES		REMARKS
		I	II	III	
		Increased displacement from homestead	Increased stress an displaced households and possible outmigration		
		Disruption in com-munication	Difficulty in getting to school, market and medical facilities		
		Disruption in kinship and socio-religions obligations			
		Increased health risk and decreased sanitation facilities			Increased deterioration in the general quality of life . .
		Contamination of water sources for domestic use	Increased incidence of water borne diseases	Loss of productive potential due to illness	
				Increased loss of capital to cover expenses for illness	
		Increased vector diseases			
		Temporary interruption in the use of common property resources			
		Loss/damage to personal/ household assets			
		Increased stress on women and children			

Figure 7.18. Continued

EVENT/ IN-TERVENTION	RESOURCE COMPONENTS EFFECTED/ IMPACTED	EFFECT/IMPACT	SEQUENCES		
		I	II	III	IV
Erosion of river banks	Homestead, Agricultural land	Increased landlessness	Possible outmigr-ation	Increased disruption in kinship and lineage	Poor householdS more affected
			Displacement and stress		
		Loss of property and assets	Increased health risk and nutritional deficiency	Increased deterioration in the overall economic con-ditions of households affected	
		Loss of national territory			
		Loss of cultural sites/heritage			

Figure 7.18. Continued

EVENT/ INTER-VENTION	RESOURCE COMPONENTS EFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
EMBANKMENT AT DESIGN FLOOD LEVEL	Human resources inside the project	Increased agricultural production	Increased land price inside the project	
			Increased credit needs (HYV)	
			Increased agricultural employment	
			Increased competition for share cropping	Increased replacement of share cropping by cash rentals.
				Reduced importance of kinship factor in share cropping
			Inequitable distribution of increased production benefits	Increased diversification of income by large land owners
				Increasing concentration of land in fewer hands
			More commercial and impersonal relationship of domination and dependence	

Figure 7.19. Existing impacts to human resources from full flood protection: Surma-Kushiyara Project Area

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
		Increased involvement of women in home-gardening, poultry, and livestock raising		
		Increased supply of firewood from homestead and roadside		
		Decreased capture fisheries production in the long run	More carbo-hydrate dependent nutrition	
			Reduced employment for traditional fishing communities	Increased pauperization of traditional fishermen house-holds
			Increased income from capture and culture fisheries for socially advantaged	
		Decreased traditional fishing opportu-nities	Decreased fish consumption by poorer households	Increased nutritional deficiency for poorer households
		Improved road communication	Increased mobility	

Figure 7.19. Continued

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES		
		I	II	III
		Increased homestead production	Increased nutrition	
		Wider scope for non-farm employment		
		Increased landlessness due to land acquisition for embankment		
		Social threat on embankment due to conflict between inside and outside		
		Reduced flushing of contaminants	Possible increases in vector diseases	
	Human resources outside the project	Decreased agricultural and homestead production	Decreased land price outside project	
		Increased health risk outside project		

Figure 7.19. Continued

EVENT/ INTERVENTION	RESOURCE COMPONENTS AFFECTED/IMPACTED	EFFECT/IMPACT SEQUENCES I	II	III	IV
SUBMERGIBLE EMBANKMENT IRRIGATION	Human resources inside project	Increased benefits from homestead production			
		Increased benefits from agricultural production	Increased employment opportunities for landless and marginal farmers	Increased buying capacity for the poor	Increased food intake for the poor
			Increased land price for lands saved from flash flood		
			Inequitable distribution of benefits amongst large and medium farmers		
		Slightly improved health and hygiene situation			

Figure 7.20. Excepted impacts to human resource from submersible embankments: Surma-Kushiyara Project Area

7.2.1.2 Full Flood Protection

Full flood protection involves building embankments at points of high flood recurrence. If the left bank of the Surma River and the right bank of the Kushiyara River are embanked and drainage networks are developed, the following impacts are foreseen.

a. Impacts

Full flood protection would aim to protect the project area from uncontrolled overbank flooding during early and late flash floods, and during abnormally high, early and late seasonal floods. A 20-year flood design would protect the area from devastating events similar to those in 1959 and 1991 when the river Kushiyara had the highest stage of 5.9 m.

Properly designed, constructed and maintained embankments would contain breaches and therefore flooding, and would reduce erosion alongside the river banks. The inflow of sediment from the rivers and deposition of sand and silt would be prevented, thereby protecting the area's drainage network from increased sedimentation. In addition, drainage congestion would be reduced due to less river flooding and consequent water stagnation.

Properly designed, operated and maintained regulators would control flooding enough to support normal agricultural activities, provide water for irrigation, and allow groundwater recharge.

Negative impacts would occur if an embankment is constructed along the banks of the Surma and the Kushiyara Rivers. An embankment would have a confinement effect, raising water levels and affecting downstream reaches toward Sylhet and Fenchuganj. It is difficult to accurately predict how much the river stage would rise downstream of the embankment but, because the Surma would continue to flood, areas below Charkhai are likely to be greatly affected. Currently the Surma flood flow spills into the Kushiyara primarily through Sada Khal.

Construction of an embankment would create modest and slow-acting geomorphological consequences at a rate which is difficult to estimate. Currently, the rivers have low gradients and velocity. A 100-year flood design would increase velocities to 0.5 m/sec over the current bankfull conditions. Bank channels also would tend to widen gradually, while gradients would decrease. It is difficult to determine what effect confinement would create on the non-embanked side of the rivers. Some estimates (EPWAPDA 1966) suggest that the rivers may widen up to 0.5 km and create some overland flow.

There is the possibility that the embankment could fail, creating unexpected flooding with serious consequences.

The area within the set-back distance (from river bank to the embankment, an estimated area of 1,000 ha) would be constantly threatened by erosion and recurring flash and seasonal floods more frequently because of confinement effect.

Farmers in the area are presently in favor of sediment deposition within their lands because of the popular belief that natural flood water (river overspill) enriches soil fertility. Flood protection would end this natural process and would end the natural flushing of the area (see health section below). The extent of the value of these natural benefits of flooding has yet to be adequately quantified.

b. Mitigation

The silted canals should be re-excavated for proper drainage and the canal network restored to contain flooding that would occur from accidental breaching. This would reduce the severity of floods as drainage network would absorb the onrush of water to a great extent. Such measures should reduce congestion by trapped rainfall. Drainage improvement is expected to reduce flood damage on medium-high and medium-lowlands.

To promote stabilization, the embankments might need to be continuously raised and maintained.

Ideally, the people living within the set-back distance should be resettled. In addition, the road network near the Kushiyara River should be developed as an embankment. This would reduce costs and partially solve the resettlement issue because this would not require acquisition of additional land by the Government.

Full flood protection calls for containment of rivers by embankments. The rivers are highly flashy and have quite a velocity. Therefore, construction of embankment should be high quality design and work. Moreover disaster shelters need to be constructed at convenient locations for safety in extreme events like sudden failure on embankment.

7.2.1.3 Submersible Embankments

a. Impacts

Submersible embankments would provide protection from uncontrolled flash floods and reduce frequent seasonal floods. Since submersible embankments do not provide full flood protection, the flood threat would remain. Although floods would occur less frequently, they would continue to devastate the lives and livelihood of the people.

Despite the presence of submersible embankments, flash and seasonal floods would continue to batter areas from the river banks to the embankments. In addition, breached embankments would continue to create unexpected flooding.

b. Mitigation

Re-excavating silted canals and restoring the canal network would enhance drainage and therefore contain flooding that results from accidental breaching. All canals and drainage networks previously connected with the rivers should be excavated. Restoring the drainage network and excavating canals also should reduce congestive trapped rainwater.

Because of the rising river bed, embankments need to be continuously raised, stabilized and properly maintained. Regulators also should be properly maintained.

If submersible embankments are constructed, the existing dike system should be improved using proper section and slope.

7.2.2. Water Quality

7.2.2.1 Future Without Project

Floods, especially river bank overflow, flush the project area. This flush washes away animal and human faeces and accumulated domestic wastes. It also dilutes pollutants such as insecticides and other chemicals. Fresh flood water is higher in dissolved oxygen than stagnant waters and generally improve water quality.

Industrial wastes discharged into the Barak and Kushiyara Rivers presently contaminate the Surma and Kushiyara and are potentially toxic to both humans and fish. The carbon dioxide content is increasing. River water contaminated by industrial wastes also reduces water quality in khals, beels and ponds. People are presently not adequately educated to understand the hazards of throwing or discharging domestic or industrial waste into the water systems. They are also frequently unaware of the hazards of defecating near or into the water systems.

People drink both surface water and groundwater. The water in rivers, beels and ponds is contaminated and is probably responsible for most gastrointestinal diseases. Groundwater is very high in iron (2 to 12 mg/l) making it unsafe for human consumption.

7.2.2.2 Full Flood Protection

a. Impacts

As flood water is not expected to enter the project it is difficult to predict water quality changes that might occur with full embankment protection. While the embankment would protect the area from damaging floods, it would also prevent the seasonal and flash flood flushing that is considered beneficial to water quality. Because the area receives large quantities of rainfall, an embankment is not expected to affect groundwater quality as percolation would continue to recharge the aquifer. A long term study on groundwater hydrology, however, is needed to truly assess this issue.

An embankment would allow an increase in cropping intensity and promote the use of HYVs. With such changes, farmers would increase their use of pesticides (by an estimated 1000 kg annually) which might degrade water quality, depending on the mode and rates of application.

b. Mitigation

People must be educated not to dispose or discharge domestic or industrial waste in or near water systems. They must also understand the health hazards of defecating in or near water systems. People should be educated to boil their drinking water or at least use water purifying tablets. The tablets should be available at low cost.

More hand tubewells should be provided for domestic water use.

Pesticides should be used strictly in the prescribed manner. They should never be handled near surface waters nor should the containers be washed in ponds, canals, beels or rivers. There should be awareness and education programs on this important problem from the extension agencies and public information systems. The manufacturers should label their products with health related information and instruction.

7.2.2.3 Submersible Embankments

a. Impacts

The situation where submersible embankments are provided is similar to the future without project except that the intensity and severity of flash and seasonal floods would be reduced. Submersible embankments would allow an increase in cropping intensity and promote the use of HYVs. Such changes would promote increased pesticide use which might degrade water quality.

Irrigation would increase, which would reduce the availability of water for domestic purposes. Therefore, people would become more dependent on groundwater for domestic uses.

With submersible embankments the drainage system is expected to hold more water. Surface water quality is not expected to deteriorate because water flow situation remains almost same as is at present.

b. Mitigation

With an increase in cropping intensity and the use of HYVs, farmers would use more pesticides which could degrade water quality. In addition, pesticides should be used strictly in the prescribed manner. Pesticides never should be handled near surface water areas, nor should the container be washed in such areas. People should be educated to boil their drinking water or at least use water purifying tablets. The tablets should be available at a low cost. More hand tubewells should be provided for domestic water use.

7.3 Land Resources

7.3.1 Soils and Topography

7.3.1.1 Future Without Project

Without embankments, soils of the area would continue to support the current agricultural practices. The soils would continue to be exposed to flash and seasonal floods that cause heavy crop losses every year.

Each year, fresh sediments are deposited within the project area, primarily on the highlands and medium-highlands. These sediments may add nutrients to the soils. Local farmers favor annual sedimentation since they believe it increases crop production.

Without the project there would be continued erosion along the Kushiyara River. Continued erosion would result in more territorial loss for Bangladesh.

In addition, the project area's drainage system may deteriorate further. Soils in the basin area would continue to remain under water for long periods, possibly affecting its physical properties. The current adverse hydrological situation of the area would keep land in fallow condition. At present, about 500 ha. remains fallow every year.

7.3.1.2 Full Flood Protection

a. Impacts

With project intervention, the soils of the project area would be protected from flash floods and, therefore, used more for agricultural purposes. The depth of surface inundation of soils would be reduced in the monsoon season, thereby increasing highland and medium highland areas, and decreasing medium lowland and lowland areas (Table 7.1).

Soil phase changes may occur. Part of the Goyainghat medium highland phase may become highland phase, while the Kanairghat medium lowland phase may be included partly under the medium highland phase of the same soil series.

As crops are protected from floods, farmers may invest more in intensive cultivation with HYV crops, fertilizers and pesticides. Increased pesticide use may harm beneficial soil microbes. Random application of fertilizer without addition of organic manure may degrade the natural fertility of the soils. Groundwater and surface water also may be contaminated.

As a consequence of reduced number of days of inundation on the soils of the Project areas, biological fixation of nitrogen in the soils may be decreased. In addition, the deposition of nutrients via fresh sediments may be reduced and the soils may develop more acidity.

b. Mitigation

To stop probable degradation of soil fertility, the following measures should be adopted:

- Using of more organic manure
- Practicing green manure technology
- Using of fertilizers and pesticides judiciously
- Occasional operation of regulators to flush the area

Using less harmful pesticides or adopting Integrated Pest Management (IPM), and cautious use of fertilizers may prevent groundwater and surface water contamination. Environmental monitoring programs should be taken up to determine the extent of degradation of soil fertility

Table 7.1. Land Type Distribution under Post-Project Condition with Alternate Options in the Surma-Kushiyara Project Area

Land Type	Total Area in ha (% of Total Area)	Net Area Available for Agriculture in ha ((% of Total Net Area)	Remarks
Future Without Project(Option 1)/Submersible Embankment(Option 3)			
High Land	13,831 (35)	7,201 (24)	6,630 ha under homesteads orchards, roads etc.
Medium High Land	5,954 (15)	5,954 (20)	
Medium Low Land	8,320 (22)	8,320 (28)	
Low Land	10,895 (28)	8,225 (28)	2,670 ha under permanent water
Totals:	39,000	29,700	
Future with Flood Control and Drainage (Option 2):			
High Land	16,059 (41)	9,429 (32)	6,630 ha under homesteads orchards, roads etc.
Medium High Land	6,764 (17)	6,764 (23)	
Medium Low Land	7,275 (19)	7,275 (24)	
Low Land	8,902 (23)	6,232 (21)	2,670 ha under permanent water bodies
Totals:	39,000	29,700	

after project implementation.

