People's Plan of Action for Management of Rivers

IN SOUTH-WEST COASTAL REGION OF BANGLADESH

STUDY CONDUCTED BY

Uttaran

Paani Committee

CEGIS

INSTITUTE OF WATER MODELLING

IWM

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Message

Director, Uttaran

This coastal region of Bangladesh is considered to be the most vulnerable area in the world due to upcoming climate change scenario, especially due to possible sea level rise and recurrent storm surges. Currently eleven estuarine river basins in the coastal region of Jessore, Khulna and Satkhira districts are threatened. Without reducing vulnerability and restoring these eleven estuarine rivers, the situation will not improve. A sustainable regional river management plan is necessary for resolving these problems.

In this region around 5 million people's lives and livelihoods are under threat. Waterlogging, annual inundation of massive areas has become a recurrent and chronic environmental disaster. Waterlogging crisis directly affects a million people, submerges massive area for five to seven months every year, for more than a decade and indirectly affects the whole region, resulting in breakdown of economy, education, livelihood of the whole area.

Over the last 25 to 30 years, the region is facing serious waterlogging problem. Besides, climate change related problems like sea level rise, tidal surge, increased intensity of flood and draught etc. are increasing day by day. The situation is worsening with every passing second. For more than a decade local people had been forced to migrate from the area. If necessary immediate steps are not taken, the migration will be worsened and may go out of control.

The southwest coastal region of Bangladesh is unique and sensitive in terms of ecology and environment. It is very rich in natural resources and bio-diversity, and one of the most fertile regions in the world. Tidal flood plains with mangrove forests are considered a very complex eco-system, which has the highest production of organic subsistence. River estuaries are very much productive and rich in fish, aquatic and marine species and it is one of the prime fishery and aquatic resource for Bangladesh.

During the 1960s, the Government of East Pakistan implemented a project called Coastal Embankment Project (CEP), with an objective to convert brackish water zone to fresh water zone and cultivating more crops. The project was funded by a number of funding agencies including USAID. However, the project design failed to comprehend the environmental and ecological consequences of an embankment construction. Although the immediate outcome was bumper crop production in the initial years but inhabitants started to face severe environmental and ecological problems within a decade.

This flood plain is the lower part of the Gangetic Delta. According to geographical language, this area is known as an active delta. Around 150 years ago this area was disconnected from the flow of Mathabhanga River, which was connected to the Ganges. The land formation process and rivers were alive only due to the sediments brought by the tidal flow. But the land formation process completely stopped when polders were constructed during mid 1960s. Gradually the rivers started to silt up and resulted in water logging. The main reason for waterlogging is sedimentation of the rivers.

The structural river control models imposed in the southwest coastal region to handle the situation have not been proved effective enough. The affected communities came up with an indigenous knowledge to address the problems, which is known as the Tidal River Management (TRM). After a detailed study by Centre for Environmental and Geographical Information Services (CEGIS), the Government gave recognition to TRM. According to the study, TRM is "technically feasible, economically viable, environment friendly and highly socially acceptable". Since 2002, the Government is implementing TRM in the Hari River Basin.

TRM will not only mitigate waterlogging crisis but also will be a tool to adopt adaptation measures against sea level rise, soil subsidence, tidal surge, flood and drought. TRM will also enrich the bio-diversity of the local area. This knowledge had been passed on to the people from generations. Historically it is seen that in every delta in the world, the people do water management and government patronize the process. But since Pakistan period, Government is controlling the water management process through establishment of polder and neglected the indigenous knowledge of local people, local environment and public participation. So these man made disasters are consequences of this.

People's participation in tackling and mitigating the current problems related with climate change must be emphasised. Keeping this in mind, People's Plan for the eleven river basins is developed. The rivers are Sholmari, Hamkura, Hari, Upper Bhadra, Ghengrile, Salta, Kapotakshi, Shalikha, Betna, Morirchap and Shapmara.

Uttaran has closely worked with local communities to learn and successfully persuade the national and international policy makers to adopt indigenous water management practices, such as Tidal River Management (TRM) to solve the waterlogging crisis in the region. TRM has been accepted by the first PRSP as priority method for river management in the region. Uttaran's advocacy, together with the community platform and the Paani Committee, has ensured community participation in the decision-making process.

Uttaran, with support from Trocaire, implemented a project titled "Social Mobilization and Policy Advocacy to Mitigate the Recurrent Environmental Crisis of Water-logging in Southwest Coastal Region in Bangladesh" from April 2009 to March 2010. The project operatinalized Disaster Risk Reduction (DRR) in an innovative way. The core thrust is community based river basin management to reduce the risk factors related to environmental disasters that unleashed in the region for more than a decade.

We believe that sygergy between indigenous knowledge along with academic knowledge is important for any sustainable plan. That is why Institute of Water Modelling (IWM) and CEGIS were involved with the people's plan. These two autonomous organizations are working for the Ministry of Water Resources. These organizations are working in the southwest region since 1998 and our working relation with them is deepening day by day. IWM and CEGIS have contributed their scientific expertise to validate the technical soundness and environmental viability of the plan. The plan was developed with community consultations throughout the eleven river basins in the region. Through these consultations, the locations where TRM can be implemented were identified. The possible solutions derived from the study are:

- Tidal River Management (TRM)
- Re-establishing connection with the Ganges flow
- Re-linking the rivers with each other.

We highly appreciate Trocaire's support for developing a People's Plan of Action for Management of Rivers in Southwest Coastal Region of Bangladesh. We are also sending our heartfelt thanks to IWM and CEGIS authority for their technical contribution towards the study of this people's plan.

Since April 2012 Misereor got involved with Uttaran to implement a project titled "Sustainable River Basin Management (SRBM): Adapting Climate Change in the Southwest Bangladesh". Overall goal of this project is sustainable management of river basins with increased participation of community people that reduce human sufferings and economic loss and contributing to reduction in poverty and inequality in the South-western Bangladesh. Misereor provided funding support to Uttaran for publishing this People's Plan of Action for Management of Rivers in Southwest Region. We are very much grateful to Misereor for their kind support for publishing this booklet.

Numerous members of Panni Committee, active community members have given me the benefit of their knowledge of particular points, and my hearty thanks are due to them. Much of the heavier work involved in preparing the present edition, especially the collation of data and knowledge, has been done by my colleagues of Uttaran and without their untiring assistance the book could not have been published.

