ENVIRONMENTAL IMPACTS OF RE-EXCAVATION OF THE KAPOTAKSHA RIVER

by

Most. Nazneen Aktar

Department of Civil Engineering

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

DHAKA

September 2005

ENVIRONMENTAL IMPACTS OF RE-EXCAVATION OF THE KAPOTAKSHA RIVER

by

MOST. NAZNEEN AKTAR

DEPARTMENT OF CIVIL ENGINEERING
BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY
DHAKA

A thesis submitted to the Department of Civil Engineering of
Bangladesh University of Engineering and Technology, Dhaka,
in partial fulfilment of the requirements for the degree
of

MASTER OF SCIENCE IN CIVIL AND ENVIRONMENTAL ENGINEERING

September 2005

ENVIRONMENTAL IMPACTS OF RE-EXCAVATION OF THE KAPOTAKSHA RIVER

BY
MOST. NAZNEEN AKTAR
(Student No. 040204121 F)

This Project is approved as to style and content for the degree of M.Sc. Eng. (Civil and Environmental)

Rowshan Mamtaz

Dr. Rowshan Mamtaz — Chairman (Supervisor)
Associate Professor
Department of Civil Engineering
BUET, Dhaka

Dr. Md. Mazharul Hoque — Member
Professor and Head
Department of Civil Engineering
BUET, Dhaka

Dr. Md. Mafizur Rahman — Member
Associate Professor
Department of Civil Engineering
BUET, Dhaka

Mr. Shamsul Gafur Mahmud — Member (External)
Training & Technology Specialist
ITN- Bangladesh
Dhaka

DECLARATION

I do hereby declare that the project work reported herein has been performed by me and this work has neither been submitted nor being concurrently submitted in candidature for any degree at any other university.

Nazneen Aktar

Signature of the student
(Most. Nazneen Aktar)
Roll: 040204121 (F)

DEDICATED

TO

My Family

Table of Contents

Chapter 3

STUDY AREA AND THE PROJECT FEATURES

Chapter 4

BASELINE SURVEY OF THE KRREP

Chapter 5

ENVIRONMENTAL IMPACT ASSESSMENT OF THE KRREP

Chapter 6
ENVIRONMENTAL MANAGEMENT PLAN

Chapter 7
CONCLUSION AND RECOMMENDATION

List of Tables

List of Figures

List of Photos

Abbreviation

AWWA	American Water Works Association
BBS	Bangladesh Bureau of Statistics
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CEGIS	Center for Environmental and Geographic Information Services
COD	Chemical Oxygen Demand
DAE	Department of Agriculture Extension
DoF	Department of Fisheries
DPHE	Department of Public Health
DTW	Deep Tube well
EC	Electrical Conductivity
EES	Environmental Evaluation System
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FFWC	Flood Forecasting and Warning Center
HYV	High Yield Variety
IEE	Initial Environmental Examination
IWM	Institute of Water Modelling
KRREP	Kapotaksha River Re-excavation Project
LGED	Local Government Engineering Department
LLP	Low Lift Pump
MOP	Manually Operated Pump
NEPA	National Environmental Policy Act
NGO	Non Government Organization
NMIDP	National Minor Irrigation Development Project
NWMP	National Water management Plan
NWRD	National Water Resource Database

PWD	Public Works Department
SRDI	Soil Resources Development Institute
STW	Shallow Tube well
TDS	Total Dissolved Solids
UNEP	United Nations Environment Policy

ACKNOWLEDGEMENT

At first, the author acknowledges the blessing as of almighty for enabling her to complete the study successfully.

The author wishes her sincere gratitude to Dr. Rowshan Mamtaz, Associate Professor, Department of Civil Engineering, BUET, for her continuous guidance, and caring and affectionate encouragement at every stage of this work.

The author is grateful to Dr. M. Ali Ashraf, Associate Professor, Department of Civil Engineering, BUET, for his encouragement at the initial stage of thesis. She expresses her profound thanks to Mr. Manminul Haque Sarker, Morphologist, CEGIS, for his guidance in selecting the topics of the study. She is also grateful to Dr. Md. Mafizur Rahman Associate Professor, Department of Civil Engineering, BUET, for his sincere guidance at the final stage of the study.

The author expresses her gratitude to Mr. Nityananda Chakravorty, Socio-economist, CEGIS, for his profound support to have secondary data of baseline survey conducted by CEGIS. She is also grateful to CEGIS authority for allowing her to use CEGIS library.

The author thanks to Mr. Anis and Mr. Abbas of Environmental Engineering Laboratory, BUET who assisted her in laboratory work.

The author finally expresses her profound thanks to her family for supporting and inspiring to conduct the MSc at BUET.

ABSTRACT

The river Kapotaksha is located in the southwest part of Bangladesh. Due to reduced cross section and siltation, annual flooding and drainage congestion is a common phenomenon in this area. To offer a short-term relief, Bangladesh Water Development Board (BWDB) has undertaken a decision of re-excavating a portion of the river named Kapotaksha River Re-excavation Project (KRREP). The present study is aimed at carrying out a detail Environmental Impact Assessment (EIA) and prepares an Environmental Management Plan (EMP) so that the dredging activities can be carried out in an environmental friendly and sustainable manner. To carryout the Environmental Impact Assessment (EIA), primary and secondary data and information were collected by field visit and from different relevant sources. Environmental Evaluation System (EES) was adopted to assess the impacts due to re-excavation.

The net impact due to the re-excavation of the Kapotaksha River is assessed as positive. The impact assessment shows that the re-excavation offers not only a short-term relief from flooding and drainage problem but also a long-term beneficial option for an extended program of re-excavation. During dredging work, water quality and sedimentation will experience negative effects, but this situation will improve gradually with time. Water level and salinity will improve significantly (Environmental impact value, EIV was found +20 to +40 for water level and +100 to +175 for salinity). Incase of flood control, high EIV (+900) shows that more than 90% of flood control is expected due to re-excavation. Navigation situation will also improve (about 90%). Among the ecological parameters, fisheries resource shows zero impact during dredging. But it will experience a large-scale positive impact (EIV +280) after the completion of the re-excavation. The situation of partly terrestrial- partly aquatic ecosystem will worsen (about 10%) during dredging. However, the situation will improve with time. The re-excavation project will offer employment opportunity to the local people. Around 30% of unemployed persons can be involved in manual re-

excavation work. After re-excavation, about 40- 50% employment is expected to increase due to better situation in agriculture, irrigation and transport communication sector. Noise level and dust pollution will be a major problem during dredging. However, this problem will be diminished after completion of the project.

A complete EMP has been prepared to reduce and mitigate adverse effects at three phases of the project i.e. during dredging, for a short period after dredging and for a long period after dredging. During dredging, an extensive mitigation measure should be undertaken for maintaining ground water quality and sedimentation. Moreover care should be taken to minimize land loss. After short period of dredging, mitigation measures should be taken for ground water level, sediment quality and soil quality. A restricted use of ground water for irrigation can ensure a sufficient ground water level. Prohibition of extensive use of agricultural land and limited use of fertilizer and pesticides may reduce the degradation of soil quality. Moreover, limited movement of engine driven vehicle on the Kapotaksha River may limit the deterioration of the sediment and water quality. For long run, a good control on use of land and fertilizer are essential to ensure good soil and sediment quality. A monitoring plan has also been provided which would enable to detect any changes in the physical, ecological, and social sectors due to the implementation of the project. Salinity, water level and river cross-sections, fisheries, flooding and drainage situation is suggested to be closely monitored. Some special aspects such as occupation and employment, agriculture and fisheries activities, waterway navigation, land loss due to riverbed erosion etc. should be monitored throughout the year. Some enhancement plan like re-establishment of connectivity of the river with neighbouring beels and baors, fish friendly operation of fish pass etc. are provided in the EMP to ensure improved benefit from the project.

The impact assessment of the Kapotaksha River Re-excavation (KRREP) conducted in the present study, showed that the re-excavation activity would definitely lessen the siltation on the riverbed to a great extent giving a sustainable solution to drainage congestion occurring every year in this area.

Chapter 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Kapotaksha is a 200 km long river in South-western Bangladesh, which has suffered loss of navigability over the last few decades. Kapotaksha originates from the Bhairab River at Tahirpur and confluences with the Sibsa River with a meandering pattern. Historically it was a perennial river with connection to the Ganges River through Mathabhanga River from which it drained fresh water into the Sundarbans (Fig. 1.1). The river was navigable up to Trimohoni until 1919 (Williams, 1966) that has since been reduced only up to Patkelghata. Loss of the supply of fresh water from the Ganges in the recent year reduced regime of flow and sediment. Over time, upstream reaches became two level terraces and the downstream reaches converted into a tide-dominated river. During the dry season, a large amount of fine particles intrudes in the river by pumping process, which comes in contact with saline water and forms sediment to settle at riverbed. As a result, it was continuously losing its depth and drainage capacity. The total drainage area of Kapotaksha River is 1,067 km^2 in the western part of the Ganges floodplain, which is mainly highland and medium highland. Since 2000, the upazilas named Jhikargachha, Manirampur, Keshabpur , Kalaroa and Tala in Jessore and Satkhira districts have been suffering from severe drainage congestion due to reduced drainage capacity of the Kapotaksha River (Fig. 1.1). To relieve this congestion and resulting water logging, Bangladesh Water Development Board (BWDB) decided to re-excavate the river and started dredging from May 2004. In order to establish the baseline condition and facilitate environmental impact of the dredging activities, the Center for Environmental and Geographic Information Services (CEGIS), under contract from BWDB, carried out a baseline survey of the Kapotaksha River and the area of influence of the dredging works from March to August 2004.

To restore navigability of the river and also to solve the problems of drainage congestion and flooding, BWDB started dredging this river in 2004. The present study is aimed at carrying out a detail Environmental Impact Assessment (EIA) and prepares an Environmental Management Plan (EMP) so that the dredging activities can be carried out in an environmental friendly and sustainable manner.

This study took off from the baseline survey undertaken by CEGIS (CEGIS, 2004) and carried out a detailed EIA, the outcome of which is an EMP having a potential to be used in other dredging projects under similar conditions.

1.2 OBJECTIVES OF THE STUDY

The main objective of the study is to assess the environmental impacts due to the re-excavation of the river Kapotaksha. In the light of the main objective of the EIA of the KRREP would be to identify the important environmental and social components in the concerned areas that relate to the re-excavation activities and assess the possible impacts of the intervention on these parameters. Since one of the primary objectives of the KRREP is to relief the local people from flooding and drainage congestion, it is imperative that an appropriate EIA should be performed to achieve the stated goal. The re-excavation of the Kapotaksha River is expected to increase fresh water flow in the wet season and augmenting this flow during dry season. This would bring change in living condition of the local people, in agriculture and fishing activities. Changes will also be expected in the quality (in terms of salinity and sediment concentration) and quantity of water

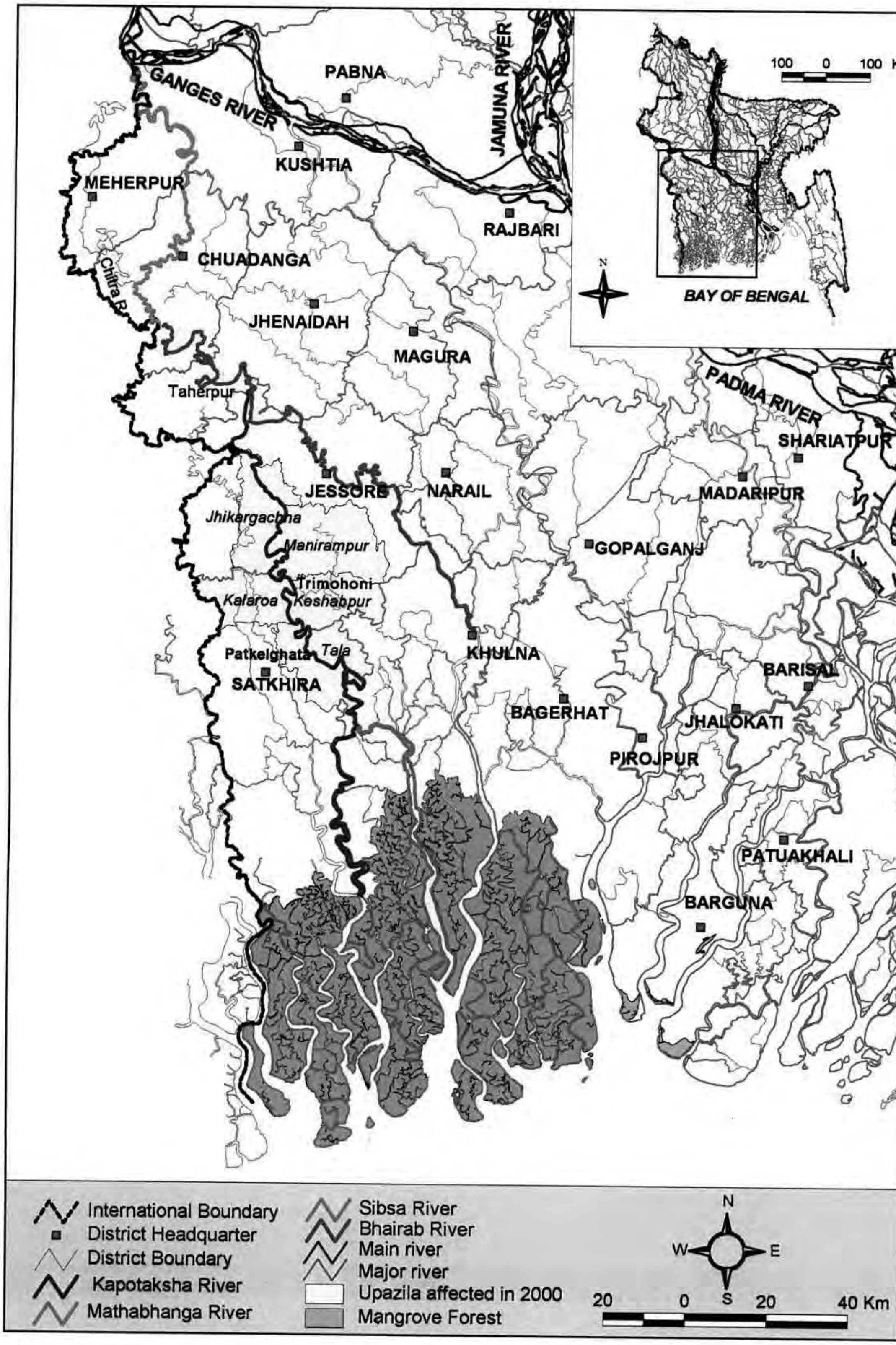

Fig. 1.1: Map showing the route of the Kapotaksha River along with other features (CEGIS, 2004)

available for various domestic and agricultural uses. Impacts will also results on waterway navigation affecting occupation and income of certain households. All of these would suggest that there are important environmental and social dimensions that need to be investigated. The specific objectives of the present study can be summarized as follows:

- To identify the major areas (environmental and social) with verifiable indicators where short and long term positive and negative impacts are expected.
- To prepare a complete environmental management plan (EMP) to ensure, enhance and sustain the expected positive impacts in the long run.
- To suggest mitigation measures to minimize the negative impacts to an acceptable level and present a compensation plan for negative impacts that can not be mitigated.
- To provide an environmental and social monitoring plan for the KRREP to monitor changes taking place due to the re-excavation of the river. This monitoring plan will offer an opportunity to check if the impacts predicted in the EIA study are valid and detect unanticipated impacts.

1.3 SCOPE AND METHODOLOGY

To achieve the above stated goals, data were collected by field visit and from secondary sources. Data on rainfall, evaporation, sunshine hours, surface water level, ground water level, population, housing condition, sanitation condition etc were collected from different secondary sources such as BWDB, NWRD, BBS, BMD and CEGIS. Ecological data (fisheries, flora, fauna etc) was gathered by field survey and from secondary sources such as SRDI, BBS and CEGIS. The physicochemical quality of the river Kapotaksha was determined by analysing heavy metal content of sediment and different water quality parameters such as pH, Electrical Conductivity (EC), salinity, Total Dissolved Solids (TDS), Turbidity, PO_4, NO_3, NH_3-N etc, in the BUET laboratory. Secondary sources have been used to reflect the socio-economic baseline in the project area. Spot survey has been conducted in the congestion area to assess the existing vulnerability to drainage congestion. Secondary sources like DAE and NMIDP have been used to collect information of agricultural situation in the project area. Environmental Evaluation System (EES) was adopted to assess the environmental impacts due to re-excavation.

1.4 ORGANIZATION OF THE THESIS

This thesis comprises of six chapters. Apart from this chapter, the remaining of the thesis has been divided into five chapters. Chapter 2 includes literature review covering details of EIA. Chapter 3 describes about the study area and re-excavation project in detail. Chapter 4 provides in detail the baseline survey result. A brief description of the methodology adopted in conducting survey has also been stated here. Chapter 5 presents a detail assessment of impacts on various environmental and social sectors and suggests a number of mitigation measures to overcome those effects. Finally Chapter 6 states a summary of the findings and recommendation for further research.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The term 'environment' refers to the sum of all external conditions that influences the life and development of organism. It consists of air, water, food and sunlight, which are the basic needs of all living beings and plants, to carry on their life function. 'Environment' also includes other living things as well as temperature, wind, radiation etc. In broad sense, "environment" is the physiochemical, biological and social surroundings of a man. Environment as a productive system provides basic supports that are required for flourishing all forms of lives, materials that are harvested, services for transportation and recreation and aesthetics for spiritual renewal. Sometimes people interfere the natural environment to prevail their living. This human interference is sometimes refers as development when they try to fulfil their demand with limited resources such as shortage of knowledge, skills and technology imposed and restriction of social organizations' in context of environmental ability. It is necessary to make assurance of the project to be sustainable. Precondition of the sustainability of a project is to assess the environmental impacts and its mitigation measures related to the implementation of the project.

2.2 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Although the term " Environmental Impact Assessment" is widely used, there is no general and universal definition of EIA. Several authors and organizations define EIA in different ways. Some of these definitions are given below:

The United Nations Program (1978) defined EIA as " to identify, predict and to describe in appropriate terms the pros and cons (penalties and benefits) of a proposed development. To be useful, the assessment needs to be communicated in terms understandable by the community and decision-makers and the pros and cons should be identified on the basis of criteria relevant to the countries affected".

Munn (1979) provided a definition of EIA "as an activity designed to identify and predict the impact on the bio-geophysical environment and on man's health and well-being of legislative proposals, policies, programs, projects and operational procedures, and to interpret and communicate information about impacts".

Clark (1983) defined EIA as " the systematic examination of the environmental, social and economical consequences of projects, plans and policies".

A recent definition of EIA is given by Canter (1996) as the systematic definition and evaluation of potential impacts (effects) of proposed projects, plans, programs, or legislative actions relative to the physical-chemical, biological, cultural, and socio-economical components of the total environment.

The first definition given by UNEP, as initiated by Clark (1983), implies that decision making on the relative importance, based on local conditions, of beneficial and adverse impacts, should be part of EIA. The second definition clearly defines the scope of EIA. Although a great diversification is apparent in various definitions of EIA, Lohani and Halim (1990) suggests that the process of EIA essentially comprise of three sequential elements-identification, prediction and evaluation.

Identification involves in describing the existing environmental system as well as determining the components of a developed project, which shall have effects on the environment.

Prediction quantifies the identified impacts of a project action with respect to a common base and with respect to impacts from other project actions. Evaluation is the commutation of the EIA based on the previous two functions and aids in the communications to appropriate actions or possible alternatives.

2.2.1 Objective of EIA

The main objective of EIA is to provide decision-makers with an account of the implications of proposed courses of actions before a decision is made. As a planning tool, the environmental assessment process serves to inform interested parties of the likely environmental impacts of proposed project and the methodologies that are to be used to mitigate or reduce the scale and significance of those impacts. The Department of Environment, UK (1994), identifies the aim of an environmental assessment as:

"to provide a full and systematic account of a development's likely effects on the environment, including those which are subject to pollution controls and the measures envisaged to avoid, reduce or remedy significant effects".

The purpose of environmental assessment can therefore be defined as to serve as management tool not only to assess impacts but also to improve the quality of decisions. As a consequence, environmental assessment should be perceived not just as an interdisciplinary methodology that has to be followed to satisfy the regulations but also as an process whereby the best and most appropriate decision are made within the constrains of available resources.

2.2.2 Relationship of Environmental Assessment to Project Cycle

Prior to 1960's a very little attention to environmental concerns in economic development planning and individual project feasibility studies seldom considered any environmental parameters. Since about 1970, after the enactment of NEPA (National Environmental Policy Act), the comprehensive environmental studies were performed and included in feasibility studies. A similar trend emerged since then in other industrial courtiers and gradually in many developing countries.

The relationship of EIA to planning and implementation is illustrated in Fig. 2.1. This shows that, for many projects, the EIA is now being considered as an integral part of the overall project feasibility. It is also shown that the entire process of the project implementation will be facilitated if the environmental parameter is incorporated into project planning from the outset, including a preliminary EIA or IEE (Initial Environmental Examination) along with pre-feasibility stage of project planning.

2.2.3 Steps in EIA

Including "no action" alternative and other alternatives EIA has the main activities (Fig. 2.2) such as:

- Impact identification
- Impact prediction
- Impact interpretation or evaluation
- Identification of monitoring requirements and mitigating measures
- Communication of impact information to users such as decision-makers and members of the public

2.2.4 Impact Identification

The first task of EIA is to identify the likely impacts, which need to be investigated in detail. The term 'impact' means effect in nature and in bio-geophysical environment as a consequence of some man-induced changes. An impact has both spatial and temporal components and can be described as the change in an environmental parameter, over a specified period and within a defined area, resulting from a particular activity compared with the situation which would have occurred had the activity not been initiated. This can easily be envisaged as shown in Fig. 2.3

Fig. 2.3 can be explaining in such a way that if 'a' is a quality of a particular parameter at a particular time, after this time a project is undertaken. It was predicted that after a spell of time 'b' and 'c' would be the quality of that parameter with project and without project. The impact on this particular parameter for this project will be the vertical distance in between 'b' and 'c'.

Environmental systems are dynamic, which change over time even without the influence of man. During the environmental impact assessment, it will be necessary to describe the impacts in terms of whether they are direct (primary) or indirect (secondary, tertiary and higher order). Some impacts are direct consequence of a particular activity. Thus without adequate mitigation measures, construction of a dam on a river, for example, will prevent the upward movement of migratory fish. This would be a direct impact of the project. Some times impacts are indirect. As for example, dam construction obstructs upward fish migration. As a result, fish catch will be reduced in upstream location and consequences of that per capita income of the fishermen will be reduced at that location. This is an indirect impact of dam construction (Fig. 2.4). Moreover, there are also interactive and cumulative impacts.

It is also necessary to identify whether the impacts will be of short, medium or long term, whether they are of a beneficial or adverse nature, whether they can be reversed and whether they are cumulative. They are the central concern of EIA process. It is therefore, vital to consider various natures of impacts before discussing various aspects of EIA. Impact characteristics can be considered according to the following categories:

- Spatial dimension
- Temporal dimension
- Beneficial/Adverse
- Socio-political dimension

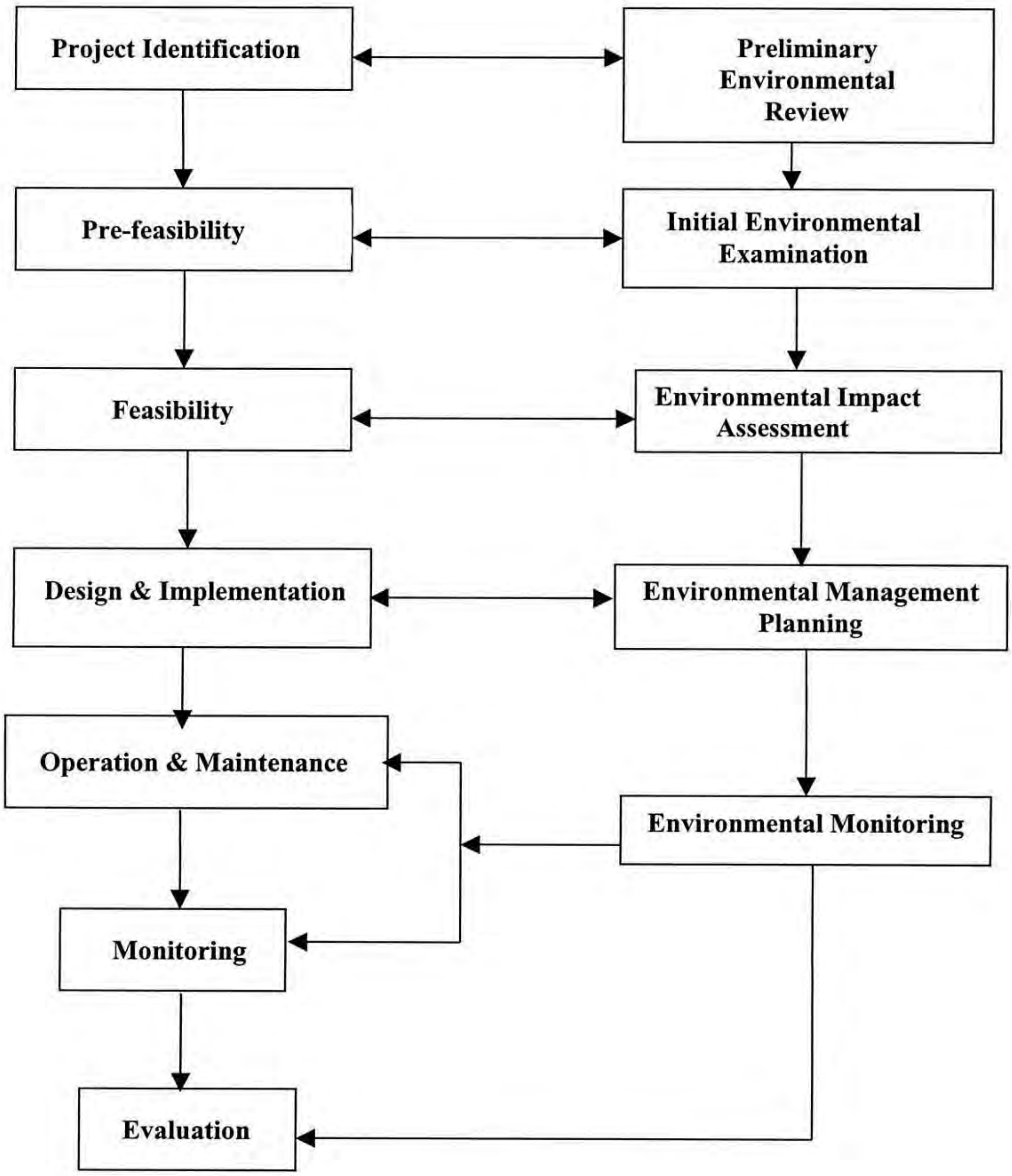

Fig. 2.1: Relationship of Environmental Assessment to Project planning and Implementation (CERM, 2003)

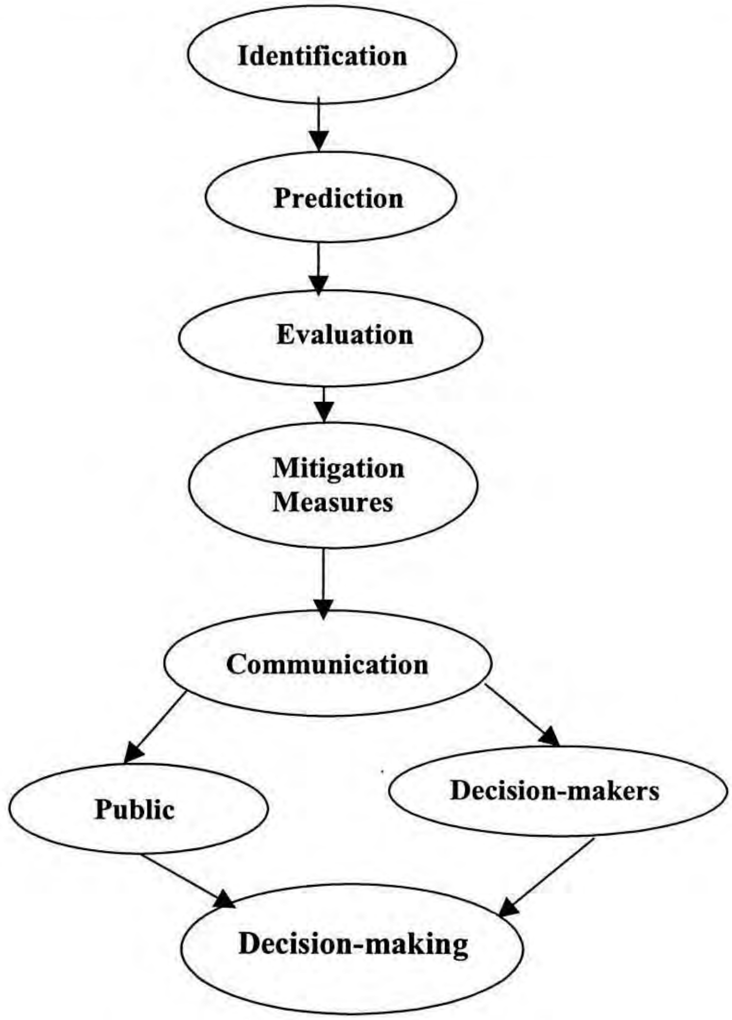

Fig. 2.2: Main Activities in EIA (CERM, 2003)

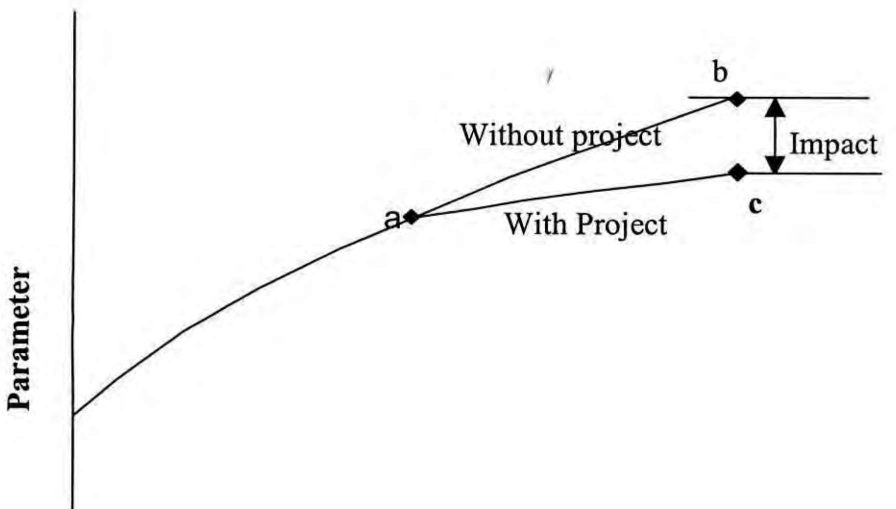

Fig. 2.3: Concept of Environmental Impact

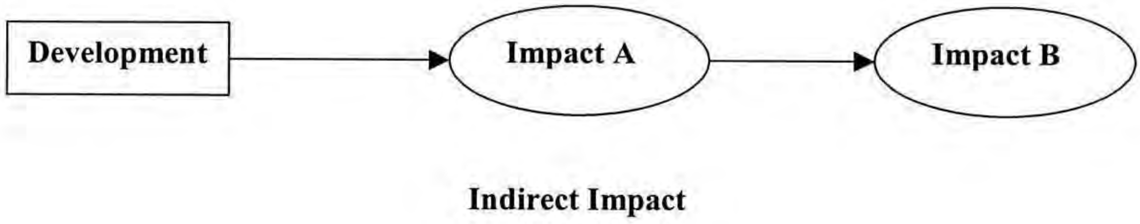

Fig. 2.4: Indirect Impact

2.2.4.1 Spatial dimension

Impact can occurred in the vicinity of a project. For example, odour problem of a tannery industry in surroundings. Alternatively, impacts can be observed at considerable distance. For example, acid rain in Scandinavia is a consequence of hydrocarbon combustion in UK/Northern central Europe.