7.3.1.3 Submersible Embankments

a. Impacts

Submersible embankments would not change soil series phases as land types under this option is not changed (Table 7.1). Natural fertility of the soils on highland and medium highland will remain more or less intact. Soil will continue to receive fresh sediments and period of inundation on these soils will remain same. Intensive use of fertilizers by farmers may not be same as the full flood protection option for fear of flood. Dry season irrigation may bring more areas under boro cultivation on Kanairghat soils. Phagu, Kanairghat and Terchibari soils would remain under wetland conditions throughout the year. Winter rice would be grown on these soils, possibly decreasing the micronutrient availability. Sulphur and zinc deficiencies may occur in these soils in the future due to reduced conditions caused by irrigation.

Irrigation may cause seepage losses in irrigation canals and percolation losses in fields passing through of light textured soils (Kushiyara and Balaganj series). Irrigation water may drain onto Phagu and Terchibari soils and accumulate in basins to form water-logged areas.

b. Mitigation

The practice of growing two rice crops in basin soils may be intermittently replaced by growing a dry land crop to overcome soil mineral deficiencies. Introduction of legumes in crop rotation may prevent micronutrient availability problems. Chemical fertilizers may be applied to thwart micronutrient deficiencies.

Better soil and water management and lining of irrigation canals would prevent seepage and percolation losses of Balaganj and Kushiyara soils.

7.3.2 Agriculture

7.3.2.1 Future Without Project

Without a project, the current land types and current cropping practices are expected to remain the same (Table 7.1).

Seasonal floods caused by heavy rainfall would continue to damage transplanted aman and broadcast aman crops almost every year. April and May flash floods would continue to damage broadcast aus, transplanted aus, boro and broadcast aman crops. Damage would be more frequent when existing embankments are breached or eroded. Farmers are unlikely to intensely cultivate with HYVs, fertilities and pesticides because of their repeated crop loss.

Farmers are likely to continue seeking fresh flood sediment to raise cropland elevation and enhance soil fertility. In some areas large quantities of sediment would continue to damage seedling crops.

Continual drainage congestion would aggravate and delay transplanting aman from flood-damaged fields and would increase the extent of flood damage.

Farmers cannot sustain transplanted aman and broadcast aman in the field due to repeated flood damage. As a result, lands are allowed to lie fallow. This current trend would likely restrict cropping intensity to the level of 141 percent.

7.3.2.2 Full Flood Protection

a. Impacts

If full flood protection is provided, about 24,000 tons of annual crop damage could be prevented. Both aus and broadcast aman crops would be protected from flash floods at their early growth stage. Boro crops could be protected until harvest time and the repeated seasonal flood damage to transplanted aman could be greatly reduced.

With the risk of seasonal flooding reduced, single crop of transplanted (including deep water) or broadcast aman could be grown in medium lowlands.

Current cropping intensity on highland and medium-highland areas may increase in future as proposed intervention would include more areas under these land types (Table 7.1).

Present cropping patterns on different land types are likely to be picked up by neighboring farmers if identical hydrologic conditions are created in their fields. Based on this assumption projected cropping patterns are shown in Table 7.2.

Outside the embankment , loss of crops by flash flood would be more frequent.

Projected cropping patterns may increase cereal production up to 85,000 tons (Table 7.3) annually and cropping intensity to 153 percent from present annual production of 55,000 tons. Increase crop production and cropping intensity with increase agricultural labor requirements and inputs (Table 7.4 and 7.5) which would have impact on socio-economic situation of the area (For detail, please see Chapter 7.5)

b. Mitigation

New sustainable cropping patterns are needed for areas outside the embankments. One proposed cropping pattern may be late transplanted aman (BR-23) followed by short-term rabi crops (potato) or winter vegetables. River water irrigation may be provided to these crops.

7.3.2.3 Submersible Embankments

a. Impacts

Submersible embankments would aid in delaying flash floods for about a month, allowing farmers extra time to successfully harvest their boro crop and aman crops.

Transplanted aman grown on higher areas, and grown in areas where broadcast aman was damaged, may be hurt by seasonal and late flash floods.If irrigation is provided, HYV boro may replace broadcast aman in medium-lowland areas. In addition, lowland areas would produce more boro crop because current fallow lands would be cultivated.

With submersible embankments in place, flash floods would not damage aus and broadcast aman as often. Although reduced, the fear of flooding may persuade farmers to replace aus with boro crops on some highland and medium-highland areas instead of irrigating aus. If submersible embankments are used, future cropping patterns (Table 7.2) may produce 70,000 tons of cereal per year (Table 7.3) and increase cropping intensity to 146 percent. Crop irrigation requirements with submersible embankments are shown in (Table 5.15)

b. Mitigation

Loss of Aus and Aman crops may be recovered if farmers are supported timely with seedlings and credits during their second transplantation of crops.

Table 7.2. Cropping Patterns under Post-Project Conditions with Alternate Options in the Surma-Kushiyara Project Area

Land Type	Cropping Pattern Kharif-1	Kharif-2	Rabi	Area (ha) under Pattern Without Project Opt.1)	FCD (Opt.2)	Sub. Emb. Opt.3)
High Land	B.Aus(L)	T.Aman(L)	Fallow	2,520	3,300	2,520
	T.Aus(L)	T.Aman(L)	Fallow	1,440	1,885	1,440
	T.Aus(L)	T.Aman(H)	Fallow	360	471	360
	T.Aus(H)	T.Aman(L)	Fallow	1,080	1,415	1,080
	B.Aus(L)	T.Aman(H)	Fallow	720	942	720
	Seed Bed	T.Aman(L)	Fallow	360	695	-
	Seed Bed	T.Aman(L)	Boro(H)	-	-	360
	B.Aus(L)	Fallow	Rabi Crop	721	721	721
			Sub-Total:	7,201	9,429	7,201
Medium High Land	B.Aus(L)	T.Aman(L)	Fallow	2,380	2,705	2,380
	T.Aus(L)	T.Aman(L)	Fallow	1,913	2,175	1,913
	T.Aus(L)	T.Aman(H)	Fallow	1,311	1,490	1,311
	T.Aus(H)	T.Aman(L)	Fallow	350	394	-
	Fallow	T.Aman(L)	Boro(H)	-	-	350
			Sub-Total:	5,954	6,764	5,954
Medium Low Land	B.Aus(L)	T.Aman(L)	Fallow	1,030	1,030	1,030
	B.Aman(D)	T.Aman(L)	Fallow	4,000	-	2,970
	Fallow	T.Aman(L)	Fallow	830	2,622	-
	Fallow	T.Aman(L)	Boro(H)	-	-	1,550
	B.Aman	B.Aman	Fallow	1,660	2,770	2,770
	Fallow	Fallow	Boro(H)	500	853	-
	Fallow	Fallow	Fallow	300	-	-
			Sub-Total:	8,320	7,725	8,320
Low Land	B.Aman	B.Aman	Fallow	1,040	-	-
	Fallow	Fallow	Boro(H)	1,645	1,292	2,725
	Fallow	Fallow	Boro(L)	4,940	4,940	5,500
	Fallow	Fallow	Fallow	600	-	-
			Sub-Total	8,225	6,232	8,225
			Grand Total:	29,700	29,700	29,700

L= local H= high yield D= damaged

7.3.3 Livestock

7.3.3.1 Future Without Project

Seasonal and flash floods would continue to damage major crops of the area, creating shortages of livestock fodder. Economic restraints would prevent most farmers from purchasing feed or fodder from the market. Much poultry would be lost during flash floods. Disease and

Table 7.3. Crop Area and Production under Post-Project Condition with Alternate Options in the Surma-Kushiyara Project Area

Crop	Area (ha) Normal	Area (ha) Damaged	Yield (t/ha) Normal	Yield (t/ha) Damaged	Production (tons)	Production Lost (tons)
Future Without Project (Option 1):						
B Aus(L)	2,904	4,467	1.2	0.5	5,718	3,127
T Aus(L)	2,472	2,552	1.5	0.8	5,725	2,026
T Aus(H)	694	736	2.7	1.0	2,610	1,251
B Aman	1,012	1,758	1.6	0.0	1,619	2,812
T Aman(L)	6,155	9,748	1.8	1.0	20,827	7,798
T Aman(H)	1,054	1,337	3.0	1.6	5,301	1,872
Boro(L)	3,155	1,785	2.0	1.0	8,095	1,785
Boro(H)	690	1,455	4.0	1.6	5,088	3,492
			Total Paddy:		54,468	24,536
With Flood Control and Drainage (Option 2):						
B Aus(L)	8,698		1.2		10,438	
T Aus(L)	6,021		1.5		9,031	
T Aus(H)	1,809		2.7		4,884	
B Aman	2,770		1.6		4,432	
T Aman(L)	16,221		1.8		29,197	
T Aman(H)	2,903		3.0		8,709	
Boro(L)	4,940		2.0		9,880	
Boro(H)	2,145		4.0		8,580	
			Total Paddy:		85,151	
With Submersible Embankment, Drainage and Irrigation (Option 3):						
B Aus(L)	2,904	4,467	1.2	0.5	5,718	3,127
T Aus(L)	2,472	1,112	1.5	0.8	4,598	778
T Aus(H)	694	386	2.7	1.0	2,260	656
B Aman	1,012	1,758	1.6	0.0	1,619	2,813
T Aman(L)	6,155	9,438	1.8	1.0	20,517	7,550
T Aman(H)	1,054	1,337	3.0	1.6	5,301	1,871
Boro(L)	5,500	-	2.0	-	11,000	-
Boro(H)	4,985	-	4.0	-	19,940	-
			Total Paddy:		70,953	16,795

epidemics would continue to be limiting factors on livestock populations.

7.3.3.2 Full Flood Protection

a. Impacts

If full flood protection is provided, crop production would increase, thereby reducing the feed

Table 7.4. Input Use Level in Different Crops under Post-Project Condition in the Surma-Kushiyara Project Area.

Crop	Person -Days	Animal Pair-Days	Seed (kg)	Fertilizers (Kg)			Pesti-cides (kg)
				Urea	TSP	MP	
B Aus(L)	137	42	100	7	5	2	0.0
T Aus(L)	157	53	25	14	12	8	0.0
T Aus(H)	167	55	25	41	33	18	0.0
B Aman	115	42	100	0	0	0	0.0
T Aman(L)	157	44	25	15	11	8	0.0
T Aman(H)	167	46	25	28	24	16	0.5
Boro(L)	162	40	25	12	0	0	0.3
Boro(H)	207	42	25	40	0	0	0.5
Rabi Crops	95	35	1	6	5	3	0.0

Table 7.5. Agricultural Labor Requirements under Post-Project Condition with Alternate Options in the Surma-Kushiyara Project Area.

Crop	Area (ha)	Person-Days per Hectare												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Future Without Project (Option 1)														
B Aus(L)	7,371			31	30	30	25	15	5					136
T Aus(L)	5,024			10	40	30	15	15	25	20				155
T Aus(H)	1,430			10	40	30	20	20	25	20				165
B Aman	2,770			30	30	10						25	20	115
T Aman(L)	15,903						10	40	30	20	10	25	20	155
T Aman(H)	2,391						10	40	30	25	15	25	20	165
Boro(L)	4,940	30	20	15	25	20						10	40	160
Boro(H)	2,145	30	30	25	25	25	20					10	40	205
Rabi Crops	721	10	10	15	10							30	20	95
Total Requirement: (000 person-days)		220	170	513	745	604	518	954	747	520	262	604	700	6557

and fodder shortages.

Full flood protection also may reduce disease due to an improved hygienic environment during the wet months. In turn, healthy livestock may provide more draft power and increase availability of animal protein for human consumption. Increase cropping intensity and conversion of fallow land into crop land may limit the grazing facility of the area.

b. Mitigation

Grazing facility on wasteland, along roadsides and embankments may be improved by growing napier and para forage grasses.

Table 7.6. Agricultural Labor Requirements under Post-Project Condition with Alternate Options in the Surma-Kushiyara Project Area.

Crop	Area (ha)	Person-Days per Hectare: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
With Flood Control and Drainage (Option 2):														
B Aus(L)	8,698			31	30	30	25	16	5					137
T Aus(L)	6,021			10	40	30	15	15	25	22				157
T Aus(H)	1,809			10	40	30	20	20	25	22				167
B Aman	2,770			30	30	10						25	20	115
T Aman(L)	16,221						10	40	30	20	10	25	22	157
T Aman(H)	2,903						10	40	30	25	15	25	22	167
Boro(L)	4,940	30	20	15	25	22						10	40	162
Boro(H)	2,145	30	30	25	25	25	22					10	40	207
Rabi Crops	721	10	10	15	10							30	20	95
Total Requirement: (000 person-days)		220	170	570	842	686	582	1031	813	569	275	626	719	7102
With Submersible Embankment, Drainage and Irrigation (Option 3):														
B Aus(L)	7,371			31	30	30	25	15	5					136
T Aus(L)	5,024			10	40	30	15	15	25	20				155
T Aus(H)	1,080			10	40	30	20	20	25	20				165
B Aman	2,770			30	30	10						25	20	115
T Aman(L)	15,593						10	40	30	20	10	25	20	155
T Aman(H)	2,391						10	40	30	25	15	25	20	165
Boro(L)	5,500	30	20	15	25	20						10	40	160
Boro(H)	4,985	30	30	25	25	25	20					10	40	205
Rabi Crops	721	10	10	15	10							30	20	95
Total Requirement: (000 person-days)		322	267	591	818	678	571	934	729	506	261	631	829	7136

7.3.3.3 Submersible embankments

a. Impacts

If submersible embankments are built and irrigation facility increases, grazing areas may be reduced because farmers would use more land to increase boro production during the dry season. But flash floods would continue to damage crop residues (fodder) stored in homestead courtyards. Protection from submersible embankments may not improve hygienic conditions.

b. Mitigation

To offset the negative impacts of submersible embankments quality fodder crops (khesari, black grass) should be incorporated into the current cropping pattern. Forage grasses (napier, para) may be grown on wastelands, along roadsides and embankments.

The number of buffalo should be increased because they are well-adapted to the project wetland situation. They also would increase draft power for various agricultural operations.