We hope that the People's Plan of Action for Management of Rivers in Southwest Coastal Region of Bangladesh will draw attention of the policy makers, national and international institutions and stakeholders and through implementation of the People's Plan, waterlogging crisis in the coastal area of Bangladesh will be mitigated.

Shahidul Islam
Director
Uttaran

Message

Executive Director, CEGIS

Lives and livelihoods of the people of the southwest region are at serious stake because of frequent occurrences of natural hazards. Most parts of the region covering the Districts of Jessore, Khulna and Satkhira have been experiencing massive water logging for the last 25 - 30 years because of rise of beds of the rivers due to siltation and relatively lower elevation of lands inside the poldered floodplains of these rivers that prevented drainage onto the rivers. As a result, around 30-35% of the study area remains water logged, affects about 28% of the households, loss counts to the agriculture sector by about 2 lac metric tons of paddy, disrupts communication, dies fruit trees, reduces the number of domestic animals, triggers out migration, makes acute fuel crisis, etc mostly concentrated in Tala, Kalaroa, north part of Sadar upazila under Satkhira District; Koyra, Paikgachha, Dumuria under Khulna; and Keshabpur and Monirampur under Jessore District. Around 25% of the brackish water aquaculture of the districts mostly concentrated in water logging prone area also suffers from inundation and causes huge damage to the gher owners.

Several government initiatives like Khulna-Jessore Drainage Rehabilitation Project (KJDRP), Re-Excavation of the Kapotakshi River Project (RKRP), Monitoring and Integration of the Environmental and Socio-economic Impacts of Implementing the Tidal River Management (TRM) Option to solve the problem of drainage congestion in the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) area, different Beel based TRM, Sustainable Drainage and Flood Management of Kobadak River Basin project under Jessore and Satkhira Districts have been taken in the past, a few of them are still going on. Again, in the current initiatives like the Tidal River Management (TRM) in Beel Khuksia and other water management activities in the catchment of the Kobadak River, consideration of people's opinion for solving problems sustainably seems shortfall. For a successful TRM operation, people's perception and their participation in solving the problems is further needed. The initiatives so far taken are found not up to the expected level to release the affected people from such mounting problem of the area. Hence, attempt for sustainable solution on long term basis is felt necessary.

Uttaran getting technical and scientific support from CEGIS has attempted for mitigating this problem ensuring the participation of the local stakeholders in developing People's Plan for sustainable water management of that area. In this approach, local people identified the catchment wise problems and suggested potential measures in solving them. CEGIS has delineated river catchments area, prepared corresponding maps and conducted Initial Environmental Examination (IEE) on the engineering option finalized by Institute of Water Modelling (IWM).

An interdisciplinary team of professionals of CEGIS were engaged in this study that identified the environmental consequences of the indicative plan with their expert judgment using local people's opinions. This work has immediate and long term positive impacts on the lives and livelihoods of the affected people if the recommended and suggested environmental management plan (EMP) is implemented. Among the EMP measures followings are crucial to implement.

Water resources: Facilitating quicker drainage, designing the height of peripheral embankments for TRM considering sea level rise, keeping water control structures open during monsoon, arranging year round de-silting programme, etc

Agriculture resources: Introducing suitable salt tolerant and high yielding variety of crops, ensuring dry season surface water irrigation facilities to reduce water scarcity induced crop damage and manage it as such to sustain fisheries, increasing IPM practices, etc.

Fisheries resources: Ensuring preservation of 10% of area in the TRM beel for conserving brood fish and for sustaining fishery, restricting fishing at cut point to avoid further exacerbation, avoiding period of pre-monsoon spawning migration of indigenous fish species for TRM operation, restoring beel and baor connectivity, bringing the remaining beels under pile/reserve fishery to conserve brood fish and fish species diversity, suggesting people to go for rice-cum-prawn culture instead of brackish water aquaculture, replacing traditional water control structures by fish/eco-friendly structures as much as possible;

Ecosystem: Plantation on both banks of rivers after re-excavation and on the periphery of beels with suitable mangrove species; etc. and

Socio-economic sector: Compensating the landowners for TRM activities, arranging employment opportunity to reduce the out-migration; etc.

The plan will be made environment friendly subject to carrying out detail feasibility and environmental and social impact assessment (ESIA) studies.

The Center for Environmental and Geographic Information Services (CEGIS) is greatly indebted to Uttaran for entrusting CEGIS with the responsibility of conducting the study of the Initial Environmental Examination (IEE) on the Management of Rivers of South-West Coastal Region of Bangladesh.

The multi-disciplinary team engaged in the study remembers with gratitude the guidance and support received from Mr. Shahidul Islam, Director, Uttaran and Mr. Hashem Ali Fakir, Consultant, Uttaran, Satkhira while conducting the reconnaissance and baseline survey.

Last but not least, special appreciation goes to Principal A B M Shafiqul Islam, Chuknagar College, Khulna and President, Central Paani Committee for his wise suggestions.

Md. Waji Ullah
Executive Director
CEGIS

Message

Director, IWM

Khulna and Satkhira, the coastal districts of south-western region of Bangladesh, is a widely discussed issue in both national and international level. The rivers of this region are dying one after another. The region has been experiencing water logging problem for the last 25 to 30 years and the problem is increasing day by day. The Sundarbans, situated in the south of this region, been declared a world heritage site. The Sundarbans plays a vital role on the ecology and lives of people in the coastal areas. Experts fear that if no effective steps are taken immediately, this region will go under water because of climate change. This would eventually force people to migrate to other places that would be the world's largest migration for . The climate refugees have already started migrating to new places for the last few years.

Drainage congestion or water logging is the most crucial problem in this region resulting from river siltation. The area under coastal region used to be inundated twice a day during flood tide. During dry season, incoming silt laden tidal saline water used to be spread over the vast land & deposit silt. After construction of coastal polders area of flushing tidal water have decreased significantly & in-coming silt laden tidal saline water started to deposit silt within river bed.

Uttaran and Paani Committee have decided to develop People's Plan of Action for Management of Rivers in Southwest Region for the eleven river basin areas in the south-west coastal region. Institute of Water Modeling (IWM)was involved and provided technical support to the study. IWM provided technical support to Uttaran and Paani Committee in preparing the report and plan . It is seen that implementation of TRM i.e. allowing natural tidal movement from the river into a low-lying area increases the tidal flow and drainage capacity of the river thus river sustains for long time with proper drainage capacity. Study also shows that restoration of upland flow enriches the ecosystem as mentioned in the People's Plan of Uttaran. A holistic approach of study of the problems & their solutions are needed for integrating the most vulnerable river basins of the severely affected districts atkhira, Jessore & Khulna for survival & existence of about five million people.