2.2.4.2 Temporal dimension

Some impacts occur immediately. For example, noise level raise is the immediate effect of construction. Some impacts may occur after a long period of time. For example, accumulation of heavy metal in aquatic organization occurs after a long period of time.

2.2.4.3 Beneficial/Adverse

Some impacts are beneficial. For example, for a project, employment, community development etc. may be the beneficial impacts. Projects may have adverse impacts such as loss of habitat, loss of productivity etc.

2.2.4.4 Reversibility

Some impacts are irreversible. For example, loss of agricultural land after building construction is irreversible impact. Some impacts are reversible. For example, raise of noise level would be returning to normal level after the construction is ceased.

2.2.4.5 Socio-political dimension

Societies are made up of groups and individuals with different interests and values.

For example, conservationists may see a change in wild life habitat due to some action as ecologically significant impact. Other interest groups,e.g., the unemployed looking for new jobs may not recognize it as an impact. Therefore, the social groups and individuals assign different values to environmental changes. Also people/experts conducting EIA may reflect different values than local interest groups.

Study teams own perception/political influence/lack of knowledge of the causal relations between development activity and environmental/social change may cause to differences between groups. Environmental changes are often not converted to real consequences for example, changes including concentration of air or water pollutants at various locations are predicted, but their effects on people are not explained.

Distribution of impacts on social groups:

- Some may have only beneficial impact
- Some may have only adverse impacts
- Some may have mixed impacts.

There has been tendency to identify all impacts and to investigate them individually. Often, after much work it was found that many of the impacts were unimportant both to those people living in the vicinity of the proposed project and experts in environmental sciences. Considerable time, manpower and finance might have been saved had greater attention been paid at an early stage to an initial identification of the most likely important impacts - an activity often known as "scoping".

Basically "scoping" involves discussion, frequently in the form of meetings, between those implementing an EIA, those responsible for design, construction and operation of a project, and representatives of government departments and agencies, which have an interest in a development proposal. In some countries representatives of communities likely to be affected participate in the meetings. The main aim of "scoping" is to select from the total number of possible impacts those that are important enough to deserve further study. This objective is of crucial in situations where resources for EIA are limited.

2.3 IMPACT PREDICTIONS AND MEASUREMENT

This part involves the estimation of likely nature or characteristics of impacts in quantitative/qualitative terms. In many instances it is necessary to predict in quantitative terms the magnitude of the changes in particular environmental feature due to the influence of a development. For example, in the hypothetical case of the pulp mill, it might be essential to calculate changes in noise levels at the nearest inhabitant site, the concentration of air pollutants such as SO_2 at varying sensitive locations, and change in downstream dissolved O_2 as a result of the discharge of aqueous effluent with a high organic loading.

Predictions can be carried out by means of various techniques. For instance, many types of analytical mathematical models exist to allow predictions of concentrations of chemicals in the air or in the water at varying distance from a source. The measurement of changes in the state of environmental features is an important first stage in estimating the nature of many impacts. The next stage is to determine the nature of these effects on human, animals or plants.

In a few cases this is relatively easy, especially when dose-response curves are available. Unfortunately these do not usually exist, and experts can only make an estimate or educated guess of the effects of a particular environmental parameter on individual organization, and perhaps more importantly, on populations and communities of organizations. This is probably one of the most difficult activities within EIA.

2.4 IMPACT INTERPRETATIONS OR EVALUATION

Impact identification has two distinct operations. At first the importance of an impact has to be determined. For example, in building construction it might be predicted that inhabitants of the local community will be exposed to a certain increase in noise level. How important is this change? This question has to be faced at some point in the EIA process. Secondly, the relative importance of impacts when compared with each other is sometimes considered as part of impact interpretation. This exercise is often known as "evaluation". EIAs constantly investigate a number of impacts that cannot be easily expressed in common units (e.g. money) and thereby directly compared. Not all impacts will be considered to be of equal importance by decision makers, environmental experts and/or members of public. Some judgment will be made on the relative importance of the impacts. This can be done at all stages in EIA but usually it occurs towards the end of EIA work when results are being collected and collated for preparation of an Environmental Impact Statement (EIS) by decision-makers and members of the public after they have received the copies of the EIS.

2.5 MITIGATION MEASURES

The identification of mitigation actions to prevent the harmful impacts or reduce their scale and intensity is also an important part of EIA. Mitigation measures make the project more sustainable and environmentally friendly. Monitoring during operation of project makes a guidance of mitigation measures. Monitoring provides early warning of environmental damage so that actions may be taken, if possible, to prevent or reduce the seriousness of the unwanted impact. Further recommendation for mitigation of negative environmental impacts is given with the EIA report to make the project more sustainable and successful.

2.6 EIA METHODOLOGIES

There are a variety of EIA methodologies. Different methodologies are useful for different category of project and supported data.

Common EIA methodologies are:

- **Checklists**
- **EES**
- **Matrices**
- **Network**
- **Cost benefit analysis**
- **Overlays/GIS**

2.6.1 Checklist

A variety of checklist methods are available having varying degrees of complexity.

The common feature of the checklist methods consists of a list of environmental, social and economic factors that may be affected by the development.

There are four broad categories of checklists:

- **Simple checklist**
- **Descriptive checklist**
- **Scaling checklist**
- **Scaling-weighting checklist**

2.6.1.1 Simple checklist

This method only identifies the impacts and ensures that the impacts are not overlooked. Since this method provides no information on specific data needs, methods of measurements or prediction and assessment, additional guidelines is therefore, needed to perform other EIA tasks.

2.6.1.2 Descriptive checklist

This method includes the environmental factors likely to be affected and also provides information on data requirements, sources of information and prediction techniques. The method is widely used in EIA studies of water resources projects, transportation projects and land development projects.

2.6.1.3 Scaling checklist

In this method numerical or 'letter' scales are assigned to the impacts of each alternative being evaluate on each identified environmental factors. This method is useful in comparative evaluation of alternatives.

2.6.1.4 Scaling-weighing checklist

The method assigns relative importance weights to environmental factors. Impacts scales are also assigned for each alternative to each factor. Environmental Evaluation System (EES) is an example of this type.

2.6.2 Environmental Evaluation System (EES)

The Environmental Evaluation System (EES) is used to evaluate the expected future conditions of the environmental quality, both "with" and "without" the project. A difference in Environmental Impact Units (EIU) between these conditions constitutes either an adverse impact, which corresponds to a loss in EIU, or a beneficial impact, which corresponds to a gain in EIU.

Mathematically this is represented as (Dee, N., et al., 1972)

$$EI = \Sigma (Vi)_1 \, Wi - \Sigma (Vi)_2 \, Wi$$

$$[i = 1, 2, 3, \ldots\ldots\ldots\ldots, m]$$

EI = environmental impact

$(Vi)_1$ = value in EQ of parameter 'i' with project

$(Vi)_2$ = value in EQ of parameter 'i' without project

Wi = relative importance weight unit

m = total number of parameters

To aid in transforming these parameters into an environmental quality scale, value function graphs are used for each parameter. To determine value function for an environmental parameter, Dee, N., et al (1972) suggested a general approach as follows:

1. Collect information on the relationship between the parameter and the quality of the environment.
2. Order the parameter scale, which is normally the abscissa, so that the lowest value is zero.
3. Divided the environmental quality scale intervals ranging between 0 and 10 and determine the appropriate value of the parameter for each interval. This process is to be continued until a reasonable curve may be drawn.
4. Steps 1 to 3 should be repeated by various experts independently. The average values should produce the group curve. The above procedure should be conducted for all environmental parameters of interest or concern. The next step is the computation of environmental impact units (EIU) for environmental components and categories.

Local Government Engineering Department (LGED) suggests to consider the degree of impact within a range of –5 to +5 (LGED, 1992). Fig. 2.5 shows the quantification standard of LGED.

Since the changes of environmental parameters are measured with respect to existing condition, no change has 0 value. The adverse changes have been given values –1, -2, -3, -4 and –5 to represent very low, low, moderate, high and severe negative impacts respectively. Similarly +1, +2, +3, +4 and +5 represent very low, low, moderate, high and severe positive impacts respectively. A value from the scale representing effect of the project on each parameter will be taken to compute the Environmental Impact Value (EIV) of the project.

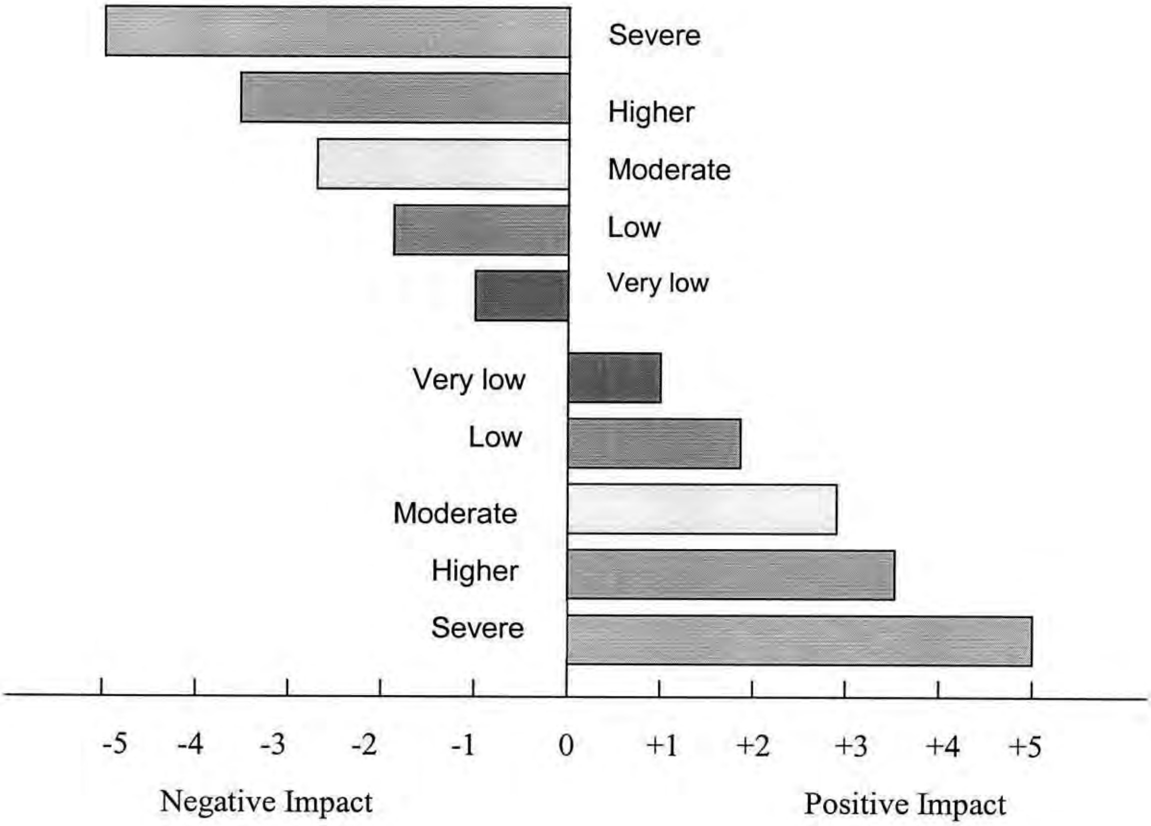

Fig. 2.5: Quantification of Environmental Impact (LGED, 1992)

All environmental parameters influenced by the project are not of equal importance or weight. The importance of parameter varies from country to country depending on the environmental concerns of the country. In Bangladesh, flood, employment, agriculture, fisheries, etc. carry more importance than many others. The parameters related to infrastructure projects have been given different values by LGED based on prevailing environmental concerns in Bangladesh and presented in Fig. 2.6. The values representing importance or weight of parameters can be used to compute the relative impacts of the parameters, which are then summed up to obtain the total EIV of the project.

TOTAL IMPORTANCE VALUE OF ENVIRONMENTAL PARAMETERS

100

25 ECOLOGICAL PARAMETERS

[10] Fisheries
[3] Wildlife
[5] Forest
[2] Tree Plantation
[4] Wetlands

35 PHYSICO-CHEMICAL PARAMETERS

[2] Erosion and Siltation
[5] Drainage Congestion/Water Logging
[6] Regional Hydrology/Flooding
[6] Flood Control/Drainage
[5] Soil Characteristics/Soil Fertility
[3] Ground Water Table
[3] Water Pollution

40 HUMAN INTEREST RELATED PARAMETERS

[6] Health and Nutrition
[8] Loss of Agricultural Lands
[8] Employment Opportunity
[6] Commercial and Service Facilities
[3] Navigation/Transportation
[3] Industrial Activities
[2] Irrigation Facilities
[2] Land Ownership Pattern
[2] Landscape

[ ] Parameter Value
☐ Total and Component Values

Fig. 2.6: Relative Importance Value of Environmental Parameters Related to Infrastructure Projects (LGED, 1992)

2.6.2.1 Advantage of EES

- This method is very comprehensive. It provides an extensive checklist of environmental characteristics and impacts that should be considered.
- Both spatial and temporal aspects of identified impacts can be accounted for in the weighting system.
- This method is highly replicable since the direction for identification and evaluation of impacts is explicit.
- It utilizes the best judgment of multidisciplinary evaluations.

2.6.2.2 Disadvantages of EES

- The most weak point of this method is the manner in which it compartmenlises and fragments the environment.
- The environment factors are assessed in isolation. No consideration is given on how changes in one parameter might affect the others.
- This method is heavily dependent on quantification.

2.6.3 Matrices

This method is an extension of checklist. In addition to list of environmental characteristics or impact indicators, it makes a list of project activities. The two are related in a matrix in order to identify cause and affect relationships.

The simple matrix displays project action or activities along one axis, with appropriate environmental factors listed along the other axis of the matrix. When a given action or activity is anticipated to cause a change in an environmental factor, this is noted at the intersection point in the matrix.

2.6.3.1 Advantage of matrix method

- This method provides systematic lists of both development actions and environmental factors and therefore, easy to identify impacts.
- Major advantage of matrix method is its highly visual nature.
- This method is useful in measuring and interpreting impacts in terms of magnitude and importance.

- Matrix is very useful in communicating ideas to the public and to decision-makers.

2.6.3.2 Disadvantages of matrix method

The most important disadvantage of this method is that it compartmentalizes the environment into separate items. Therefore the influence of one parameter on other parameters cannot be observed.

2.6.4 Networks

This method is capable of identifying direct and indirect impacts, higher-order effects and interactions between impacts, and hence, is able to identify and incorporate mitigation measures into the planning stages of the project. Weighting and rating of impacts are not features of network analysis.

2.6.5 Cost Benefit Analysis

When cost and benefit of a project is determined it become easier for the planner to decide whether the project should be implemented or not.

The UNEP Test Model based on cost-benefit approach has developed a framework in the following six-part format:

- Essential project description, which set the physical and economical parameters for the analysis.
- Itemizing the resources used in the project, indirectly affected, and residues created.
- Itemizing the resources exhausted depleted or deteriorated.
- Itemizing the resource enhanced.
- Listing of the required additional project components.
- Summary of the conclusion and the formulation of integrated cost-benefit presentation.

2.6.5.1 Advantage

The important advantage of this method is that the impacts are provided in monetary terms and hence, easily understandable. Monetary conversion of impacts aids decision-makers for their decision.

2.6.5.2 Disadvantage

There are some environmental factors (e.g. loss of health) cannot be converted in monetary value. Their impact identification is not possible in this method.

2.6.6 Adaptive Environmental Assessment and Management (AEAM)

Adaptive assessment can be divided into three types of workshops:

- The initial workshop
- The second-phase workshop
- The transfer workshop

This method overcomes the shortcoming of most other methods in that other methods assume unchanging conditions or project impacts in a single time frame with statistically described environmental conditions.

The AEAM technique can handle higher-order impacts and interactions between impacts. But is depended on a small group of experts. This method has no avenue for public participation. This aspect is of particular significance for large-scale development, where the options of interest groups are important.

2.6.11 Overlays

This method involves the use of superimposed transparencies to identify, evaluate, compare and communicate impacts in a geographical reference framework. The study area is divided into a number of environmental factors e.g., topography, vegetation distribution, ecologically sensitive areas, historical sites etc. All maps prepared in this way are superimposed. The resulting map shows the simulation of all values employed and thus the suitability of the area for given activity.

Although the method is flexible, efficient and very simple to conduit, preparation of maps may be costly and time consuming. The method does not specify cause-effect relationships and suffers by lumping physical, biological and social factors together. Although the method is primarily used for the comparison of impacts e.g., selection of alternative, it is to be noted that it has no predictive capability whatsoever. Geographic Information System (GIS) is similar to Overlays, but more sophisticated time saving method that can handle mostly land reformation.

GIS is a collection of computer hardware, software, geographic data, and personnel designed to efficiently compute, store, update, manipulate, analyze, and display all display all forms of geographically referenced information. In short GIS can be defined as a computer system capable of holding and using data describing places on the earth's surface.

2.7 DOCUMENTING EIA REPORT

The sustainable use of natural resources and protection of environment is one of the main concerns of different funding agencies. The feasibility of proposed project is also the governing concern of the agencies. There are different funding agencies such as Sida, ADB, World Bank etc. Different guidelines are followed by the different agencies to protect the environment and to make the project sustainable. The requirements of a particular agency must be fulfilled to have fund from that particular agency. The steps involved to identify is more or less same for different agencies. The difference among the agencies is only to categorize the class of impact. As for example, Sida categorizes the EIA needs for a project, in two broad classes as Simple EIA and Major EIA (Sida, 1998). The projects, which are expected to have little effect on environment, need a very brief EIAs (simple EIA). The projects, which will have major environmental impact, require extensive and detail EIAs (Major EIA). World Bank categorizes EIA in four classes such as Category A, Category B, Category

C and Category FI (World Bank, 2000). A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. For Category A type project, potential positive and negative environmental impacts should be examined, compared to feasible alternatives (including without project), and measures to minimize, mitigate or to compensate should be recommended. The borrower is responsible to make EIA for Category A type project. A proposed project is classified as Category B if its potential adverse environmental on human populations or environmentally important areas-including wetlands, and other natural habitats-are less adverse than those of Category A projects. These effects are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. The scope of EIA for Category B project may vary from project to project, but if is narrower than that of Category A. Like Category A EIA, it examines project's potential positive and negative environmental impacts and recommends any measure needed to minimize, mitigate, or compensate for adverse impacts and improve environmental performance. A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact. Beyond screening no further EIA action is required for a Category C type project. A proposed project is classified as Category FI if it involves investment of bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts. ADB also categorizes the project in four classes as Category A, Category B, Category C and Category FI (ADB, 1993). Project with potential for significant adverse environmental impacts are categories as Category A. An environmental impact assessment (EIA) is required to address significant impacts. Projects judges to have some adverse environmental impacts, but of lesser degree and/or significant than those for category A projects are of Category B. An initial environmental examination (IEE) is required to determine whether or not significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report. Projects unlikely to have adverse environmental impacts are regarded as Category C type project. No EIA or IEE is required, although environmental implications are still reviewed. Projects are classified as Category FI type if they involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply an environmental management system, unless all subprojects will result in insignificant impacts.

2.7.1 Component of an EIA Report

EIA report should include the following items (not necessarily in the order shown):

2.7.1.1 Executive summary

Executive summary concisely discusses significant findings and recommended actions. This part of document is a summery of the EIA. The final finding after analysis is presented in this section. Moreover, summery of recommendations is made in this part of report.

2.7.1.2 Policy, legal and administrative framework

EIA report discusses the policy; legal and administrative framework within which the EIA is carried out. It explains the environmental requirements of any co financiers. A relevant international environmental agreement to which the country is a party is identified.

2.7.1.3 Project description

Details of project together with geographic, ecological, social etc. should be described in project description. If any resettlement required, resettlement plan should also be described in project description. Normally a map, showing the project site and the project's area of influence, is prepared for EIA.

2.7.1.4 Baseline data

Baseline data is necessary to assess the dimensions of the study area and describes relevant physical, biological, and socio economic conditions; including any changes anticipated before the project commence. Current and proposed development activities within the project area, which are not directly connected, are also is taken into account. Data should be relevant to decision about project location, design, operation, or mitigatory measures. Data should be collected from reliable sources and should be relevant.

2.7.1.5 Environmental Impact Assessment

Potential positive and negative impacts should be assessed and predicted in quantitative term to the extent possible. In assessment part, mitigatory measures and residual negative impacts cannot be mitigated are identified. This part also identifies and estimates the extent and quality of available data; key data gaps and uncertainties associated with the predictions, and specify topics that do not require further attention.

2.7.1.6 Analysis of Alternatives

Feasible alternatives of proposed project including their site, technology, design etc. and also their potential environmental impacts and feasibility of mitigation of these impacts are analyzed. "Without project" situation is also analyzed. Environmental impacts of the alternatives should be quantified to the extent possible. Economic values should be attached where feasible. Basis for selecting particular project is stated. Recommendation for emission levels and approaches to pollution prevention is justified. Sometimes this part is merged with Environmental Impact Assessment part.

2.7.1.7 Environmental Management

Environmental management plan covers mitigation measures, monitoring and institutional strengthening. Management plan are essential element for Category A type projects; for many Category B type projects. A set of mitigation measures is taken to eliminate or to reduce the adverse effects to an acceptable limit.

2.8 PREVIOUS STUDY ON THIS STUDY

During last few years, the Kapotaksha River has been experiencing huge sedimentation at Jhikargachha, Manirampur, Keshabpur, Kalaroa and Tala upazilas. People of this area raised persisting demand for restoring the flow of the Kapotaksha to get rid of the drainage congestion. BWDB conducted a feasibility study in 2000. The study came up with recommendations for dredging as the short-term solution. In pursuance of BWDB's decision, CEGIS has been engaged with several works, such as baseline survey, motivational campaign and monitoring of impacts of dredging.

2.9 SUMMARY

Environmental Impact Assessment is a very important part of a project. The sustainability and feasibility of a proposed project is strongly dependent on the EIA. Further more, steps to be taken to mitigate adverse impact or to reduce negative impact is associated with EIA. Very systematic and careful approach of accumulating mass heterogeneous data and effective impact prediction makes a proper assessment of the sustainability of the project. So data capturing, accumulation and manipulation of data and application of appropriate methodology of EIA is a very sensitive part of EIA, which makes a project successful, or failure. In a word this sensitive part of a proposed project should be handled very carefully to make the project sustainable.

Chapter 3

STUDY AREA AND THE PROJECT FEATURES

3.1 INTRODUCTION

The Kapotaksha River located in the southwest part of Bangladesh. The river originates from Bhairab River at Tahirpur and confluences to Sibsa River having a length of 200 km. This river has 1,067 sq. km drainage area (CEGIS, 2004) over eight upazilas in Jhinaidah, Jessore and Satkhira district (Fig. 3.1).

The Kapotaksha was a perennial river when it had a connection to the Ganges through Mathabhanga and drained fresh water to the Sundarbans. After losing its perineality i.e. connection with the Ganges River the river Kapotaksha has started to decline to adjust its size with the new regime of flow and sediment. As a result, the upstream reaches became two level terraces over time and the down stream reaches converted into tide-dominated river.

According to the local information, tide penetrated up to Tahirpur. In dry season, a huge amount of sediment intrudes by pumping process together with high salinity. High salinity facilitated sedimentation of fine sediment to riverbed. As a consequence of pumping process, the river lost its depth i.e. drainage capacity. The drainage situation falls drastically in both banks in Jhikargachha, Manirampur, Keshabpur and Kalaroa upazilas of Jessore and Satkhira districts. To have a relief from the regular flooding and drainage congestion, BWDB had undertaken a re-excavation project named Kapotaksha River Re-excavation Project (KRREP), in 2004.