7.3.4 Other Land Uses

7.3.4.1 Future Without Project

Flash floods are likely to continue to damage homes, homestead vegetation, vegetable gardens and cowsheds. Poorly built schools, madrasas, bazaars, and mosques are also damaged. Roadside plantations are affected and road communications are interrupted during peak hours of a flash flood.

Existing embankments are frequently breached or eroded, causing damage to life and property. This trend is likely to continue.

7.3.4.2 Full Flood Protection

a. Impacts

Full flood protection would protect homesteads, roads, embankments, schools, madrasas, bazaars etc. Homestead vegetation and vegetable production also would be protected. The number of plantations may increase along embankments and roadsides as people become interested in intensive plantations.

b. Mitigation

The embankment should be properly designed for plantation programs which should be accompanied with benefit sharing agreement with local people. Embankments should be well built to avoid risks of failure.

7.3.4.3 Submersible Embankments

a. Impacts

Submersible embankments will reduce the depth and duration of flash floods. Reduced damage to homesteads, roads, bazaars, plantations and vegetation are expected.

b. Mitigation

Embankments should be strengthened at all breaching points. Roads should be raised and repaired at points where flood water overflows. Homestead courtyards and home foundations should be raised to safe heights. Pond banks should be raised and strengthened to control overflow flood water. Vegetation and plantations should be drained to limit flash flood damage.

7.3.5 Forestry and Homestead Vegetation

7.3.5.1 Future Without Project

Repeated floods would continue to damage homestead vegetation. Floods also would continue to damage economically important trees such as betelnut, cane, patipata, jack fruit, wood apple and neem. It would be difficult for new seedlings and saplings to become established.

As the human population continues to grow, people would settle on medium-highland and medium-lowland areas with corresponding decreases in available crop land. Farmers are unlikely to cultivate summer vegetable crops and there would be an increase in the trend toward biomass depletion.

7.3.5.2 Full Flood Protection

a. Impacts

With full flood protection about 80 percent homesteads would be protected from flood inundation. Such protection also would promote an increase in plantation forests and natural vegetation, and decrease deforestation. Homestead and plantation production would increase, resulting in more food, fodder, fuel, timber and building materials. Such increases would improve nutrition, health conditions and overall economic conditions. More vegetative cover also should lessen the negative effects of floods, droughts, cyclones and other environmental disasters.

If full flood protection is provided, however, homesteads are likely to spread over medium-highlands and medium-lowlands. This increase in homesteads would result in a loss of croplands and natural vegetation. Even with full flood protection, homesteads, plantations and natural vegetation would be seriously damaged during major floods.

New fast growing and high yielding plant species may be introduced, but are likely to be damaged during extreme floods when embankments are overtopped and breached.

b. Mitigation

To offset the losses caused by a reduction in crop area, farmers need more economic return from homestead groves, embankments, roadsides and waterway bank plantations. The returns could be in the form of food, fodder, fuel or cash. The design of embankment structures should be suitable for plantation programs and plantation programs should be accompanied with the benefit sharing agreement with the local people.

Drainage and irrigation facilities should also be improved to facilitate increased plant production.

7.3.5.3 Submersible Embankments

a. Impacts

With submersible embankments, slow and late inundation would occur for short periods of time as the flood water will enter late and slowly. There should be less homestead plantation loss depending upon the depth and duration of inundation. Because the embankment construction is controlled, displaced households may be resettled inside the project area. This would result in a loss of homesteads and cropland production outside the embankment, thereby promoting river erosion.

b. Mitigation

Properly designed and constructed embankments may minimize the set-back distance and the risks of embankment failure as well. Raising of homestead mounds, vegetable gardens, roads to a safe height will be needed. Introduction of flood resistant species for vegetation/cultivation will be needed to avoid malnutrition, fuel and fodder crisis.

7.4 Biological Resources

7.4.1 Open Water Capture Fisheries

7.4.1.1 Future Without Project

If the project is not built, the existing fish habitat would remain mostly unchanged provided that the siltation rate is not high. Continuous siltation, however, would gradually raise wetland and canal beds, resulting in reduced fish habitat and hinder migration of major carp and other species in early monsoon. High turbidity would continue to harm fish health and limit primary productivity. Fish species diversity and production would gradually decline over years.

7.4.1.2 Full Flood Protection

a. Impacts

With full flood protection the existing fish habitat (seasonal wetlands) would be greatly reduced by about 6000 ha resulting in the loss of about 1000 tonnes of fish per year (based on average assumed production rates). Besides spatial reduction, there would also be temporal (hectare-month) reduction of flood plains within the project area i.e. reduction of existing 6-7 months (May-November) to 4-5 months (June-October). Such protection also would inhibit the migration of fish and fry from inside the project area to outside, and vice versa. The population of major carp species would be reduced by about 80 percent. Fish stock replenishment would be reduced as well as fish population and species diversity.

Full flood protection would prevent allochthonous nutrient sources from entering the area in its usual flood-transported manner. The absence of such nutrients would reduce wetland productivity. Eutrophication of beels may occur over years which would promote excessive macrophyte growth and algal bloom that would result in adverse environmental condition viz. oxygen depletion, accumulation of toxic gases etc. thereby, make the wetlands unsuitable for some fish species.

Increase application of agro-chemicals (about 1000 kg. per year) due to intensive HYV crop cultivation could jeopardize fish health.

Reduced fish habitat compounded with reduced migration and increased fishing pressure would decrease overall capture fishing production within the project area.

b. Mitigation

If full flood protection is used there should be increased numbers and distribution of structural openings of the proposed canals and existing open canals. Canals and beel beds should be desilted to maintain water levels year round. In addition, regulator vents should be open during April to May, and August to October to facilitate fish migration and replenishment of stocks.

The parent stock of resident fish should be conserved. Fishing in some large beels (Andu Baor, and Dubail, Chatal, Dubag and Septi beels) should be limited to every two to three years in alternate sequences. Fishing for major carp should be restricted during spawning migration and wetlands should be regularly stocked with carp fingerlings. Fish hatcheries should be installed and culture fisheries improved. Excess macrophytes should be removed from stagnant wetlands. Application of non-degradable pesticides should be carefully controlled.

7.4.1.3 Submersible Embankments

a. Impacts

If submersible embankments are used major carp would be inhibited in migrating from beels and baors within the project area to adjacent rivers during the early monsoon (March to May). Therefore, the number of major carp inside the project area and in the adjoining areas would decrease by about 50 percent.

b. Mitigation

If submersible embankments are used wetlands should be regularly stocked with carp fingerlings. Fishing the permanent wetlands by complete dewatering should be restricted. Sluice gates should be kept open during the entire seasonal flood that comes after the boro harvest at the end of May.

7.4.2 Closed Water Culture Fishery

7.4.2.1 Future Without Project

If the project is not built, closed water culture fisheries (pond fishery) would continue to be adversely affected by both flash and seasonal floods. As flood water inundates fish ponds, stocked fish as well as undesirable fish swim out or are swept away by flood water.

7.4.2.2 Full Flood Protection

a. Impacts

Because the area would be fully protected from flash and seasonal floods, closed water culture fisheries would be developed gradually inside the project area by around 5 percent ponds per year. People would be encouraged to engage in pond fisheries for additional income. Production of fish would increase from existing 400-8000 kg/ha/year to around 1500 kg/ha/year.

b. Mitigation

All support services related to culture fisheries, such as quality fish seed, and technical and credit supports, should be available to local people.

7.4.2.3 Submersible Embankments

a. Impacts

Submersible embankments would protect culture fishery ponds by about 30 percent. Seasonal floods, however, would continue to damage ponds, discouraging pond owners from engaging in pond fisheries.

b. Mitigation

To avoid losing fish to floods, ponds should be stocked with large fingerlings after the flooding period (between September and November). The fish should be harvested before the next flooding period by May.

7.4.3 Wildlife

7.4.3.1 Future Without Project

a. Impacts

Without project intervention dholkolmi (*Ipomoea fistulosa*) would probably expand its coverage over a large area between perennial water bodies and lowlands. Because of flash floods these lands are not cultivated (mostly belonging to poor people). If these lands are allowed to remain fallow for 2 - years dholkolmi growth makes it impossible for cultivation.

The fertility of wetlands would be continually affected by the loss of aquatic macrophytes through frequent flash floods. These macrophytes are currently the main sources of nitrogen and phosphorus.

Human activities next to wetland areas, principally boro cultivation from November, would continue to create problems for migratory birds during the migration period (October to Mid April). Over-extraction of macrophytes, beel water for irrigation and overfishing would continue to negatively affect migratory birds.

Habitats for endangered and threatened wildlife species are declining country wide, and wildlife populations in general are declining due to overhunting and trapping, mainly by outsiders. These trends would continue in the project area.

7.4.3.2 Full flood protection

a. Impacts

With full flood protection the existing land - water ratio would be changed. Highland would be increased by 6 percent and medium highland by about 2 percent. This would favor terrestrial wildlife (mainly the rat population). Reduction of medium lowland by 3 percent, lowland by 5 per cent and a reduction in perennial water surface area would negatively affect the population of resident and migratory wetland dependent birds. Critical wetland habitats for endangered and threatened wildlife species would be reduced.

Large populations of rates would likely negatively affect full flood embankments, creating suitable conditions for embankment failure. Outbreaks of insect and rodent pests would increase due to HYV practices and land - water ratio since flood is the major controlling factor for rat populations.

b. Mitigation

Some of the existing wetlands (Chatal Beel, Dubail Beel, Septi Beel, etc) could be declared as sanctuaries for wildlife under joint management by Fisheries, Agriculture and Forest departments with the help of local people and administrations. The remaining water bodies should be placed under some form of integrated wetland management programme. The flushing of these areas should be a prime objective of management.

Integrated pest management should be practiced instead of chemical control of pests. The Wildlife Preservation Act and other applicable laws should be strictly enforced. Plantation programs should be encourage to enhance the availability of wildlife habitat.

7.4.3.3 Submersible Embankments

a. Impacts

There would be little change expected from the present situation without the project. Sudden overtopping) of submersible embankments might cause damage to aquatic macrophytes and some burrowing wildlife.

b. Mitigation

Controlled flooding and a smooth release of water inside the project area might protect the loss of macrophytes. Integrated wetland management, including the controlled extraction of irrigation water, reasonable extraction of macrophytes for cattle and as green fertilizer, control/alternate year fishing and strict control of legal wildlife hunting would be helpful for wildlife populations as well as to obtaining the greatest output of wetlands. Re-excavation of canals and wetlands would mitigate the loss of wetland areas through sedimentation.

7.5 Human Resources

7.5.1 Population and Communities

7.5.1.1 Future Without Project

Without a project the severity of flash floods would continue with natural or man-made breaching and overtopping of existing dykes. The incidence of flash flooding could worsen in the future, causing more damage to crops, livestock and other productive assets. Seasonal floods caused by heavy rainfall would remain a concern for people. Damages from such floods would be aggravated by blocked drainage channel outlets. Waterlogging and drainage congestion from blocked channels would further deteriorate, causing flood water to stand in homestead compounds and lowlands for longer durations. Erosion would continue to have a devastating effect, displacing households and exacerbating the process of landlessness. Erosion also would reduce the amount of productive agricultural land, promote the process of out-migration and contribute further to the loss of national territory.

Settlements along the main rivers and people living on the project area periphery would continue to be affected by flooding and embankment breaching. Repeated flood-related damage would progressively deteriorate the quality of life, especially for those of lower socioeconomic status. Ill health, nutritional deficiency, and loss of life due to flood-related diseases would increase. Outbreaks of disease and epidemics may reduce the population.

The net effect of continued flooding, waterlogging, drainage congestion and erosion would be continuing low agricultural productivity, increasing poverty, landlessness and unemployment.

7.5.1.2 Full Flood Protection

a. Impacts

Full flood protection would stop flash flooding, improve drainage and improve the waterlogging situation. This would enhance agricultural production, facilitate year-round productive activities within agriculture, and widen the scope for non-farm employment. Farmers would grow more HYV varieties, use more chemical fertilizers and pesticides, and increase intense cultivation. Agricultural production should increase as a result. The intensive cultivation would generate employment opportunities and a possible rise in wages. Such changes would increase the income of many landless and land-poor households and help absorb the expanding agricultural labor force.

Full flood protection would improve homestead production and increase the opportunity for women to be more involved in home gardening, poultry and livestock raising activities. Such involvement would increase household income.

With full flood protection, homestead areas are likely to spread from the existing medium-highlands to medium-lowlands, leading to the loss of potential agricultural land. During extreme flooding, breaching and embankment overtopping may seriously damage newly constructed homes and homesteads, and threaten human life. Increased use of chemical fertilizers and pesticides, however, may harm natural soil fertility and contaminate groundwater and surface water. As a result, human health risks and fish diseases could increase.

Families displaced by embankment construction and set-back requirements would lose ancestral homes, homesteads and agricultural land. This may cause considerable psychological stress, particularly to the poorest who would become "environmental refugees" for the protection of their own environment.

Areas outside the project area, but inside the impact area, such as the northern side of Surma River or downstream of the project, already face severe flood damage from Lubha River over-spill. This situation would be further aggravated if a full embankment is constructed only on the left southern side of the Surma River.

b. Mitigation

If full flood protection is provided, farmers should be educated in judicious use of chemical fertilizers and pesticides. The use of organic manures should be increased and the Integrated Pest Management (IPM) Program should be adopted.

People should be alerted to extreme flooding events through public awareness programs. These programs should be presented through local level institutions and the national media.

Displaced households should be fully and immediately compensated for loss of homestead and agricultural land acquired through FCD intervention. Compensation payments could be made based on the socioeconomic condition of those affected and incorporate several options, including full compensation, allotment of khas land and/or resettlement in clustered villages without payment.

People living outside the protection area should be educated on flood proofing and disaster preparedness measures.

Embankments should be monitored and assessed for natural and intentional breaching. Local people should help in the monitoring.

7.5.1.3 Submersible Embankments

a. Impacts

Submersible embankments would reduce frequent seasonal floods, delay flash floods and allow farmers to safely harvest their boro crop. More areas would be brought under HYV boro crop and more fallow lands would go under cultivation. Irrigation facilities may improve, but the continued fear of flooding may stop farmers from irrigating aus and aman crops.