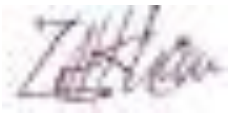
IWM applied the following methods for providing the technical support:

Identification of the problems has done through extensive field visits, interaction with the stakeholders, focus group discussions & review of the past studies.

Probable options for solutions are extracted through field topographic survey, river cross-sections & bathymetric survey, primary & secondary data collection of WL, discharge, velocity, salinity & sediment concentration, data processing & mathematical modeling.

Tidal River Management (TRM) through tidal basin approach was adopted in KJDRP area as a technically feasible, environment friendly to solve longstanding drainage problem in a sustainable manner, which brought immediate benefit in the project area. In the KJDRP results of hydraulic modeling and monitoring were used for screening options, selection of TRM through stakeholder consultations. Mathematical modeling is a proven technology for identification of causes of drainage congestions, proper selection of water management improvement plan considering number, location, dimensions and invert level of water management infrastructures in an integrated manner. It is worthy to identify areas where tidal river management might be implemented to solve drainage congestion. Alternative options need to be investigated in accordance with the physical setting and environmental characteristics using state of art technologies.

After going through this study time and time again, we have come to realize that the People's Plan for the eleven river basin area in the south-west coastal zone is an effective plan for adaptation measures. Through proper implementation and monitoring of the People's Plan, we can certainly say that it will improve the livelihood condition of the coastal communities and the coastal eco-system and this will also bring positive outcomes to all stakeholders.



Zahirul Haque Khan
Director
Coast Port & Estuary Management Division
Institute of Water Modelling (IWM)

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Acronyms and Abbreviations

AEZ	Agro Ecological Zone
BADC	Bangladesh Agriculture Development Corporation
BARI	Bangladesh Agriculture Rsearch Institute
BBS	Bureau of Bangladesh Statistics
BKB	Bangladesh Krishi Bank
BMD	Bangladesh Meteorological Department
BPH	Brown Plant Hopper
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
C	Catchment
CEGIS	Center for Environmental and Geographic Information Services
CS	Cadastral Survey
DAE	Department of Agriculture Extension
DAP	Di-ammonium phosphate
DC	Deputy Commissioner
DG	Director General
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
ECA '95	Bangladesh Environment Conservation Act of 1995
ECR	Environmental Conservation Rule
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FAD	Fish Aggregating Device
FCBO	Fishermen Community Based Organization
FGD	Focus Group Discussion
FRSS	Fisheries Resources Survey System
FWIP	Future With Project
FWOP	Future Without Project
GDP	Gross Domestic Product
GIS	Global Information Services
GOB	Government of People's Republic of Bangladesh
GPS	Global Positioning System
GPWM	Guideline for Participatory Water Management
HTW	Hand Tubewell
HYV	High Yielding Variety
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modeling
KJDRP	Khulna Jessore Drainage Rehabilitation Project
LGED	Local Government Engineering Department
LGI	Local Government Institute

LLP	Low Lift Pump
MoWR	Ministry of Water Resources
MP	Local Members of Parliament
MP	Murate of Potash
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NEMAP	National Environmental Management Action Plan
NGO	Non Government Organization
NWMP	National Water Management Plan
NWRD	National Water Resources Database
PCM	Public Consultation Meeting
PL	Post Larvae
PRA	Participatory Rural Appraisal
RAP	Resettlement Action Plan
RRA	Rapid Rural Appraisal
SIS	Small Indigenous Species
SRDI	Soil Resources Development Institute
STW	Shallow Tubewell
SW	South West
TOR	Terms of Reference
TRM	Tidal River Management
TSP	Tripple Super Phosphate
UFO	Upazila Fisheries Office
VGD	Vulnerable Group Development
VGF	Vulnerable Group Feeding
WARPO	Water Resources Planning Organization

Executive Summary

Water logging hazard is a burning issue for Jessore, Khulna and Satkhira, the three coastal districts of the southwest region of Bangladesh. The region has been experiencing problems created by water logging for the last 25 to 30 years and the situation is worsening.

Several scattered initiatives have been taken to resolve the problem by the government, a few of which are ongoing. Most of the past initiatives were unsuccessful in giving ease to the affected people and none of the current initiatives like the TRM in Beel Khuksia and the initiatives in the Kabodak River Catchment took into consideration people's perceptions.

Uttran has taken a holistic approach for mitigating the problem with participation of local people. CEGIS has been engaged for strengthening the approach scientifically. In this connection, CEGIS is providing support in catchment delineation, mapping and conducting Initial Environmental Examination (IEE).

The study area falls in Jessore, Khulna, Satkhira and Jhenaidah districts covering 22 upazilas including Dumuria, Phultala, Daulatpur, Metropolitan, Batiaghata, Dacope and Paikgachha under Khulna district; Keshabpur, Monirampur, Jessore Sadar, Abhaynagar, Jhikargachha, Sharsha and Chougachha under Jessore district; Tala, Kolaroa, Satkhira Sadar, Assasuni, Shyamnagar, Debhata and Kaliganj under Satkhira district and Maheshpur under Jhenaidah district. The study area is divided into 11 catchments which include (i) Sholmari-Salta-Lower Bhadra, (ii) Hamkura-Bhadra-Joykhali, (iii) Hari-Mukteshwari, (iv) Upper-Buri Bhadra-Harihar, (v) Teligati-Ghengrile, (vi) Salta-Gunakhali-Haria, (vii) Kapotakshi, (viii) Shalikha, (ix) Betna, (x) Morirchap-Labonyabati and (xi) Shapmara-Galghesiya. This report presents the findings of the IEE study conducted by a multi-disciplinary team of professional from CEGIS.

The major vision of the Initial Environmental Examination (IEE) study of the Southwest River Management Project of Uttaran was to make a preliminary assessment of the environmental and social consequences of the identified options.