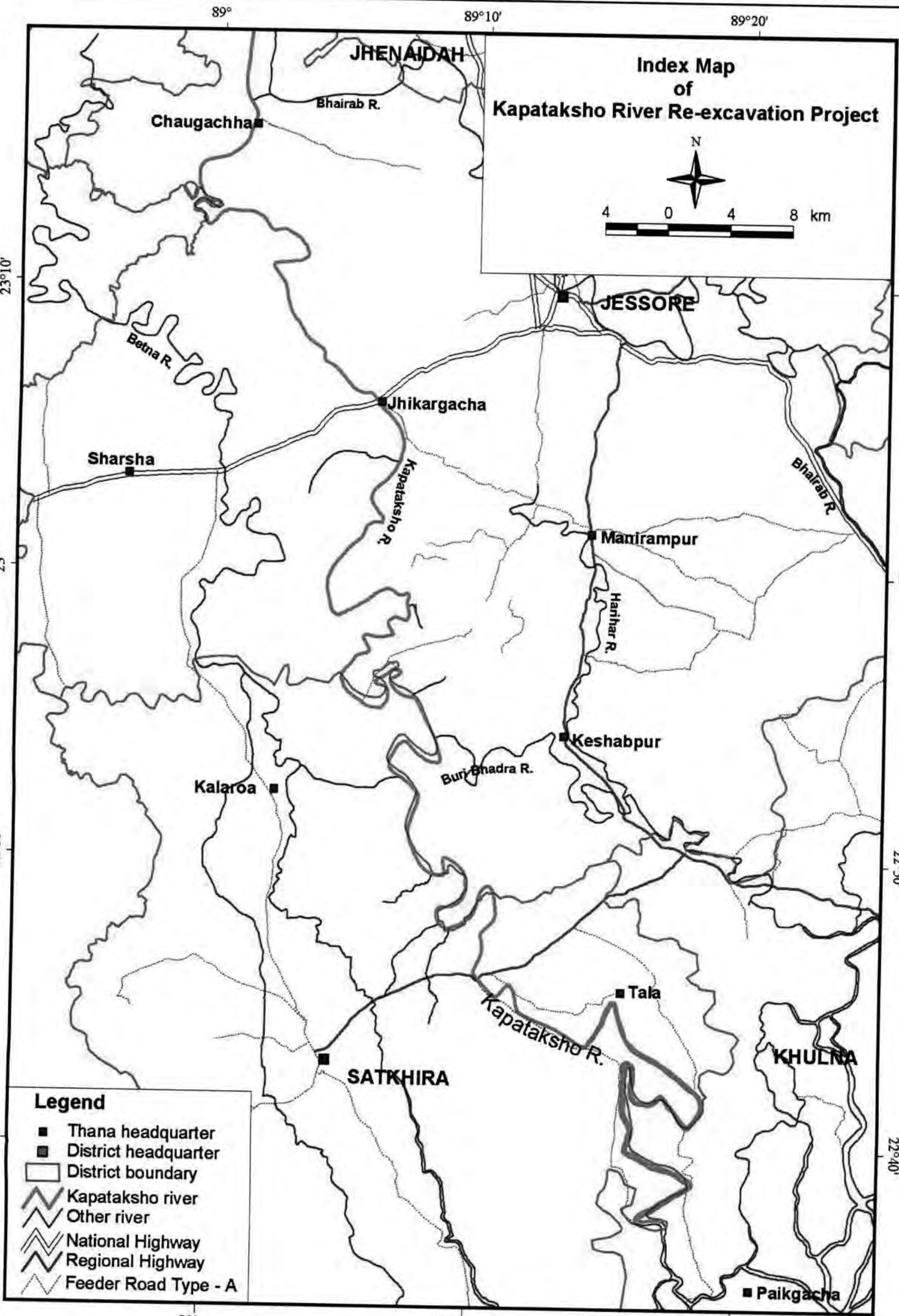

Fig. 3.1: Map of Kapotaksha River (CEGIS, 2004)

3.2 TOPOGRAPHY AND LANDFORM

The project area includes the western part of Ganges River Floodplain, which is predominantly highland and medium highlands. The area is located mainly on lower Ganges River Floodplain. The land type of the study area is high land and medium high land. General elevation of the project area varies from 1.5 m to 8m from Mean sea level (MSL) (NWRD, 2004). Major part of high lands becomes wet during spells of heavy rainfall. The lower ridge and basins are shallowly flooded by pounded rainwater. Flood level fluctuates year to year according to rainfall intensity.

The soil of upper part floodplain ridges is of olive brown, silt loams and silty clay and that of the lower part is of dark grey, malted brown, and mainly clay. The available soil nutrients vary from place to place. In general, the soils of the areas have low nitrogen and zinc. But have high Phosphorous, Potassium, Magnesium and Calcium. The soils in the areas are non-saline (except only the lower part there is slight salinity in dry season).

3.3 AREA AND POPULATION

The river Kapotaksha flows through three districts named Jhinaidah, Jessore and Satkhira. The total area of these three districts is 8386 km^2. It is expected that only around 9% area of the total district area will be benefited i.e. 767 km^2 by KRREP (Kranti Associates, 2001) (Table 3.1). The total population of the study area is around 0.75 million. The area includes eight Upazilas: Mahespur of Jhinaidah district, Jhikargachha, Manirampur, Keshabpur, Sarsha and Chaugachha of Jessore district and Tala and Kalaroa of Satkhira district.

Table3.1: District-wise area and population distribution of the study area (BBS, 2003; Kranti Associates, 2001; and CEGIS, 2004)

District	Total area in the district (km^2)	Area and population in the project (km^2)			
		Total area in project		Population in 2003 ('000)	
		Area	% of district	Population in district	Population in project area
Jhinaidah	1950	28.85	1.48	1460	216
Jessore	2578	625.23	24.25	1880	456
Satkhira	3858	112.92	2.92	2700	79
Total	*8386*	*767*	*9.15*	*6040*	*751*

3.4 WATER RESOURCES SYSTEM

Surrounding river network along the Kapotaksha River is shown in Fig. 3.2. The water resource system of the Kapotaksha River system consists of a number of drainage channels and khals originate either from lowlands or from beels. The drainage channels drain into the Kapotaksha River and maintain the hydrological connectivity between beels, baors etc. (Fig. 3.3). There are about nine drainage khals on the both banks of the Kapotaksha River (CEGIS, 2004). These khals are performing mainly drainage function of the water resources system and also maintain water environment of the catchment area under KRREP area. Table 3.2 shows different drainage channels connected to the Kapotaksha River.

Table 3.2: Drainage khals and their sources (CEGIS, 2004)

Sl No.	Name of drainage channels	Originating sources
1	Hajrakata/Par-Khajura Khal, Kadar Khal, Joynagar khal, Jhillitolar/Laskar Khal and Sarulia Khal	Parkhajura beel; Muthura beel: Kadar beel; Bramarajpur beels and localized beels
2	Derikhali Khal and Buri Khal	Betna river and Buri nadi
3	Choto Naimat Khal, Mosumpur Khal, Chutipurar Khal, Khalisha Khal, Haridra Khal, Meherpur Khal, Baliadangi Khal and Barabdali/Mirjapur Khal	Low laying depression and agricultural lands

3.4.1 Baor

Baors are abandoned courses of rivers created by loop cutting of the river bend and are perennial water bodies. Normally a baor receives local runoff water during wet season and some times spill over the adjacent floodplain and may cause local flooding. The total area covered by the baors in the Kapotaksha River area is about 500 hectors including Jhapa baor, the biggest baor in Bangladesh. Baors act as drainage basin to receive upstream water through many connecting khals. For example, 18 khals are connected with Jhapa baor. At present, northern mouth of the Jhapa baor is completely closed by an embankment. In some places, people are encroaching into the land of the baor for agriculture. Baors in the project area get connection with the rivers during monsoon (June-October) and beyond this period start to loose their connectivity and become disconnect during dry season (February-April). Local people informed that before drainage congestion, people could cultivate almost 40% area of the baor land during dry season. But in last few years, baors located in the impacted area remains connected with the Kapotaksha River throughout the year. During monsoon, almost all of the agricultural lands and homestead area in the impacted area becomes inundated during monsoon and continued up to January. In 2003 monsoon, agricultural lands went about 3 to 3.5 ft under water.

Table 3.3: Area under different baors in the study area (CEGIS, 2004)

Sl no	Name of baor	Location (upazila)	Area in hectare
1	Parkhajura	Manirumpur	148
2	Jhapa	Manirumpur	205
3	Khatura	Manirumpur	65
4	Hariharnagar	Manirumpur	2.50
5	Ujjalpur	Jhikargachha	25
6	Tepir	Jhikargachha	4
7	Khorado	Kalaroa	51
		Total	*500*

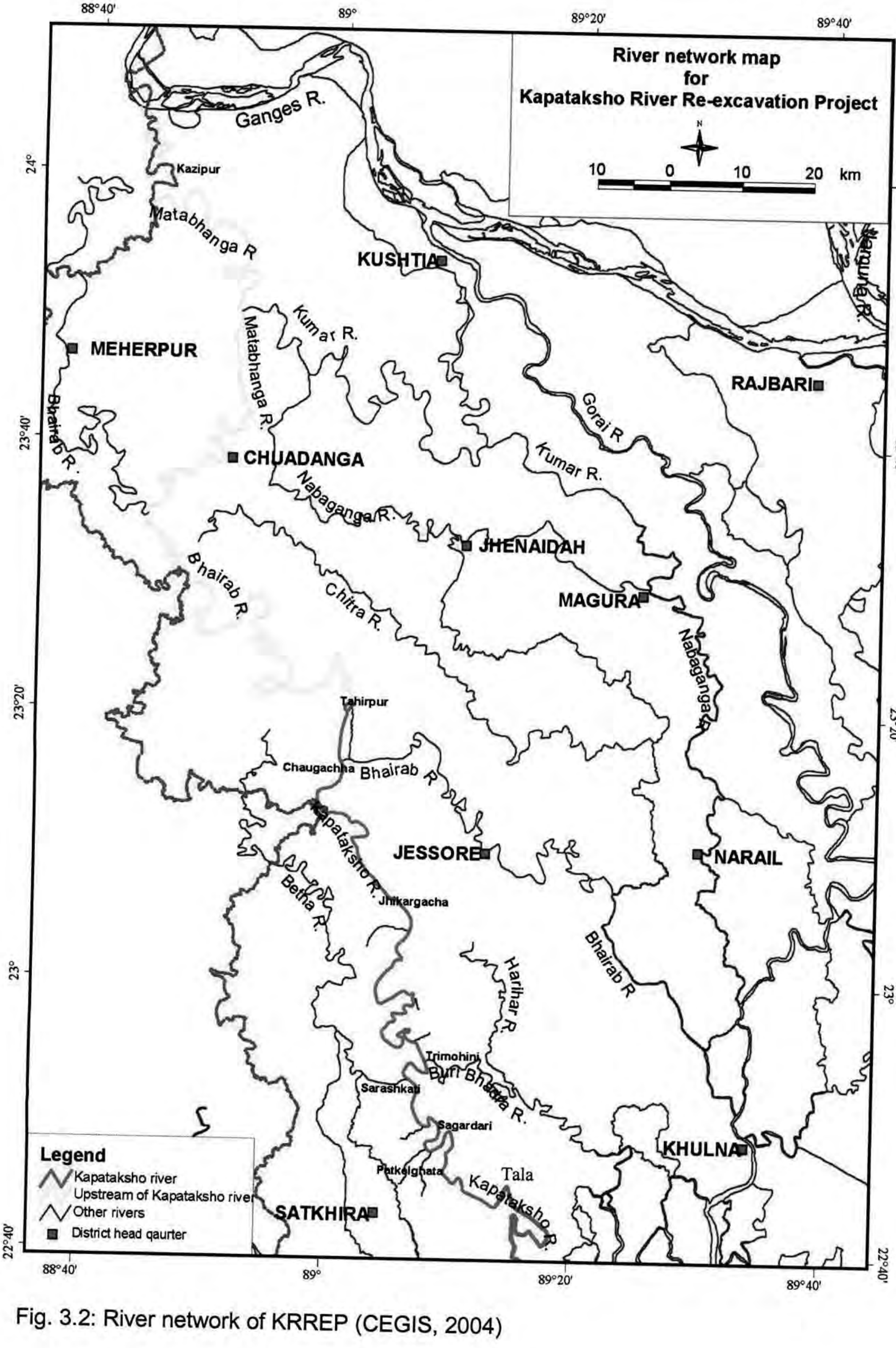

Fig. 3.2: River network of KRREP (CEGIS, 2004)

3.4.2 Beels

Beels are topographic depression of large surface area; accumulate surface runoff through internal drainage channels. Many beels dry up in winter and become a fresh water lagoon in monsoon. Large beels are fed by parent river in dry season. There are many beels in the study area and among which the major beels are Parkhajura beel, Mathura beel, Bramarajpur beel and localized beels. The beels covering about 1100 hectares (CEGIS, 2004) are giving support to aquatic habitat and providing sufficient water resources potential for agricultural use.

3.5 KAPOTAKSHA RIVER RE-EXCAVATION PROJECT (KRREP) FEATURES

During the last few years, the drainage capacity of the Kapotaksha has been declining rapidly. A huge sedimentation occurred and created a hump in the tidal reaches downstream of Trimohoni (km 83.00) shifting the tidal limit down to km 110.00 within a few years (BWDB et al, 2003). The high sedimentation aggravated the situation drastically and caused widespread drainage congestion in this area. To get rid of this drainage congestion problem, BWDB undertook a project of re-excavating the Kapotaksha River as a short-term solution in year 2003. After conducting a preliminary feasibility study, BWDB has undertaken a program in September 2003 to dredge a total 53 km (from Ch- 77.5 km to Ch-130 km). BWDB planned to dredge the critical length of 47 km of river from Trimohoni to Patkelghata (Ch-83 km to Ch-130km) with dredger, 8 km of length of river (from Ch-77.5 km to Ch-83 km) to re-excavate manually (Fig. 3.3) and 50 km of length of connecting khals to re-excavate from low-laying areas and erecting embankments and drainage regulators with fish pass (Table 3.4).

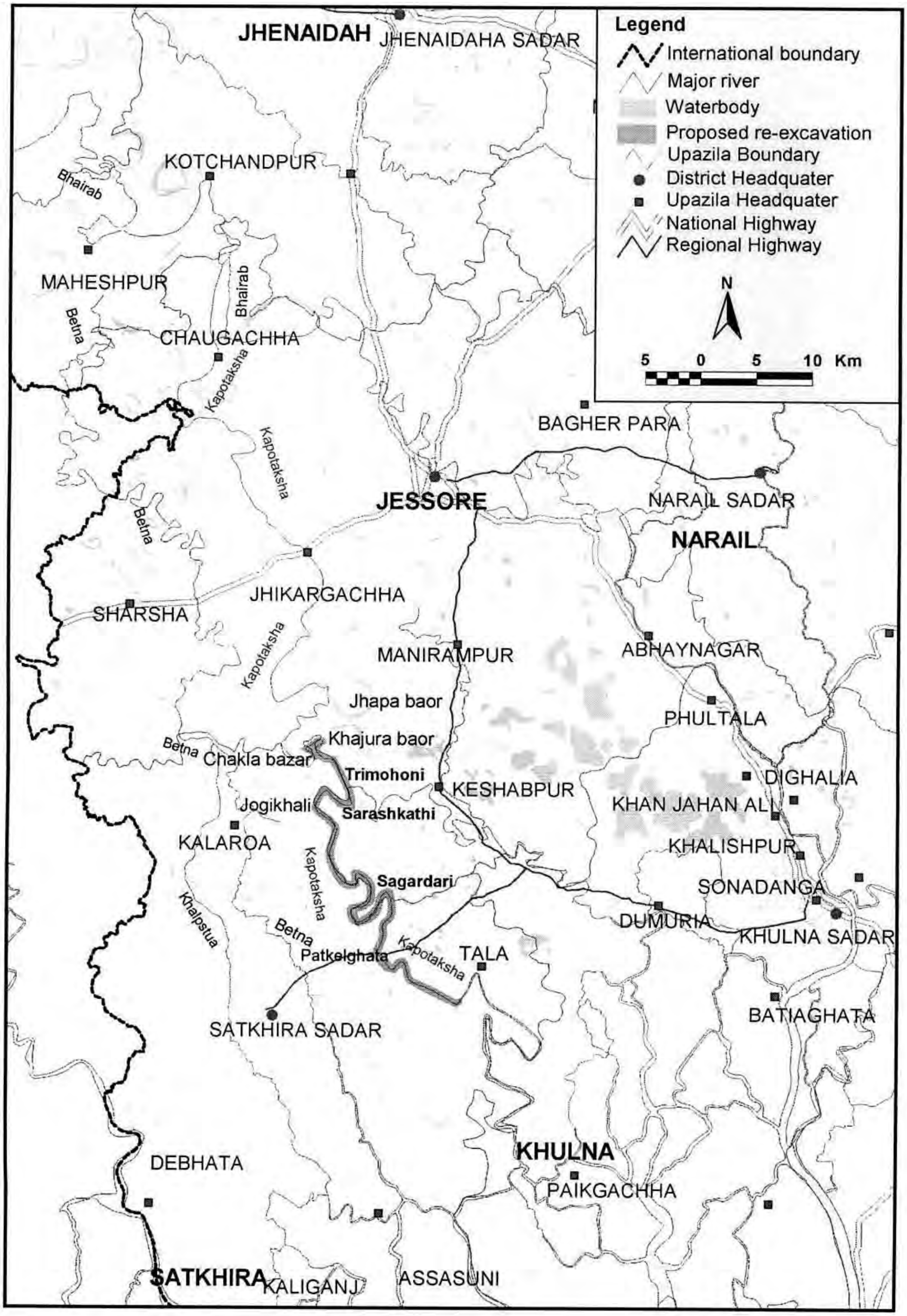

Fig. 3.3: Baors in KRREP area and proposed re-excavation for KRREP (CEGIS, 2004)

Table 3.4: Different features of the KRREP (CEGIS, 2004)

Component	Feature
1. Dredging of the river	47 km
2. Manual re-excavation	8 km
3. Re-excavation of existing khals	50 km
4. Flood control embankment	10 km
5. Drainage regulator	4 no
6. Fish-pass	1 no

The floodplain of the Kapotaksha River is two level terraces (Fig. 3.5). The proposed project will extent dredging up to present flood level. Hence around 24 sq. km is to dredge on both sides of the river. The total design dredging volume of the KRREP is around 27,00,000 m^3 (BWDB et al, 2003). It is designed that in first phase, a total 30.56 km length of the Kapotaksha will be dredged from Sarashkathi bridge (Ch-93.3 km) to downstream of Patkelghata bridge (Ch-12.5.5 km). The proposed locations for dumping of the dredged materials are shown in Fig. 3.4.

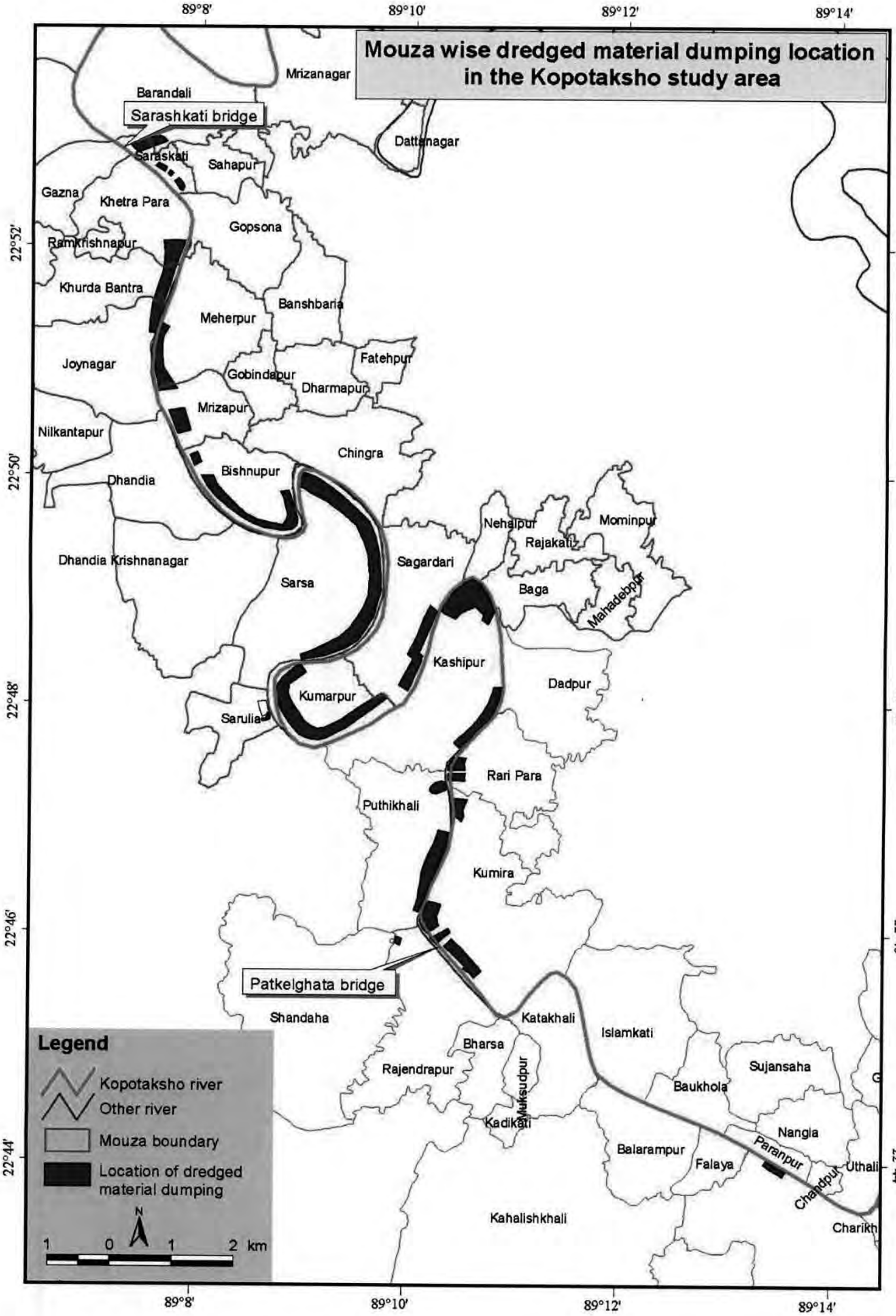

Fig. 3.4: Mouza-wise location where dredged materials are to dumped (CEGIS, 2004)

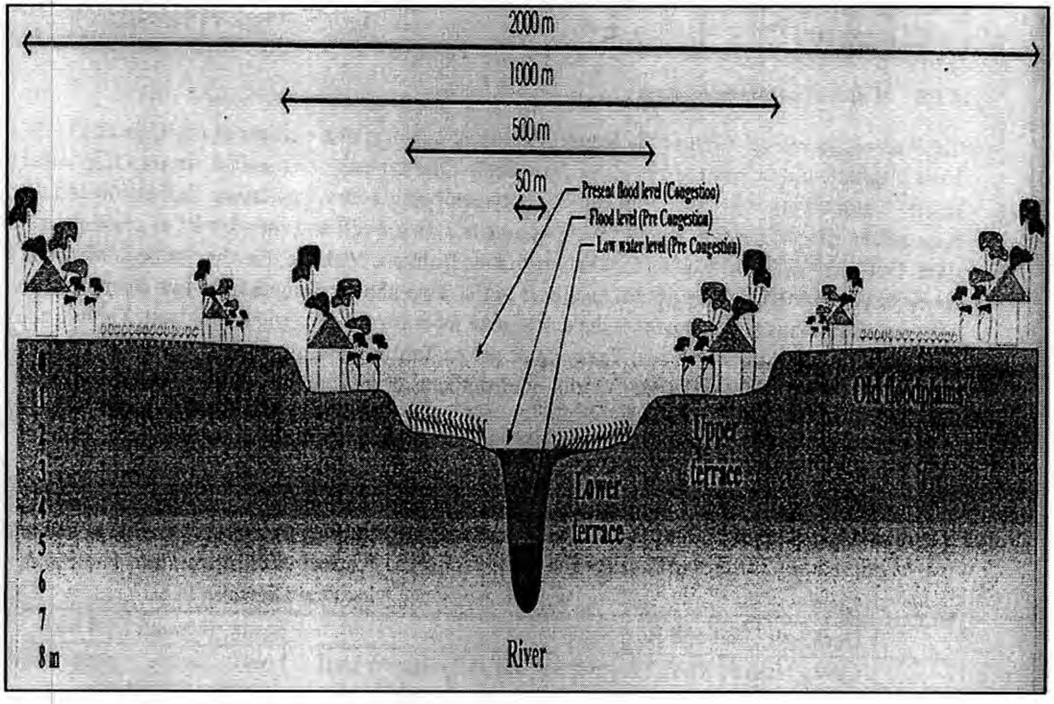

Fig. 3.5: Floodplain terrace to the Kapotaksha River (CEGIS, 2004)

Chapter 4

BASELINE SURVEY OF THE KRREP

4.1 INTRODUCTION

Participatory and exploratory approach is followed in carrying out the study. Baseline survey result includes data and information of various types such as environmental data (physical and ecological data) and social data. All these data and information were collected either by field visit or from secondary sources. Data on rainfall, evaporation, sunshine hours, surface water level, ground water level, population, housing condition, sanitation condition etc were collected from publications of different secondary sources such as BWDB, NWRD, BBS and CEGIS. Ecological data (fisheries, flora, fauna etc) was gathered by field survey and from publications of organizations such as SRDI, BBS and CEGIS. The physiochemical quality of the river Kapotaksha was determined by collecting field sample (water and sediment sample) from the study area and analysing them in the BUET Environmental Engineering Laboratory. Secondary sources have been used to reflect the socio-economic baseline in the project area. Spot survey has been conducted in the congestion area to assess the existing vulnerability to drainage congestion. Secondary sources like DAE and NMIDP have been used to collect information of agricultural situation in the project area. The following sections in this chapter present information and data of relevant parameters, which are necessary to prepare the baseline survey report for conducting the EIA of the proposed KRREP.

4.2 HYDRO-METEROLOGICAL INFORMATION

To generate reliable information on the extent and magnitude of the drainage congestion, various hydro-meteorological data such as rainfall, evaporation, temperature, humidity, sunshine hours, water level, discharge, water quality etc were collected and analysed.

4.2.1 Rainfall

There are eight BWDB rainfall stations in the project area. Data were collected to have an assessment of temporal variation. Rainfall data of most of the stations were unavailable for the period of 1999-2003. Table 4.1 shows long-term rainfall data of the designated stations around the study area. The mean aerial rainfall of the study area is about 1642 mm while the maximum annual average rainfall was 1730 mm at the Keshabpur station. The minimum annual rainfall was found 1486 mm at the Islamkati station. Both the mean annual and maximum annual rainfall (1967 mm) is less than the country's mean annual (1967 mm) and maximum annual rainfall (7717 mm at Bholaganj) (NWRD, 2004).

Table4.1: Rainfall information in the Kapotaksha study area (NWRD, 2004)

Station name	Station ID	Long term (1973- 2003) annual average (mm)
Chaugachha	454	1691
Jessore	456	1709
Benapole	453	1602
Kalaroa	507	1648
Keshabpur	459	1730
Islamkati	505	1486
Benarpota	502	1693
Kopilmoni	509	1573
Average		*1642*

4.2.2 Evaporation

Around the Kapotaksha study area there are three BWDB evaporation stations. Like rainfall data, evaporation data are not readily available for the all stations. Long term evaporation data experiences a significant variation ranging from the annual average minimum evaporation of 964 mm at Khulna to a maximum of 1143 mm at Benarpota (Table 4.2).

Table 4.2: Evaporation information in the Kapotaksha study area (NWRD, 2004)

Station name	Station ID	Long term (1973-2003) annual average (mm)
Jessore	17	992
Benarpota	4	1143
Khulna	20	964

4.2.3 Temperature

There are three BMD meteorological stations in the study area. Different climatic data are collected on daily basis such as rainfall, temperature, wind speed and direction, sunshine hours, relative humidity and cloudiness. As temperature varies from dry season to monsoon, temperature data were analyzed separately for dry season (November to May) and monsoon (June to October). The average value of maximum and minimum temperature in the dry season was slightly higher in 1999 than 2001 and the variation is within one degree Celsius. During the monsoon, both the average values of maximum and minimum temperature were slightly lower (about 0.5 degree Celsius) in 1999 than in 2000 and 2001.

Table 4.3: Temperature condition in the Kapotaksha study area in different years (CEGIS, 2004)

St. name	St. ID	1999				2000				2001			
		Dry (Nov.-May)		Monsoon (Jun.-Oct.)		Dry (Nov.-May)		Monsoon (Jun.-Oct.)		Dry (Nov.-May)		Monsoon (Jun.-Oct.)	
		Avg. of Max.	Avg. of Min.	Avg. of Max.	Avg. of Min.	Avg. of Max.	Avg. of Min.	Avg. of Max.	Avg. of Min.	Avg. of Max.	Avg. of Min.	Avg. of Max.	Avg. of Min.
Jessore	11407	32.10	18.65	32.80	25.50	30.87	17.86	33.13	25.36	31.19	17.24	33.11	25.58
Satkhira	11610	31.40	18.45	32.01	24.28	30.41	17.09	32.55	25.82	30.48	18.08	32.12	25.95
Khulna	11604	31.42	19.64	32.10	25.63	30.78	18.40	32.81	25.22	31.01	18.58	32.39	26.15
Average temperature in the study area		*31.64*	*18.90*	*32.3*	*25.13*	*30.69*	*17.78*	*32.83*	*25.47*	*30.89*	*17.96*	*32.54*	*25.89*

4.2.4 Relative Humidity

The average humidity of these three stations is same (76%) during dry season while during the monsoon average humidity varies in between 85% to 87%. This shows no significant variation of humidity.