Damage to homestead production would be reduced to some extent, but unless drainage systems are improved, flood water would continue to stand in homes and homesteads for long periods.

Without improved drainage the risk of water-borne diseases and disease vectors would increase.

b. Mitigation

To offset negative impacts farmers should be encouraged to use organic manures and less harmful pesticides. Biological controls should be encouraged. Agricultural recovery programs should be strengthened by supplying seeds, seedlings, credit and other critical services.

Malaria control programs should be strengthened and health care facilities improved to ensure safe drinking water and adequate medicine.

Accurately forecasting serious flooding with an Early Warning System (EWS) may allow people time to protect household assets and to safely stock food, water and animal fodder. People within the project area, and those downstream, should be educated on flood proofing and flood preparedness.

People should be educated to more effective uses of common property resources, especially those near flood plains and roadsides.

7.5.2 Livelihood and Subsistence

7.5.2.1 Future Without Project

Without project intervention flash floods would continue to be exacerbated by natural or manmade breaching and dyke overtopping. Homes and homesteads would continue to be damaged, and personal and household assets lost. Seasonal and flash floods would continue to damage major crops annually and the blocked drainage system would further waterlog the situation. The drainage system would become more blocked and silted, waterlogging more land and making it unsuitable for cultivation. Existing dykes would offer little protection against erosion. If allowed to continue, erosion would devastate riverside households and erode national territory.

Without project intervention, many households would suffer repeated damage to crops, livestock and homestead production. Their loss of income and assets would progressively deteriorate their quality of life. Such deterioration would accelerate the trend toward landlessness, poverty, inequality and unemployment.

7.5.2.2 Full Flood Protection

a. Impacts

Full flood protection impacts would be similar to those presented in section 7.5.1.2. In addition there would be fisheries-related impacts. Total fish numbers and productivity would diminish which would negatively impact household fish consumption and nutrition. In addition, professional fishermen may abandon fishing to seek other occupations, pressuring the already tight employment situation. Many fish-inhabited haors, baors and flooded beels would be

If they do not add to drainage problems, submersible embankments are not expected to increase health risks. More accurate prediction of the onset of delayed floods may allow communities time to safeguard health. It may be possible to stock some food and water.

Without considerable drainage system improvements, flood water would still stand in homes and homesteads for long periods, and risk of in injection by water-borne diseases would remain. If water does not drain as the floods recede, mosquitoes would multiply and an increase in the incidence of malaria may result.

b. Mitigation

Proper maintenance of the embankment and drainage improvement would reduce the risk of water borne and vector disease. Construction of new or adaption of existing buildings for use as sanitary flood shelters, and installation of tubewells and latrines on higher ground or along roads currently used as flood refuges would be of major benefit during severe flooding. Primary health education and improvement of emergency medical services would enhance people's ability to manage flooding situations.

7.5.8 Food and Nutrition

7.5.8.1 Future Without Project

There is no population growth rate figure available for the case study area. However, given the relatively large family size and negligible use of family planning (See Section 5.5.3), the population growth rate is probably the same or higher than the national annual growth rate of 2.6 percent. As elsewhere in Bangladesh, this indicates a growing imbalance between land and population. Without intervention, the repeated flash flooding would continue to damage crops, property and assets, further exacerbating the trend toward increasing landlessness, unemployment, poverty and malnutrition.

If the population continues to grow at the current rate, it would double in about 30 years. Marginal to medium farmers would continue to sell land to feed their families. Even occasional bumper crops would not compensate farmers for the continual flood losses sustained. This process would increase the concentration of land and income in the hands of large landowners, who would continue to diversify their income from non-agricultural sources. The number of landless would grow both in absolute and relative terms. Loss of land, however, would not be matched by employment opportunities. Capture fisheries would continue to decline due to population pressure, blocked fish migration and the practices environmentally damaging of water body leaseholders. Poverty would increase. The landless and land poor, the majority of the population, would suffer from nutritional deficiencies. Women and girl children, who tend to suffer disproportionately at times of crisis, may be more affected.

converted to agricultural fields. This would reduce fish habitat, and hinder fish migration and fishing activities.

b. Mitigation

The mitigation strategies for full flood protection would be similar to those presented in section 7.5.1.2 (b). Additional mitigation measures related to fisheries would,include controlled water passages for fish migration and protection of fish habitat, changes in the existing jalmahal and fishing leasing systems, stopping of unregulated and indiscriminate fishing and the use of current nets, and the establishment of reserve fishery areas and fish hatcheries in every Union.

Fish culture production should be increased, particularly by supplying fingerlings and improving carp stocking programs. Local people should be involved in re-excavating abandoned ponds and tanks. The re-excavated ponds, tanks and burrow pits should go to landless groups.

7.5.2.3 Submersible Embankments

a. Impacts

Impacts from submersible embankments on the livelihood and subsistence pattern of people, and the possible adverse health risks associated with it, are similar to those discussed in 7.5.1.2. Additional concerns related to water quality and fish supplies. Submersible embankments would have less adverse impact than full flood protection on fish stock recruitment. But without an improved drainage system, submersible embankments would prevent fish migrating from beels to rivers and vice versa. On the other hand, if canal outlets are opened and the drainage system is improved, fish migration would be easier and fish numbers would increase. An effective drainage system also would improve surface water quality and protect homestead production from flood damage.

b. Mitigation

Mitigation strategies for submersible embankments would be similar to those presented in 7.5.2.2. (b).

7.5.3 Gender Relations

7.5.3.1 Future Without Project

Without project intervention flash floods, water logging and erosion would continue to devastate households in the study area. Existing embankments would offer little protection against erosion and water would continue standing for long periods in homes and homesteads. Repeated damage to homes and loss of land and assets would continue.

The loss of household assets such as home gardens, livestock and poultry would undermine the primary opportunity for expanding the role of women in generating income and securing food. In addition, limited opportunities for women to generate non-farm income from mat making would be further reduced if the grasses used as raw materials continue to be destroyed and become more scarce in the market.

The loss of womens personal assets such as jewellery and valuables would increase with flood indebtedness. Such overall deterioration of the economic situation may adversely affect women's sociocultural position and reduce the liberalizing trend towards greater female education.

Women are the primary caretakers of the home, and of the health of their families. With worsening poverty and increased landlessness, women would face even greater stress. As flooding continues, loss of life and ill health caused by flood related diseases and nutritional deficiencies would increase. During severe flooding drinking water would be contaminated, posing serious health risks. Storing safe water, food and animal fodder for prolonged periods of time would continue to be a problem for poor women.

Further plunges into poverty may weaken the bonds of marriage obligations, leading to a higher rate of divorce and abandonment.

7.5.3.2 Full Flood Protection

a. Impacts

The economic development accompanying flood protection may strengthen the trend towards educating daughters. This, in turn, may benefit future levels of education and awareness. The growth in income and employment that would increase agricultural production might benefit dependent women. But given the extreme concentration of land ownership and distribution of wealth, improved consumption and quality of life for land-poor and landless women might be marginal.

Flood protection would give women more opportunity to home garden and raise poultry and livestock. but the full realization of this potential would depend on credit delivery, input and extension services.

Greater purchasing power may offer women opportunities for generating nonagricultural income. Given the current limited participation of women in the agricultural labor market, there would not be much increase in paid employment for women. Increased agricultural production would lead to increased crop processing, but this gap mainly would be filled by commercial rice mills.

Women are responsible for household food consumption, and fish are a major source of protein. With flood protection the major impact on household food consumption would be less fish.

Women would have better access to medical and family planning facilities. Unless drainage is considerably improved, however, drainage congestion due to heavy rainfall, high river water levels, and continue siltation is likely to continue and improvements in women and children's access to facilities may be limited.

Even with full flood protection, extreme flooding events could occur, creating embankment overspills and breaching. Such events would seriously damage homes and homestead production.

Households would be displaced by construction of embankments. Set-back requirements would cause considerable stress to families, particularly for women and children.

Areas outside the project area, but inside the impact area, such as those on the northern side of the Surma River, already face severe flood damage from the outfall of the Lubha River. This situation would be further aggravated by a high embankment on the southern side. Areas downstream also may be severely flooded due to the confinement effect.

2. Mitigation

To protect against extreme flooding events, drinking pumps and latrines should be installed on high ground. The ground around existing public buildings, such as schools, should be raised. Poor women could be employed to raise ground levels.

Public awareness programs should be developed to alert people of extreme flooding events.

Households who lose homestead and agricultural land as a result of full flood protection should be fully compensated. In addition, social and economic rehabilitation should be provided for those whose land was acquired, eroded, or were resettled due to their location within the set-back distance.

Communities on the Norther side of the Surma River need embankment protection from the Lubha outfall. If not provided, flood shelters, flood proofing and disaster preparedness education should be provided for people living in the two unions of Kanairghat Upazila and in vulnerable areas downstream.

Provision of disaster preparedness and health education, and improvement of emergency. Medical services would enhance womens ability to manage extreme flooding events.

7.5.3.3 Submersible Embankments

a. Impacts

If submersible embankments are provided, dependent women would gain limited benefits from the small income and employment increases expected from improved boro crop production. There would be reduced flash flood damage to home gardens, poultry and livestock.

If serious flooding was more accurately predicted, and adequate flood warnings given, there would be more time for women to protect household assets, livestock and poultry. They also could better prepare by stocking water, and storing food and animal fodder.

Unless drainage congestion is considerably improved, the problem of standing flood water would remain. Women would continue to suffer stress due to inadequate temporary living conditions.

b. Mitigation

To protect against severe flooding, drinking pumps and latrines should be installed on high ground. The ground around existing public buildings, such as schools, should be raised in use as flood shelters. Poor women could be employed to raise ground levels. Properly maintaining the embankment, and improving the drainage system, would reduce damage to homes and loss of women's persona assets and resources. Poor women could be trained to strengthen, maintain and inspect existing dykes. Such a system would reduce flood frequency and severity, and become the basis of an early warning system.

The following measures would enhance women's ability to manage flooding situations and to contribute to household income and food security:

- Provide low cost drinking pumps.
- Provide extensive disaster preparedness education.
- Expand and improve primary health and family planning education and facilities, particularly in the areas of Maternal Child Health (MCH), safe childbirth and immunization.
- Employ poor women in planting and caring for roadside trees. Women should benefit from tree products after employment contracts expire.
- Develop extension services for women cultivating winter vegetables.
- Provide wide-scale credit delivery for poultry rearing and other appropriate income generating activities.
- Train women to provide low cost inputs and services, such as poultry vaccination, and flood-proof nurseries for vegetable seedlings and tree saplings, for other women.

7.5.4 Land Ownership, Tenancy and Credit Relations

7.5.4.1 Future Without Project

Without project intervention, flash flooding would continue to damage crops and other assets, severely reducing the primary source of income for poor and landless households. In turn, marginal and small farmers would be forced to sell their land, probably at less than value prices, to feed their families. This trend would further concentrate land and income into the hands of large land owners.

As more land is acquired by the already large land owners, the tenancy system would increase. And, as the population increases pressure on the limited amount of land, little land would be available for sharecropping or cash rental. The lack of employment opportunities outside agriculture also would increase competition for sharecropped or rented land among landless and land-poor households. Such shortages gives more advantage to large land owners who would probably stiffen the terms and conditions of tenancy, dominate the land and tenancy market, and gain more power locally.

The patron turned client turned dependent relationship would persist and possibly turn into other dominate or dependent commercialized relationships. This would increase the marginalization and polarization process as well as the deteriorating equity situation. Non-institutional sources of credit would continue to dominate the rural credit market. Loan interest rates may increase. Farmers may advance sale more crops to meet their present needs. Existing kinship and friendship bonds may decline.

7.5.4.2 Full Flood Protection

a. Impacts

Full flood protection would open more land for cultivation. Drainage congestion from blocked channels would improve, raising cropping intensity, crop production, and use of HYV inputs. The benefits of increased production, however, may not be shared equally by all households as land and other assets distribution are highly uneven.

With full flood protection, the existing tenancy market would expand and the demand for sharecropping would increase. However, given the growing imbalance between land and population pressure, there is not enough land for all possible tenants. This imbalance enables large landowners to dictate, in their favor, the tenant terms and conditions. In a situation where all tenancy contracts are verbal and insecure, it is most likely that tenant farmers would work the land under more iniquitous terms and conditions. With increased cost of HYV inputs, land owners may contribute to production costs in proportion to the outputs they receive.

The traditional bargain system would give way to various forms of annual cash leases and long-term usufructuary mortgage arrangements. Land transactions, such as land sales, mortgages and rentals, would be governed more by personal economic and political significance rather than by kinship factors.

With full flood protection, land prices would increase, allowing some economic benefit to small and marginal farmers who must sell or mortgage land under stringent situations. However, the small and marginal farmers may sell less because crop and asset damage would be reduced.

Non-institutional sources of credit with usurious interest rates would continue to dominate the credit and money lending markets. Not only would this enhance transfer of resources from poorer to richer households but also exacerbate the process of landlessness.

Without significant changes in the land tenure system, the tenancy and credit markets would operate in a way that only helps perpetuate the existing agrarian structure.

b. Mitigation

Mitigation strategies would be similar to those presented above. Additional mitigation measures would include strict enforcement of tenancy regulations by local participatory institutions, especially regarding sharecropping and cost-sharing practices. Government and reputable NGOs should become more involved in poverty alleviation programs and in establishing microindustrial enterprises to expand non-agricultural employment opportunities. The credit delivery system should be improved and more effective cooperatives for women and the landless should be formed. Distributing khas lands among landless households and development around clustered villages should be strengthened. New enforceable property rights to rehabilitate socially disadvantaged and ecologically displaced people should be developed.

7.5.4.3 Submersible Embankments

a. Impacts

Submersible embankments would have little impact on the existing land tenure system or its distribution pattern. There also would be little change in tenancy and credit relations. If submersible embankments do not add to drainage problems, they would protect lowlands from frequent flooding, increasing boro crop production. All farmers would benefit some, but large and medium farmers would benefit most. Land prices for both medium and lowlands would increase. Other impacts would be similar to the impacts of submersible embankments on communities and populations.

b. Mitigation

Mitigation measures would be similar to those presented above.

7.5.5 Distribution of Wealth and Equity

7.5.5.1 Future Without Project

The implications of this option on the distribution of wealth and equity is similar to that discussed in 7.5.4.3.