The proposed plan has been generated by using a bottom-up approach during the planning stage. The affected local people were the major decision makers contributing to the plan. All interventions or concepts in the plan have been drawn through a catchment-wise participatory approach. The participants took part at all levels in the decision making process. After completion of the proposed plan, the technical justifications were tested by the Institute of Water Modeling (IWM) using the mathematical modeling approach. An Initial Environmental Examination (IEE) of the proposed plan has been executed by CEGIS.

The following four aspects are the basis of the plan:

- Application of the Tidal River Management (TRM) concept
- Inter-river linking network
- Reviving of dead rivers, and
- Management of canals and beels inside the polders

Keeping pace with the Participatory Water Management Instructions (nirdeshika), all the authorities concerned were invited to take part in the opinion-sharing meeting. Especial importance was given to collecting the opinions of those who could potentially play an active and cordial role in solving the problems. The dialogue system was practised in the opinion-sharing meetings.

Meteorological data such as on rainfall, evaporation, temperature, humidity, wind speed, and sunshine hours were collected and analysed for assessing meteorological resources directly related to water resources. The mean annual rainfall of the project area is about 1,640 mm while the maximum annual average rainfall is 1,730 mm. Both the mean annual and maximum annual rainfall are less than the national mean annual and maximum annual rainfall.

The open water evaporation data of the study area experiences a significant variation ranging from an annual average minimum open water evaporation of 965 mm in Khulna to a maximum of 1140 mm in Binerpota. The study area is situated in a warmer part of the country where the annual maximum average temperature varies from 26.00C to 36.50C from March to October. Annual minimum temperatures were recorded during the period from November to February at a range between 11.00C to 26.00C. The average humidity values of these three stations during dry season are almost the same. The calculated average humidity in this area is 76% while the average humidity value varies between 86% and 87% during monsoon seasons. The monthly average distribution of wind speed shows a flat distribution from Khulna to Faridpur (3.3 knots) and Jessore with peaks in the month of the April. The wind speed distribution at Satkhira shows

two peaks during April and August. The sunshine hours in the monsoon season from June to September are much lower compared to the rest of the year.

Eleven Catchment areas with sustainable water management interventions have been identified in the People's Plan for management of rivers in the southwest region. These are: 1. the Sholmari-Salta-Lower Bhadra System; 2. the Hamkura-Bhadra-Joykhali Catchment System; 3. the Hari- Mukteshwari Catchment System; 4. the Upper Bhadra- Buri Bhadra-Harihar Catchment System; 5. the Teligati-Ghengrile Catchment; 6. the Salta- Gunakhali -Haria Catchment System; 7. the Kapotakshi Catchment System; 8. the Shalikha Catchment System; 9. the Betna Catchment; 10. the Morirchap and Labonyabati Catchment System; and 11. the Shapmara- Galgheshiya Catchment

The geographic area of the water management project of the south-western coastal region comprises of three agro-ecological regions: (i) the High Ganges River Floodplain (AEZ-11), (ii) the Ganges Tidal Floodplain (AEZ-13), and (iii) the Gopalganj-Khulna Beels (AEZ-14).

The range of high land, medium high land, medium low land and low land are 2-18%, 66-90%, 0-20% and 4-7% respectively in the catchment areas of the project. However, the average percentages of land type are about 8.3%, 81.9%, 7.6% and 2.2% of the net cultivable area (NCA) for high land, medium high land, medium low land and low land respectively. The land utilisation for crop production is about 72%. About 20% and 8% areas are covered by settlements and water bodies (water bodies, ponds and rivers) respectively. The overall land utilisation for single, double and triple cropped area is 44.8%, 42.8% and 4% respectively. About 8.4% of area remains fallow in the entire study area.

Three varieties of rice crops, namely Aus, T. Aman and Boro, are grown in three crop growing seasons. The total annual cropped area of the project is 4,34,599 ha of which paddy covers about 3,76,131 ha. The area is about 86.5% of the total cropped area. The remaining 13.5% is occupied by different types of non-rice crops. Among rice, the percentages of Boro (HYV), Aus, T.Aman (HYV) and T.Aman (Local) are 45.7%, 2.8%, 15.3%, and 36.2% respectively.

Based on field investigations it is estimated that around 78.5% of the overall shrimp and prawn farms of the project area comprises rice-cum-shrimp or prawn culture practice. On the other hand, brackish water aquaculture practice is expanding and thus environmental issues are becoming a high concern. Currently, most of the land owners (farmers) are inhibiting shrimp farming as they are deprived of getting paddy due to high soil salinity or proper share from their lands. On the contrary, people have recently changed their mind set to go for more paddy cultivation instead of shrimp farming as it is not environment friendly. So, potential shrimp area needs to be identified properly wherein people will go for shrimp cultivation and other areas will be cultivated with paddy or rice-cum-prawn farming.

The shrimp production per unit area is, however, still rather low. The need for increase of the production rate by intensification of the culture methodologies is currently being emphasised. The capture fish production rate is also significantly lower in the project area than in other parts of the country. The estimated total fish production from both capture and culture sectors is 125,298 m ton of which the bulk portion of around 122,350 m ton (97.6%) comes from culture fishery while capture fish production of the project area is only 2,948 m ton (2.4%). In totality, shrimp and prawn farms along with rice-cum-shrimp and prawn farms contribute about 77.7% which indicates apparent dominance on other fisheries sectors. Another 24,580 m ton which is 19.6% of the total fish production, is produced from aquaculture ponds of the project area. The baors are producing about 405 m ton which is 0.3% of the total fish production.

Three major Bio-ecological Zones fall within the study area. The study area contains various landforms and ecosystems such as homestead gardens, croplands, fruit and wood tree gardens, urban areas, rural settlements, roadside and embankment vegetation, mangroves, rivers, khals, ponds, shrimp ghers, beels and depressions. The study area occupies terrestrial as well as aquatic ecosystems. Except for the settlement areas, the entire land area is used for two major purposes, one for paddy cultivation and the other for saline or fresh water shrimp and fish culture.

In terms of the demographic scenario of the proposed project area, the total number of households is estimated at 869,815. The total population is 41,31,620 of which the male population is 21,22,994 and female 20,08,626. The ratio of male and female in this project area is calculated as 51.38 : 48.62. The average household size is 4.75 persons per household. The population density of the study area is approximately 1,022 persons per square kilometer.

The major impacts and the proposed EMP measures in respect of water resources, land resources, agriculture, fisheries, ecosystems and socio-economic conditions are as follows.