Table 4.4: Seasonal average relative humidity (%) in the Kapotaksha study area in different years (NWRD, 2004)

Station name	Station ID	1999		2000		2001	
		Dry season (Nov.-May)	Monsoon (Jun.-Oct.)	Dry season (Nov.-May)	Monsoon (Jun.-Oct.)	Dry season (Nov.-May)	Monsoon (Jun.-Oct.)
Jessore	11407	76	87	77	86	77	86
Satkhira	11610	76	86	75	83	74	86
Khulna	11604	76	87	77	87	76	87
Average humidity in the study area		*76*	*87*	*76*	*85*	*76*	*86*

4.2.5 Sunshine Hours

BMD record shows a significant variation in mean daily sunshine hours between dry season and monsoon season across the project area.

Table 4.5 Seasonal average sunshine hours in the Kapotaksha study area in different years (NWRD, 2004)

		1999		2000		2001	
Station name	**Station ID**	Dry season (Nov.-May)	Monsoon (Jun.-Oct.)	Dry season (Nov.-May)	Monsoon (Jun.-Oct.)	Dry season (Nov.-May)	Monsoon (Jun.-Oct.)
Jessore	11407	7.15	4.59	8.00	6.34	7.63	4.46
Satkhira	11610	8.41	4.30	8.32	5.24	8.67	4.89
Khulna	11604	8.37	4.44	8.14	5.38	8.59	5.06
Average sunshine hour in the study area		*7.98*	*4.44*	*8.15*	*5.65*	*8.30*	*4.80*

4.2.6 Discharge

BWDB has records of 25 years daily discharge data up to 1989. The only available discharge data of the Kapotaksha was for station at Jhikargachha (st. no. 162). After 1989, no discharge data is available for Kapotaksha River. This happened due to loss of connectivity of the Kapotaksha River with upper portion. Therefore, present low flow condition cannot be assessed now. The discharge data of previous 25 years shows the maximum discharge of 120 m^3/sec and minimum discharge of 4 m^3/sec (NWRD, 2004). Main flow during wet season is due to rainfall-runoff.

4.2.7 Surface Water Level

The upper part of the Kapotaksha study area is under free from tidal influence while the lower part of that area is under the tidal influence. After the drainage congestion, the tidal influence in lower part is much higher than the previous situation. There are three water level stations at Tahirpur (161), Jhikargachha (162) and Tala Magura (163). Tahirpur is a non-tidal station, located at upstream part of the study area. Tala Magura is a tidal station located at lower part of the station. BWDB considers Jhikargachha as both tidal and non-tidal station. To analyze drainage congestion Jhikargachha and Tala Magura stations are analyzed (Table 4.6). Water level variation at Jhikargachha station is shown in Fig. 4.1. Due to flood in 2000, the average water level at Jhikargachha station increased at that time.

Table 4.6: Surface water level in Kapotaksha study area (NWRD, 2004)

Station name	Station ID	Maximum water level (m+PWD)				Minimum water level (m+PWD)				Average water level (m+PWD)			
		1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002
Jhikargachha	162	4.03	5.45	3.88	4.39	1.27	1.47	1.63	1.78	2.52	3.07	2.88	3.22
Tala Magura	163	2.92	3.02	-	-	-1.02	-1.10	-	-	0.75	0.77	-	-

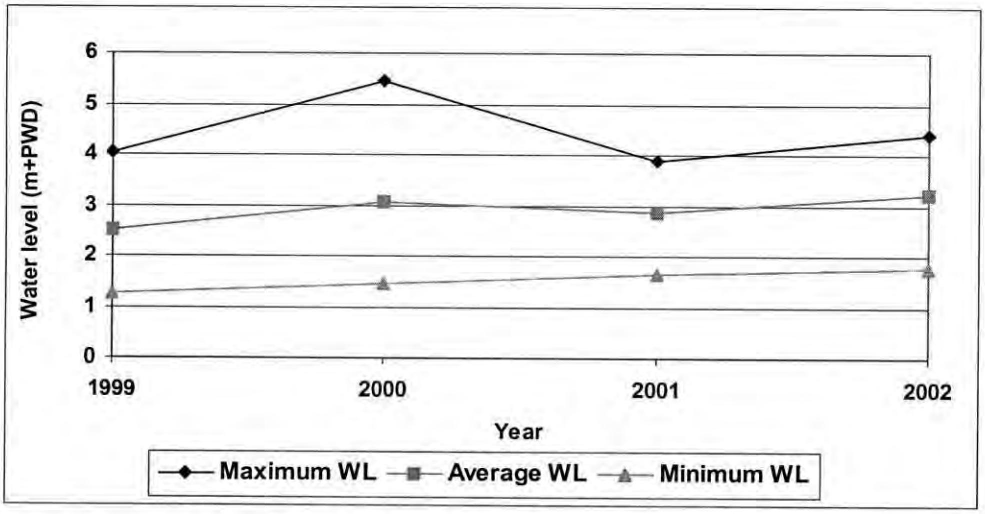

Fig. 4.1: Water level variation in different years at Jhikargachha

4.2.8 Ground Water Level

Ground water is an important alternative resource in Kapotaksha study area. People use ground water in household purposes and irrigation purposes due to deterioration of surface water quality. There are eight BWDB stations in Kapotaksha study area. Secondary data collected from 1999 to 2002 were analyzed. A upward trend of ground water table was observed both in dry season and in monsoon season from 1999 to 2001 and then downward in 2002.

Table 4.7: Ground water level condition in the Kapotaksha study area in different years (NWRD, 2004)

Station ID	Village	1999		2000		2001		2002	
		Dry (m)	Wet (m)	Dry (m)	Wet (m)	Dry (m)	Wet (m)	Dry (m)	Wet (m)
JES006	Godkhali	2.87	3.32	3.45	3.53	2.90	2.24	3.15	2.30
JES007	Meshridual	3.79	2.74	3.37	2.59	3.23	2.18	3.60	2.90
JES008	Altapur	4.37	2.38	4.31	2.56	4.27	2.30	5.27	2.12
JES504	Keshabpur	3.40	1.73	3.24	1.39	3.18	1.11	3.48	1.11
SAT003	Hamidpur	6.11	2.62	5.91	2.26	5.30	2.16	5.87	2.46
SAT007	Talabazar	2.66	1.66	2.27	0.88	2.69	0.97	2.63	0.94
KHU507	Kopilmoni	-	-	-	-	-	-	-	-
Average ground water level from surface in the study area		3.87	2.41	3.76	2.20	3.60	1.83	4.00	1.97

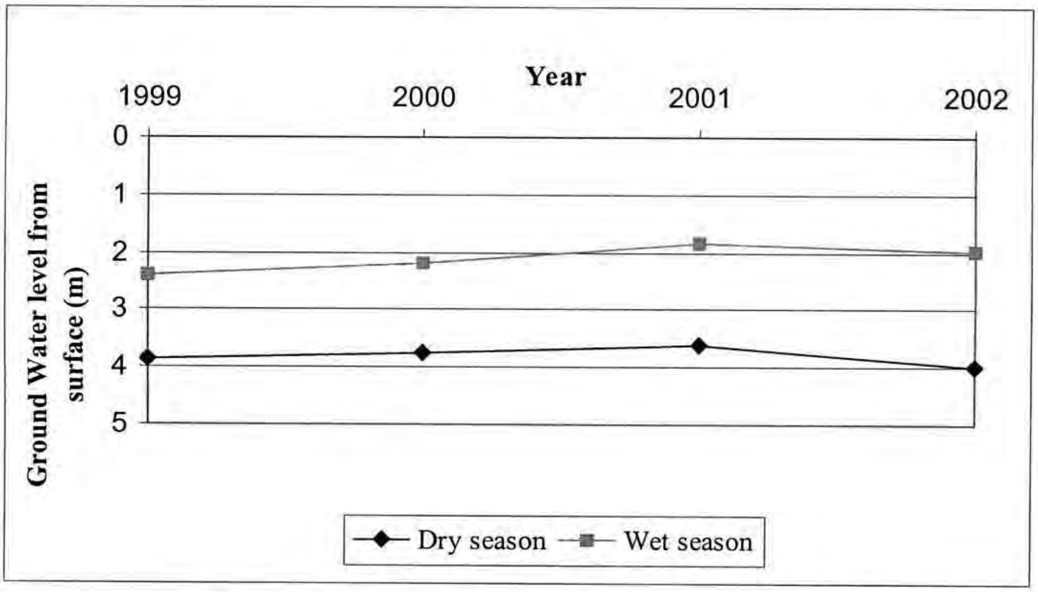

Fig. 4.2: Average ground water level in the Kapotaksha study area

4.2.9 Surface Water Quality

To identify different physicochemical parameters related to water and sediment quality, water and sediment of the Kapotaksha River of different locations were collected in monsoon period in 2004. Water samples from three locations named Sagardari, Sarashkathi and Trimohoni were collected (Fig. 4.3) during field visit. Water of two different river depths (0.6 of total depth and 0.8 of total depth) were collected to investigate depth-wise and location-wise variation of different parameters such as pH, Electrical conductivity (EC), Total Dissolved Solid

(TDS), Turbidity, Chloride content, PO_4, NO_3, NH_3-N etc. Samples were tested in the Environmental Engineering Laboratory of BUET following the standard methods (APHA, 1995). The test results are presented in following sections.

4.2.9.1 Chloride content

The past history shows that dry season salinity of the river Kapotaksha varies within 350 ppm to 16000 ppm (at Jogikhali station) during 1981 to 1989 (NWRD, 2004) (Annex A-1). Past study on Sundarbans mangrove forest (Aktaruzzaman, 2003) also shows a high salinity during dry season, which is close to the study area (Fig. 4.4). During field visit, six water samples were collected to test water salinity at three different locations at the Kapotaksha River during monsoon period of 2004. From the test result, it is observed that the chloride content is much lower than salinity data reported in previous studies. The reason may be the sample was collected in monsoon period and previous study data represents dry season data. Moreover, the sampling locations are not exactly the same as that of the previous studies.

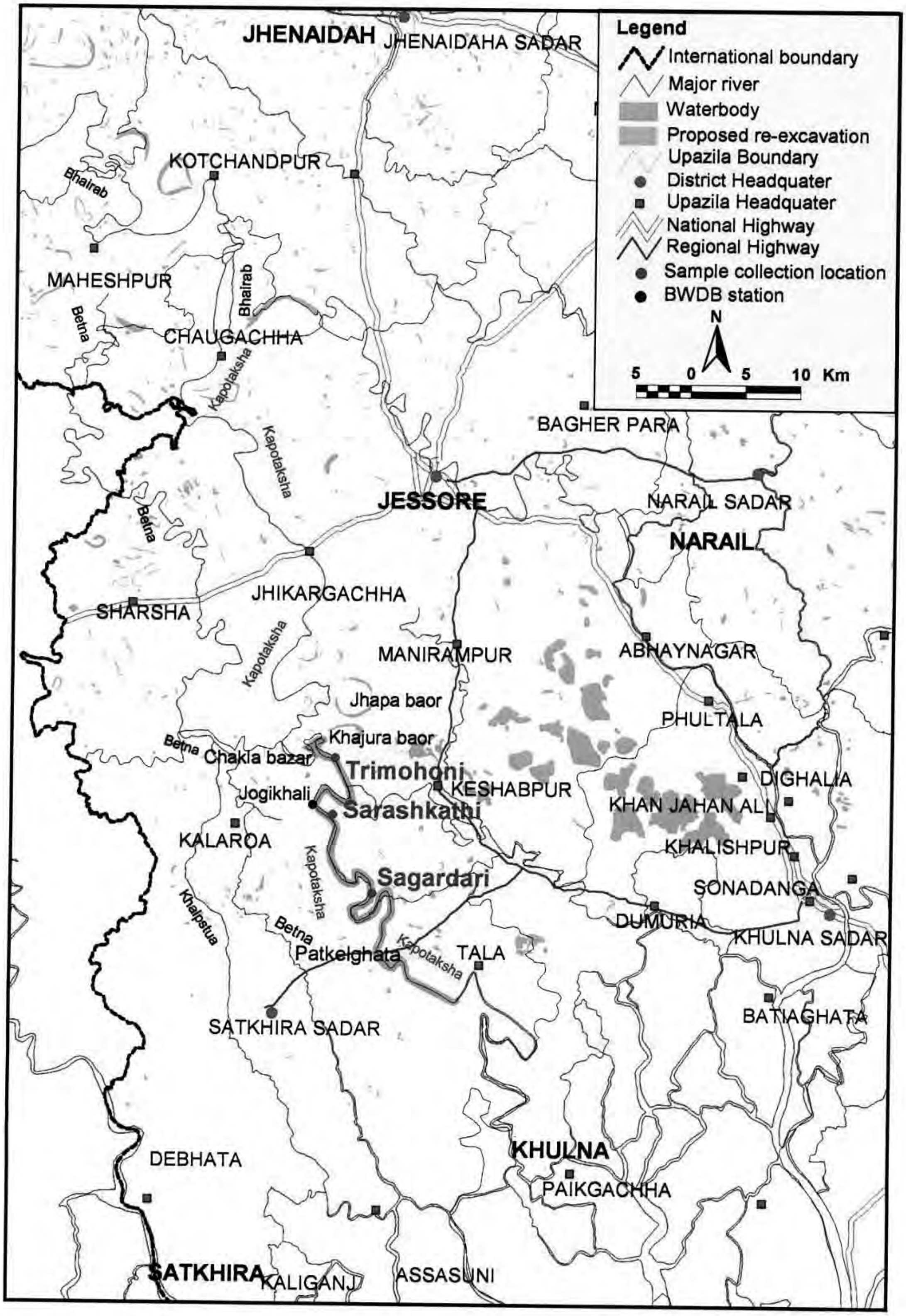

Fig. 4.3: Sampling locations of the KRREP (CEGIS, 2004)

Table 4.8: Chloride content (mg/l) at different locations and at different depths in the Kapotaksha River

Location	Chloride Content (mg/l)	
	0.6 of depth	0.8 of depth
Trimohoni	20	20
Sarashkathi	48	48
Sagardari	20	24

4.2.9.2 Electrical Conductivity (EC)

The laboratory test result shows that electrical conductivity is higher in upstream location. Depth wise variation is very negligible. Table 4.9 presents electrical conductivity at different depth of the Kapotaksha River at those locations.

Table 4.9: Electrical conductivity (µS/cm) at different location at different depth in the Kapotaksha River

Location	Electrical Conductivity (µS/cm)	
	0.6 of depth	0.8 of depth
Trimohoni	391	391
Sarashkathi	355	354
Sagardari	328	327

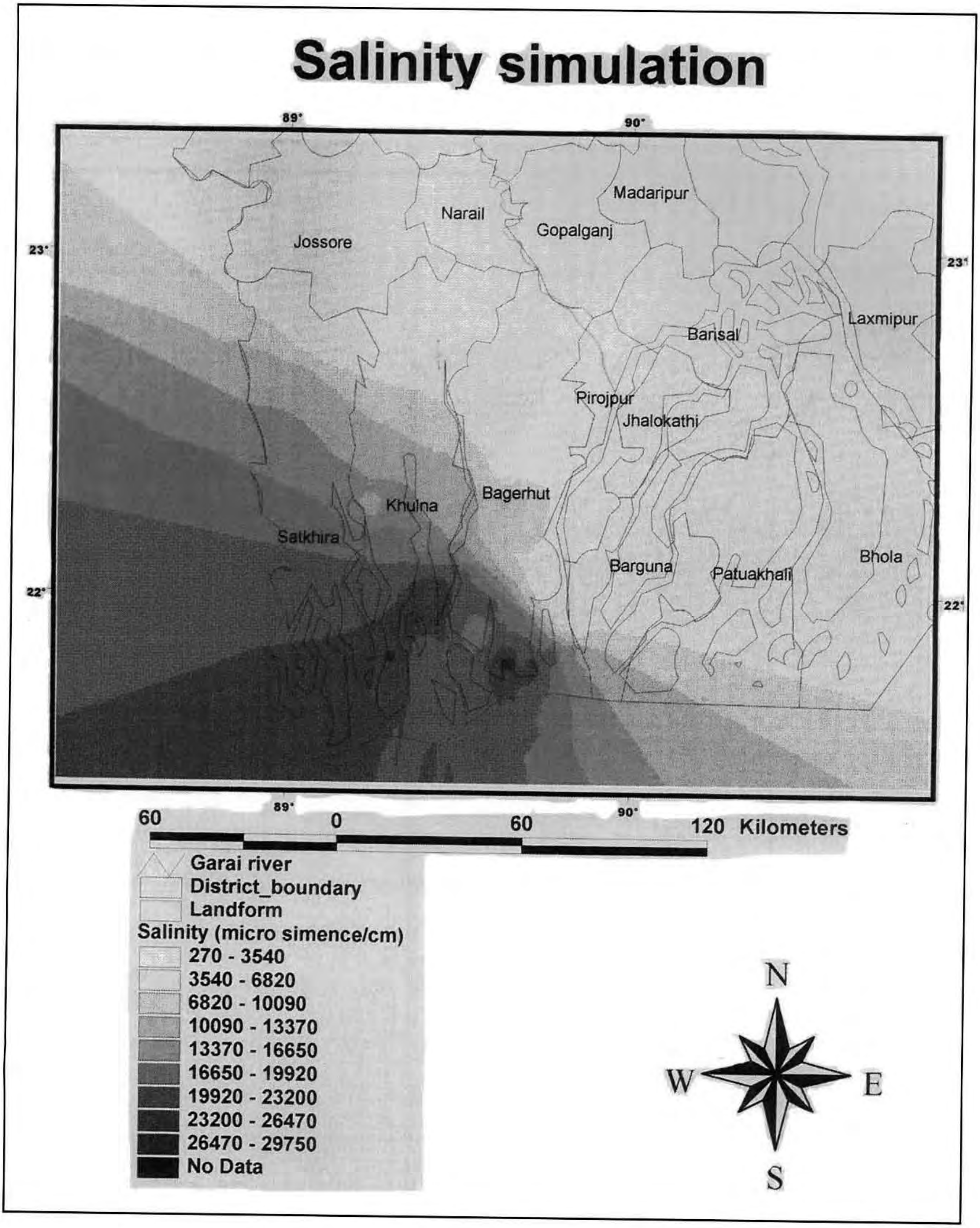

Fig. 4.4: Salinity simulation in Sundarbans Mangrove forest (Aktaruzzaman, 2003)

4.2.9.3 pH

The locations of collected samples are Sagardari, Sarashkathi and Trimohoni started from up stream to down stream. Water samples were collected from two depths at 0.6 and 0.8 of total depth. For each location, pH increases with increase of depth of water from surface (Fig. 4.5). But no trend (increasing or decreasing) was seen from upstream to downstream direction.

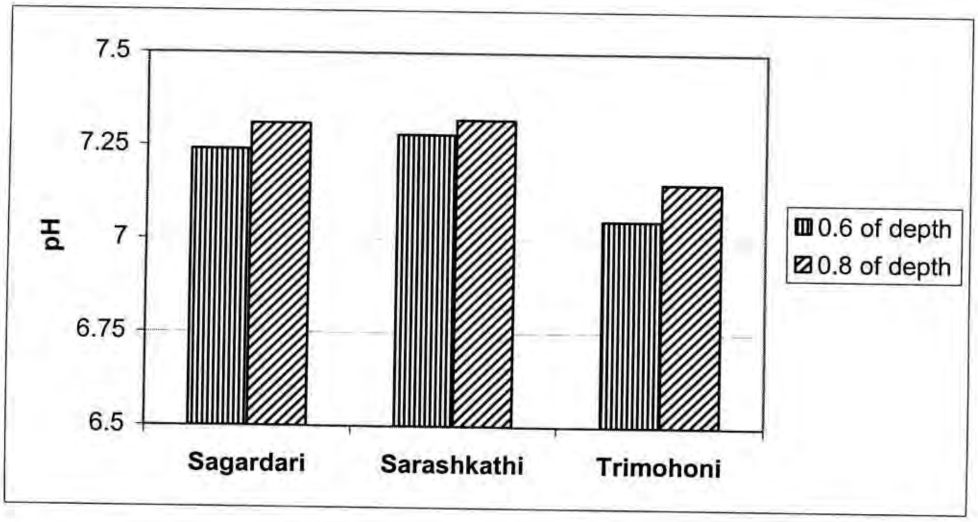

Fig. 4.5: Surface water pH variation at different locations in the Kapotaksha River

4.2.9.4 Total Dissolved Solids (TDS)

TDS is measured for the same water samples. Total Dissolved Solids does not vary with depth (Fig. 4.6).

4.2.9.5 Turbidity

The collected water samples at Sagardari, Sarashkathi and Trimohoni started from up stream to down stream locations and at two depths at 0.6 and 0.8 of total depth were tested for the measurement of Turbidity. For each location, turbidity increases with increase in depth of water from surface (Table 4.10). But no trend (increasing or decreasing) was seen from upstream to downstream direction.

Table 4.10: Turbidity (NTU) at different locations along the Kapotaksha River

Location	Turbidity (NTU)	
	0.6 of depth	0.8 of depth
Trimohoni	3.4	7.4
Sarashkathi	45	55
Sagardari	26	42

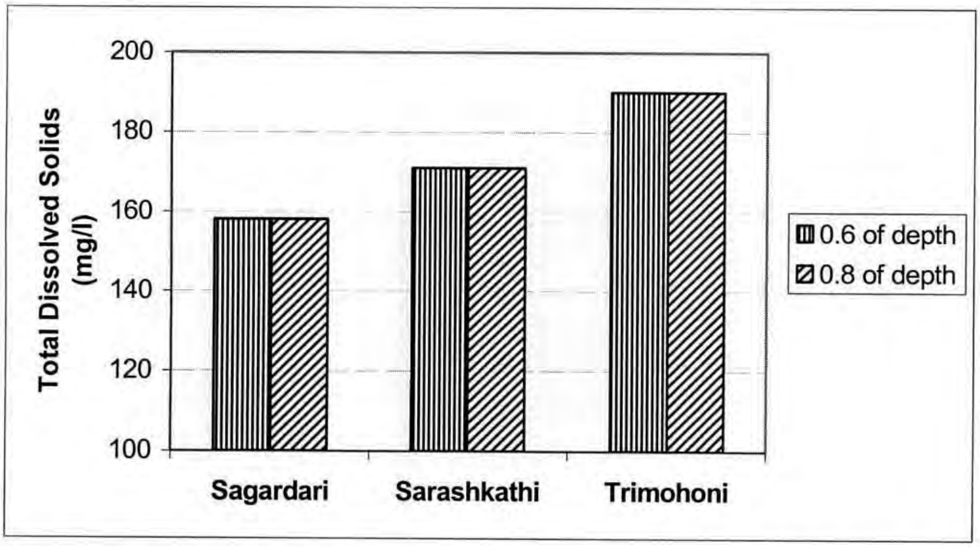

Fig. 4.6: Surface water TDS variation at different locations in the Kapotaksha River

4.2.9.6 Chemical Oxygen Demand (COD)

Test result of COD does not show any specific trend (increasing or decreasing) along the Kapotaksha River related to depth. COD at Sagardari and Sarashkathi is almost the same but high at Trimohoni, most upstream location of sample collection at 0.6 of total depth (Fig. 4.7).

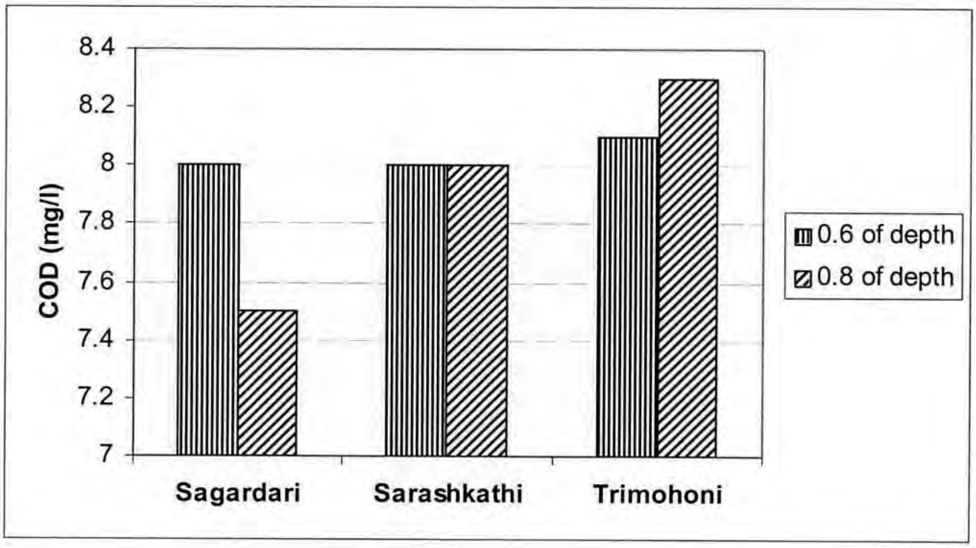

Fig. 4.7: COD variation at different locations in the Kapotaksha River

4.2.9.6 Phosphate (PO_4)

The highest value of Phosphate was seen at 0.6 of depth at Sagardari. Phosphate at 0.6 of depth is higher at Sagardari and Trimohoni but lower in Sarashkathi from that of at 0.8 of depth (Table 4.11). No correlation can be drawn between PO_4 concentration and distance along the river from upstream to downstream.

Table 4.11 Phosphate (mg/l) at different locations along the Kapotaksha River

Location	PO_4 (mg/l)	
	0.6 of depth	0.8 of depth
Trimohoni	0.28	0.18
Sarashkathi	0.16	0.19
Sagardari	0.45	0.09

4.2.9.7 Nitrate (NO_3)

Nitrate at 0.6 of depth at Sarashkathi and Trimohoni is higher than that at 0.8 of depth at that locations (Table 4.12). But at Sagardari Nitrate is higher at 0.8 of depth. Nitrate increases with moving towards downstream direction for 0.6 of depth. But for depth 0.8 of depth, no trend was shown.

Table 4.12: Concentration of NO_3 (mg/l) of different locations along the Kapotaksha River

Location	NO_3 (mg/l)	
	0.6 of depth	**0.8 of depth**
Trimohoni	2.9	2.5
Sarashkathi	3.3	2.6
Sagardari	2.8	3.1

4.2.9.8 Ammonia-Nitrogen (NH_3-N)

Sarashkathi and Sagardari have same amount of NH_3-N at 0.8 of depth. But Trimohoni has higher value. For each depth Trimohoni contains higher amount of NH3-N. No trend was observed for both depths related to upstream to downstream direction.

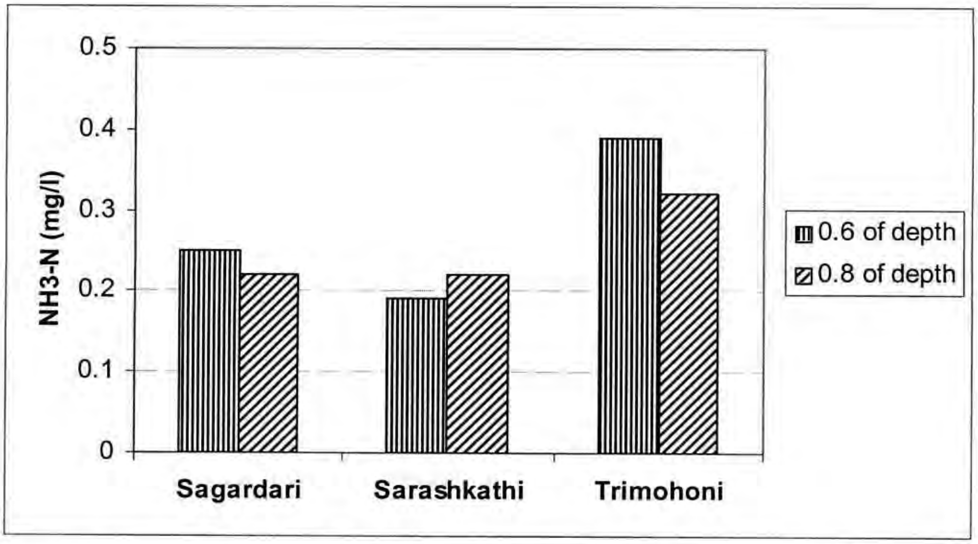

Fig. 4.8: Ammonia-Nitrogen variation at different locations in the Kapotaksha River

4.3 SEDIMENT QUALITY

Riverbed sediment of three locations (Sagardari, Sarashkathi and Trimohoni) is tested in laboratory to find out heavy metal accumulation on bed. Results of test are shown in Table 4.13. Amount of chromium varies around 19 to 30 mg/kg, which is within the acceptable limit (EPA, 2005). Cadmium of bed sediment at Sagardari and Trimohoni is same (0.29 mg/kg), but Sarashkathi has a higher value (0.34 mg/kg). Sediment at Sagardari contains highest lead value (19.0 mg/kg). All those values are within tolerance limit (EPA, 2005).