7.5.5.2 Full Flood Protection

a. Impacts

Full flood protection would increase crop production and cropping intensity in the project area. But, given the skewed land ownership distribution (see section 5.5.4), it is unlikely that increased production from the use of HYV inputs would equally benefit all household categories. Studies based on farm level data (Hoque 1987, Hossain 1977 and Rahman 1979) indicate that the initial resource position of a cultivating household is an important factor in who adopts HYVs and, therefore, in who benefits. Large land owners who already stand to benefit disproportionately also would be able to more diversify their income from non-agricultural sources, thereby increasing their wealth and income. The Gini ratio and Lorenz curve data (see Figure 5.22) shows that incremental increases would neither markedly reduce inequality nor hinder the concentration of wealth.

Other distribution impacts are similar to those discussed in section 7.5.4.1

b. Mitigation

Mitigation strategies for this option would be similar to those presented in 7.5.4.1.

7.5.5.3 Submersible Embankments

a. Impacts

As with full-flood protection embankments, large and medium farmers would continue to benefit disproportionately because productive resources are concentrated in the hands of the wealthy. Landless and small farmers would benefit some from increased production and employment opportunities in the winter season. The overall equity situation, however, would not improve unless major changes in the agrarian production structure and the creation of employment opportunities outside agriculture are made. Other impacts of this option are similar to impacts described in 7.5.4.3.

b. Mitigation

Mitigation measures would be similar to those described above.

7.5.6 Education and Awareness

7.5.6.1 Future Without Project

Without intervention, embankment overspill and manmade breaching would continue with flash flooding. Flood water would continue to stand for long periods due to drainage congestion. The blockage and siltation of the drainage system would progressively worsen. These damages would promote more poverty and landlessness, increasing the importance of child labor for family survival. Poor families would not be able to clothe their children or send them to school regularly. It would continue to be difficult for children to reach school during the rainy season.

7.5.6.2 Full Flood Protection

a. Impacts

The fact that full flood protection would either reduce or prevent flooding would allow more children to attend school during the rainy season. Major flooding events would seriously disrupt children's education. With a rise in income and subsistence levels, the trend toward educating girls may increase. The need for boys to contribute economically from non-farm jobs also may be reduced.

Small and marginal farmers use family labor to meet additional labor requirements and rarely hire outsiders except during peak periods (BARD 1988). If agricultural growth generates only minor increases in income for these households, then there may be an unwanted outcome, i.e. an increase in child labor, particularly boys.

Construction of embankments and set-back requirements may cause considerable stress for displaced households, particularly for children.

Communities outside the project area but inside the impact area, such as those downstream or on the Northern side of the Surma River, would be subject to even more severe flooding. The education of children in those communities would be seriously disrupted. Similarly, children in communities also may be adversely affected.

b. Mitigation

Existing schools should be repaired and new ones constructed on raised ground for use as flood shelters during extreme flooding events. Public awareness programs should be developed to alert people of extreme flooding events. Households that lose homestead and agricultural land as a result of full flood protection should be fully compensated immediately. Households whose land was acquired or eroded, and those who are resettled because they live within the set-back distance, should be socially and economically rehabilitated.

Communities on the northern side of the Surma River would benefit from Lubha outfall flood protection provisions. At minimum, flood proofing and disaster preparedness education should be provided in the two unions of Kanaighat Upazila, and wherever necessary downstream.

7.5.6.3 Submersible Embankments

a. Impacts

Submersible embankments would improve access to schools only during the delayed flooding period. Severe flooding would continue to disrupt children's education. Poverty would continue to be a reason for families not sending children to school.

b. Mitigation

Proper maintenance of embankments, improvement of the drainage system, and construction of culverts on local roads would improve access to schools.

7.5.7 Health and Sanitation

7.5.7.1 Future Without Project

Without intervention, embankment overspill, and natural and manmade breaching would continue with flash flooding. Much land would become water logged and unusable through progressive siltation of drainage channels. Stagnant and standing water in homes and homesteads would increase the chance of disease. Surface water quality would continue to degrade due to microbiological contamination.

Although there is a move to provide safe water for more households, progress is slow. The annual allocation of drinking pumps to upazilas is small. For example, last year in Kanairghat

Upazila the allocation of hand tubewells was only four per union. Many families would continue to use surface water for domestic purposes, at least in the near future. This use would increase water-borne diseases, especially during the monsoon and post-monsoon seasons.

Water quality would worsen if industrial pollution from the Barak River to the Surma and Kushiyara affects other surface water. This may have serious implications for households drinking pond water. The major source of chemical pollution is a paper and pulp mill in Badarpur, India, eight miles upstream from Amalshid. During severe flooding, polluted water carried by the rivers may contaminate hand tubewells. If flood waters carry chemical pollutants, a serious health hazard would result.

Two varieties of malaria-carrying mosquitoes are currently found in the project area. Further study is needed to determine whether more water stagnation would increase the breeding capacity of these particular malarial vectors.

7.5.7.2 Full Flood Protection

a. Impacts

With full flood protection there would be some overall positive impacts on general health conditions. Improved drainage would result in contaminated flood water no longer standing for long periods in homes and compounds and would lower health risks associated with unsanitary temporary living conditions.

Reducing river bank erosion would prevent dislocations and the resulting stress and negative health impacts of families who might otherwise lose their land and homes.

The project area, however, would be contained by a high embankment. Water entering the area would be controlled and the normal flushing effect of flooding would be greatly reduced or eliminated. As a result, surface water quality would deteriorate and households without access to tubewells would face health hazards.

Elimination of or a reduction in flooding may result in increased cropping intensity with increased investment in HYVs. HYV production, however, involves more fertilizers and pesticides. The run-off would further contaminate surface water. This agrochemical contamination may produce serious health hazards for households using surface water for domestic purposes.

In addition, during major flooding events such as embankment overspill or breaching, hand tube well water may be contaminated. Such contamination would pose more health hazards than tube well users currently face. Increased use of fertilizers and pesticides also may pollute ground water.

Mosquitos typically increase as flood waters recede and the dry season begins. The flushing effect of floods is considered a major deterrent to mosquito breeding and mosquito-related epidemics. Without flushing, the congestion caused by rain water could sharply increase vector carrying capacity.

Sanitation problems would worsen as open-pit latrines would not receive their annual flushing with the floods. This flushing effect of floods on parasitic diseases has not been well studied, but without flushing there could be an increase in helminthiasis.

Constructing full embankments with required set-back distances would displace significant numbers of households. Displacement would be exceptionally high in the project area where many people live along the rivers. About 46 percent of households in the project area are estimated to live within one and one-half miles of the Surma or Kushiyara Rivers. If displaced, families would lose homes, homestead agricultural land and crop land. The stress associated with such dislocation may have prolonged negative health impacts for those concerned. Pregnant women, children and the elderly would be particularly vulnerable.

Households located downstream and on the Northern side of the Surma River also may suffer similar adverse effects.

2. Mitigation

If full flood protection is provided, low-cost drinking water pumps should be available for the people of the study area. Primary health care should be developed. Health education should emphasize how to purify water, how to make oral rehydration solution from readily available ingredients, and the importance of immunization and sanitation. In addition, medical and family planning facilities should be expanded and improved.

Drainage re-excavation would improve water quality, reduce breeding sites for mosquitoes and the consequent risk of disease transmission. In addition, malarial control programs should be strengthened. Culverts on local roads would improve both water flows and communications, resulting in better access to health services and facilities.

The use of organic manures and less harmful pesticides should be encouraged.

Resettled households should be fully and immediately compensated and rehabilitated.

Communities outside the project area but inside the impact area should receive flood protection or flood proofing.

Protection from extreme flooding events should include flood shelters with safe water and latrines, raising ground around existing public buildings, installing tubewells and latrines on higher ground, and along roads currently used as flood refuges.

7.5.7.3 Submersible embankments

a. Impacts

Construction of submersible embankments would delay flooding and protect agricultural crops.

7.5.8.2 Full Flood Protection

a. Impacts

Because of the inequalities in distribution and consumption, particularly during lean periods, it is difficult to assess overall nutritional impacts with respect to rice production increases that would occur with full flood protection. Critical improvements in rice consumption require increase in purchasing power of rice deficient small farmers and landless laborers, who form the majority of the population.

Surplus farmers who own three to four hectares stand to benefit disproportionately from crop increases and/or reduced crop damage losses. The Lorenz curve data shows that incremental increases in production would not necessary generate marked improvements in food consumption. Moreover, the common food consumption pattern of poor people in the study area is heavily carbohydrate dependent. There is limited intake of nutritious foods such as leafy vegetables. Even with improvements in income, diet may remain unchanged. Full flood protection would improve homestead production of vegetables, fruit, poultry and livestock. Poor households, however, may sell their products to buy rice rather than consuming them.

Major flooding events would seriously damage homes and homestead production. In addition, households outside the project area, but inside the impact area, may be seriously affected by major floods.

The most important nutritional impact would be reduced fish consumption. Fishing would decline because of full embankments would block fish migration and reduce fish stocks. Increases in agricultural employment must be compared with losses in fishing activities. Although the impact would be felt by all, the poor would suffer the most.

b. Mitigation

Disaster preparedness education and flood proofing should be available in the two unions of Kanairghat Upazila and wherever necessary downstream. Also communities in the project area should be advised to be alert for extreme flooding events.

Measures to facilitate fish migration should be implemented (Sections 7.4.1. and 7.5.2.).

Privately owned fish ponds cannot replace the loss of capture fisheries to the poor. Derelict ponds and tanks, however, could be re-excavated for fish culture, and together with borrow pits, be designated for landless groups.

Training, credit delivery, timely input supplies and extension services should be available to landless groups for fish pond management.

Opening canals and improving drainage would improve recruitment of fish stock into the area and improve water quality. Improved water quality would enrich the food chain and raise oxygen levels. This, in turn, is expected to improve fish growth rates and support higher numbers.

Constructing culverts on local roads re-excavation would improve homestead production and allow water logged land to be cultivated. This would improve both water flow and communications, resulting in better access to local markets.

Proper drainage would allow currently waterlogged land to be cultivated.

The following measures would help local people better manage flooding situations, and improve food production and nutrition:

- Food grains and seeds should be properly stored and nursery beds flood proofed.
- Primary health care education should be expanded, emphasizing the importance of balanced nutrition.
- Agricultural should be extended to include pulses and winter vegetables.
- Winter vegetable and poultry rearing should be developed, especially for women from poor households.
- Marketing channels and transportation for agricultural and homestead products should be developed.
- Inputs and services for homestead production, such as seeds, seedlings, saplings, credit, poultry vaccination and veterinary services should be available, especially to the poor.

7.5.8.3 Submersible embankments

a. Impacts

Submersible embankments would be beneficial to boro crop production and would have less adverse impacts on the recruitment of fish stocks than full flood protection.

Submersible embankments, however, may change the catch composition (Hunting Technical Services 1991a). Although submersible embankments only temporarily block fish migration, it occurs at a critical stage in the spawning cycle of certain species, particularly major carps.

Increased crop production resulting from irrigation would not necessarily improve nutrition. Given the monocrop system of rice production in the area, crop diversity is unlikely to increase and may even decrease. Farmers may plant more rice, but less vegetable, pulses and oilseeds. Further reduction in crop diversity would have negative effects on nutrition.

An improved nutritional status of landless and land poor would occur only with a substantial increase in labor demand, income and purchasing power. Such changes are necessary to give poor households the resources to buy nutritious food.

b. Mitigation

Proper maintenance of embankments and drainage improvement would reduce damage to homestead production and allow waterlogged land to be cultivated. Construction of culverts on local roads would improve both water flows and communications recently in better access to local markets. Local arrangements for storage of food grains, seeds and flood proofing of nursery beads would enhance the ability of people to manage severe flooding situations. Local people would benefit from health education emphasizing the importance of balanced nutrition.

7.5.9 Hazards

Hazard risk impact assessment involves analysis of the vulnerability of physical, social and economic elements to direct or indirect damage or loss, both tangible and intangible, by one or more identified hazards. Systematic and adequate time series data on damage or loss by types of hazards are not officially available. During the field study, various local people and officials of the relevant departments were interviewed and maps were studied to get an indication of the hazard risks and the extent of damage. The following statements describes impacts most likely to happen under the various development options.

7.5.9.1 Future Without Project

The present trend of increasing frequency of flash and seasonal floods is expected to continue. The overall associated risks to human life will increase as population density increases, but the relative risks to crops and other resources will remain about the same.

Bank erosion will continue at the same rate with more erosion along the Kushiyara than along the Surma. Existing poor-quality dikes will continue to be breached at the time of flash floods. Sedimentation in the internal canals will continue, creating problems with drainage congestion. Water stagnation will probably increase at the outlet of the project area particularly in the Sada Khal area.

Water quality will be further degraded because of pollutants carried by the Barak and water stagnation within the project area. This will increase the health hazards as well as degrading aquatic habitats.

The frequency and occurrence of natural hazards such as earthquakes, cyclone, and hailstorms are not expected to change measurably in the foreseeable future.

7.5.9.2 Full Flood Protection

a. Impacts

There should be a reduction in the risks of annual crop and infrastructural damage due to flash floods, and seasonal flood damage will be reduced within the project area. The risks of damage to unprotected areas outside the project area will be increased. Bank erosion may be increased due to confinement effects along the river which will increase the volume and velocity of the discharge.

The potential risk of embankment breaching will be increased in extreme events. Historical trends show that earthquakes generally occur in the peak monsoon period, which would increase the risks associated with embankment failures. The river bed may be raised over time by sedimentation which will increase flooding intensity in the unprotected area.

Deterioration of water quality within the project area from sources outside the project area such as the Borak River will be reduced, however the reduction in widespread seasonal flushing will lead to local deterioration in water quality with associated risks to health.

b. Mitigation

Risks associated with embankment breaching and failures can be reduced by sound construction methods and increased people's participation in project development and maintenance. Design of embankments should consider seismic factors.