Major Impacts	Major EMP
• Reduced drainage congestion of the total study area; • Increased cropping intensity due to improved land type; • Introduction of dwarf HYV crop cultivars subsequently enhancing crop production; • Reduced flood hazard to livestock; • Decreased soil salinity; • Suitable habitat created for riverine fish species; • Increased fish grazing and breeding area; • Supply of saline water to shrimp farms restored through connecting khals; • Possible mingling of brackish and fresh water fish species; • Possible reduction of fish production due to loss of habitat area as well as increased closed water fish production; • Possible damage to terrestrial vegetation and possible loss of wildlife habitat due to incorrect dumping of dredged soil; • Possible regeneration of some mangrove species like the Kewrah and the Hargoza along the river side; • Possible damage to terrestrial vegetation and loss to wildlife habitat due to incorrect dumping of dredged soil; • Possible regeneration of some mangrove species like the Kewrah and the Hargoza along the river side; • Reduced water logging due to the interventions as well as increased involvement of day labourers. Consequent high demand for day labourers and wage rate. • Food security and income ensured due to the intervention and the basic need for education emphasised by local stakeholders accordingly; • Crop security ensured due to the interventions and percentage of deficit households reduced; and • Reduced water logging due to the interventions and significant increase in land price.	• During dredging work, the bed of tidal creeks must be clear for tidal water movement by following day night tidal penetrating schedule by contractor. These activities will facilitate quicker drainage; • During wet season, all types of water control structures should be kept open for runoff without any encroachment in their paths. This can be achieved through proper union-wise monitoring. • Maintenance dredging should be taken up all the year round. • After re-excavation, both banks of dead rivers should be planted with ecologically friendly and morphologically erosion protected trees; • After the revival of dead rivers, the right and left banks of rivers should be embanked considering afforestation situation; • The land cannot be used for crop production during the TRM period. Landowners should be given compensation for their land; • Crop diversification should be introduced by selecting high yielding crop cultivars; • Fishing in the river near the cut point should be strongly restricted to avoid further exacerbation; • Preservation of at least 10% of the core beel area for conserving brood fish for future generation and for sustaining fishery; • Renovation of light dykes in the aquaculture habitat is needed to avoid sudden inundation from breaches; • The beel connecting khals with these river reaches needs to be re-excavated for creating better lateral fish migratory routes and exchange of more nutrients; • Some suitable mangrove species like Kewrah, Bain, Hargoza may be planted inside the beel periphery to make up for the loss of aquatic vegetation to some extent; • Excavated soil should be placed carefully where possible loss of vegetation would be minimum; • Proper compensation should be given for the land requiring excavation or re-excavation especially for the loop cut project and for the revival of the dead river project; and • Proper motivational services are needed from relevant departments and NGOs.

Chapter 1

Introduction

1.1 Background

Water logging hazard is a burning issue for Jessore, Khulna and Satkhira- the three coastal districts of the southwestern region of Bangladesh. The region has been experiencing problems created by waterlogging for the last 25 to 30 years and the situation is worsening. The prolonging water logging induced problems of this region have been widely discussed at national and international levels. Cutting off one after another upstream riverine flows and other anthropogenic interferences have been exacerbating the situation. The widely discussed issue of sea level rise has already started to have its deleterious impacts on the region by constraining the receding water from the land and thus hastening the aggravation of the problems. Most of the rivers of this region are highly silted up and are dying one after another. The rivers of the study area ultimately meet the Bay of Bengal by crossing the Sundarbans, the largest mangrove forest of the world, declared as a world heritage site. Earlier, these rivers received fresh water from the upstream and had an important role in maintaining the equilibrium of the Sundarbans. Reduced upstream flow and increasing salinity is destabilising the harmony of the ecosystem of the Sundarbans and jeopardising the lives and livelihoods of the people dependent on the coastal areas. Currently, the water logging hazard is spreading to the Sundarbans, and wildlife and low saline tolerant plant species are becoming vulnerable. It is anticipated that if no effective steps are taken immediately, this region will go under water because of climate change induced sea level rise. This would eventually force people to migrate to other places that would be the world's largest migration for environmental disaster. The climate refugees have already started migrating to new places since the last ten years.

Several scattered initiatives were taken to resolve the problem by the government, a few of which are still running. Most of the past initiatives were unsuccessful in giving ease to the affected people and none of the current initiatives like the Tidal River Management (TRM) in Beel Khuksia and the initiatives in the Kabodak river Catchment took people's perception into consideration.

People's movement to combat water logging and to implement TRM in the renowned Beel Dakatia, Beel Bhayna, Bhabodaha and the Catchment of Kapotaksha River is an important measure for removing the water logging hazard. Silt management and people's participation in the project activities are considered as prior issues for resolving the problems successfully. By this time it has become clear that there is no alternative to letting people participate in the projects and giving importance to their experiences in mitigating the water logging problem.

Uttran has taken a holistic approach for mitigating the problem with participation of local people. The Center for Environmental and Geographic Information Services (CEGIS) has been engaged for strengthening the approach scientifically. In this connection, CEGIS is providing support in catchment delineation, mapping and conducting Initial Environmental Examination (IEE).