Table 4.13: Heavy metal concentration of river bed sediment at different locations in the Kapotaksha River

Parameter	Location		
	Sagardari	Sarashkathi	Trimohoni
Cr (mg/kg)	18.9	22.8	29.9
Cd (mg/kg)	0.29	0.34	0.29
Pb (mg/kg)	19.0	13.0	17.5

The riverbed sediment was collected and sent to the Soil Resources Development Institute (SRDI) to analyse the nutrients by CEGIS in May 2004. Table 4.14 shows the nutrients content in riverbed sediment.

Table 4.14: Analytical results of soil nutrients of riverbed sediment (CEGIS, 2004)

Place of collection	PH	EC	Ca	Mg	K	TN	P	S	B	Cu	Mn	Zn
		dS/m	me/100gm soil			%	ug/g soil (ppm)					
Patkelghata, Tala	8.1	5.01	30.5	3.0	0.32	0.03	8.90	132.31	0.85	3.16	58	0.34
Joynagar, Kalaroa	8.3	3.93	34.0	6.0	0.54	0.05	16.73	120.84	1.00	7.84	38	0.34
Sharsha, Tala	8.1	5.20	35.0	6.5	0.49	0.06	13.64	206.18	1.50	10,20	34	0.36

The nutrients like Calcium, Magnesium, Potassium, Sulphur, Boron, Copper and Manganese are high, and Nitrogen and Zinc are low in bed sediment (CEGIS, 2004).

4.4 FLOODING AND DRAINAGE CONGESTION

The study area historically does not suffer from flood (CEGIS, 2004). People experienced first flood in the year 2000. After 2000, flood becomes a common phenomenon in every year. The flood 2000 occurred due to huge amount of cross-boundary flow coming from India, which exceeded the conveyance capacity of the river Kapotaksha due to excessive sedimentation in the riverbed over the years. During this flood, mainly middle part of the project area (Keshabpur Upazila) was badly affected. Flood occurred also in 2001, 2002 and 2003. A massive damage has been occurred due to 2003 flooding. In 2004, CEGIS made a comparative study to find out the affected area due to flood by Degital Elevation Model (DEM) and social survey. Table 4.15 shows a comparison of the hydrological analysis and social survey.

Table 4.15: Comparison of temporal flood extent calculated hydrological analysis and information obtained from social survey (CEGIS, 2004)

Year	1999	2000	2001	2002	2003
Flooding extent (ha) obtained by hydrological analysis	760	11,925	9,120	10,070	11,840
Flooding extent (ha) obtained by social survey	800	11,220	6,920	7,520	10,420
% of variation	*(-) 5%*	*(+) 6%*	*(+) 30%*	*(+) 34%*	*(+) 14%*

According to the study, there is a slight variation between the two methods. The variation may be due to under estimation by the local people.

4.5 ECOLOGICAL DATA

The ecosystem of the study area is located in between the fresh water of the Ganges river system at the north and huge estuaries of the Bay of Bengal at the south. The ecosystem of the study area was changed in last 2-3 decades due to massive human interaction (CEGIS, 2004). The hydro-morphological changes influenced the riverine species composition as well as plant composition either sides of the river. None or little fresh water from the north (Ganges) allows salinity intrusion. Salinity changes the species composition in the aquatic life and wetland dependent terrestrial flora and fauna.

The supply of phosphorus limits primary production in fresh water while the supply of nitrogen limits primary production in salt water. In estuaries, where fresh and salt-water mix, either element may be limiting depending on position along the seasonally shifting salinity gradient. Impact of salinity related change in the relative availability of nitrogen and phosphorus played a crucial role in ecological succession of the study area in last decade.

The project area can be classified as i) Terrestrial ecosystem, ii) Aquatic ecosystem and iii) Partly terrestrial and partly aquatic ecosystem in different time of the year.

4.5.1 Terrestrial Ecosystem

The terrestrial ecosystem mainly consists of the agricultural lands. Unlike other agricultural lands, the croplands of the study area have plantation of palms and other trees.

Last two major floods (2000 and 2003) caused increase of insects, pests in rice fields. If soil does not get totally dry, the insect larvae get good chance to remain in soil. When the paddy becomes very green in one part of the field due to high nutrient and moisture, the pests attack and damage the crops easily. The major three species such as Jackfruit, Mango and Coconut were badly affected during flood.

4.5.2 Partly Terrestrial and Partly Aquatic Ecosystem

Low-lying areas, baors, beels ditches where no crop cultivation is practiced, sometimes remain under water in different time of the year and rest of the periods remains dry. In these places, a large number of aquatic plants grow and form thick natural vegetation. In such vegetations plants like shola, paniphal, kalmi and many species of grass and other families are found and crowded together. Some of these species are sources of food and shelter of many aquatic birds, fishes etc.

Jhapa is one of the largest oxbow lake that is connected with the Kapotaksha River through a narrow channel- the Jhapa Khal. Since 4-5 years, it is completely disconnected with the river system during the dry season. Last two years of flooding caused a lot of damage to the overall baor ecosystem.

4.5.3 Aquatic Ecosystem

The ecosystem of the study area is one of the established ecosystems of the country. River dolphin was once a common aquatic mammal of the Kapotaksha River. This species disappeared 5-7 years ago (CEGIS, 2004). The presence of river dolphin signals a healthy ecosystem. Since river dolphin is at the apex of aquatic food chain, its presence in adequate number symbolizes greater biodiversity in the river system. Most of the part of Kapotaksha River surface is presently covered with water hyacinth like a carpet. The situation is degrading the reverine biological system. Navigation and fishing are obstructed and irrigation and drainage system are blocked. Excessive accumulation of water hyacinth makes the riverine ecosystem anaerobic. It affects the aquatic environment by reducing dissolved oxygen (DO), pH and temperature, and increasing CO_2 level. These changed water quality severely affect plants, fishes and animals.

4.6 Fisheries Resources

Fisheries resources of the study area is comprised of inland capture fisheries of the Kapotaksha River, canals, beels, flood plains, and baors, and culture fisheries of the ponds and ghers.

Rui, catla, mrigal, tengra, chapila, kholisha, chela, kakila are moderately found species in the study area. Hilsha is abundant in the southern part but rare in the northern part of the study area. Koral, bhetki, goggonia, kani and rekha fishes are found in the confluence of Kapotaksha with Sibsa. Golda and Bagda are abundant in the lower part of the area. Species like taki, kholisa, boal, sing, koi, baim, gazar, kaika, kuicha are available in the waterlogged area coverd with water hyacinth.

An estimate of fish production from river, canal, beel, baor, ponds and ghers are given in Table 4.16.

Table 4.16: Estimated annual fish production of the study area (CEGIS, 2004)

Source	Production (mt/annum)
River	40
Canals	10
Flood plains/Beels	30
Sub Total	*80*
Baors	250
Ponds	240
Ghers	30
Sub Total	*520*
Total	600

A large number of water bodies have been affected by drainage congestion. A total of 51 hector area was affected in 2003 along both sides of the Kapotaksha River (CEGIS, 2004). Bagra Khal had affected area of 3.53 acres. Affected area of Mihirpur Khal and Mirjapur Khal was 3.5 km and 1 km respectively. Many ponds have been damaged and fishes escaped due to water logging and over flooding. The following table (Table 4.17) shows the loss of pond-fish production in different places of Keshabpur Upazila.

Table 4.17: Affected ponds in the affected unions of Keshabpur Upazila (CEGIS, 2004)

Union	**Village/Mouza**	**Nos. of affected ponds**	**Area affected (hectare)**
Trimohoni	Chandra	75	7.27
	Mirzanagar	82	15.49
	Borondali	100	9.32
	Sarashkathi	9	1.01
	Shahapur	25	2.17
	Satbaria	57	6.53
	Dottonagar	9	0.49
Sagardari	Bistapur	40	5.46
	Saragdari	24	5.12
	Komorpur	14	0.87
	Gopshana	50	5.38
	Gobindapur	15	2.67
	Mirzapur	21	3.00
	Mirerpur	28	4.17
	Chingra	31	9.78
	Dhorompur	22	3.13
	Bashbaria	59	5.15
	Fatepur	30	2.30
	Kasta	67	8.06
Biddanondakati	Boga	42	3.29
	Mohadebpur	20	2.13
	Rezakati	16	2.20
	Nehalpur	28	2.44
	Momenpur	61	8.01
	Total	*925*	*115.44*

4.7 LAND RESOURCES DATA

The project area includes the western part of the Ganges River floodplain, which is predominantly highland, and medium highland. The major part of highland becomes wet periodically during spells of heavy rainfall. The lower ridges and basins are mainly shallowly flooded by pounded water or by the raised water table during period of heavy rainfall. Flood level fluctuates within the rainy season from year to year depending on rainfall intensity. Drainage congestion and flooding occurs due to increasing silting up of Kapotaksha River.

The upper part of floodplain ridges is consists of olive brown, silt loams and silty clay loam and the lower ridges and the basins are consisting of dark grey, malted brown clay soils.

The nutrients available in the project area vary from place to place. In general, the soil of this area has low nitrogen and zinc, high Calcium and medium to high Phosphorus, Potassium, and Magnesium. The soil of this area is non-saline except the slightly saline soil of lower part in dry season. The nutrients of this soil are suitable for a wide range of crops in the dry season. But drainage congestion makes the soil unsuitable for dry land Rabi crops.

4.7.1 Cropping Pattern

Prior to drainage congestion, two or three crops were grown on the same land. On the higher lands, B.Aus or Jute was followed by T.Aman and then by Rabi crops. T.Aman followed by Boro Crop was grown on the lower ridges and basin areas. The cropping intensity was 209 percent during 1999-2000 (CEGIS, 2004). But drainage congestion reduced the cropping intensity. The area suitable for dry land Rabi crop started to shrink. Triple cropped area has fallen down about 8%. Single cropped area has been increased. At present the double-cropped area predominates. If the drainage congestion continues, single cropped area will be predominating. At present the cropping intensity reduced to 197 percent. The following table (Table 4.18) shows the present cropping pattern of the study area.

Table 4.18: Present cropping pattern of the study area (CEGIS, 2004)

Land type	Cropping pattern	Area occupied (ha)	Percent of Net Cultivable Area
Highland	B. Aus – Rabi crops	9393	16.2
	Teel – Rabi crops	2899	5.0
	Jute – T.Aman – Rabi crops	4756	8.2
	B. Aus – T. Aman – Fallow	4175	7.2
	Teel – T.Aman – Fallow	2957	5.1
	T.Aman – Boro	8813	15.2
	T.Aus – T.Aman – Fallow	1160	2.0
Medium highland	T.Aman – Rabi crops	5102	8.8
	T.Aman – Boro	11943	20.6
	T.Aman - Fallow	5624	9.7
Medium lowland	Boro – Fallow	1160	2.0
	Total	*57982*	*100*

4.7.2 Irrigation Practices

Though the cropping of the study area is mostly done under rain fed condition, supplementary irrigation is required for HYV T.Aman, Rabi crops like Boro, vegetables and Wheat. Both surface water and ground water are used for irrigation. The river Kapotaksha, beels, khals and baors are sources of surface water supplied by Low Lift Pump (LLP) and traditional practice. Ground water is abstracted using Shallow Tube-well (STW) and Deep Tube-well (DTW). Use of DTW is about 4% of STW. Ground water irrigation covers more than 90% of total irrigation (Table 4.19).

Table 4.19: Irrigation coverage by modes in the study area (NMIDP, 2002)

Sl No.	Water sources	Modes	Nos	Irrigated area in hectors		
				Kharif-I	Kharif-II	Rabi
1	Surface water	LLP	413	08	0	1115
		Traditional	1181	13	0	224
	Sub-Total			*21*	*0*	*1359*
2	Ground water	STW	12730	1384	0	27721
		DTW	518	160	0	7618
		MOP	258	0	0	39
	Sub-Total			*1544*	*0*	*35378*

4.8 SOCIO-ECONOMIC DATA

To prepare the baseline report of the study area, some socio-economic data like area, population, housing, drinking water, sanitation, occupational composition, transport, communication, navigation etc are collected from different secondary sources and also from field visit.

4.8.1 Employment

The KRREP area includes eight upazilas of Jessore, Jhinaidah and Satkhira district. The population census data (10years and over) shows that most of the people are engaged in household works (38%). Around 20% are totally unemployed and rest part is involved in agricultural works, business purpose or service and other types of activities (BBS, 1993). The 1991 census is projected based on employment rate (3.4%) and unemployment rate (3.9%) (BBS, 1996). The household activity does not contribution in national economy. Hence in gross, around 40 % are employed. Table 4.20 shows the employment and unemployment population number in different upazilas in the KRREP area.

Table 4.20: Employment and unemployment in the study area (BBS, 1996)

District	Upazila	Population	
		Employed	Unemployed
Satkhira	Kalaroa	54618	80121
	Tala	79122	105762
Jhinaidah	Mahespur	72104	99075
Jessore	Chaugachha	54066	75537
	Keshabpur	57152	87095
	Jhikargachha	67836	100540
	Manirampur	93601	141832
	Sarsha	76186	101226

4.8.2 Occupational Composition

Most of the people's occupation was related to farming prior to water congestion. People shifted their livelihood from farming to different mode due to scarcity of cultivable land. At present around 48% people of total 7.5 lakhs population is farmer (BBS, 2003), 4% household of total population is fishermen, 5% are Carpenters, 6% are involved in different services such as teaching, craft, private/govt. job, worker in brick-field and 32% are labourer (BBS, 2003).

4.8.3 Poverty Situation

Poverty situation states the overall economic condition of the population of particular area. The study area covers two districts- Jessore and Satkhira, under Khulna division.

Indicators used to identify general poverty situation in the study are:

a) Head- Count Ratio

b) Poverty Gap and

c) Squared Poverty Gap

a) Head Count Ratio

This indicator measures the percentage of population below poverty line. Poverty line is defined in two ways: (i) estimating a level of expenditure to meet the per capita calorie intake less than 1805 Kcal, and (ii) estimating a level of expenditure to meet the per capita calorie intake less than 2122 kcal. These expenditures refer to the cost of basic needs (CBN) for a household to survive. These represent actually the number of poor on two different lines.

b) Poverty Gap

It is average distance below poverty line. This is an estimate of average distance separating the poor from poverty line as a portion of the line. It is a measure of depth of poverty.

c) Squared Poverty Gap

The severity of poverty is measured by squared poverty gap. This take accounts the inequality among the poor.

The poverty indicators of the study area show no significant variation from the national values (Table 4.21).

Table 4.21: Poverty situation in study area (BBS, 2003)

Measures of Poverty	Poverty value for Khulna, including KRREP area	National Values
Head-count Ratio (using lower poverty line)	36.8	37.4
Head-count Ratio (using upper poverty line)	52.2	53.1
Poverty Gap (using lower poverty line)	6.6	8.2
Poverty Gap (using upper poverty line)	12.6	13.8
Squared Poverty Gap (using lower poverty line)	1.7	2.6
Squared Poverty Gap (using upper poverty line)	4.0	4.8

4.8.4 Housing

According to the Bangladesh Rural (1999), 51% of the houses of the study area are made of straw/bamboo, 48% are made of galvanized iron sheet and only 1% is pucca (Table 4.22).

Table 4.22: Upazila-wise housing status of KRREP households (BBS, 1993)

District	Upazila	% of households with materials of roof		
		Straw/bamboo	Tiles/GI sheet	Cement
Jessore	Jhikargachha	39	55	6
	Manirampur	40	57	3
	Keshabpur	30	64	6
Satkhira	Kalaroa	20	75	5
	Tala	46	49	5

4.8.4 Drinking Water and Sanitation

The main source of drinking water in the study area is tube well. The status of drinking water sources in the project area is given in Table 4.23.

Table 4.23: Upazila-wise drinking water situation in the study area (BBS, 1993)

District	Project Upazila	% of households with drinking water sources			
		Tube well	Dug-well	Pond	River
Jessore	Jhikargachha	98	0.8	0.7	0.5
	Manirampur	98	0.7	0.9	0.4
	Keshabpur	99	0.5	0.3	0.2
Satkhira	Kalaroa	99	0.3	0.6	0.1
	Tala	98	0.5	1.4	0.1

The people of the project area use various methods for human waste disposal such as pit latrine, bucket latrine, kacha latrine and open defecation. Table 4.24 shows the sanitation condition of the study area.

Table 4.24: Sanitation condition in the study area (BBS, 1993)

District	Upazila in project area	% of Households under Different Sanitation Condition		
		Sanitary	Kacha	Outside
Jessore	Jhikargachha	6	19	75
	Manirampur	6	18	76
	Keshabpur	6	19	75
Satkhira	Kalaroa	10	12	78
	Tala	10	24	66

4.8.5 Transport and Communication

The main mode of transportation in the study area is road. There are National highway, Regional highway and Zila road in the study area. National road connects each district headquarter to others whereas regional highway connects one Upazila headquarter to others. Moreover LGED constructed feeder roads connecting regional roads to facilitate communication with thanas and villages. In monsoon, major part of the roads goes under water. At that period, people use country boat to move in their locality.

4.8.6 Navigation

Once upon a time, the Kapotaksha River was navigable up to Jhikargachha, and played an important role in inland navigation of that area. People used to bring their saleable goods from downstream river port to far inland areas up to Jhikargachha. Local people informed that boats having 500-1000 mounds load-bearing capacity travelled from Chandpur to Jhikargachha carrying salt, paddy, molasses and lime. There was regular launch round trip from Jhikargachha to Kopilmoni. At present, no navigation facility is available from Tahirpur to Sagardari due to low river reach and reaches packed with water hyacinth. A part of southern part from Sagardari to Patkelghata is only navigable in wet season.

4.8.7 Situation of Affected Areas Due to Drainage Congestion

Due to flooding in 2003, a vast area of the project site suffered severe drainage congestion (Fig. 4.9). The extent of congestion in most villages occurred in an alarming state ranging from 21% to 60% of the total area. There are instances where 100% area of a village plunged into water. The total population affected by the inundation in 2003 is estimated around 1.15 lakh (CEGIS, 2004) (Table 4.25).

Rural roads, ashroy centers and educational and other institutions were severely affected by the inundation. This hampered the mobility of socio-economic life, livelihood and habitat of the local people. The local offices and NGOs estimated that around 275 km of roads, 15 ashroy centers and 54 institutions were disrupted during inundation 2003 (Table 4.26).

The important water-bodies like ponds, ghers and baors were affected by the inundation in 2003. More than two thousand ponds, four hundred ghers and eight large baors were affected during this inundation (Table 4.27).

Land price is an indicator of land use and scarcity. The price of inundated land has been lowered sharply. Jhikargachha, Manirampur and Keshabpur experienced a sharp fall of land price in those places where drainage congestion took place. Kalaroa and Tala had less impact in terms of land price (Table 4.28).

Table 4.25: Affected population and location and extent of inundation in KRREP area (CEGIS, 2004)

District	Upazila	# Union/ Poura shava	# Village/ Mouza/ Ward	Number of Mouzas/Villages with % of area inundated					Affected Population Statistics	
				1-20%	21-40%	41-60%	61-80%	81-100 %	# House hold	Population in 2003
Jessore	Jhikargachha	5 major	20	5	4	5	5	1	3298	20,000
	Manirampur	3	21	2	10	1	4	4	7500	37,500
	Keshabpur	3	23	1	6	12	4	-	7050	32,200
Satkhira	Kalaroa	3	10	-	4	3	2	1	3543	21,000
	Tala	2	3	1	1	1	-	-	800	4,500
Total		*16*	*77*	*9*	*25*	*22*	*15*	*6*	*22,191*	*1,15,200*

Table 4.26: Upazila-wise affected social overhead capital in KRREP area (CEGIS, 2004)

District	Upazila	#Union/ Pourashava	Affected SOC		
			# Institution	# Ashroy center	Road (km)
Jessore	Jhikargachha	5	11	-	170
	Manirampur	3	22	15	35
	Keshabpur	3	12	-	25
Satkhira	Kalaroa	3	9	-	45
	Tala	2	-	-	-
Total		*16*	*54*	*15*	*275*

Table 4.27: Upazila-wise affected water-body in KRREP area (CEGIS, 2004)

District	Upazila	#Union/ Pourashava	Affected Water-body (Number)		
			Ponds	Gher	Baor
Jessore	Jhikargachha	5	1050	-	2
	Manirampur	3	142	171	4
	Keshabpur	3	543	157	1
Satkhira	Kalaroa	3	445	110	1
	Tala	2	-	-	-
	Total	*16*	*2180*	*438*	*8*

Table 4.28: Fall of land price in affected KRREP area (CEGIS, 2004)

District	Upazila	#Union/ Pourashava	Maximum affected Land Price (% lower than non-affected area) by type		
			Agricultural	Homestead	Non-agricultural
Jessore	Jhikargachha	5	40	30	30
	Manirampur	3	50	40	40
	Keshabpur	3	40	40	30
Satkhira	Kalaroa	3	30	20	20
	Tala	2	20	10	10

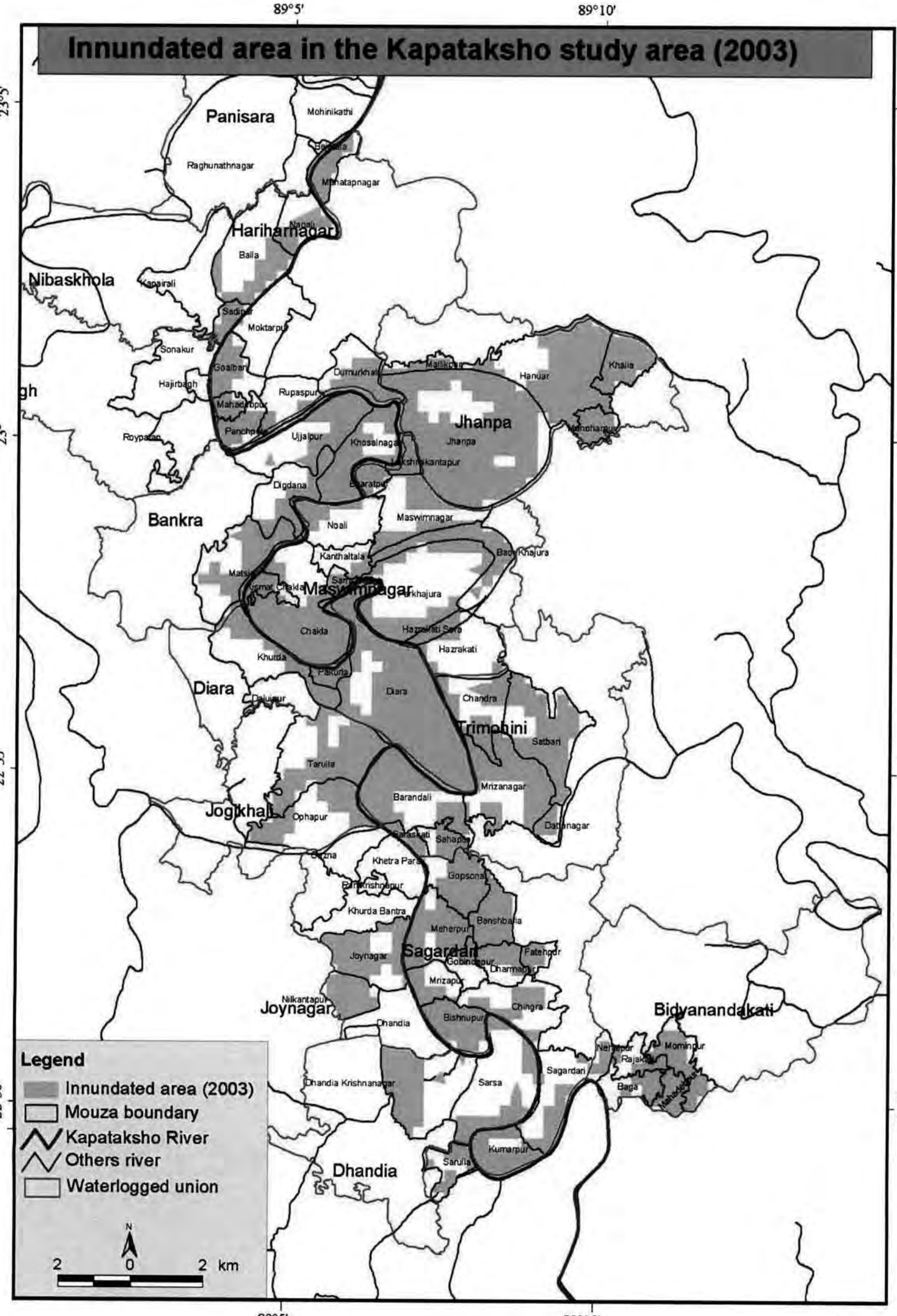

Fig. 4.9: Inundated area in KRREP in 2003 (CEGIS, 2004)

4.9 SUFFERINGS DURING DRAINAGE CONGESTION IN 2003

The vulnerability of different social groups differs depending on their source of livelihood. Land is the main concern for farmers whereas water is an important item for fishermen. There are other social groups such as fish traders and agricultural labours who are directly dependent on both land and water. Both the resources were more or less damaged by drainage congestion in 2003. The vulnerabilities of other social groups (carpenters, timber traders and service providers) were caused by general socio-economic dynamics of the local economy. The monsoon flooding (during June-October) due to spill from Mathabhanga and local rainfall run-off, affected around 50% (roughly 38,000 ha) of the entire KRREP area, 2,50,000 people and around 41,000 households (CEGIS, 2004) (Photo 4.1).

Photo 4.1: Sufferings of people during annual flooding in the KRREP area

Agricultural production, fish production, livestock, homestead garden were the major vulnerabilities of these households. The drainage congestion during monsoon and post-monsoon caused a great damage to standing crops, particularly transplanted Aman. It also limited cultivation of transplanted Aus since land remained under water for a long period. Four to six months sustainable drainage congestion caused vulnerabilities to perennial trees like date palm, jackfruit etc. (Photo 4.2).

Photo 4.2: Disturbance of terrestrial ecosystem during water logging in the KRREP area

It also brought death and sporadic skin diseases and diarrhoea of children and very aged people, polluted environment and lack of security of women in slums. At this period unemployment became a common crisis. Around 15% of the project households are of agricultural labour. During flooding and drainage congestion, agricultural activities are almost ceased and this population becomes unemployed. As result, income shrink, consumption level decreased and sustainability of livelihood remains at a stake. Moreover, people of non-farming households were forcedly evicted from their economic units due to overland flooding, inundation of roads, houses, shops and other business units. As a result, income level of different livelihood fell down. Educational institutions were closed for a long period at that time having long break of education. Prolonged water logging in baors, beels, khals and river Kapotaksha deteriorated water quality. People used water from those sources for bathing and washing cloths. As a result they suffered from different skin diseases. Moreover, the ground water table also contaminated in some locations and people of those locations suffered from diarrhoea. Since the income shrank, people of most households were unable to afford treatment of the diseases. As a result, health became serious phenomena after congestion.

A total of 1846 families took shelter in 52 emergency centers during flooding and drainage congestion in 2003. Some of them took shelter in pucca houses, high roads or local school premises built on relatively highlands (Photo 4.3).

Photo 4.3: Most of the people take shelter on road during annual flooding in the KRREP area

Some families from three unions of Kalaroa under Satkhira Upazila, two unions of Manirampur Upazila and three unions of Keshabpur Upazila under Jessore district lived in slums (Table 4.29).

Table 4.29: Number of households affected severely by water logging in 2003 (CEGIS, 2004)

District	Upazila	Union	Number of families suffered Housing problem due to water-logging in 2003	
			# Lived in water-logged house	Lived in slums
Jessore	Manirampur	Maswimnagar	293	509
		Jhanpa	75	53
	Keshabpur	Trimohoni	1045	457
		Sagardari	113	46
		Bidhanandakati	80	-
Satkhira	Kalaroa	Diara	824	781
	Total		*2430*	*1846*

4.10 SUMMARY

The baseline survey of the KRREP area has been performed to have a clear idea of the environmental and social condition of that area. This report also made a portrait of the living picture of the people during drainage congestion and the sufferings of the social life of the community. This baseline information is the basis to assess environmental impacts of different parameters. This assessment is essential for the sustainability of the KRREP.