7.5.9.3 Submersible Embankments

a. Impacts

Submersible embankments would substantially reduce the risks of damage to crops and housing from flash floods, and would reduce those cause by seasonal floods. Bank erosion in the mainstem rivers would be increased due to the confinement effect. Water quality would be affected slightly, but there would be the possibility of water stagnation and siltation. Climatic and geophysical hazards would be unaffected.

b. Mitigation

Proper bank protection measures would reduce bank erosion as well as embankment breaching. Desiltation and maintenance of the drainage network would reduce the risk of water stagnation and would improve water quality.

7.6 Assessment of Impacts

Table 7.7 presents a summary assessment of the biophysical and social impacts in accordance with the principles and formats outlined in the Guidelines for Project assessment (FPCO 1992), the Environmental Impact assessment Guidelines (ISPAN 1992) and the EIA Manual Volume 1 (ISPAN 1992).

Full flood protection embankments would be expected to have major positive impacts in terms of protection from the damaging effects of both flash and seasonal flooding. They would be markedly beneficial in terms of increased agricultural production, production diversity and reduced crop damage. Tree and shrub cover in homestead forests and any remaining natural woodland patches would benefit from reduced flooding damage. Assuming efficient operation and maintenance of the embankments and avoidance of accidental and deliberate breaches, social impacts would be positive in terms of reduced household flooding, improved economic conditions and improved quality of life for some, but not all, segments of the population.

The major negative impacts of full flood protection embankments would relate to the drainage

Table 7.1. Assessment* of Environmental Impacts for Alternative Developments of the Surma-Kushiyara Project.

Resource Group	Important Environmental Component	Option 2 - Full Flood Protection		Option 3 - Subm. Embankments	
		W/o Mitigation	With Mitigation	W/o Mitigation	With Mitigation
Aquatic Resources					
Wetlands	Permanent wetland surface area	+2	+2	+1	+1
	Seasonal wetland surface area	-2	-2	0	0
	Benthic/plankton diversity/abundance	-2	0	0	0
	Macrophyte diversity and abundance	-3	-2	0	0
	Critical habitat for endangered spp.	-2	0	-1	0
Capture Fisheries	Major carp abundance/production	-4	-3	-3	-2
	Minor spp. abundance/production	-3	-2	-2	-1
	Fish species diversity	-3	-2	-2	-1
	Fish disease incidence	-3	-3	-1	-1
Culture Fisheries	Fish production	+2	+4	0	0
Wildlife	Wetland habitat diversity	-3	-3	0	0
	Wetland species diversity	-3	-3	0	0
Land Resources					
Agriculture	Dry season soil moisture	0	0	+3	+3
	Land type ratio	+3	+3	0	0
	Soil fertility	-2	0	-1	0
	Soil drainage	+3	+3	0	0
	Cropping patterns	+2	+3	+1	+1
	Cropping intensity	+4	+5	0	0
	Cropping yields	+4	+5	+2	+3

Continued

Table 7.1. Continued.

Resource Group	Important Environmental Component	Option 2 - Full Flood Protection		Option 3 - Subm. Embankments	
		W/o Mitigation	With Mitigation	W/o Mitigation	With Mitigation
Land Resources (continued)					
Agriculture (continued)	Crop damage	+4	+4	+1	+1
	Crop diversity	0	0	0	0
	Livestock abundance and diversity	+2	+3	+1	+1
	Feed and fodder quantity and quality	+2	+3	+1	+2
Vegetation Resources	Natural vegetation	+2	+2	+1	+1
	Homestead veg. abundance	+3	+4	+2	+2
	Species diversity	0	+2	+1	+1
	Fuelwood abundance	+3	+4	+1	+2
Wildlife	Terrestrial habitat abundance	+4	+4	0	0
	Terrestrial habitat diversity	+1	+2	0	0
	Wildlife species diversity/abundance	+2	+3	0	0
	Commercially valuable wildlife	+1	+1	0	0
	Wildlife pests	-3	-2	-1	0
Human Resources					
Household Damage	Damage inside embanked area	+5	+5	+2	+2
	Damage outside embanked area	-4	-2	-2	0
	Flood hazards	+3	+4	0	0
Employment	Local employment - agriculture	+3	+3	+3	+3
	Local employment - fisheries	-2	-1	0	0
	Total income generation	+3	+3	+2	+2

Continued

Table 7.1. Continued.

Resource Group	Important Environmental Component	Option 2 - Full Flood Protection		Option 3 - Subm. Embankments	
		W/o Mitigation	With Mitigation	W/o Mitigation	With Mitigation
Human Resources (continued)					
Nutrition	Nutritional quantity	+2	+3	0	0
	Nutritional quality	-2	-2	0	0
Health & sanitation	Drinking water quality	-2	0	0	0
	Waterborne disease incidence	-2	0	0	0
Quality of life	Quality of life	+2	+3	+2	+2
	Wealth	+2	+3	+1	+1
	Equity	0	+1	+1	+1

* +1 :slightly beneficial +2 :somewhat beneficial +3 :beneficial +4 :very beneficial +5 :highly beneficial
-1 :slightly negative -2 :somewhat negative -3 :negative -4 :very negative -5 :highly negative and irreversible

congestion and additional erosion hazards created, extensive irreversible loss of natural permanent and seasonal wetlands, loss of wetland habitat quantity, quality and diversity, loss of fish and wetland wildlife habitats and fish and wildlife populations. These negative impacts could be mitigated to some extent by effective development of regulators and desilting and maintenance of drainage canals. In addition the beneficial effects of seasonal flooding in terms of water quality and sanitation would be lost. Most of these impacts would be amenable to mitigation, but complete avoidance of losses is unlikely. Effective placement and use of regulators to permit inflow and recharging of wetlands, and efficient desilting of canals to permit good drainage would be the primary mitigation measure to be employed. It should be noted that in order to effect the levels of mitigation required the quality of regulator and canal management would have to be high, and such efficiency has rarely been documented for any FCD/I scheme in Bangladesh.

Submersible embankments of the appropriate design would have considerably fewer positive as well as positive as well as negative impacts than full flood protection embankments. The major negative impacts would be those related to floodplain fisheries and the impedance of free movement of fish migrants and juveniles between the floodplains and the rivers. These impacts could be overcome to some extent by the efficient placement and operation of regulators and management of canals to permit good drainage and access for migrant fish. Submersible embankments would create more favorable conditions for agriculture in the area, i.e. less crop damage from flash floods, but overall benefits would probably not be as high as with full flood protection.

Although there are as yet no standards for evaluating negative environmental resource impacts in Bangladesh, the assessment given above suggests that the full flood protection option might produce impacts of unacceptably high levels for several important groups of resources, i.e.

a. *Floodplain fisheries* would be substantially reduced through obstruction of access and reduction in substantial quantities and quality of wetland habitats. The resultant loss of an important nutritional resource would be significant for the poorer classes. Present methods of replacement of these losses is through culture fisheries where the benefits do not accrue to those groups suffering the highest losses.
b. *Wildlife resources* would be heavily impacted through loss of wetland habitats and conversion of other habitats into croplands once the threats of flooding damage were diminished. Associated with this loss of habitat would be a loss in *biological diversity* through reduction in numbers of plant, wildlife and limnetic species. At least four species presently listed as endangered[1] and nine species listed as threatened[2] would be imperilled through habitat loss. Loss of wetland and wildlife habitats is not amenable to mitigation nor to compensatory replacement.

7.7 Residual Impacts

Assuming an efficiency of mitigation measures approximately similar to that displayed by other recent and ongoing FCD/I projects in Bangladesh, there are likely to be a number of significant residual impacts resulting from both developmental options.

7.7.1 Full Flood Protection

a. Assured protection from flooding inside the embankment will require construction and maintenance of a high order as well as effective participation between various groups within the project area to avoid deliberate cutting and breaching. Such protection has not occurred in the past and there is little reason to expect it to occur in the future, hence there is a high probability of occasional breaches accompanied by destructive sudden flooding.
b. Drainage congestion inside the embankments is likely to be a recurring and constant problem due to heavy rainfall, high river water levels relative to the floodplain behind the embankment, continual siltation of drainage khals, inter-group conflicts over the operation of regulators and lack of regulator maintenance. The consequent amount of damage to late season boro crops will depend on the relative amount of congestion caused by these various

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1 Fishing cats, openbill storks, brown fish owl and greater whistling teal

2 Vulture, darter, grey heron, rednecked grebe, little grebe, grey-headed fishing eagle, monitor lizard, yellow monitor lizard and bull frog

c. Deterioration of surface water quality is expected to occur, due to the absence of regular flushing from floods. Extension programs are not expected to have a mitigating effect on poor water quality similar to that achieved by widespread annual flushing.
d. There is little that project development can do to overcome ongoing loss of productive cropland from continual population pressure. This would require population growth limitation programs at the highest national level.
e. Substantial reduction in the quantity and quality of wetland habitats from absence of seasonal flooding will unlikely be mitigated by allowing water inflows through constrictive regulators since the latter are not expected to function at full efficiency. The associated reductions in populations of wetland dependant wildlife are expected to be significant, leading to equally significant declines in biological diversity.
f. For the same reasons as 7.7.1.(e) above, substantial reductions in floodplain fisheries are to expected. Fisheries management programs in other parts of the country have to date still to demonstrate the capacity for replenishing floodplain fisheries through the use of controlled water inflows, artificial stocking and fishing management.
g. Even with full implementation of the mitigation suggested above, it is highly likely that residual social impacts will occur and will be more severe in the lower-income, landless and women's groups. These impacts are likely to encompass declines in income, health and nutritional levels.

7.7.2 Submersible Embankments

a. A risk of sudden unexpected flash floods is likely to remain, as noted under 7.6.1(a) above.
b. As noted under 7.7.1(b) above, drainage congestion behind embankments is expected to be an ongoing residual impact.
c. Some declines in natural fish production are to expected, even with mitigation, since full access for migrating fish between floodplains and the Surma and Kushiyara rivers through installed regulators is likely to be less than fully effective. The resultant resource losers are likely to be concentrated amongst the poorer and landless classes, as noted above.

Chapter 8

PROPOSED MITIGATION PLAN

Chapter 7 assessed the impacts expected to occur from two alternative developments for the Surma Kushiyara Project, i.e. full-flood protection and submersible embankments. For each negative impact indicated it recommended methods of mitigating the same. Chapter 8 outlines the initial steps towards formulation of a detailed mitigation plan which will form part of the overall environmental management plan to be developed following project review, a decision on implementation, and development of detailed engineering design. The detailed environmental management plan will eventually be developed and costed for the specific and selected developmental option in a separate report.

8.1 Main Mitigation Measures

Tables 8.1 and 8.2 summarize the major proposed mitigation measures and the impacts intended to be addressed, identify the agency best suited to execute the proposed mitigation, categorize the costs of the mitigation relative to the magnitude of the development costs and the assumed magnitude of the mitigated impacts, indicate when these measures should be adopted, and summarize the expected residual impacts.

8.2 Institutions Involved in Mitigation

The following institutions have been identified in this initial assessment as being in a key position to implement the mitigation provisions of the environmental management plan. Specific schedules and details of the plans will appear in the detailed environmental management plan.

8.2.1 Bangladesh Water Development Board

a. Design and Construction
   1. Sound embankment design and construction to minimize setback range
   2. Excavation of drainage canals
   3. Design of regulators which facilitate fish passage
   4. Placement and construction of regulators as per specification

b. Maintenance and Inspection
   1. Inspection and maintenance of embankments, drainage canals and regulators
   2. Sustained use of embankments for timber, fuel and fodder production

c. Operation of Regulators
   1. Use of regulators to permit seasonal migrations of fish
   2. Use of regulators to permit water inflows to floodplain and beels as and when needed.

Table 8.1. Summary of Main Impacts and Mitigation Measures Recommended for Surma-Kushiyara Project Development: Full-Flood Protection

Impacts	Mitigation	Responsible Agencies	Relative Costs	Scheduling	Residual Impacts
Sudden embankment failure	1. Inspection and maintenance 2. Embankment and roadside tree plantation and caretaking	BWDB*1 Upazila/-Union FD*2	1. Low 2. Moderate	Continuous after completion. Part of project development operation and maintenance	None
Drainage congestion inside embankments due to rainfall	Excavation of khals and installation of regulators	BWDB	Moderate	Part of project development and maintenance	None if regulators work effectively, many if they do not
Deterioration of surface water quality	1. Provision of groundwater for domestic purposes 2. Health and sanitation programs 3. Extension programs to limit unwise use of pesticides 4. Integrated Pest Management to reduce use of pesticides	BWDB, DOH*3, DPHE*4, DAE*5	Moderate	Ongoing developmental programs	None
Soil quality degradation due to intensive use and possible in exclusion of sediment	1. Use of organic manures 2. Practice of green manuring occasionally 3. Judicious use of fertilizers 4. Use regulators to flush areas occasionally	DAE, BWDB	Low	Following project development	

*1 Bangladesh Water Development Board

*2 Forest Department

*3 Department of Health

*4 Directorate of Public Health and Engineering

*5 Department of Agricultural Extension

Table 8.1. Continued.

Impact	Mitigation	Responsible Agency	Relative Costs	Scheduling	Residual Impacts
Loss of crops outside embankment areas	Introduction of new sustainable cropping pattern	DAE	Low	Following project development	Mitigation unlikely to be fully effective
Reduction of grazing facility due to increased cropping intensity	1. Improve grazing facility on wasteland, roadside, embankment by growing forage grasses 2. Stall feeding	DLS*6	Low	Following project development	None
Reduction in cropland area due to spread of homesteads into medium high and highland	2. Increased tree crop production along embankments and roadways	DAE	Low	Following project development	Agricultural cropland will continue to be lost from increase in homestead numbers
Reduction in floodplain fish and wildlife habitat quantity and quality	1. Use of regulators to permit inflows to floodplain 2. Excavation and maintenance of khals to ensure inflows 3. Extension programs to limit unwise use of pesticides 4. Integrated Pest Management to reduce use of pesticides	BWDB DAE	Moderate	Regulators included in initial project design, other programs continually ongoing	Mitigation unlikely to be fully effective and residual loss of wetland habitats will likely occur
Restricted access for fish stocks to floodplain	1. Regulators open April-May and August-October to permit fish passage 2. Design of regulators which facilitate fish passage 3. Stocking of floodplain habitats (including development of new hatchery facilities) 4. Control of fishing effort to reduce impact on young stocks	BWDB, DOF*7	Moderate to High	Ongoing as part of project operations and floodplain management	Mitigation unlikely to be fully effective and residual impacts to fisheries resources will occur

*6 Department of Livestock Services

*7 Department of Fisheries

Table 8.1. Continued.