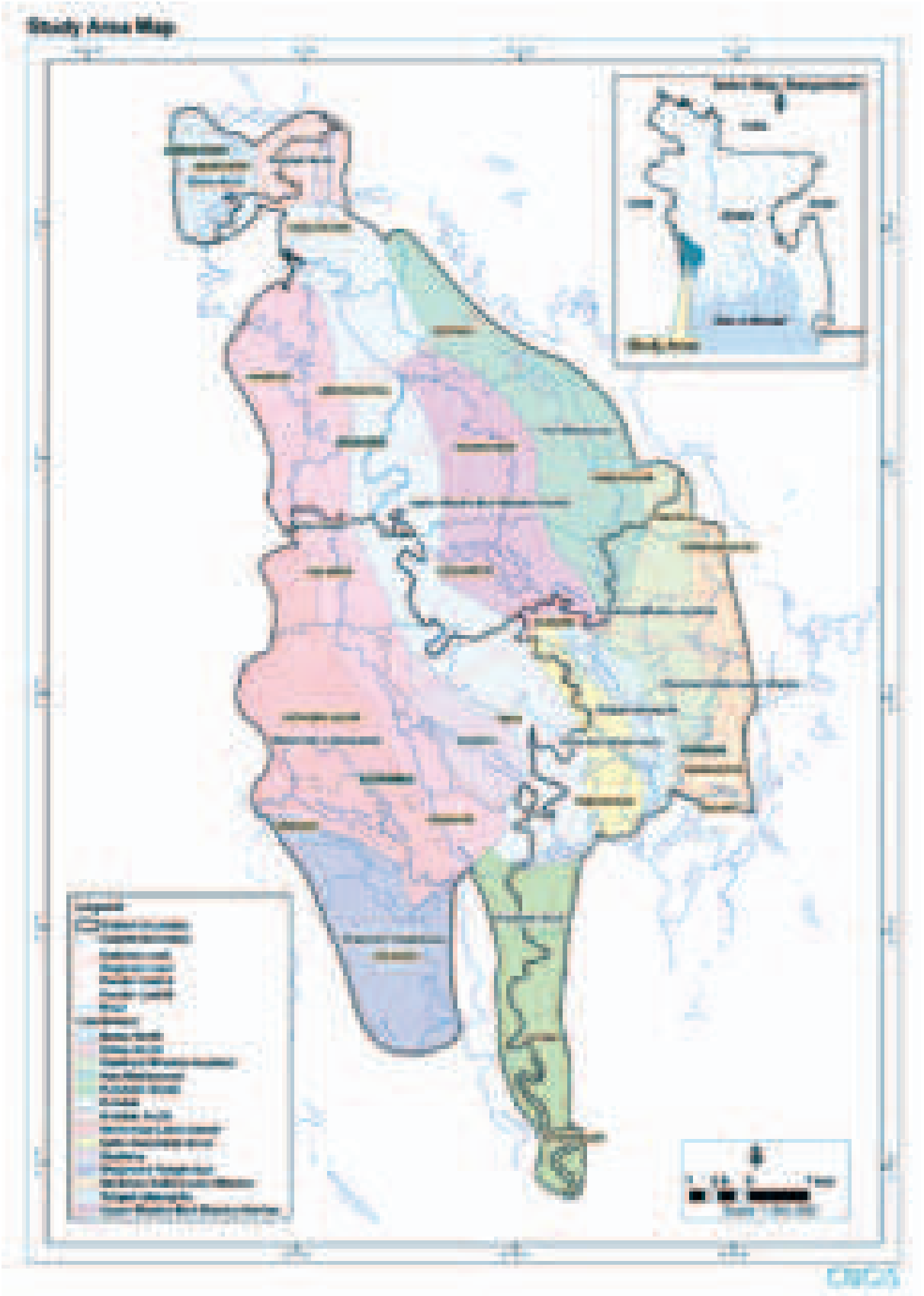
The study area falls in Jessore, Khulna, Satkhira and Jhenaidah districts covering 22 upazilas including Dumuria, Phultala, Daulatpur, Metropolitan, Batiaghata, Dacope and Paikgachha under Khulna district; Keshabpur, Monirampur, Jessore Sadar, Abhaynagar, Jhikargachha, Sharsha and Chougachha under Jessore district; Tala, Kolaroa, Satkhira Sadar, Assasuni, Shyamnagar, Debhata and Kaliganj under Satkhira district and Maheshpur under Jhenaidah district. The study area is divided into 11 catchments which include (i) Sholmari-Salta-Lower Bhadra, (ii) Hamkura-Bhadra-Joykhali, (iii) Hari-Mukteshwari, (iv) Upper-Buri Bhadra-Harihar, (v) Teligati-Ghengrile, (vi) Salta-Gunakhali-Haria, (vii) Kapotakshi, (viii) Shalikha, (ix) Betna, (x) Morirchap-Labonyabati and (xi) Shapmara-Galghesiya (Map 1-1).

The environmental legislation in Bangladesh, particularly, the Bangladesh Environment Conservation Act, 1995 (Amended in 2002), states that any development project shall require environmental clearance from the Department of Environment (DoE), Ministry of Environment and Forest, Government of the People's Republic of Bangladesh. The Southwest River Management project falls under the "Red Category" as per The Environment Conservation Rules, 1997, which requires submitting a report to the DoE on the Initial Environmental Examination (IEE) relating to re-excavation and TRM measures and also a Terms of Reference (ToR) for the Environmental Impact Assessment (EIA) of

the Southwest River Management Project for site clearance. This will have to be followed by the submission of a report on the EIA of the Southwest River Management Project including a detailed Environmental Management Plan (EMP) to obtain Environmental Clearance from the DoE. A Resettlement Action Plan (RAP) will have to be prepared which will form the basis of compensating land owners whose land will be acquired and resettling households, if any, in the area acquired for the purpose.

CEGIS, a Public Trust and center of excellence under the Ministry of Water Resources (MoWR), Government of the People's Republic of Bangladesh (GoB) has been engaged for conducting the Initial Environmental Examination (IEE) of the Southwest River Management Project of Uttaran.

This report presents the findings of the IEE study conducted by a multi-disciplinary team of professional from CEGIS.



Map 1-1: Location of the study area

1.2 Objective

The objective of the IEE study of the Southwest River Management Project of Uttaran is to make a preliminary assessment of the environmental and social consequences of the identified options.

1.3 Scope of study

The scope of the IEE study of the Southwest River Management Project included the following:

- Preparation of the river network and delineation of the catchment area;
- Collection of information from Uttaran on catchment-wise proposed interventions;
- Participation in public consultations arranged by Uttaran for developing a sustainable plan;
- Establishment of environmental and the social baseline condition through different types of surveys, RRA, and consultation with local people;
- Selection of important environmental and social components (IESCs) likely to be impacted by the proposed interventions;
- Preliminary assessment of impacts of the proposed interventions on the IESCs;
- Preparation of an EMP suggesting mitigation measures for minimising the affect of negative impacts, enhancement measures for increasing the benefits of positive impacts, compensation for negative impacts that cannot be mitigated, contingency measures for taking care of accidental events and a monitoring plan for checking the efficacy of the IEE predictions;
- Preparation of a public disclosure plan so as to involve local people at all stages of the IEE study; and
- Preparation of an IEE Report on the Southwest River Management Project for obtaining Site Clearance from the DoE.