Chapter 5

ENVIRONMENTAL IMPACT ASSESSMENT OF THE FRREP

5.1 INTRODUCTION

BWDB's project of re-excavation (partly) of the Kapotaksha River is an initiative to relief the people of that area from excessive sufferings due to heavy siltation and drainage congestion. Due to re-excavation activities, there will be a series of effects (positive and negative) on different systems such as ecological impacts, social impacts, hydro-geological impacts, land resources impacts etc. In this present study, an attempt has been undertaken to assess the environmental and social impacts due to this re-excavation project. An EIA will help in future planning and management of the project work as well as in monitoring and mitigating any unforeseen adverse effect in the future. In the present study EES methodology has been adopted to accomplish EIA of the KRREP. Details of this methodology (EES) have already been discussed in section 2.6.6 in Chapter 2. Based on the baseline survey (Chapter 4) report, interrelated parameters are identified as effective parameters to be affected by re-excavation work. Relative importance of these parameters was decided based on previous study (Islam, 2003) and degree of impact for each of the parameters was assessed following LGED EIA guidelines (1992). Twenty-five parameters are grouped into four categories such as i) Physical resources ii) Ecological resources iii) Human use value and iv) Quality of life value. Relative importance values for different groups are assessed to be different depending on the importance of those groups. Since the ultimate goal of a project is to improve the status of the people of that locality, the group *Human use value* and *Quality of life value* are given more importance than *Physical resources* and *Ecological resources*. *Physical resources* contains relative importance value of 100, whereas *Ecological resources*, *Human use value* and *Quality of life value* carries relative importance value of 100, 400 and 300 respectively. Which means that one unit impact on *Human use value* or *Quality of life value* carries 4 or 3 times impact than *Physical resources* or *Ecological resources*.

The environmental impact for each of the parameters has been assessed for three conditions: during dredging, after short period of dredging (one season after dredging) and after long period of dredging (two years after dredging). The following sections present a detail assessment of impacts on the above categories.

Finally a list of mitigation measures to combat those impacts is presented at the end of this chapter.

5.2 IMPACTS ON PHYSICAL RESOURCES

It is assumed that parameters such as water quality, water level, chloride content, ground water level, sediment quality, soil quality and climate will be affected due to implementation of re-excavation project. The total relative importance value of *Physical Resources* is given as 100 and degree of impact for those parameters is in between –5 to +4. Both the relative importance value and degree of impact on above stated parameters are discussed in the following sub sections.

5.2.1 Water Quality

The surface water of the study area is slightly alkaline (pH ranging from 7.1 to 7.3). Other water quality measuring parameters such as total dissolved solids, turbidity, electrical conductivity, chemical oxygen demand, phosphate, nitrate, ammonia-nitrogen etc. were found to be suitable for household use and irrigation purposes (TNRCC, 2005). The relative importance value for this parameter is given as 10. During dredging the water quality of the Kapotaksha River is assessed to deteriorate in a large scale. A huge amount of turbidity and total dissolved solids will deteriorate the water quality. Moreover movement of dredging vessels will release oil and grease on water. The degree of impact for this stage is considered as –5. After a short period of time the water quality will be better than the dredging period but not of better quality. The degree of impact for short period is assessed as –2. Since the present water quality is not posing any threat for aquatic and human life, the re-excavation will have a very little positive impact on surface water quality making the water quality a little bit better. Considering this, the degree of impact of proposed project on water quality has been considered as +1 for long period. It is assessed that without re-excavation, water quality will deteriorate causing decreasing dissolved oxygen in a small scale. The degree of impact without the project is considered as –1.

5.2.2 Water Level

Surface water level is an important parameter for irrigation. Average water level data in the study area varies within 2.5 m to 3 m (Table 4.6). Since surface water level plays an important role and expected to be influenced by re-excavation, relative importance value is considered as 10. During dredging, surface water level of the river Kapotaksha will improve. The degree of impact on this parameter at this stage is considered as +1. After a short period of dredging water level will gain a better situation. It is assessed that degree of impact for short period is assessed as +2. After re-excavation, the Kapotaksha is considered to have better level. The impact of the project upon surface water level for long period will be as high as +3. If the present situation continues, the river will have reduced water level in a small scale with the passage of time. The degree of impact without project is assessed as very low as –1.

5.2.3 Salinity

The surface water salinity is the main problem of the study area. Excessive salinity makes deposition of sediment on riverbed which results reduction of river depth and capacity. High salinity is also harmful for plant life and aquatic life. The water samples were collected in monsoon shows a lower level but generally salinity remains high in dry season at the study area (Annex A-1). A relative importance value 25 is taken for surface water salinity. During dredging, salinity situation is expected to improve in a small scale. The degree of impact during this period is considered as low as +1. After short period of completion of dredging, salinity situation will improve further. For this period, degree of impact is assessed as +3. It is expected that after the completion of the re-excavations, the river will drain upstream fed fresh water and catchment runoff. As a result, the salinity of the river will be reduced in a large scale. The degree of impact for long period has been considered as +4. At present excessive surface water salinity is the main cause of suffering. If no excavation is implemented, the water salinity will enhance in a large scale. The degree of impact for salinity without project is assessed as high as –3.

5.2.3 Sedimentation

Sedimentation is an important parameter influencing the aquatic life. Excessive sediment prohibits sunlight passing through water. The relative importance value for this parameter is assessed as 10. It can be assessed that during the dredging operation, a huge amount of sedimentation will occur. The degree of impact during this period is considered highly negative as –4. After a short period of dredging, the sedimentation is expected to reduce in a significant scale. The degree of impact for this stage is assessed as –2. After a long period, sedimentation will be in a better mode than the short period but not better than the present since at that period the river will carry the rainfall runoff along with mud. The degree of impact for this period is considered as –1. If the present situation continues, no significant change of sedimentation is expected. The degree of impact for no project situation is considered as 0.

5.2.4 Ground Water Level

Ground water table has an upward trend from 1999 to 2001 and then downward (Table 4.7). Ground water level is an important parameter influencing the cultivation and irrigation from ground water recharge. The relative importance value of this parameter is considered as 10. During dredging, no impact on ground water level is assessed. Hence degree impact on this parameter for this period is considered as 0. For a short period after the completion of dredging, water level will decline in a very small scale. Degree of impact for this stage is assessed as low as –1. If the project runs successfully, it can be hoped that ground water recharge will be slightly reduced due to have no water congestion or flooding which will lessen the ground water irrigation although the ground water replenishes from surface water and also influence the cultivation practice. Therefore, the degree of impact for this parameter for long period has been considered as low as –2. Continuation of the present situation will have no effect on ground water level. The degree of impact without project for this parameter is assessed as 0.

5.2.5 Riverbed Sediment Quality

Sediment quality not being so important for the existing condition of the study area, the relative importance value for sediment quality is given as 10. Different metal concentration like chromium, cadmium and lead varies from 19 to 30 mg/l, 0.29 to 0.34 mg/l and 13 to 19 mg/l respectively. All the values are within acceptable limit (TNRCC, 2005). Moreover riverbed sediment is reach in nutrients (Table 4.14). During dredging, sediment quality may degrade a little bit having removal of bed sediment. Furthermore, dredging equipment may accumulate some heavy metals on bed sediment. The degree of impact during dredging is assessed as low as -1. After a short period of the completion of the project, engine driven water vessels may move through the river having sufficient navigability. Hence sediment quality will deteriorate due to heavy metal accumulation on riverbed during this period. The degree of impact at this period for this parameter is assessed as –2. After a long period, further heavy metal accumulation may degrade the sediment quality. Therefore, for long period, degree of impact on sediment quality has been considered as –3. Without project, the sediment quality will remain as usual since no possibility to move engine driven water vessel. The degree of impact without project is assessed as 0.

5.2.6 Soil Quality

The cropping pattern is based on soil quality. The soil quality being a governing factor of cultivation, the relative importance value is given as 25. The soil of the most part of the study area is mainly saline except the lower part (CEGIS, 2004). Soil of lower area is slightly saline in dry season. The nutrients of the soil in this area are suitable for a wide range of crops. Riverbed sediment contains a good variety of nutrients (CEGIS, 2004). Which indicates that during dredging, dumping of bed sediment on adjacent lands will make the soil quality better. Degree of impact of this parameter during dredging is considered moderately positive as +2. After a short period, lands will be available throughout the year for cultivation. Soil quality is predicted to deteriorate in a small scale due to excessive use of land and fertilizer. The degree of impact for short time is assessed a small-scale negative impact and considered as low as –2. After a long period soil quality will further deteriorate. The degree of impact for long period has been considered as –3. The soil quality will also degrade in without project situation. This degradation will be due to prolonged water congestion. The degree of impact on this parameter for without project is considered as low as – 1.

5.2.7 Climate

Different climatic parameters such as rainfall, evaporation, temperature, relative humidity, sunshine hour etc. have less significant effect on the project. Therefore, the relative importance value for climate is given as 5. During dredging, climate will have negative impact. Dust will pollute air during dumping of spoils. Noise level will be raised during excavation. Hence during dredging climate will deteriorate and degree of impact at this stage is considered as –1. After a short period, dust pollution and noise pollution will minimised. At this stage, no impact on climate has been assessed. Hence degree of impact is considered as 0. Since climatic will not be directly influenced by the re-excavation, degree of impact is considered as 0 for long period. Since without project will not affect the climate, degree of impact for this situation is assessed as 0.

Table 5.1 shows the summary of the relative importance value and degree of impact assessed for the project for Physical Resources.

Table 5.1: Relative importance value and degree of impacts of the Physical Resources

Parameter	Relative importanc e value	Degree of impact during dredging	Degree of impact after a short period of dredging	Degree of impact after a long period of dredging	Degree of impact without project
Water quality	10	-5	-2	+1	-1
Water level	10	+1	+2	+3	-1
Salinity	25	+1	+3	+4	-3
Sedimentation	10	-4	-2	-1	0
Ground water level	10	0	-1	-2	0
Sediment quality	10	-1	-2	-3	0
Soil quality	20	+2	-2	-3	-1
Climate	5	-1	0	0	0

5.3 IMPACTS ON ECOLOGICAL RESOURCES

The ecological parameters such as fisheries resources, terrestrial ecosystem, partly terrestrial- partly aquatic ecosystem and aquatic ecosystem are expected to be influenced by the re-excavation project. Based on the present situation, the total relative importance value of *Ecological Resources* is given as 100 and degree of impact for those parameters is in between -3 to +4. Both the relative importance value and degree of impact are discussed in the following sub sections.

5.3.1 Fisheries Resources

Fisheries resources are a major part of total ecosystem of the study area. A detail of different existing fish species is given in section 4.6 in Chapter 4. The average total annual of fish production is around 600 mt (CEGIS, 2004). The relative importance value for this parameter is given as 40. A large number of water bodies are being damaged during flood. As for example, nine hundred and twenty five ponds, around fifty-two hectares area along the river Kapotaksha and major part of khals named Bagar Khal, Mihirpur Khal and Mirjapur Khal has been damaged in flood 2003. The re-excavation will protect the fish production and existing fish species. But during dredging, water quality will be unfavourable for fisheries resources. The suspended sediments will make the environment unfavourable for fish. As a result, it is assessed that fisheries resources will get a great loss during dredging period. Moreover the dredging equipment will obstruct fish migration. The degree of impact for this period is considered as high as –3. After a short period of completion of dredging, suspended sediments will settle and the study area is expected to have relief of annual flooding and drainage congestion. But at this period people may re-establish the fisheries resources. Though the overall environment during this period is expected to favourable, net gain will not be in huge amount. The degree of impact for short period is considered as low as +1. It is expected that after a long period, a well-planned and favourable environment will facilitate the fish production. The degree of impact for long period is considered as high as +4. In recent years, a severe loss of fisheries resources occurs during monsoon flooding. So without project, the loss will be high. The degree of impact on fisheries resources without project is assessed as high as –3.

5.3.2 Terrestrial Ecosystem

Present terrestrial ecosystem of the study area mainly consists of the agricultural lands and the rest consists of palm, jackfruit, coconut and mango trees. Every year terrestrial ecosystem suffers a lot due to flooding and drainage congestion. The terrestrial ecosystem is an important resource among the ecological resources. Relative importance of this parameter is considered as 20. It is assessed that during dredging, the terrestrial ecosystem will have a partial relief of suffering. The degree of impact for this period is considered a small scale positive as +1. After a short period of dredging, the terrestrial ecosystem is expected to in the way to the establishment of a stable situation. The degree of impact for this stage is +2. After a long period, the terrestrial ecosystem is expected to in a well-established manner. The degree of impact of long period has been considered as moderate and a value of +3 is given to this parameter. It can be predicted that if the present situation continues, the terrestrial ecosystem will be hampered in a small scale. The degree of impact of without project situation is considered as low as –1.

5.3.3 Partly Terrestrial- Partly Aquatic Ecosystem

Beels baors and low-lying areas are partly terrestrial- partly aquatic in nature. Different species of grass and vegetations plants like shola, paniphal, kalmi etc grow here. Some of these species are sources of food and shelter of many aquatic birds, fishes. The relative importance value is given as 15 for this system. Annual flooding and drainage congestion have disturbed this type of ecosystem. During dredging, this type of ecosystem is expected to be disturbed a lot. The degree of impact during dredging is assessed as –2. After a short period of dredging, the baors are expected to have connectivity with the Kapotaksha River. As a result, this type of ecosystem will be in the way to get a stable ecosystem. The degree of impact for this period is considered as low as +1. After a long period, a more stable ecosystem is expected. The degree of impact for long period is considered as +2. If the present situation continues, the partly terrestrial and partly aquatic ecosystem will be hampered in a small scale. Without project impact on this parameter is assessed as low as –1.

5.3.4 Aquatic Ecosystem

Aquatic ecosystem is a major part of present ecosystem of the study area. Relative importance value is considered as 25 for this parameter. The present aquatic ecosystem of the study area is not in good condition. Water hyacinth covers the most part of water surface making the aquatic system anaerobic. The changed environment of the aquatic system severely affects plants, fishes and animals existing in that system. During dredging, aquatic ecosystem is expected to have a better situation. Water hyacinth removal will improve the aquatic ecosystem but excessive sediment will hamper the aquatic ecosystem during this period. The degree of impact for this period is considered as very small scale positive as +1. After a short period, this part of ecosystem is expected to improve further. The degree of impact for short period has been assessed as low as +2. After a long period of the re-excavation, river water will flow throughout the year making better aquatic environment. Moreover, drainage condition is expected to be better after re-excavation. The degree of impact for long period, on aquatic ecosystem has been considered as +3. Without project the anaerobic condition of aquatic ecosystem will be sever. The degree of impact in without project situation on this parameter is considered as medium as –2.

The following table (Table 5.2) shows the summary of the relative importance value and degree of impact assessed for the project for Ecological Resources.

Table: 5.2 Relative importance value and degree of impacts of the Ecological Resources

Parameter	Relative importance value	Degree of impact during dredging	Degree of impact after a short period of dredging	Degree of impact after a long period of dredging	Degree of impact without project
Fisheries resources	40	-3	+1	+4	-3
Terrestrial ecosystem	20	+1	+2	+3	-1
Partly terrestrial-partly aquatic ecosystem	15	-2	+1	+2	-1
Aquatic ecosystem	25	+1	+2	+3	-2

5.4 IMPACTS ON HUMAN USE VALUE

Based on the baseline information, the parameters such as Agriculture, Irrigation, Flood Control, Navigation, Transportation and Sanitation are considered as important parameters to be influenced by the re-excavation project. Since human use value is a major consideration for any project's sustainability, a total relative importance value of 400 is given for this system.

The degree of impact for KRREP on different parameters of this system has been assessed from -5 to +5. Both the relative importance value and degree of impact are discussed in the following sub sections.

5.4.1 Agriculture

Agriculture is considered as one of the most important parameters in the study area among the human use value. The relative importance value for this parameter is considered as 90. Though the drainage congestion and yearly flooding disrupt agriculture, a large number of total populations choose agriculture as main mode of their livelihood. During dredging, the agricultural production will be hampered due to dumping of spoils of dredging to the adjacent lands. The degree of impact during dredging is considered negative and assessed as –2. Since the riverbed sediment contains a good level of nutrients, after a short period of dredging, the agricultural product will be enhanced. Moreover more land will be available for cultivation throughout the year. The degree of impact for this stage is considered positive and assessed as +2. After a long period, a well-organized cultivation practice is expected which may enhance further production. Therefore, the degree of impact on agriculture for long period is considered as moderate as +3. For without project situation, agricultural production will be reduced. The degree of impact for without project condition is considered as –3.

5.4.2 Irrigation

Irrigation influences the agriculture directly. The relative importance value for this parameter has been assessed as 50. Ground water is main source of irrigation at present (Table 4.18). During dredging, the surface water quality was not suitable for irrigation. Since very small portion of irrigation is being contributed from surface water, no significant impact may occur. The degree of impact at this period is considered as low as –1. After a short period of the re-excavation, the ground water level is expected to be lowered down. At period people will use surface water for irrigation. During this period surface water is expected to have a better quality than the dredging period. It is expected that surface water may replenish the shortage of ground water availability for irrigation. The degree of impact for this period is assessed as 0. It can be expected that after a long period, surface water may be a good source of irrigation having better quality and better quantity. The degree of impact for long period on this parameter has been considered low as +1. If the present condition continues, no effect on irrigation will be exercised. The degree of impact for the parameter, irrigation, is considered as 0.

5.4.3 Flood Control

Flooding becomes a common phenomenon in every year starting from 2000 mainly due to reduced capacity of the river and huge amount of cross-boundary flow coming from India. More area started to be affected by flood from year to year. Flood control is another very important parameter. The regular yearly flooding affects around 50% of total KRREP area (around 38,000 ha) with suffering of around 2.5 lakh people and damage of 41,000 households (CEGIS, 2004). This flooding and drainage congestion hampered fish production, damage livestock, homestead garden etc. The relative importance value for this parameter is given as 90. During dredging, a small-scale relief from flooding is expected. The degree of impact at this period is considered as +2. It can be assessed that after a short period, the flooding situation will improve more. The degree of impact after a short period is considered as +4. After a long period, the study area is expected to have full control on flooding. The degree of impact for long period is considered as +5. If no project is accomplished, the flood scenario will degrade severely. The degree of impact on this parameter in without project situation is considered as very high as –5.

5.4.4 Navigation

Navigation directly influences the mode of communication and transportation. The relative importance value of this parameter has been assessed as 60. At present navigability of the river Kapotaksha is very poor. Most part of the river loses navigability during dry season. Large country boats cannot move through Kapotaksha even in wet season due to unavailability of sufficient draft. During dredging draft will improve but navigability will be disturbed due to presence of dredging vehicles. The degree of impact during dredging is expected to negative and assessed as –2. After short period of dredging, the navigability the entire river is expected to be navigable throughout the year. The degree of impact at this period is assessed as high as +5. After a long period, the navigability is also expected to in a good mode. The degree of impact for long period is assessed as +5. If no excavation is done, continuous siltation will make the navigation worst. The degree of impact on navigation parameter is assessed as high as –4.

5.4.5 Transportation

Transportation is a parameter that influences life of people of that community. The relative importance value of this parameter is considered as 30. Once upon a time, people used launch and boat to move from one place to another and to transport goods and commodities. Now days, roads are the main way to move. During monsoon people use small country boat to move a short distance in the locality. During dredging, transportation on waterway will be disturbed. The degree of impact during this period has been assessed as –1. After a short period, the transportation is expected to be better having more roads usable throughout the whole year. Moreover, river will play a significant role in transportation. The degree of impact for short period is assessed as +2. After a long period of dredging, the transportation mode is expected to be as usual as the short period. The degree of impact for long period is considered as +2. In without project situation, the transportation situation will degrade with time. The degree of impact of without project condition in this parameter is considered as low as –2.

5.4.6 Water Supply and Sanitation

Water supply and sanitation is a part of human use value. The relative importance value of this parameter has been assessed as 20. In most part of the study area, almost cent percent (98 to 99%) of households use tube-well water

(Table 4.23). But sanitation condition is very poor in this area. Major part of total household use outside latrine (Table 4.23). During dredging, some health problem related to sanitation of the worker of dredging would occur. The degree of impact on sanitation at this period has been assessed as –1. If the re-excavation project does not take any movement of consciousness on sanitation, no improvement can be expected after dredging. The degree of impact for both the short and long period after dredging has been assessed as 0. The degree of impact on this parameter for without project is also considered as 0.

5.4.7 Land Loss

The availability of land is a very important parameter for any locality. The relative importance value on this parameter has been assessed as 60. The dredging operation will reduce around 25 sq. km area on the both sides of the Kapotaksha River. Moreover some land loss will occur for short time during the dredging where spoils will be dumped. At this stage the impact on this parameter is negative and assessed as –2. After short period, the land will be available for cultivation and hence negative impact will be reduced. The degree of impact at this stage is considered as –1. After a long period no improvement of land gain will occur. Hence the degree of impact at this stage also has been assessed as –1. For without project situation no impact on this parameter has been assessed. The degree of impact for without project condition is considered as 0.

Table 5.3 shows the summary of the relative importance value and degree of impact assessed for the project for Human Use Value.

Table: 5.3 Relative importance value and degree of impacts of the Human Use Value

Parameter	Relative importance value	Degree of impact during dredging	Degree of impact after a short period of dredging	Degree of impact after a long period of dredging	Degree of impact without project
Agriculture	90	-2	+2	+3	-3
Irrigation	50	-1	0	+1	0
Flood control	90	+2	+4	+5	-5
Navigation	60	-2	+5	+5	-4
Transportation	30	-1	+2	+2	-2
Water supply and sanitation	20	-1	0	0	0
Land Loss	60	-2	-1	-1	0

5.5 IMPACTS ON QUALITY OF LIFE VALUE

The parameters such as employment, social group, economic condition, nutrition level, housing condition and land loss are expected to be influenced by the re-excavation project. Based on the present situation, the total relative importance value of *Quality of Life Value* is given as 300 and the degree of impact due to re-excavation for those parameters is in between -3 to +3. Both the relative importance value and degree of impact are discussed in the following sub sections.

5.5.1 Employment

Employment or unemployment is a very important parameter reflecting the socio-economic situation of the area. The relative importance value for this parameter has been considered as 90. Table 4.20 shows that around 60% of population (over 10years of age) are unemployment. Every year more people has becoming unemployed during annual flooding and drainage congestion. During re-excavation, some people will be engaged in manual dredging and also in operating equipments of mechanical dredger. Hence at this period the degree of impact has been assessed as +1. Moreover after short period of the completion of the project, more land will be available. More people will be involved in agricultural activities having high demand of that type of labour. The degree of impact at this stage is assessed as +2. After a long period of the dredging, more stable mode of agriculture will enhance the stable mode of livelihood related to agricultural activities. At this stage more stable mode of livelihood is expected to enhance the employment. The degree of impact on this period for long period is considered as +3. If the present situation continues, unemployment will increase. The degree of impact on population for without project is considered as low as –2.

5.5.2 Social Group

Social group is another important parameter influencing the quality of life value. The relative importance value for this parameter has been assessed as 40. The history of this area shows that major part of population was involved in agricultural works. In recent years, major part of that population shift their livelihood from cultivation to other mode due to scarcity of agricultural land and other unfavorable situation arise in monsoon. Around 48% people of study area are farmer (CEGIS, 2004). Rest is fishermen, carpenters, brickfield workers, businessmen and other jobholders. During dredging, the social group will be disturbed due to migration from one group to another. The degree of impact during, dredging is considered as –2. The project will change the overall social group pattern. It will minimize agricultural land scarcity and other problems due to drainage congestion. Hence more people will be involved in agricultural purpose. The degree of impact on social group for both short and long period is considered as moderate as +2. If no project is done people of different occupation will switch. But this switching will not affect the overall social structure in a significant scale. The degree of impact for without project situation is assessed as low as –1.

5.5.3 Economic Condition

Economic condition is a very important parameter controlling the life standard and social structure. The relative importance value for this parameter has been assessed as 70. During dredging, some local unemployed people will be involved in manual dredging. Hence economic condition is expected to improve in a small scale at this stage. The degree of impact at this period is considered as +1. After a short period, better economic condition is expected since having relief from unemployment during flooding and more stable mode of occupation. The degree of impact for short period is assessed as +2. It is expected that the project will increase per capita income of the study area after a long period due to more stable livelihood and more employment opportunity related to agriculture. The degree of impact for long period is considered as +3. If the present situation continues, people will remain unemployed for a long period during monsoon every year. This situation will degrade with the passage of time. The degree of impact for without project situation is considered as –2.

5.5.4 Nutrition Level

Nutrition level indicates social condition as well as economic standard of an area. This parameter should be given an importance value considering the present situation. The relative importance value of the parameter is given as 40. Though there is no statistics of nutrition data, the field survey states that the nutrition level is very poor in this study area. Most of the children in the study area have symptom of vitamin deficiency and they seem to be malnourished. The women of this locality are totally unconscious of health care of their own and also of their children. Moreover, the economic condition does not support sufficient nutrition. Very limited type cropping pattern has worsened the situation. No change in nutrition is expected during dredging. The degree of impact during dredging has been assessed as 0. After completion of re-excavation, the financial condition of population is expected to be better and hence nutrition level will rise. Therefore, the project will lessen nutrition problem. The degree of impact for both short and long period is considered as

+3. Reduced per capita income due to continuation of present situation will make the nutrition level to low. Hence degree of impact on nutrition level for without project condition is –1.

5.5.5 Housing Condition

Housing condition is a parameter to measure the quality of life vale of population. The relative importance value for this parameter has been assessed as 20. Houses of major population are either of tin shed or of straw/bamboo. A very small portion has brick built house (Table 4.22). This feature indicates that most of the people in this area are not enough solvent financially. During dredging, no significant impact on housing condition is expected. The degree of impact during dredging is assessed as 0. It is expected that re-excavation will make people more solvent compare to present status. Considering the socio-economic condition, degree of impact is considered as +2 for both short and long period after dredging. If the present condition continues, the ability of people will reduce with time. Therefore housing condition will degrade. The degree of impact on this parameter is considered as low as -1.

5.5.6 Land Price

Around 580 km^2 of area is under agricultural purpose of the total area of 767 km^2 (Kranti Associates and et al, 2000). Land gain for agricultural purpose is an important parameter to be affected by the re-excavation project. The relative importance value under this parameter is considered as 50. Yearly flooding and drainage congestion lowered the land price (Table 4.28). During dredging no effect on land price has been assessed and degree of impact is considered as 0. After re-excavation more land will be under cultivation throughout the year. The degree of impact for both the short and long period is assessed as +3. The continuous drainage congestion and annual flooding will make a sever scarcity of agricultural land. The degree of impact on this parameter is considered as high as –3.

The following table shows the summery of the relative importance value and degree of impact assessed for the project for Quality of Life Value.

Table: 5.4 Relative importance value and degree of impacts of the Quality of Life Value

Parameter	Relative importance value	Degree of impact during dredging	Degree of impact after a short period of dredging	Degree of impact after a long period of dredging	Degree of impact without project
Employment	90	+1	+2	+3	-2
Social group	40	-2	+2	+2	-1
Economic condition	70	+1	+2	+3	-2
Nutrition level	40	0	+3	+3	-1
Housing condition	20	0	+2	+2	-1
Land price	50	0	+3	+3	-3

5.6 Impact Prediction and Assessment

Based on field observation and collected secondary information, the degree of impact due to re-excavation project varies from -5 to +5; -5 represents an extreme negative impact and +5 represent an extreme positive impact. For individual cases, such as physical resources, social values etc. this range changes but varies within this stated value –5 to +5. Hence maximum possible change of positive impact value is +10 and negative impact value is –10 for a specific parameter. Therefore, the change of each parameter has been expressed in percentage (Table 5.5 – 5.7) to make the assessment clearly understandable. The weightage given in Physical Resource is 100, in Economic Resource is 100, in Human Use Value is 400 and in Quality of Life Value is 300; total is 900 (Table 5.5- 5.7). The environmental impact value of each parameter for three phases has been shown in Table 5.8.