Impact	Mitigation	Responsible Agency	Relative Costs	Scheduling	Residual Impacts
Reduction in animal nutrient inputs to floodplain habitats	1. Use of regulators to permit inflows to floodplain 2. Excavation and maintenance of khals to ensure inflows of water	BWDB	Moderate	As above	As above
Increased threats to rare and endangered species from habitat loss	1. Use of regulators to permit inflows to floodplain 2. Excavation and maintenance of khals to ensure inflows to key wetlands 3. Protection of key wetland habitats through conservation programs	BWDB, DOF, Upazilas	Moderate to high	As above	As above. Wetland conservation programs have low probability of success and residual impacts will likely be high
Loss of biological diversity through loss of wetland habitats	Maintenance and restoration of key habitats as described above	BWDB, DOF, Upazilas	As above	As above	As above
Displacement of ___ households by embankment construction	1. Relocation of affected households to areas inside embankments 2. Compensation of displaced households 3. Reduction in required setback range through improved embankment design and construction	BWDB, BRDB*, Upazila	High	Preceding project development	None if all people can be relocated
Higher flood risks for people within setback range	1. Relocation of affected households to areas inside embankments 2. Flood-proofing measures for exposed settlements	BWDB, BRDB, Upazila	High	Preceding project development	None if all people can be relocated
Higher flood risks per people on N. side of Surma	Embankment of Lubha on rainfall and N. side of Surma Flood proofing of 2 Unions of Kanaighat Upazila	BWDB	High	Part of project development	Potentially low if mitigation measures are fully effective

*8 Bangladesh Rural Development Board

Table 8.1. Continued.

Impact	Mitigation	Responsible Agency	Relative Costs	Scheduling	Residual Impacts
High flood risks from extreme flooding events	Early warning system via radio and public media	BWDB	Low	Following project completion	Potentially very high
Reduced nutritional input due to loss of floodplain fisheries	1. Maintenance of sustainable floodplain fishery through floodwater inflows and stocking programs (see above) 2. Revision of Jalmahal leasing system to ensure more equitable fish availability 3. Establishment of reserve fishing areas 4. Development of culture fishery programs for landless groups	DOF	Moderate	During and following project development	Potentially low if mitigation measures fully effective
Tenancy, land use and equity impacts on holders of small properties and landless groups	1. Improvements in tenancy regulations, property rights and credit delivery systems 2. Income generation programs 3. More effective distribution of available khas lands	Upazila, unions	Moderate	Ongoing social development programs	Full efficacy unlikely and residual impacts on poorer classes will likely occur
Increases in malaria incidence	Mosquito and vector habitat control programs	DOH, Upazilas	Moderate	Requirements determined by ongoing monitoring	Potentially low
Increased health risks due to poor water quality, increased use of agricultural chemicals, reduced nutrition, etc	1. Improved health care facilities and programs 2. Improved sanitation, groundwater development and fisheries rehabilitation programs as described above	DOH[*9], Upazilas	Moderate	As above	Health programs likely to be effective, fishery restoration probably not.
Downstream hydrological and associated changes	To be determined	-	-	-	-

*9 Department of Health

Table 8.2. Summary of Main Impacts and Mitigation Measures Recommended for Surma-Kushiyara Project Development: Submersible Embankments.

Impact	Mitigation	Responsible Agency	Relative Costs	Scheduling	Residual Impacts
Blockage of early season flood flows into floodplain	Construction of regulators	BWDB	Low	Part of project development	None if regulators work effectively.
Drainage congestion behind embankments due to rainfall	Excavation and maintenance of khals and installation of regulators	BWDB	Moderate	Part of project development and maintenance	None if regulators work effectively, many if they do not
Deterioration of surface water quality	1. Extension programs to limit unwise use of pesticides 2. Integrated Pest Management to reduce use of pesticides	DAE	Moderate	Ongoing developmental programs	
Soil quality degradation in lowland and medium lowland	1. Use of chemical fertilizer to prevent micro-nutrient deficiency 2. Change cropping pattern 3. Limit irrigation seepage losses	DAE	Low	Following project development	None
Reduction in livestock carrying capacity due to fodder production	1. Incorporation of fodder crops into cropping patterns 2. Use of embankments for fodder production 3. Increased use of buffalo 4. Stall feeding	DLS	Low	Following project development	None
Restricted of grazing facility due to Boro cultivates	1. Regulators open April-May and September-October to permit fish passage 2. Design of regulators which facilitate fish passage 3. Stocking of floodplain habitats (including development of new hatchery facilities)	BWDB, DOF	Moderate to High	Ongoing as part of project operations and floodplain management	Mitigation unlikely to be fully effective and residual impacts to fisheries resources will occur

Table 8.2 (Cont.)

Impact	Mitigation	Responsible Agency	Relative Costs	Scheduling	Residual Impacts
Displacement of affected households by embankment construction	1. Relocation of affected households to areas inside embankments 2. Compensation of displaced households 3. Reduction in required setback range through improved embankment design and construction	BWDB, Upazila	High	Preceding project develop-ment	None if all people can be relocated
Higher flood risks for people within setback range	1. Relocation of affected households to areas behind embankments 2. Flood-proofing measures for exposed settle ments	BWDB, BRDB, Upazila	High	Preceding project develop-ment	None if all people can be relocated
Higher flood risks for people on N. side of Surma	Embankment of Lubha out fall and N. side of Surma/flood proofing 2 Unions of Kanaighat Upazila	BWDB			
High flood risks from extreme flooding events	Early warning system via radio and public media	BWDB	Low	Following project completion	Potentially very high
Reduced nutritional input due to loss of floodplain fisheries	1. Use of regulators to permit early season floodwater inflows 2. Floodplain stocking programs	DOF	Moder-ate	During and following project develop-ment	Potentially low if mitiga-tion measures fully effective
Increased health risks due to in-creased use of agricultural chemi-cals, reduced nutri-tion, etc.	1. Improved health-care facilities and programs 2. Improved sanitation, groundwater development and fisheries rehabilitation programs as described above 3. Integrated pest management to reduce use of pesticides	DOH, Upazilas DEA	Moder-ate	As above	Health pro-grams likely to be effec-tive, fishery restoration probably not.
Downstream hydro-logical and associ-ated changes	To be determined	-	-	-	-

d. Irrigation and Groundwater Development

1. Sustained use of ground water for irrigation
2. Provision of groundwater for domestic purposes.

e. Settlements and Households

1. Relocation of _ _ _ households to areas inside embankments
2. Flood-proofing measures for exposed settlements outside the embankments
3. Early warning system via mass media and other media.

8.2.2 Directorate of Health and Family Affairs

a. Health and sanitation programs
b. Mosquito and vector habitat control programs.

8.2.3 Department of Agricultural Extension

a. Registration and use of pesticides
b. Integrated Pest Management
c. Judicious use of fertilizers
d. Increased use of organic manures
e. Incorporation of fodder crops into cropping patterns
f. Increased tree crop production by implementing agroforestry
g. Increased supply of improved seeds, seedlings and saplings.

8.2.4 Department of Fisheries

a. Protection of key wetland habitats through conservation programs
b. Maintenance and restoration of key habitats
c. Stocking of floodplain habitats (including development of new hatchery facilities)
d. Reduction in of fishing effort to reduce impact on young stocks
e. Maintenance of sustainable floodplain fishery through floodwater inflows and stocking programs
f. Revision of Jalmahal leasing system to ensure more equitable fish availability
g. Establishment of reserve fishing areas
h. Development of culture fishery programs for landless groups.

8.2.5 Upazilas, Union Parishads and Local Government Bodies

a. Maintenance and restoration of key wetland habitats
b. Improvements in tenancy regulations, property rights and credit delivery systems
c. Income-generation programs
d. Distribution of available Khas lands
e. Improved sanitation, groundwater development and fisheries rehabilitation programs
f. Tree plantation and caretaking along embankments (and raid wats)

g. Improved distribution of fast growing timber, fuel and fodder species.

8.3 Compensation Programs

No compensation[*10] programs were identified for implementation at the level of investigation undertaken for this EIA case study. Although mitigation was considered unlikely to overcome all the negative impacts identified for fisheries, wetland losses and increases in breaching risks, it was considered equally unlikely that payment of compensation to be of any kind would have major beneficial effects in the long-term. Receipt of cash or goods for lost resources is only useful where the recipients have the opportunities of alternative developments through the use of the compensation provided. For the main losers in the Surma-Kushiyara project area, this would not be the case. Poor and landless classes would have no alternative if they were displaced and received cash compensation other than to remain in the project area. Thus a fully effective mitigation plan to resettle displaced households on Khas or other lands is essential. Equally, these people would have no alternatives to floodplain fisheries as viable long-term sources of nutrients and especially protein. A mitigation program to overcome fishery losses through efficient provision and operation of regulators and fishery stocking programs which effectively replenish the diversity of floodplain fisheries are thus essential. Wetland habitats and the diversity of species which utilize them cannot be replaced artificially under practical and economic conditions; protection of key habitats is thus an essential part of the mitigation program and is not amenable to compensation programs.

*10 Compensation in this case refers to the payment in cash or kind to groups and/or persons who suffer unavoidable negative impacts.

Chapter 9

PROPOSED ENVIRONMENTAL MONITORING PROGRAM

Chapter 9 outlines the initial recommendations on environmental monitoring. As with mitigation, monitoring will form part of the overall environmental management plan to be developed following project review, a decision on implementation, and development of detailed engineering design. The detailed environmental management plan, which will eventually be developed and costed for the specific selected developmental option in a separate report, will contain the proposed sampling programs, a list of the parameters to be measured, sampling strategies, locations and times of sampling, personnel and equipment requirements and estimated costs.

9.1 Monitoring Requirements

Environmental monitoring is an integral part of the assessment process, and has two main objectives for the Surma-Kushiyara Project.

a. Monitoring of specific activities during the construction and implementation phases to:

1. Measure the extent of expected or poorly quantified impacts;
2. Ensure early detection of unexpected impacts;
3. Determine the efficacy of implemented mitigation measures in reducing impacts; and
4. Provide for periodic review and adjustment of the mitigation program.

b. Monitoring of the actual impacts caused by the project to:

1. Acquire knowledge of the type and magnitude of ongoing project environmental interactions; and
2. Discover any unforeseen secondary benefits or adverse impacts

9.2 Major Issues of Concern

9.2.1 Structural Integrity of Embankments

In the Surma-Kushiyara Project area, full flood protection (Option 2) is designed to prevent damage to resources up to a magnitude of 20 years return period. Any natural catastrophe of greater magnitude may have serious consequences. Severe floods may cause serious damage in the protected area either by breaching or overtopping of embankments. Embankment failure would have a devastating effect on homesteads especially in the lower land types and would cause extensive damage to crops orchards, livestock and other household property including loss of culture fishery.

Extent of rise of river beds and possible breaching points of embankments should, therefore, be identified and monitored periodically. Breaching of embankments, either through erosion and or scouring or by public cuts, should also be monitored particularly during the most vulnerable periods to reduce unacceptable structural damage. Damage to the embankment from earthquakes or other natural calamities would need to be evaluated and necessary steps taken for the safety of the people without any delay.

9.2.2 Flood Forecasting

With option 3, timely forecasting of the impending floods will allow people time for preparations to make harvesting of crops, marketing of saleable products and stocking of food, fodder, fuel, water, seeds and protecting household assets. The rise in water level during flooding season should be continuously monitored and assessed to reduce unexpected flood damage.

9.2.3 Drainage

Planned excavation of the silted canals with people's participation will reduce the severity of flood damage as well as any local impacts of embankment breaching. The efficiency of public participation and consultation during construction, operation and maintenance phases should be monitored for effective long-term maintenance of the drainage system.

The construction of full flood control embankments may cause confinement of discharges in narrower channels resulting in change of hydraulic parameters of the channels thereby manifesting higher flood levels in the impact areas other than the project area. By means of hydrological analysis and hydraulic calculations, the effect of hydrological changes on the impact area as well as the project area should be monitored and assessed.

9.2.4 Increased Use of Agricultural Chemicals

With full flood protection, farmers are likely to undertake intensive cultivation with HYVs using increased amount of fertilizers, pesticides and irrigated water. Integrated Pest Management (IPM) should be encouraged to reduce the use of pesticides. HYV cultivation is expected to increase by about 15 percent and the associated use of fertilizers and pesticides is expected to increase by 17 percent and 1.0 tonnes annually, respectively, throughout the project area.

The impact of the use of such HYV inputs on the soil and water quality should be monitored and farmers should be motivated and or educated to use chemical fertilizers and pesticides in prescribed fashion so that contamination of ground and surface water can be minimized. The extent to which farmers are motivated to make judicious use of such inputs should also be monitored.

9.2.5 Declines in Soil Fertility

Despite the prevalence of sedimentation of agricultural lands throughout the region and the country, the role of such sedimentation in providing essential soil nutrients remains unclear. Sustainable soil management practices and the use of organic manures and fertilizers should be practiced as also the use of regulators to occasionally flush the area with fresh sediments. With or without these measures there is a possibility that soil fertility will decline in the project area if sediments are excluded and cropping practices become more intensive. Periodic analysis of soils should be undertaken to check for the gradual development of any such deficiencies.

9.2.6 Forest and Fuelwood Resources

Afforestation programs using economic and fast growing multipurpose tree species will be needed for the alleviation of fuel wood crises, improvement of nutrition levels, development of soil fertility and protection of topsoil against erosion. Monitoring of the extent of this afforestation as well as the success or otherwise of plantation programs along embankments should be an integral part of ongoing environmental management in the project area.

9.2.7 Regulator Operations

Change of fish habitat due to project intervention (Option 2) would cause reductions in fish harvest and fish species diversity. Fish ladders and or locks and sluice gates at appropriate locations should properly be designed and kept open for suggested periods allowing sufficient passage for fish migration and stock replenishment. The operation and maintenance (O & M) of the structures and water flow periods must be monitored and optimized accordingly.