1.4 Approach and methodology

Relevant national and the international guidelines were followed in the approach for conducting the IEE of the project. Environmental and social impacts were assessed in a limited scale through a set of stages (Figure 1-1). The process remaining the same, the level of efforts varies between IEE and EIA studies. The IEE study was rougher in nature than the EIA study would be and was also not as comprehensive. The IEE study, as the term implies, had limited time and scope to make a preliminary assessment of the environmental and social consequences of the proposed interventions under the project. The EMP was addressed lightly at this stage so as to indicate whether the negative impacts of the project interventions could be properly mitigated for sustainable development.

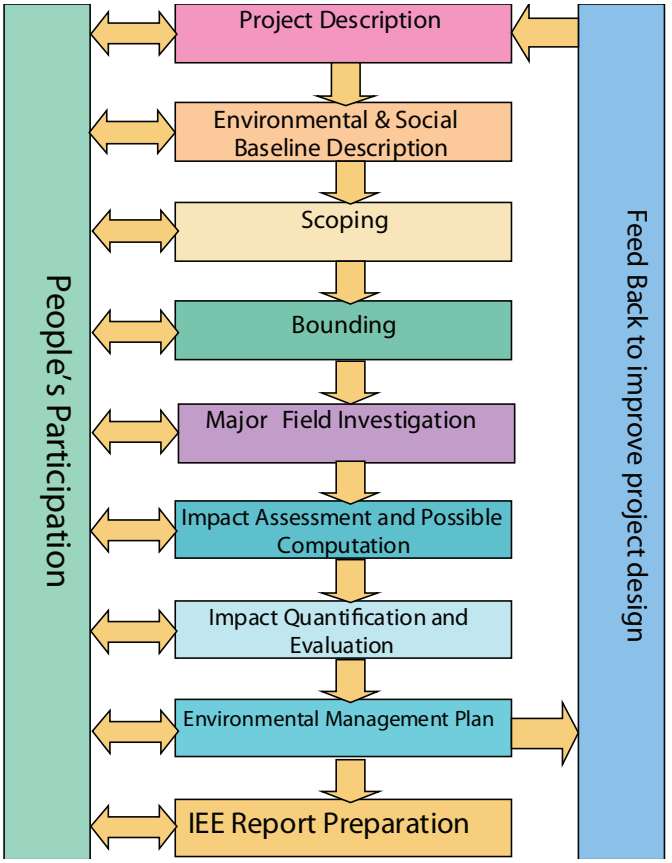


Figure 1-1: The process followed in the IEE study

Description of the Project: Detailed information on the southwest river management project was collected from Uttaran. Two meetings were held with the personnel from Uttaran, one at Dhaka in CEGIS and another at Chuknagar, Khulna regarding the interventions proposed by Uttaran. A write-up prepared by Uttaran with the active participation of the catchment-wise local stakeholders was reviewed for preparing the project description.

Environmental and Social Baseline: The multi-disciplinary IEE team made intensive field visits to individual catchments for obtaining first hand information on land use. The team also looked into the existing structures/interventions mentioned in Uttaran's report and identified their locations using GPS.

Water resource engineers collected data mainly on the drainage system of the catchments, as well as water logging and congestion, river and tributaries situation, obstruction to flow, sedimentation, condition of existing structures, etc. The Agriculture Expert collected data on existing farming practices and their productivity, cropping patterns, crop susceptibility, crop potentiality, crop inputs, crop damage, livestock status, etc from individual ctachments by intervewing agriculture farmers and local knowledgeable persons. Similarly, the Fisheries Expert collected data on open and closed water fish habitats and their productivity, species diversity, species of conservation significance, farming practices like shrimp, prawn and rice-cum-shrimp/prawn, fish migration status, fisheries trend, fishermen livelihood style, fisheries management, fish damage, etc. The Eclogist looked into the overall ecosystem status and collected data on flora and fauna, driving factors for affecting flora and fauna, etc. The Sociologist collected data on demographical issues, socio-economic status and livelihood patterns, different facilities like transportation, education, health, sanitation, etc. from BBS publications and through Rapid Rural Appraisal (RRA).

All qualitative and quantitative data and information gathered from the surveys and secondary sources were used appropriately in preparing the environmental and socio-economic baseline of the project. The data are presented in this report. All primary data and information here should be considered as expert estimation and opinion of the local people and project stakeholders. For agriculture, secondary data were mainly used from the Kapotakshi study report, 2010, while for fisheries data were used from FRSS, 2008-09, the Kapotakshi study report, 2010 and the Annual Report, 2009

of the Upazila Fisheries Office. The socio-economic data were also collected from secondary sources, mainly from BBS publications.

Scoping: A scoping process was followed for identifying Important Environmental and Social Components (IESCs) likely to be impacted by the project interventions. The professionals of the IEE team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. In the second stage, stakeholder perceptions were considered in this connection. Professional judgment of the IEE team members as well as opinions of stakeholders obtained in the scoping sessions was considered in selecting the IESCs.

Bounding: The geographical boundary of the 'Catchment Area' as well as the potential 'Impact Area' was delineated as a requirement of the environment assessment study. The Catchment Area is the physical location of the project while the Impact Area covers the geographic extent of the environmental and socioeconomic impacts resulting from implementation of the project during pre-construction, construction and post construction phases. For the IEE, the focus of the study was limited to the catchment area where impacts of the activity would be directly felt.

Major Field Investigation: Data on the IESCs were collected through RRA, PRA, and FGD using checklists for water resources, agriculture, fisheries, ecosystem and socio-economic components. The multidisciplinary IEE team members made professional observations during the field visits. This time the concentration was on the historical status of the IESCs and the possible condition of the same against the proposed interventions.

Impact Assessment and Possible Computation: The possible impacts of the proposed interventions on each of the IESC were assessed during the pre-construction, construction and post-construction phases. At this stage, local people's opinions obtained at the major field investigation stage were duly considered.

Impact Quantification and Evaluation: The impacts of the proposed interventions on the IESCs, assessed in the previous stage, were quantified to the extent possible. This being an IEE study, a qualitative assessment was also made.

Environmental Management Plan: Negative impacts, assessed in the previous stage, were picked up and mitigation measures were suggested for minimising their affects. Similarly, positive impacts, also assessed in the previous stage, were picked up and enhancement measures were suggested for increasing their benefits.

Compensation measures were suggested for the negative impacts that could not be mitigated. Contingency measures were suggested for accidental events during the project period. Finally, an Environmental Management Plan was prepared for detecting changes taking place in the environmental and social components due to project implementation. A monitoring plan was also prepared for proper implementation of the project.