Table 5.5: Environmental Impact Assessment during dredging

Parameter	Relative Importance (Wi)	During Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
PHYSICAL RESOURCES	100					
Water Quality	10	-5	-1	-4	-40	40% of maximum degradation would occur
Water level	10	+1	-1	+2	+20	20% of most favourable water level would attain
Salinity	25	+1	-3	+4	+100	40% of most favourable salinity is expected
Sedimentation	10	-4	0	-4	-40	40% of maximum sedimentation would occur
Ground water level	10	0	0	0	0	No change
Sediment quality	10	-1	0	-1	-15	10% of maximum degradation would occur
Soil quality	20	+2	-1	+3	+60	30% of excellent quality is expected
Climate	5	-1	0	-1	-5	10% of maximum climatic hazard would occur
				Sub Total	*80*	
ECOLOGICAL RESOURCE	100					
Fisheries resources	40	-3	-3	0	0	No net change is expected
Terrestrial ecosystem	20	+1	-1	+2	+40	20% of excellent ecosystem is expected
Partly terrestrial-partly aquatic ecosystem	15	-2	-1	-1	-15	10% of worst would establish

Table 5.5: (Continued)

Parameter	Relative Importance (Wi)	During Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
Aquatic ecosystem	25	+1	-2	+3	+75	30% of excellent ecosystem is expected
				Sub Total	*100*	
HUMAN USE VALUE	400					
Agriculture	90	-2	-3	+1	+90	10% of possible maximum production would expect
Irrigation	50	-1	0	-1	-50	10% of possible maximum depletion is expected
Flood control	90	+2	-5	+7	+630	70% of full control is expected
Navigation	60	-2	-4	+2	+120	20% of full navigability is expected
Transportation	30	-1	-2	+1	+30	10% of most favourable transport facility is expected
Sanitation	20	-1	0	-1	-20	10% of worst situation would occur
Land Loss	60	-2	0	-2	-120	24 sq. km will be lost due to dredging
				Sub Total	*700*	
QUALITY OF LIFE VALUE	300					
Employment	90	+1	-2	+3	+270	30% of unemployed skill labour would be employed
Social group	40	-2	-1	-1	-40	Social restructuring in 10% of the social groups

Table 5.5: (Continued)

Parameter	Relative Importance (Wi)	During Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
Economic condition	70	+1	-2	+3	+210	30% gap towards a decent life would be overcome
Nutrition Level	40	0	-1	+1	+40	10% deficiency of nutrition is expected to be minimized
Housing Condition	20	0	-1	+1	+20	Extra 10% for standard life would achieve
Land price	50	0	-3	+3	+150	Fellow land price would increase 30%
				Sub Total	*650*	
Grand Total					1530	

Table 5.6: Environmental Impact Assessment after a short period of dredging

Parameter	Relative Importance (Wi)	Short period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
PHYSICAL RESOURCES	100					
Water quality	10	-2	-1	-1	-10	10% of maximum degradation would occur
Water level	10	+2	-1	+3	+30	30% of most favourable water level would attain

Table 5.6: (Continued)

Parameter	Relative Importance (Wi)	Short period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
Salinity	25	+3	-3	+6	+150	60% of most favourable salinity is expected
Sedimentation	10	-2	0	-2	-20	20% of maximum sedimentation would occur
Ground water level	10	-1	0	-1	-10	10% of maximum depletion would occur
Sediment quality	10	-1	0	-1	-15	10% of maximum degradation would occur
Soil quality	20	-2	-1	-1	-20	10% of worst quality is expected
Climate	5	0	0	0	0	No change would occur
				Sub Total	*105*	
ECOLOGICAL RESOURCE	100					
Fisheries resources	40	+1	-3	+4	+160	40% of possible maximum production is expected
Terrestrial ecosystem	20	+2	-1	+3	+60	30% of excellent ecosystem is expected
Partly terrestrial-partly aquatic ecosystem	15	+1	-1	+2	+30	20% of excellent would establish
Aquatic ecosystem	25	+2	-2	+4	+100	40% of excellent ecosystem is expected

Table 5.6: (Continued)

Parameter	Relative Importance (Wi)	Short period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
				Sub Total	*350*	
HUMAN USE VALUE	400					
Agriculture	90	+2	-3	+5	+450	50% of possible maximum production would expect
Irrigation	50	0	0	0	0	No change is expected
Flood control	90	+4	-5	+9	+810	90% of full control is expected
Navigation	60	+5	-4	+9	+540	90% of full navigability is expected
Transportation	30	+2	-2	+4	+120	40% of most favourable transport facility is expected
Sanitation	20	0	0	0	0	No change would occur
Land Loss	60	-1	0	-1	-60	24 sq. km will be lost due to dredging
				Sub Total	*1860*	
QUALITY OF LIFE VALUE	300					
Employment	90	+2	-2	+4	+360	40% of unemployed skill labour would be employed
Social group	40	+2	-1	+3	+120	Social restructuring in 30% of the social groups

Table 5.6: (Continued)

Parameter	Relative Importance (Wi)	Short period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
Economic condition	70	+2	-2	+4	+280	40% gap towards a decent life would be overcome
Nutrition Level	40	+3	-1	+4	+160	40% deficiency of nutrition is expected to be minimized
Housing Condition	20	+2	-1	+3	+60	Extra 30% for standard life would achieve
Land price	50	+3	-3	+6	+300	Fellow land price would increase 60%
				Sub Total	*1280*	
Grand Total					3595	

Table 5.7: Environmental Impact Assessment after a long period of dredging

Parameter	Relative Importance (Wi)	Long period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
PHYSICAL RESOURCES	100					
Water Quality	10	+1	-1	+2	+20	20% towards possible best quality would be attained
Water level	10	+3	-1	+4	+40	40% of most favourable water level would attain

Table 5.7: (Continued)

Parameter	Relative Importance (Wi)	Long period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
Salinity	25	+4	-3	+7	+175	70% of most favourable salinity is expected
Sedimentation	10	-1	0	-1	-10	10% of maximum sedimentation would occur
Ground water level	10	-2	0	-2	-20	20% of maximum depletion would occur
Sediment quality	10	-2	0	-2	-20	20% of maximum degradation would occur
Soil quality	20	-3	-1	-2	-40	20% of worst quality is expected
Climate	5	0	0	0	0	No change is expected
				Sub Total	145	
ECOLOGICAL RESOURCE	100					
Fisheries resources	40	+4	-3	+7	+280	70% of possible maximum production is expected
Terrestrial ecosystem	20	+3	-1	+4	+140	40% of excellent ecosystem is expected
Partly terrestrial-partly aquatic ecosystem	15	+2	-1	+3	+45	30% of worst excellent would establish
Aquatic ecosystem	25	+3	-2	+5	+125	50% of excellent ecosystem is expected
				Sub Total	*590*	

Table 5.7: (Continued)

Parameter	Relative Importance (Wi)	Long period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
HUMAN USE VALUE	400					
Agriculture	90	+3	-3	+6	+540	60% of possible maximum production would expect
Irrigation	50	+1	0	+1	+50	Surface water would contribute 20% of total irrigation
Flood control	90	+5	-5	+10	+900	Full flood control is expected
Navigation	60	+5	-4	+9	+540	90% of full navigability is expected
Transportation	30	+2	-2	+4	+120	40% of most favourable transport facility is expected
Sanitation	20	0	0	0	0	No change would occur
Land Loss	60	-1	0	-1	-60	24 sq. km will be lost due to dredging
				Sub Total	*2090*	
QUALITY OF LIFE VALUE	300					
Employment	90	+3	-2	+5	+450	50% of unemployed skill labour would be employed
Social group	40	+2	-1	+3	+120	Social restructuring in 30% of the social groups
Economic condition	70	+3	-2	+5	+350	50% gap towards a decent life would be overcome

Table 5.7: (Continued)

Parameter	Relative Importance (Wi)	Long period after Re-excavation $(Vi)_1$	Without Re-excavation $(Vi)_2$	Change of Condition $(Vi)_1$-$(Vi)_2$	Impact of each Parameter $(Wi)[(Vi)_1$-$(Vi)_2]$	Comment
Nutrition Level	40	+3	-1	+4	+160	40% deficiency of nutrition is expected to be minimized
Housing Condition	20	+2	-1	+3	+60	Extra 30% for standard life would achieve
Land price	50	+3	-3	+6	+300	Fellow land price would increase 60%
				Sub Total	*1440*	
Grand Total					4265	

Table 5.8: Environmental Impact of each parameter at three phase

Parameter	Environmental impact value		
	During dredging	Short period after dredging	Long period after dredging
PHYSICAL RESOURCES			
Water Quality	-40	-10	+20
Water level	+20	+30	+40
Salinity	+100	+150	+175
Sedimentation	-40	-20	-10
Ground water level	0	-10	-20
Sediment quality	-15	-15	-20
Soil quality	+60	-20	-40
Climate	-5	0	0
Sub Total	*80*	*105*	*145*
ECOLOGICAL RESOURCE			
Fisheries resources	0	+160	+280
Terrestrial ecosystem	+40	+60	+140
Partly terrestrial-partly aquatic ecosystem	-15	+30	+45

Table: 5.8 (Continued)

Parameter	Environmental impact value		
	During dredging	Short period after dredging	Long period after dredging
Aquatic ecosystem	+75	+100	+125
Sub Total	*100*	*350*	*590*
HUMAN USE VALUE			
Agriculture	+90	+450	+540
Irrigation	-50	0	+50
Flood control	+630	+810	+900
Navigation	+120	+540	+540
Transportation	+30	+120	+120
Sanitation	-20	0	0
Land Loss	-120	-60	-60
Sub Total	*700*	*1860*	*2090*
QUALITY OF LIFE VALUE			
Employment	+270	+360	+450
Social group	-40	+120	+120
Economic condition	+210	+280	+350
Nutrition Level	+40	+160	+160
Housing Condition	+20	+60	+60
Land price	+150	+300	+300
Sub Total	*650*	*1280*	*1440*
Grand Total	1530	3595	4265

The overall impact of KRREP on the parameters under *Physical Resources* is positive for all the three conditions. During dredging, parameters such as water quality, sedimentation, sediment quality and climate are assessed to have negative impact. But parameter such as water level, salinity and soil quality are expected to have positive impact during dredging. Only one parameter, ground water level, has been assessed to have no impact during this period. For short period after dredging, parameters like water quality, sedimentation, ground water level, sediment quality and soil quality are assessed to have negative impact.

Salinity has been assessed to have a large-scale positive impact (+150) at this stage. Moreover, water level is assessed to have positive impact. Climate is expected to have no impact at this period. For long period after the re-excavation, parameters like ground water level, sedimentation, soil quality and sediment quality are expected to have negative impact in small-scale. Salinity is expected to have large-scale (+175) positive impact. Moreover water quality and water level are assessed to have positive impact. For long period, climate has been assessed to have no impact.

Ecological Resources are assessed to have net positive impact for all the three periods. During dredging, terrestrial ecosystem and aquatic ecosystem are assessed to have positive impact whereas partly terrestrial-partly aquatic ecosystem is expected to have negative impact at this stage. Fisheries resources have been expected no net impact at this stage. After a short period all the components of *Ecological Resources* are expected to have positive impact. For long run, all the parameters are assessed to have positive impact and among those fisheries resources are expected to have a large-scale positive impact (+280).

Net impact of re-excavation on *Human Use Value* is positive for all conditions. During dredging, irrigation, sanitation and land loss are assessed to have negative impact (-50, -20 and –120 respectively), among which land loss is large-scale. All the remaining parameters of this category will have positive impact. After short period of re-excavation, parameters like agriculture, flood control, navigation and transportation are expected to have very large-scale positive impacts. Land loss is only one parameter to have negative impact (-60). Irrigation and sanitation are assessed to have no effect at this stage. After long period, land loss is the only one parameter to have negative impact. Sanitation is assessed to have no impact at this period. All the remaining parameters are expected to have positive impacts.

Parameters of the group- *Quality of Life Value* are assessed to exercise net positive impact. During dredging, social group has been assessed to have negative impact. The remaining parameters like employment, economic condition, nutrition level housing condition and land price are expected to have positive impact. All the parameters under this group have been assessed to have positive impact for both short and long period after dredging.

The environmental impact assessment (EIA) study of KRREP shows that the overall impact of this project is a very large-scale positive impact for all the three conditions of *during dredging*, *after short period of dredging* and *after long period of dredging* (+1530, +3580 and +4265 respectively), which recommends for the implementation of the project.

5.7 ENVIRONMENTAL IMPACT STATEMENT (EIS)

The prepared EIA of the KRREP made based on EES methodology has assessed impacts on parameters under four broad categories: *Physical Resources*, *Ecological Resources*, *Human Use Value* and *Quality of Life Value*. The following sections present a brief of the environmental impact assessment of the project.

5.7.1 Physical Resources

Physical Resources consists of parameters like water quality, water level, salinity, sedimentation, ground water level, sediment quality, soil quality and climate. Water quality would degrade badly during dredging and also short period after dredging (40% and 10% of maximum degradation would occur respectively). After long period water quality would improve. Water quality is expected to attain 20% toward the best quality at this period. Surface water level would attain a good form with time (20%, 30% and 40% of most favourable level during dredging, after short period of dredging and long period after dredging respectively). Salinity would improve with time. 40%, 60% and 70% of most favourable salinity is expected during dredging, after short period of dredging and long period after dredging respectively. A huge sedimentation is expected during dredging. This situation is expected to improve after short period of dredging, shifting from 40% to 20% of maximum sedimentation. During long period after dredging, a small sedimentation would occur due to rainfall runoff along with eroded soil from catchment area. No effect on ground water level is expected during dredging. But with passage of time depletion in ground water would occur. 10% and 20% of maximum depletion would occur respectively during short and long period after dredging. During dredging, sediment quality would degrade in same scale (10% of maximum possible degradation). Sediment would degrade more after long period of dredging (20% of maximum possible degradation) due to excessive movement of engine driven vehicles. During dredging, soil quality is expected to improve (30% of excellent quality) due to dumping of nutrient reach riverbed sediment on adjacent lands and also partial relief of drainage congestion. But soil quality would degrade with time due to excessive use of land and fertilizer. After short period of dredging, soil quality would degrade 10% of worst quality. Which is expected to be 20% of worst quality during long period after dredging. Dust pollution and smoking would contaminate air during dredging. Moreover, noise level would rise at this period. 10% of maximum worst climatic hazards would occur during dredging. No effect on climate would occur by the KRREP after dredging.

5.7.2 Ecological Resources

Fisheries resource is expected to have no net impact during dredging. But fisheries resource would have large-scale positive impact during both the period-short and long period after dredging (40% and 70% of maximum possible production respectively). The terrestrial ecosystem is expected to improve with time. 20%, 30% and 40% towards the best ecosystem is expected during the period during dredging, short period after dredging and long period after dredging. Partly terrestrial-partly aquatic ecosystem would be hampered during dredging (10% of worst). But this situation would improve with time. 20% and 30% of excellent ecosystem of this type is expected during short period and long period after dredging respectively. Aquatic ecosystem would exercise better situation at all the phases. This parameter would have 30%, 40% and 50% of excellent ecosystem during dredging, short period after dredging and long period after dredging.

5.7.3 Human Use Value

Human Use Value consists of agriculture, irrigation, flood control, navigation, transportation, sanitation and land loss. More land would be available for cultivation due to the KRREP. 10%, 50% and 60% of possible excessive maximum agricultural production is expected during dredging, short period after dredging and long period after dredging respectively. Irrigation would suffer depletion (10% of possible maximum depletion) during dredging. During short period after dredging, no net effect is expected on irrigation. It is assessed that during this period, surface water could replenish the demand of ground water for irrigation. During long period after dredging, surface water would contribute more in irrigation. A partial flood control is expected during dredging (70% of full control). After completion of the project, the situation would be better. It is expected that 90% and 100% of full control would be achieved after short and long period after dredging respectively. Navigability would have very small-scale positive impact (20% of full navigability) during dredging. 90% of full navigability would have during short and long period after dredging. A partial relief from drainage congestion would facilitate (10% of favourable facility) transportation during dredging. Transport facility is expected to improve further after dredging (40% of most favourable situation). Sanitation would be hampered during dredging by dredging workers. But this would be a temporal problem. After dredging no effect on this parameter is expected. A permanent land loss of 24 sq. km would occur due to re-excavation of the Kapotaksha River.

5.7.4 Quality of Life Value

The KRREP would make employment opportunity for the skill unemployed labour. During dredging, unemployed people would be involved in dredging activities. 30% of unemployed skill labour would be employed during this period. More unemployed people is expected to involve in agricultural activities after completion of the project. 40% and 50% of employment of unemployed skill labour is expected during short and long period after dredging respectively. Social group would be badly affected during dredging. 10% of social restructuring would occur during this phase. More stable social group structure is expected after completion of the project. The KRREP would improve the economic condition. 30%, 40% and 50% gap minimization towards decent life would occur during dredging, short period after dredging and long period after dredging. Along with the economic condition, nutrition level would improve. 10% nutrition deficiency would be minimized during dredging and 40% deficiency would be minimized during short and long period after dredging. The economic condition would be reflected on housing condition in this area having better condition. Having partial relief from flooding and drainage congestion, the price of land (both fellow and cultivable) would be raised in a small-scale during dredging. After completion of the project, land price will be higher in this area.

5.8 CONCLUSION

The environmental and social parameters would have some positive and also some negative impacts due to the KRREP. A sound Environmental Management Plan (EMP) can bring the negative impacts to an acceptable limit. Furthermore, EMP sometimes enhances the positive impacts.

A part from the EMP, a regular monitoring plan is essential to detect the changes in the physical, biological, ecological and social indicators. Which assists the actual impacts of the project and also can suggest in carrying out similar projects in future.

Chapter 6

Environmental Management Plan

6.1 INTRODUCTION

The Environmental Management Plan (EMP) is an essential part of the Environmental Impact Assessment (EIA) for the project to define the environmental management requirements during the implementation and monitoring phase of the project. The EMP has been prepared for the KRREP to suggest mitigation measures and procedure to reduce the negative impacts to an acceptable level, facilitate enhancement of the positive impacts and compensate for negative impacts that can not be mitigated and prepare for handling of accidental events. In this chapter the EMP for the KRREP has been discussed for three phases: during dredging, for a short period after dredging and for a long period after dredging. During dredging, an extensive mitigation measure should be undertaken for maintaining ground water quality and sedimentation. Moreover care should be taken to minimize land loss. After short period of dredging, mitigation measures should be taken for ground water level, sediment quality and soil quality. A restricted use of ground water for irrigation can ensure a sufficient ground water level. Prohibition of extensive use of agricultural land and limited use of fertilizer and pesticides may reduce the degradation of soil quality. Moreover, limited movement of engine driven vehicle on the Kapotaksha River may limit the deterioration of the sediment and water quality. For long run, a good control on use of land and fertilizer are essential to ensure good soil and sediment quality.

6.2 MITIGATION PLAN

The mitigation plan includes measures required to neutralize/minimize the negative impacts which in the case of the KRREP, would be mostly temporary in nature. The mitigation measures against negative impacts during dredging, short period after dredging and long period after dredging are suggested in the following sections.

6.2.1 Mitigation Plan during Dredging

Impact: *Water quality degradation due to increase in Turbidity and TDS by dredging and accumulation of oil and grease on surface from dredging vehicles.*

Mitigation: Project authorities should define limits with regard to the above and ensure that these are adhered to.

Impact: *Sedimentation would be increased in a large scale and sediment quality would degrade.*

Mitigation: Project authorities should define limits with regard to sedimentation and sediment quality and ensure that these are adhered to.

Impact: *There would be noise pollution as well as dust pollution in some of the construction sites.*

Mitigation: Project authorities should define limits with regard to the above and ensure that these are adhered to. Well maintained equipment (with mufflers where appropriate) should be used. Noise screens or mounds can be used near locality. To reduce dust pollution, proper watering of the construction sites should be ensured.

Impact: *Partly terrestrial- partly aquatic ecosystem would be badly affected.*

Mitigation: Minimum disturbance should be allowed.

Impact: *Surface water contamination would affect the irrigation.*

Mitigation: Minimum contamination of surface water should be allowed.

Impact:	*Sanitation problems created by the labor force engaged in the re-excavation activities.*
Mitigation:	Temporary labour sheds with adequate provision of hand tube wells and sanitary latrines should be constructed and maintained by the contractors at all the construction sites. The health and sanitation conditions would have to be properly monitored for the adoption of appropriate measures.
Impact:	*Land loss will occur due to excavation on both sides of the river and also by dumping of dredge spoil.*
Mitigation:	Dumping of spoils on depressed area can minimize land loss. In the event of spoil being available, it should be used to backfill waste disposal pits. These areas should then be re-vegetated using local communities.

6.2.2 Mitigation Plan for a Short Period after Dredging

Impact:	*Small scale water quality degradation.*
Mitigation:	Water quality parameters like turbidity, TDS, salinity should be closely monitored at that period.
Impact:	*Ground water level would lower down in small scale.*
Mitigation:	Suggested ground water succession, by ground water expert, should be practiced by local people.
Impact:	*Sediment quality would degrade due to movement of engine driven vehicles.*
Mitigation:	The Inland Transport Authority should restrict the movement of engine driven vehicles.
Impact:	*Soil quality would degrade due to excessive use of chemical fertilizer.*

Mitigation: People should use natural fertilizer like *compost* and use limited chemical fertilizer suggested by the Department of Agriculture Extension (DAE).

6.2.3 Mitigation Plan for a Long Period after Dredging

Impact: *Sedimentation would occur due to muddy rainfall runoff from catchment area.*

Mitigation: Plantation and vegetation on unwrap land surface especially the embankment can minimize land erosion.

Impact: *Ground water level would lower down due to high demand of water for irrigation.*

Mitigation: Suggested succession should be followed by local people.

Impact: *Heavy metal accumulation on riverbed from increased engine driven vehicles would degrade the sediment quality and oil and grease would degrade the surface water quality.*

Mitigation: The Inland Transport Authority should restrict the movement of engine driven vehicles.

Impact: *Soil quality would degrade due to excessive use of land and chemical fertilizer.*

Mitigation: A proper cropping pattern should be suggested by the Department of Agriculture Extension (DAE) based on climate and soil nutrients. Following of this pattern may reduce excessive use of land. Moreover, people should use natural fertilizer like *compost* and use limited chemical fertilizer suggested by the Department of Agriculture Extension (DAE).

6.3 ENVIRONMENTAL MONITORING PLAN

Long-term environmental and social monitoring of the KRREP should be undertaken which would enable detection of changes, if any, in the physical, biological, ecological and social indicators. However, the environmental and social monitoring should be analyzed on a year to year basis, so that compilation and analysis of data collected during one year can be used as a basis for designing and executing the environmental and social monitoring program for the subsequent year. The environmental and social monitoring of the KRREP should be broken down into a number of programs as detailed in the following sections.

6.3.1 Hydrological and Morphological Monitoring Program

Some hydrological parameters such as discharge, water level, turbidity and surface water salinity should be monitored to assess the environmental impact after the implementation of the KRREP. Moreover, with the changes of the Kapotaksha River flow regime, some morphological changes are likely to occur. Hence river morphology should be monitored after completion of the project.

6.3.1.1 Water level

Availability of surface water level influences mainly irrigation and also public health issue related to use in household purpose. Moreover navigability is dependent on surface water level. BWDB should monitor daily surface water level both in dry season and wet season at Trimohoni, Sarashkathi and Sagardari.

6.3.1.2 Discharge

The dry season discharge determines the salinity in the southwest region, as well as availability of fresh water for surface water irrigation. Dry season discharge also determines navigation and fish migration. Flow during the monsoon determines the flooding in the study area, fish habitat and dispersal of fluvial activities like changes in the riverbed. BWDB should establish some discharge measuring stations at the Kapotaksha River at least at the three locations, to monitor discharge once a week in the monsoon and once a fortnight in the dry season. Hourly tidal flow measurements from January to May for 13 hours a day and twice a month covering a neap and spring tide can assess the tidal influence should be done by BWDB. Since there is no tidal station in Kapotaksha, at least one tidal station at Trimohoni and Jhikargachha should be established by BWDB for monitoring.

6.3.1.3 Turbidity

Turbidity in both wet and dry season at the three locations of the study named: Trimohoni, Sarashkathi and Sagardari should be monitored to assess the change before dredging and after dredging and also to examine temporal variation at these locations. Sediment concentration (mg/l) could be a good indicator to monitor turbidity. Turbidity occurs mostly in wet season. Turbidity should be monitored during maximum flood flow and low slack water, once a week continuing from January to December.

6.3.1.4 Surface water salinity

Salinity monitoring at those three locations stated in previous section is essential. This monitoring should be continued both in wet and dry season. Salinity being one of the main concerns of this project should be monitored intensively. Beyond these three locations, some upstream and downstream locations should be established to monitor salinity to assess the change before dredging and after dredging and also to examine temporal variation at these locations. Salinity occurs mostly in wet season. A monitoring plan of once a month in the monsoon and once a week in the dry season should be undertaken.

6.3.1.5 Ground water level

Availability of ground water level influences irrigation and also public health issue related to drinking water. Ground water level should be monitored once a week throughout the year at BWDB stations.

6.3.1.6 Cross-sections

Changes in channel dimensions like depth and width would be a good indicator for assessing the drainage capacity of the study area. Monitoring is necessary at Sarashkathi, Sagardari and Patkelghata; the most critical sections in the study area. Cross-sectional monitoring can be done by bathymetric survey. This survey should be done once in dry season and once in wet season. IWM should conduct this survey.

6.3.1.7 Erosion-accretion on riverbed

Changes in the riverbed in response to the interventions are very important to monitor the impact of the project on the river morphology. Bathymetric surveys would help to assess the aggradation/degradation on riverbed. IWM could conduct the survey every year once in wet season. Bathymetric survey should be done at Trimohoni and Patkelghata to assess the overall change in riverbed in dredged area.

Table 7.1 shows the hydro-morphological monitoring plan of the KRREP.

Table 6.1: Monitoring of the hydro-morphological indicator related to the KRREP

Resource	Indicator	Unit	Agency	Mode	Location	Frequency
Hydrology	Water level	m+PWD	BWDB	Field measurement	Trimohoni, Sarashkathi and Sagardari	Daily
	Discharge	m^3/s	BWDB	Field measurement	Trimohoni, Sarashkathi and Sagardari	Daily estimated data based on weekly or fortnightly measurements
	Tidal flow	m^3/s	BWDB	Field measurement	Trimohoni and Jhikargachha	Twice a month (1 neap tide + 1spring tide) for 5 months a year
	Turbidity	mg/l	BWDB	Field measurement	Trimohoni, Sarashkathi and Sagardari	During max. flood flow and low slack water, once a week continue from January to December
	Surface water salinity	Ppt	BWDB	Field measurement	Trimohoni, Sarashkathi and Sagardari	Once in a month in wet season and once a week in wet season
	Ground water level	m+PWD	BWDB	Field measurement	BWDB stations	Once in a week throughout the year
Morphology	Cross-section	Number of surveys	IWM	Field measurement	Sarashkathi, Sagardari and Patkelghata	Twice in a year; once in wet season and once in dry season
	Erosion/ accretion on riverbed	Number of surveys	IWM	Field measurement	Trimohoni and Patkelghata	Once in a year in wet season

6.3.2 Surface Water Quality Monitoring Program

Any major human intervention in a river causes some change on its physical, chemical and biological processes. The extent of damages depends on the nature of activity. Bottom dredging alters the bottom habitat and thus affects the bottom dwelling organisms. It may also increase water turbidity that might have different deleterious effects on the biota, which need to be monitored. The Department of Environment (DoE) have no water quality-monitoring site along the Kapotaksha River. Water quality should be monitored at the dredging sites like Trimohoni, Sarashkathi, Sadardari and Patkelghata. The water samples should be collected monthly, particularly during dry months (December to June) from different sampling sites throughout the river. The physical and chemical indicators like temperature, pH, DO, BOD, Hg, Cd, Pb, Cu and fluoride, oil and grease should be examined following standard methods (APHA, 1995). The analysis of coliform bacteria, phytoplankton, zooplankton and bottom fauna should be done in the laboratory. Both qualitative and quantitative analysis should be performed.

6.3.3 Soil Monitoring Program

Soil salinity should be monitored at SRDI locations. In dry season, surface (0-15 cm) and sub-surface (15-30 cm) soil samples should be collected to test soil salinity in SRDI Jessore Laboratory. Samples should be collected from SRDI locations and monitored once in a year. Soil moisture content influence vegetation. Some homestead should be selected for monitoring the impact of the KRREP on vegetation and should be monitored to investigate the relationship between soil moisture content and performance of sensitive species. Soil samples should be collected from the selected homestead areas and analyzed in the SRDI Jessore Laboratory to determine soil moisture content. This should be done for the dry months of the year when the river water level is expected to influence groundwater and soil moisture.