9.2.8 Capture and Culture Fishery Production

Reduction in passage for migratory fish by project interventions would decrease fish production and species diversity. Appropriate operation of regulators to permit passage of floodplain species as well as stocking of beels to replace natural incrementation have been recommended as mitigation measures. Neither of these has been particularly successful in past flood control projects in Bangladesh, and the success of any such operations in the project area would have to be measured by the maintenance of fishery production levels. The status of fish species diversity and catch per unit effort in various habitat types should be assessed on a regular basis. The trend of culture fishery production should also be monitored and necessary measures be taken for increased production of culture fisheries through involvement of local people and improved extension services.

9.2.9 Wildlife Habitats

Given the importance of the project area as a natural habitat for many wildlife species, some of which are already endangered and threatened, protection of such habitat is an imperative for their preservation. Key habitats for most threatened and endangered species have been identified, and the status of these should constantly be monitored as well as the population status of the specific threatened and endangered species.

9.2.10 Disease Vector Habitats

Loss of flushing effect in Option 2 may increase vector populations such as mosquitoes. The functional relationship between vector habitats and regular flooding is not well established, and the extent of vector habitats as well as the density of potential vectors in the project area following project implementation should be studied and monitored.

9.2.11 Communities

Families outside the project area but inside the impact area (i.e. on the other side of the embanked rivers and downstream) may suffer from severe floods damage and health hazards. Flood proofing measures and disaster preparedness education for the affected households should be planned, adopted and implemented and subsequently monitored to assess the post-flood situations outside the project area.

From the socio-economic point of view, generation of employment opportunities for the fishermen and boatmen households will be essential. Considering the geophysical, agroclimatic and socio-economic condition of the project area, appropriate income generating opportunities may be created planned, installed and monitored to minimize unemployment problem of the fishermen, boatmen, landless laborers and women.

9.2.12 Compensation Payments

Compensation payments should be made in full for the loss of homesteads and agricultural lands to the displaced families either in cash or in khas land, so that the resettlement process take less time with least suffering for the affectees. The whole compensation and resettlement process should be supervised and legal and institutional processes that delay payment of compensation should be removed.

9.3 Major Items for Monitoring

Table 9.1 summarizes the main items to be considered for post-developmental monitoring for the Surma-Kushiyara Project.

Table 9.1. Summary of Proposed Monitoring Measures Recommended for Surma-Kushiyara Project (Either Developmental Option)

Monitoring target	Objectives	Methods	Responsible Agency
Threatening floods	Reduce losses by anticipating potentially damaging floods	Continuous monitoring of weather patterns in upper catchment and timely forecasting of floods	BWDB
Embankment structural integrity	Reduce losses and damage from sudden embankment failures due to breaching, earthquakes, etc.	Periodic and through inspection of all embankments	BWDB
Regulator efficiency	Ensure continual efficiency of regulators in maintaining dry season water levels	1. Dry season monitoring of wetland cover and habitat quality 2. Periodic inspection of regulators	DOF, upazilas
Drainage canals	Ensure efficiency of drainage system in alleviating drainage congestion	1. Periodic inspection of drainage system and siltation levels	BWDB
Water quality	Water quality • domestic (surface and groundwater) • wetlands	1. Systematic and regular water quality analyses for major parameters (including pesticides)	BWDB, DOE, DAE
Groundwater	Groundwater availability	Systematic and regular monitoring of groundwater levels	BWDB
Soils	Soil nutrient level and efficiency of fertilization	Annual sampling of soil quality for key nutrients	DAE
Agricultural crops	Attained agricultural production levels	Annual analysis of actual production	DAE
Capture fisheries	Floodplain fishery diversity and production	Annual analysis of floodplain stocks and harvests	DOF
Wetlands	Conservation status of key wetland habitats	Annual ecological surveys of wetland quantity, quality, species diversity and ecological integrity	Universities, NGOs
Communities	Economic well-being of impacted households • relocated from embanked areas • outside embankments	Annual survey of relocated and flood-proofed households	LGEB
Communities	Economic well-being of project area communities	Annual survey of key economic indicators from local areas	Upazilas
Communities	Health status of communities	Analysis of routine health statistics from local and regional sources	DOH, upazilas
Disease vectors	Disease vector occurrence and abundance	Periodic survey for vector habitat quality and vector abundance	NIPSOM
Flooding in Impact area	Identify change in flooding depth and related issues	Wet season monitoring of flood depth and its consequences in sample area	BWDB
Vegetation	Increase in vegetation cover for the alleviation of fuelwood crisis, improvement of nutrition level and soil fertility	monitoring the performance of the existing indigenous species and other introduced species.	DAE BARC FD

Chapter 10

EVALUATION OF THE SURMA-KUSHIYARA EIA CASE STUDY

The Surma-Kushiyara Project EIA case study was the first FCD/I project to be assessed according to the FAP EIA Guidelines. This section provides an evaluation of the case study results to document major concerns and provide recommendations for their avoidance in future EIAs undertaken for actual FAP projects.

As a case study, the Surma-Kushiyara Project was less than ideal:

- It was not given a full regional level prefeasibility assessment in which the major environmental and social issues would have been outlined; such issues had been outlined to some extent by the previous studies on the Upper Kushiyara Project, although these were relatively weak in social impact assessment and in many environmental areas;

- The EIA was conducted without intensive interactions between design and planning engineers, on one hand, and the environmental and socioeconomic study team on the other; in a feasibility study this interaction is essential to develop an efficient and acceptable project design.

These deficiencies were identified at the outset of the study, but were largely unavoidable since the FAP 16 case study was undertaken well in advance of any substantial engineering feasibility studies in the area.

Several issues of concern which arose during the EIA are briefly outlined below.

10.1 Project Design

a. The Northeast Regional Study Team (FAP 6) provided as many details as they could on two possible development scenarios (full flood protection embankments and submersible embankments), but these were based on reconnaissance knowledge of the area with no detailed hydrological or site specific data. The lack of detail on project facilities rapidly proved a major impediment to effective assessment, and there was no feedback to project development as required in the EIA Guidelines. In addition there was no participation by local people in formulating the project designs or in fully identifying and confirming the major water management problems -this is discussed further below.

b. EIAs, as carried out in terms of the EIA Guidelines, differ from the procedures adapted in past project feasibility studies in Bangladesh in at least one important way, i.e. the sequencing and interaction of studies. Feasibility studies have traditionally been undertaken first by engineering groups, based on hydrological and engineering design criteria. Following identification and, in many cases, selection of the appropriate alternative, the agricultural and socio-economic assessments were then undertaken (Figure 11.1). The EIA Guidelines make provision for a much more interactive process (Figure

11.2) which will necessitate some restructuring and adaptation on the part of existing concepts and institutions. As exemplified in Figure 11.2 the stronger the interactions between the design and assessment teams during the studies, the less need for any major feedbacks following conceptualization of the project.

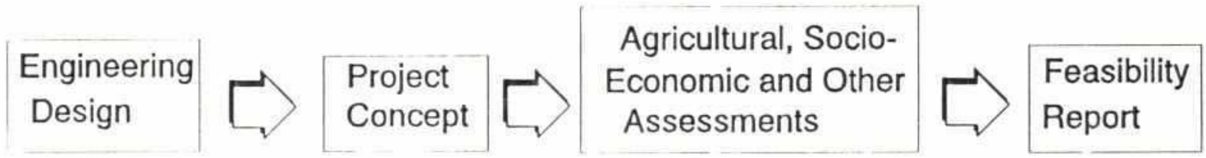

Figure 11.1. Sequencing of project feasibility studies prior to the FAP.

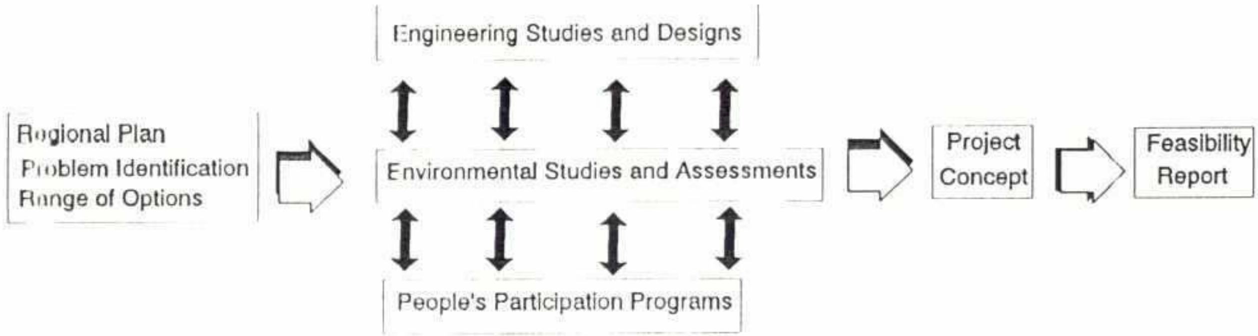

Figure 11.2. Sequencing of project feasibility studies in the FAP.

10.2 Field Studies

a. The allowable *time frame* was far too short for the field studies to collect information of the quantity and quality necessary for a defensible EIA. Field studies extended for a number of weeks only for most components. Data quantity and quality from surveys aimed at villages and households (socio-economic, homestead vegetation and crops) were more affected by the limited available field time; agricultural, fisheries and terrestrial ecological surveys were based on reconnaissance-type field surveys which collected information from maps and direct observation as well as local people and were better able to obtain useful information within the allowable time frame. The case study confirmed three important aspects which should be recognized early in future EIAs within the FAP:

- Socio-economic and other data collection which relies on information obtained from people is *time-consuming*, and requires adequate pre-planning and development of field logistics;

- Most data have to be collected at appropriate times within the annual *hydrological and biological cycles*, which in effect necessitates a full annual cycle of data collection (although not necessarily data collection at all times within that cycle - this depends on the results of the scoping);

- Landscapes in Bangladesh are very *complex* at the scale at which planning and assessment have to be undertaken for water management projects; the low relief of the landscape, the intensity of land-use and land occupation, and the often conflicting water management aims of the local communities all make for complex drainage, flooding and cropping patterns which have to be quantitatively measured and mapped at appropriate scales in the assessment process.

b. Available *resource baseline maps* for the area were found to be outdated, at inappropriate scales or not available. This is a general problem in many areas of Bangladesh. Effective EIAs require comprehensive databases of sufficient spatial coverage and levels of detail. Under ideal circumstances EIAs should have to develop very little in the nature of baseline information but should devote most effort towards the use and interpretation of available data. This is presently not the case in Bangladesh, and is not likely to be so in the foreseeable future. The implication is that EIAs at both regional and project feasibility level will have to develop basic data collection programs as part of the assessments, with significant consequential implications for time and budget requirements. A further implication is that there is a need for the ongoing development of rapid field survey techniques to acquire reliable environmental data within relatively constrained time frames and field budgets.

c. *Secondary source data* were unreliable or not available. This is a similar problem to (b) above, with similar implications. Secondary source data are a valuable information resource but require verification and field checking before use in EIAs.

10.3 People's Participation

People's participation was fully identified as a major objective prior to the study and is now well articulated in the EIA Guidelines. However, the severe scheduling constraints placed on the case study precluded the long lead times necessary to establish effective communication links with the local communities. Participation was limited to that obtained during the PRA surveys to obtain socio-economic information. Based on the FAP 16 experience in the study area and on the growing expectations for increased public participation in the FAP, it is evident that well-developed people's participation programs will require *long-term planning* and the *establishment of appropriate institutional connections* several months in advance of any field studies. There was found to be a lack of uniform understanding of the approaches and required levels of detail for effective participation, as also a lack of an effective long-term institutional structure in the study area devoted to problem identification and resolution through project development. This was an unavoidable result of the cursory nature of the case study. Guidelines for participatory development have been formulated since this case study was undertaken, but it is clear from the study team's experiences that the various *roles of the various institutions* and local government agencies, as well as NGOs and other groups, remains to be developed to a practical level within the overall EIA framework.

10.4 Impact Assessment

a. It was found that there was insufficient information available on the hydrology of the study area for effective assessment of impacts related to hydrological changes. This problem stemmed from the lack of detailed hydrological studies in the area which are only now commencing under the Northeast Regional Study (FAP 6). It emphasizes the need for *good baseline data* in critical areas such as hydrology to ensure an adequate level of prediction.

b. Impacts could not always be quantified to the extent desirable in a full EIA. This problem stemmed from a number of causes:

- Insufficient time for adequate field studies
- Use of non-quantitative methodologies, especially in the social impact assessments
- Heavy reliance on secondary source data which were found to be unreliable.

Although EIA is composed of various disciplines, and the studies and assessments require a good understanding of the many resources, the success of an EIA depends on more than the sum total of such discipline proficiency. EIA is a process of problem identification and scaling and prediction into the future, and requires considerable interactions between disciplines and between environmental and engineering components to be successful. Experience, not only in methods but also in using and defending the outputs of an EIA, is an invaluable asset.

c. The underlying intention in the assessment of impacts had been to use *network analysis* to identify cause and effect relationships between project actions and interventions on one hand and IECs. The end-points of the networks are the impacts, which were then transferred to separate tables for display and inclusion in impact assessment and evaluations. In practice, all these steps were followed but largely independently of each other. The underlying cause appeared to be a lack of tight integration between individual disciplines. Practical steps to avoid this type of occurrence in future studies would include the need to have more frequent use of workshops to develop and integrate information, and adequate training of team members to understand the advantage and disadvantages of various assessment methodologies such as networks.

d. *Off-site* and *cumulative* impacts were not adequately considered in the assessment. It was recognized early in the study that detailed information on the hydrology of the system was required before the extent of downstream impacts could be assessed. This information was largely lacking, although the assessment included the statement that impacts would unlikely extend beyond Hakaluki Haor because of the large volume of the latter. It was also recognized that an assessment of cumulative impacts would require a level of detail of information not realistically available within the constraints of the case study.

Offsite impacts were not limited to downstream effects, however. It became evident, when considering the hydrological implications, that there were potential major differences in impacts on either side of the Surma and Kushiyara rivers because of differences in embankment heights, locations of villages and other factors.

Chapter 11

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