6.3.4 Agricultural Monitoring Program

The KRREP is expected to impact irrigation and crop cultivation of the study area. Hence irrigation by modes, crop area and crop production should be monitored. The Block Supervisors (BS) of the Department of Agricultural Extension (DAE) collect data on areas irrigated by different modes (LLP, STW, DTW etc.) as well as on area and production of different crops. These data are compiled by the upazilas under each district. These data should be processed to compute changes in irrigated area and crop production in the KRREP study area.

6.3.5 Fisheries Monitoring Program

The KRREP will affect the fish habitat and bio-diversity. Which control fish production, fish species and fish quality. Total annual fish production should be monitored by the Department of Fisheries (DoF). Moreover, special investigations should be conducted on fish habitat condition and quality, fish migration including migration of the hilsha, availability of the golda and bagda post-larva in the rivers. Hatchling drift migration should be monitored in each season. Seasonal monitoring should be done on typical baor and pond fish culture, golda and bagda farming and changes on the farming system due to changes in salinity. Monthly migration and bio-diversity, seasonally fish habitat and yearly golda, bagda and pond production should be monitored.

6.3.6 Ecological Monitoring Program

Dry season water level in the Kapotaksha River would influence groundwater table and soil moisture, which in turn would impact vegetation in the study area. Coconut, mango and jackfruit should be selected for observing the impact of the water level on the dropping of flowers and pre-mature fruits. It is also recommended to monitor the coverage of herbs and shrubs in the homestead area, especially during the dry season when they would shrink with the reduction in soil moisture. Soil moisture in these homesteads should also be monitored. Moreover baors should be selected to observe migratory birds including winter visitors like the Pintai ducks (Anas acuta), Shoiveller (Anas clypeata) along with some resident and locally migratory birds. Data on algae growing in these baors should be collected as these attract the migratory birds and serve as their food.

6.3.7 Flooding and Drainage Congestion Monitoring Program

Annual flooding and drainage congestion is the main problem in the study area. Some monitoring stations should be established at eight upazilas in the study area or at least at Jhikargachha, Manirampur, Kalaroa and Tala- the most affected upazilas. Flooding and drainage congestion should be monitored during the period from June to November by FFWC.

6.3.8 Social Monitoring Program

The social monitoring would need to cover those aspects along which positive or negative impacts could be expected. Monitoring would help in adopting necessary management plans. This monitoring can also assist in making necessary adjustments to the future monitoring exercise. Some of the social aspects could be effectively monitored through household surveys to find out:

- land ownership
- occupation and employment in agricultural activities
- income earned from agricultural activities
- occupation and employment in fisheries activities
- income earned from fisheries activities
- occupation and employment in activities other than agriculture and fisheries
- income earned from activities other than agriculture and fisheries
- employment of women in different sectors
- monthly expenditure
- marketing of different commodities and mode of transportation
- availability of groundwater for drinking and extraction mode
- use of water for domestic purposes like bathing, washing and livestock rearing
- waterway navigation
- land lost due to riverbank erosion
- education of household members
- incidence of water related diseases
- food intake by household members
- nutrition of households

Further social monitoring is necessary to ensure the implementation of the compensation plan. Whether the compensation gets paid on time, the affected households receive full amounts of the compensation and their compensation without hassles from intermediaries should be monitored.

6.4 ENHANCEMENT PLAN

Some enhancement plan is necessary to ensure better benefit from the project. The following enhancement plan should be conduct:

- A large number of beels are in the study area. Dry season restoration should be established in these beels by re-excavating them. Moreover connectivity of khals with the Kapotaksha should be established by re-excavation.
- Fish friendly operation of fish pass should be ensured.
- To strengthen better waterway navigation some steps like set up of ghats at appropriate locations and construction of roads leading from important areas (like markets and other public places) to the ghats are essential.
- Discharge of oil from ships and vessels at nearest ports should be strictly controlled to safe the fish and the aquatic organisms.

6.5 COMPENSATION PLAN

Early notice must be given before acquisition of the land. The land price should be fixed considering the prevailing market rate. All out efforts must be made to minimize land acquisition with special effort to ensure proper compensation. The degree of loss to different households along with the market value of the land that is taken should be ascertained. The mode of payment must be discussed and agreed upon with the concerned household. Payment must be made directly to the household, avoiding the involvement of middlemen. Assistance through credit and/or alternative employment opportunities should be provided as well for the affected people.

6.6 CONCLUSION

The suggested Environmental Management Plan is necessary to minimize the adverse effects on environment. Some extra management plan can enhance the return from the project. Field services of the Department of Agricultural Extension (DAE) should motivate local people for better management of land and water resources. Some training on appropriate farming practices should be provided to enhance the production. Relatively rare fish species should be introduced/stocked in the floodplains and rivers to enhance recruitment in addition to natural recruitment by the Department of Fisheries (DoF). Besides, improvements should be made in relevant marketing facilities. The sanitation situation can be improved by campaign by the Department of Public Health Engineering (DPHE). The Department of Civil Aviation and Tourism (DCAT) may develop tourism facilities in this area.

The overall EMP is related to cost, which is generally integrated to the management plan. This cost depends on the cost of compensation and also professionals involved in the EMP. This report does not contain this part of EMP. Table 6.2 shows the summary of environmental management plan (EMP) for the KRREP.

Table 6.2: Summary of the Environmental Management Plan (EMP) for the KRREP

Indicator		Monitoring	Critical limit	Comment/ Corrective Action
Surface water level	What: How: When: Where: Who:	Water level Field measurement Daily Trimohoni, Sarashkathi and Sagardari BWDB	----	Observing water level throughout the year to see when maximum and minimum level exists and at what level flooding occur
Discharge	What: How: When: Where: Who:	Discharge Field measurement Weekly or fortnightly Trimohoni, Sarashkathi and Sagardari BWDB	----	Discharge should be observed throughout the year to see how discharge varies with season
Tidal flow	What: How: When: Where: Who:	Water level Field measurement Twice a month (1 neap tide + 1spring tide) from January to May every year Trimohoni and Jhikargachha BWDB	----	Tidal flow should be measured throughout the year to observe tidal effect
Turbidity	What: How: When: Where: Who:	Turbidity Laboratory test During max. flood flow and low slack water, once a week continue from January to December Trimohoni, Sarashkathi and Sagardari BWDB	Allowable limit of Turbidity should be maintained as soon as Standard of Turbidity will be set for surface water	Action should be taken to increase fresh water flow and more care should be taken for bare land vegetation to reduce mud flow from catchment area
Surface water salinity	What: How: When: Where: Who:	Salinity Laboratory test Once in a month in wet season and once a week in wet season Trimohoni, Sarashkathi and Sagardari BWDB	Electrical conductivity should be max. 2250micromho/cm for water used for irrigation	Fresh water flow should be increased by reconnecting to upstream flow and connectivity of khals with Kapotaksha should be established
Ground water level	What: How: When: Where: Who:	Water level Field measurement Once in a week throughout the year BWDB stations BWDB	----	If ground water level reduced to a level that can not supply sufficient water for irrigation, ground water suction should be reduced and alternate source like surface water should be selected

Table: 6.2 (Continued)

Indicator		Monitoring	Critical limit	Comment/ Corrective Action
Cross-section	What: How: When: Where: Who:	Bathymetric survey Field measurement Twice in a year; once in wet season and once in dry season Sarashkathi, Sagardari and Patkelghata IWM	----	Monitoring of cross section every year can say when the river is going to exceed its capacity
Erosion/ accretion on riverbed	What: How: When: Where: Who:	Bathymetric survey Field measurement Once in a year in wet season Trimohoni and Patkelghata IWM	----	Erosion/ accretion measurement can assess the change in river morphology
Surface water quality	What: How: When: Where: Who:	Temperature, pH, DO, BOD, Hg, Cd, Pb, Cu and fluoride, oil and grease Laboratory test Monthly during dry season Trimohoni, Sarashkathi, Sadardari and Patkelghata DoE	pH = 6.5 – 8.5, DO = 6 or less, BOD_5 = 2 or less	Guideline value of other parameters should be followed if set up
Soil quality	What: How: When: Where: Who:	Soil nutrient and soil moisture Laboratory test Once in a year SRDI locations SRDI	----	Guideline value should be followed if set up
Sediment quality	What: How: When: Where: Who:	pH, EC, nutrients (K, Mg, Ca, Zn, Mn, P, S, N) and heavy metals (Cd, Cr, Pb) Laboratory test Once in a year Trimohoni, Sarashkathi, Sadardari and Patkelghata SRDI	----	Guideline value should be followed if set up
Noise	What: How: When: Where: Who: Who:	Noise level Field measurement During dredging Dredging sites Project authority Local NGOs	50dBa for residential zone 85 dBa for mechanised vessel	Noise screens or mounds should be used during operation

Table: 6.2 (Continued)

Indicator		Monitoring	Critical limit	Comment/ Corrective Action
Agriculture	What: How: When: Where: Who:	Irrigation and fertilizer Field investigation Throughout the year The entire study area DAE	----	Best appropriate irrigation practice and use of fertilizer is essential to observe throughout the year to find out the suitable agricultural practice
Fisheries resources	What: How: When: Where: Who:	Fish habitat, fish production and fish migration Field investigation Throughout the year Beels, baors, khals and the Kapotaksha River in the study area DoF	----	Fish habitat should be well protected to minimize loss and fish friendly operation of fish by pass is essential to have better production
Ecology	What: How: When: Where: Who:	Relationship in between water level and dropping of flowers and pre-mature fruits, herbs and shrubs in the homestead during dry season and migratory birds in winter Field investigation Observing plantation in flowering and early mature stage and observing birds in winter season Plantation in open field and homestead, and migratory birds in baors DoE	----	If the ecological balance becomes disturbed, the performance of the project must be lowered down sharply. The DoE should monitor ecology of the study area throughout the year and take necessary steps to re-establish a balanced ecosystem
Flooding and drainage congestion	What: How: When: Where: Who: How: When: Where: Who:	Intrusion of water into the lands adjacent to the Kapotaksha River by over topping the banks and drainage congestion in the study area Inspection June to November Jhikargachha, Manirampur, Kalaroa and Tala FFWC Social survey Once in a year The entire study area Local NGOs	----	Flooding and drainage congestion effect should be closely monitored

Table: 6.2 (Continued)

Indicator		Monitoring	Critical limit	Comment/ Corrective Action
Social monitoring	What:	Occupational activity, employment, sanitation and navigation facility, drinking water, education and nutrition of households	----	Monitoring of social indicators can assess the effect of the project
	How:	Social survey		
	When:	Once in a year		
	Where:	The entire study area		
	Who:	Local NGOs		

Chapter 7

CONCLUSION AND RECOMMENDATION

7.1 CONCLUSION

The major findings of the Environmental Impact Assessment of the Kapotaksha River Re-excavation Project (KRREP) are summarized below:

(i) The net impact due to the re-excavation of the Kapotaksha River is assessed to be as positive. The impact assessment shows that the re-excavation offers not only a short-term relief from flooding and drainage problem but also a long-term beneficial option for an extended program of re-excavation.

(ii) During dredging work, water quality and sedimentation will experience negative effects, but this situation will improve gradually with time. Water level and salinity will improve significantly (EIV was found +20 to +40 for water level and +100 to +175 for salinity).

(iii) Incase of flood control, high EIV (+900) shows that more than 90% of flood control is expected due to re-excavation. Navigation situation will also improve (about 90%).

(iv) Among the ecological parameters, fisheries resource shows zero impact during dredging. But it will experience a large-scale positive impact (EIV +280) after the completion of the re-excavation. The situation of partly terrestrial- partly aquatic ecosystem will worsen (about 10%) during dredging. However, the situation will improve with time.

(v) The re-excavation project will offer employment opportunity to the local people. Around 30% of unemployed persons can be involved in manual re-excavation work. After re-excavation, about 40- 50% employment is expected to increase due to better situation in agriculture, irrigation and transport communication sector.

(vi) Noise level and dust pollution will be a major problem during dredging. However, this problem will be diminished after completion of the project.

7.2 RECOMMENDATION

To make the project effective and sustainable Environmental Management Plan (EMP) is suggested to reduce and mitigate the adverse impacts to an acceptable level. These suggestions are summarised below:

Mitigation Plan

(i) Water quality and sediment quality will degrade during dredging work. Project authorities should define limits with regard to these. The inland transport authority should restrict the movement of engine driven vehicles to protect the water quality and sediment quality from accumulation of oil and grease, and heavy metals.

(ii) To mitigate noise pollution during dredging, well-maintained equipment (with earmuffs) should be used. Noise screens on mounds can be used near locality. To reduce dust pollution, proper watering of the re-excavation sites should be ensured.

(iii) During the operation phase of re-excavation, proper care should be taken to ensure that the dumping of spoil soil should not hamper the life of surroundings. Spoil soils can be used to backfill waste disposal pits.

(iv) After re-excavation, people of that area should use natural fertilizer like compost to protect the degradation of soil quality from chemical fertilizer.

Monitoring Plan

(i) Regular monitoring of surface water level and discharge are essential for navigation and fish migration and to detect flooding and dispersal of fluvial activities like changes in the riverbed. Monitoring of discharge at the three study locations i.e. Trimohoni, Sarashkathi and Sagardari should be conducted once in a week in the monsoon and once a fortnight in the dry season. To assess the tidal influence, hourly tidal flow measurement covering a neap tide and spring tide should also be monitored.

(ii) Salinity of river water should be monitored both in wet and dry season. A salinity monitoring plan of once a month in the monsoon and once a week in the dry season at three locations as well as some upstream and downstream locations is essential. Turbidity should be monitored during maximum flood flow slack water throughout the year.

(iii) Monitoring of changes in cross section at three critical locations i.e. Trimohoni, Sarashkathi and Sagardari should be performed to assess the drainage capacity of the study area. This survey can be done once in dry season and once in wet season.

(iv) In case of fisheries resources, seasonal monitoring should be done on typical baor and pond fish culture and changes on the farming system due to changes on the salinity. Monthly migration and bio-diversity, seasonal fish habitat, yearly *golda-bagda* and pond production should be monitored.

(v) Flooding and drainage congestion should be closely monitored during the period from June to November.

(vi) Some special aspects such as occupation and employment, agriculture and fisheries activities, waterway navigation, land loss due to riverbed erosion etc. should be monitored throughout the year.

Enhancement Plan

(i) Fish friendly operation of fish pass should be ensured.

(ii) Restoration of beels should be emphasized.

(iii) Discharge of oil and grease from mechanized vessels should be strictly controlled to safe the fish and other aquatic life.

REFERENCES

1. Asian Development Bank (ADB) (1993), Environmental assessment requirements and environmental review procedures of the Asian Development Bank.
2. APHA, AWWA and WEF (1995), Standard Method for the Examination of Water and Wastewater, Washinton DC, 19 th edition.
3. Bangladesh Bureau of Statistics (1993), Bangladesh Population Census-1991.
4. Bangladesh Bureau of Statistics (1989), Yearbook of Agricultural Statistics of Bangladesh 1987-88.
5. Bangladesh Bureau of Statistics (2003), Population Census-2001 National Report (Provisional).
6. Bangladesh Bureau of Statistics (2003), Statiscal Year Book of Bangladesh-2003.
7. Bangladesh Bureau of Statistics (2002), Census of Agriculture 1996.
8. Bangladesh Bureau of Statistics (2003), Household Income Expendirture Survey, 2000.
9. Bangladesh Bureau of Statistics (1996), Bangladesh Population Census 1991, Zila- Jessore.
10. Bangladesh Bureau of Statistics (1996), Bangladesh Population Census 1991, Zila- Jhinaidah.
11. Bangladesh Bureau of Statistics (1996), Bangladesh Population Census 1991, Zila- Satkhira.
12. BWDB (Bangladesh Water Development Board), IWM (Institute of Water Modeling) and CEGIS (Center for Environmental and Geographic Information Services) (2003), Committee Report on Kapotaksha River Re-excavation Project.
13. Canter, L.W. (1996), Environmental Impact Assessment 2nd Edition, Mc Graw-Hill International.
14. Clark and Munn, eds., Cambridge University Press Cambridge, U.K., (1983) " Sustainable Development of the Biosphere".

15. Center for Environmental Geographic Information Services (2004), Report on Environmental and Social Baseline of Re-excavation of Kapotaksha River Project.

16. Center for Environment and Resource Management (2003), Environmental Impact Assessment for Professional Development Program organised by CERM, BUET.

15. Deen, N., et al. (1972), 'Environmental Evaluation System for Water Resources Planning' Final Report, Battle Columbus Laboratories, Colunbus, Ohio.

16. EGIS (Environment and GIS support project) (1997), Manual for Environmental Impact Assessment.

17. Environmental Protection Agency (2005), available: www.epa.gov/waterscience/cs/guidelines (Retrieved 25 August 2005).

18. Islam, M.N. (2003), "Environmental Impact Assessment due to the urbanization of Dhaka-Narayanganj-Demra (DND) project area", M.Sc. thesis, the Department of Civil Engineering, BUET.

19. Kranti Associates (2001), Feasibility Study Report on the Kapotaksha River Re-excavation Project.

20. Local Govt. Engineering Department (1992), Guidelines on Environmental Issue Related to Physical Planning.

21. Lohani, B.N., and Halim, N. (1990), "Environmental Impact Identification and Prediction: Methodologies and Resource Requirement", background paper for course on environmental impact assessment of hydropower and irrigation projects, International Center for Water Resources Management and Training (CEFIGRE), Bankok, Thailand.

22. Munn, R.E. (ed.) (1979), Environmental Impact Assessment: Principles and Procedures.

23. National Minor Irrigation Project (2002), National Minor Irrigation Project (1998/99).

24. National Water Resource Database (2004), available: http://adcdatabase/nwrd/ (Retrieved in 2004).

25. Swedish International Development Association (Sida) (1998), Guidelines for Environmental Impact Assessment in International Development Cooperation by Sida.

26. Soil Resources Development Institute (1991), Physical properties of soil in the Ganges river floodplain of Bangladesh.

27. Texas Natural Resourc Conservation Act (2005), available: www.tnrcc.state.tx.us/water/quality (Retrieved 25 August 2005).

28. United Nations Environment Programme (1978), Review of the areas environment and development and development and environmental management. Nairobi.

29. Williams, C.A. (1966), History of the Rivers in the Ganges Delta 1750-1918, Bengal Secretariat Press, Reprinted by East Pakistan Inland Water Transport Authority, 1966.

30. World Bank (2000), World Bank Annual Report 1998.

ANNEX

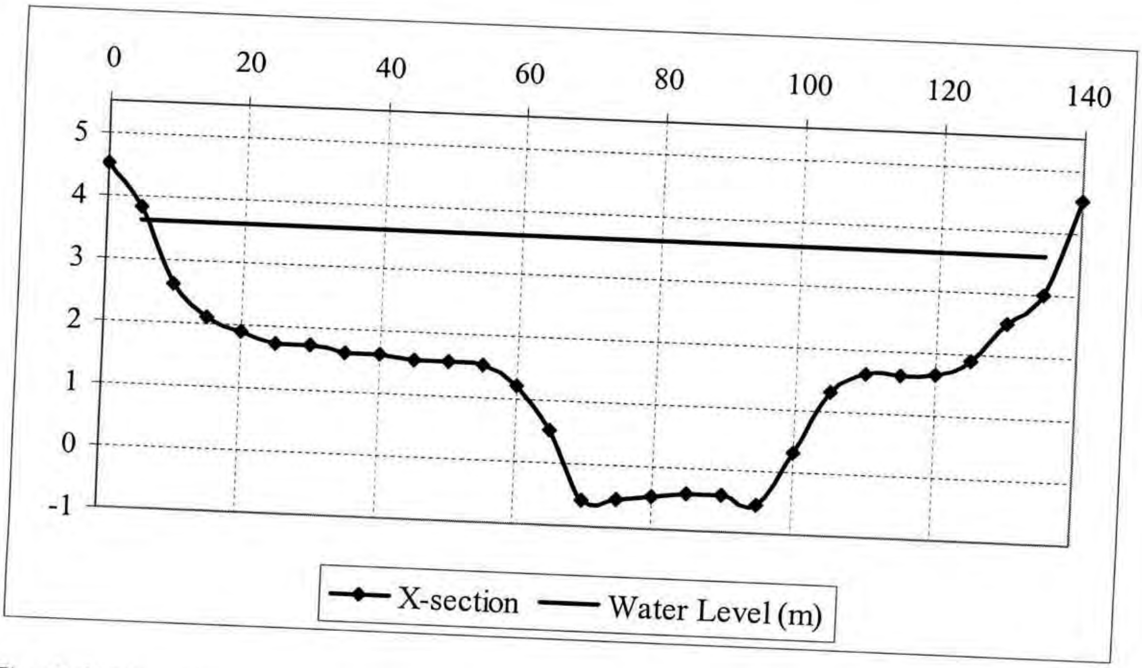

Fig. A-1: X-sectional profile of the Kapotaksha River at Ch- 70km (BWDB et al, 2003)

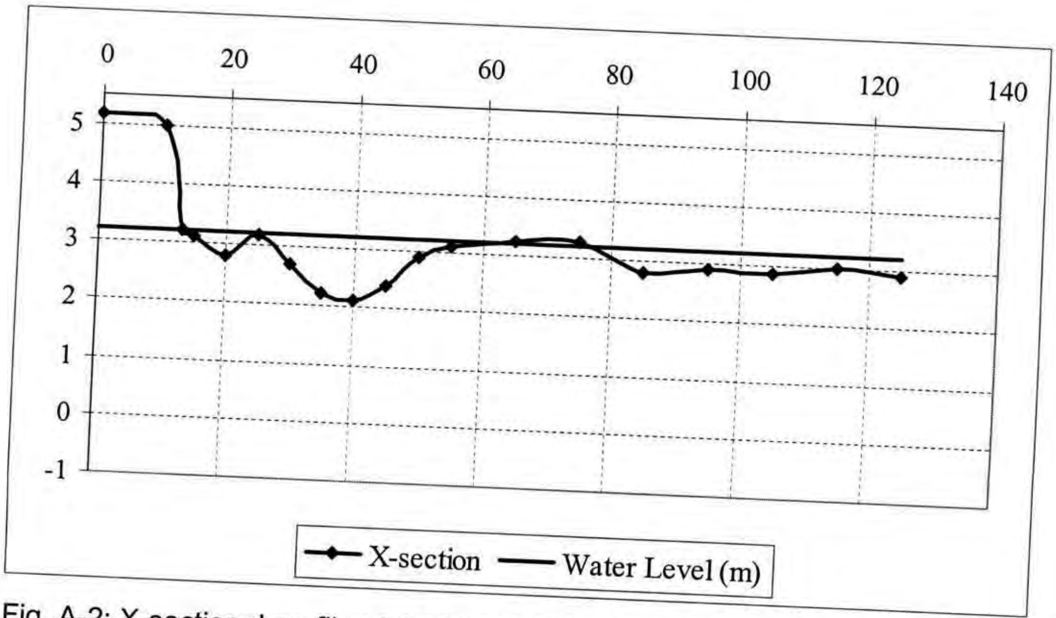

Fig. A-2: X-sectional profile of the Kapotaksha River at Ch- 105km(BWDB, et al, 2003)

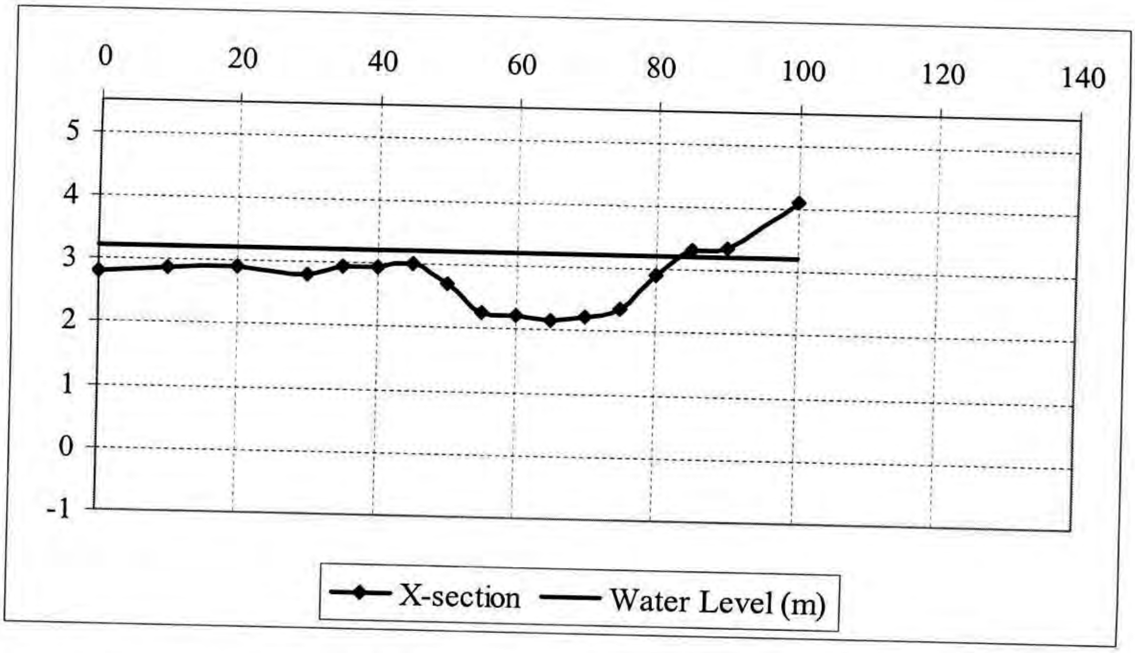

Fig. A-3: X-sectional profile of the Kapotaksha River at Ch- 110km (BWDB, et al, 2003)

Table A-1: Surface water salinity variation of BWDB at Jogikhali station during 1981 –1989 (NWRD, 2004)

Year	Salinity in dry season (ppm)	
	Minimum	**Maximum**
1981	520	7,500
1982	580	690
1983	400	450
1984	350	12,000
1985	500	4,000
1986	360	4,000
1987	418	750
1988	480	2,340
1989	480	16,000

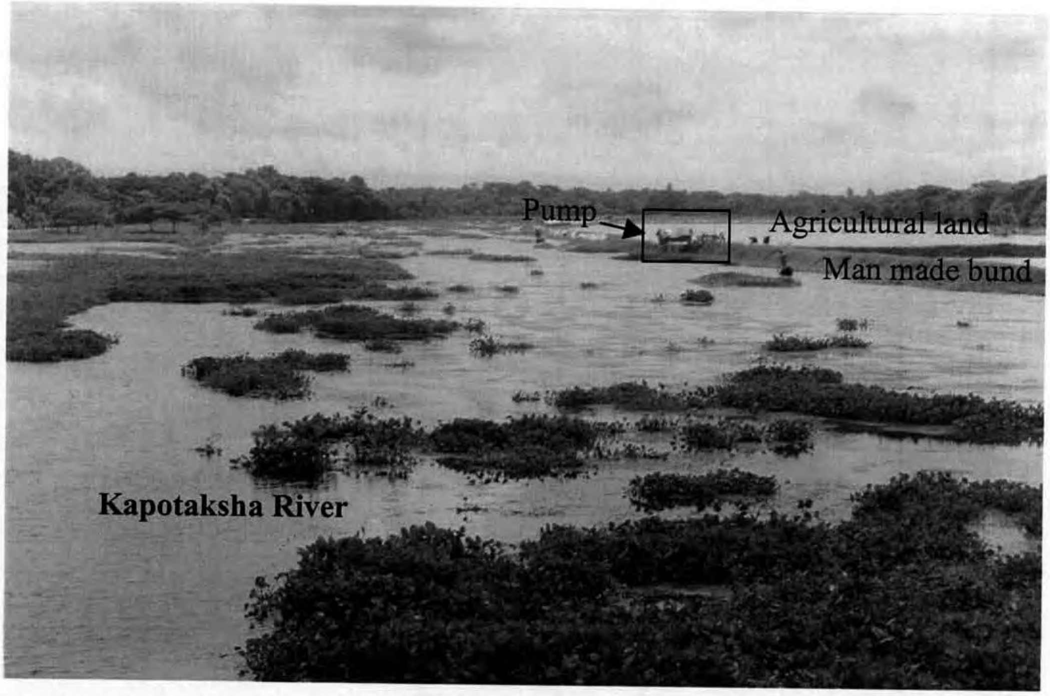

Photo A-1: Intervention of local people to have a relief of water logging in the KRREP area