IEE Report Preparation: The IEE Report has been prepared incorporating all findings according to standard format.

1.5 IEE Team

The multi-disciplinary team of professional conducting the IEE study of the Southwest River Management Project included the following:

i. Mr. Mujibul Huq, Environmental Expert/Team Leader
ii. Mr. Md. Waji Ullah, Water Resources Planner
iii. Mr. Md. Sarfaraz Wahed, Water Resources Engineer
iv. Dr. Anil Chandra Aich, Soil and Agriculture Specialist
v. Mr. Mohammed Mukteruzzaman, Senior Fisheries Specialist/Project Leader
vi. Mr. Kazi Kamrull Hassan, Senior Water Resources Professional
vii. Mr. Subrata Kumar Mondal, Socio-Economist
viii. Mr. Mohammad Shahidul Islam, Remote Sensing Specialist
ix. Mr. SM Shafi-Ul-Alam, GIS Analyst
x. Halima Neyamat, Environmental Policy Analyst
xi. Mr. Md. Amanat Ullah, Ecologist
xii. Mr. Md. Nasrat Jahan, Junior Remote Sensing Analyst
xiii. Mr. Md. Mobaswer Ali Ansary, Sociologist

1.6 Report format

The IEE report is organised in 8 (eight) Chapters. Chapter 1 is the introduction of the study. The policy, legal and administrative framework is presented in Chapter 2. Chapter 3 contains a description of the interventions proposed for the Southwest River Management Project. The Environmental and social baseline condition in the Southwest River Management Project area is described in Chapter 4. Chapter 5 presents the important environmental and social components likely to be impacted by the project along with the rationale for their selection. Public consultation and disclosure, initiated at the IEE stage and to be continued at the EIA stage are presented in Chapter 6 followed by the assessment of environmental and social impacts of the proposed interventions and suggested Environmental Management Plan in Chapter 7. Finally, Chapter 8 contains the conclusion and recommendations of the IEE study.

Chapter 2

Policy, Legal and Administrative Framework

2.1 Introduction

Development projects are governed by some legal and/or institutional requirements. So, assessment of relevant policy, strategy and regulatory issues are very important for any project proponent or developer before they actually execute a programme or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. The following sections review the relevant national legislative, regulatory and policy requirements.

2.2 Relevant National Policies and Legislation

The key pieces of policy and legislation which apply to such project execution programmes are described in the following sections.

2.2.1 National Conservation Strategy (NCS) 1992

The National Conservation Strategy was drafted in late 1991 and submitted to the Government in early 1992. This was approved in principle. However the final approval of the document is yet to be made by the government.

2.2.2 National Environmental Management Action Plan (NEMAP) 1995

The National Environmental Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends the statements set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements for the period 1995 to 2005 and to set out the framework within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement in the quality of life of the people.

2.2.3 National Water Policy (1999)

The National Water Policy of 1999 was passed to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. It also addresses issues like river Catchment management, water rights and allocation, public and private investment, water supply and sanitation and water needs for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc.

The water policy, however, fails to address issues like consequences of trans-boundary water disputes and watershed management.

2.2.4 Environmental Policy (1992)

The Bangladesh National Environmental Policy of 1992 sets out the basic framework for environmental action together with a set of broad sectoral action guidelines. The Environment Policy provides the broader framework of sustainable development in the country. It also states that all major undertakings, which will have a bearing on the environment, (including setting up of an industrial establishment) must undertake an IEE/EIA before they initiate the project.

The Environment Policy delineates the DoE as the approving agency for all such IEEs/EIAs to be undertaken in the country.

2.2.5 Environmental Conservation Act (1995, Amended in 2000 & 2002)

The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

The main objectives of ECA '95 are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarised as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried out/initiated in ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activitiy discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General (DG). An appeal procedure exists, however, for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 3 years imprisonment or a maximum fine of Tk. 300,000 or both. The DoE executes the Act under the leadership of the DG.

Bangladesh Environmental Conservation Act (Amendment 2000)

This amendment of the Act focuses on: (1) ascertaining responsibility for compensation in case of damage to the ecosystem, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognisance of offences.

Bangladesh Environmental Conservation Act (Amendment 2002)

This amendment of the Act elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

2.2.6 Environmental Conservation Rules (1997)

These are the first set of rules, promulgated under the Environmental Conservation Act of 1995 (so far there have been three amendments to this set of rules – in February and August 2002 and in April 2003). The Environment Conservation Rules of 1997 has provided categorisation of industries and projects and identified the types of environmental assessments needed against respective categories of industries or projects.

Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEEs/EIAs according to categories of industrial and other development interventions.

2.2.7 East Bengal Protection and Conservation of Fish Act (1950)

The East-Bengal Protection and Fish Conservation Act of 1950, as amended by the Protection and Conservation of Fish (Amendment) Ordinance of 1982 and the Protection and Conservation of Fish (Amendment) Act of 1995, has provisions for the protection and conservation of fish in the inland waters of Bangladesh. It is relatively unspecific and simply

provides a means by which the government may introduce rules to protect inland waters not under private ownership.

This is the legislation framework with rule making powers. Among others, some of these rules may prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, trade effluent or otherwise.

2.3 The Protection and Conservation of Fish Rules (1985)

These are a set of rules in line with the overall objectives of the Fish Act. Section 5 of the Rules requires that "No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". Section 6 of the Rules states- "No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters".

2.4 Compliance with DoE EIA Guidelines

The DoE has issued EIA Guidelines for Industries (this document was released in December 1997) and addresses the lEE and EIA for several industrial sectors and activities. Each project proponent shall conduct an IEE or EIA and is expected to consult and follow the DoE guidelines. Figure 2-1 shows the application procedure for obtaining site/ environmental clearance.

Environmental clearance from the DoE is required under the Environment Conservation Act of 1995. Section 12 of the Act stipulates that "no industrial unit or project shall be established or undertaken without obtaining Environmental Clearance from the Director General in the manner prescribed by the Rules". The procedure for obtaining the Environmental Clearance from the DoE is set out in the Environment Conservation Rules, 1997. The Rules divide projects into four categories, namely Green, Orange A, Orange B, and Red, depending upon their nature, and hence perceived environmental impacts. A schedule attached to the Rules defines the categories into which various types of projects fall. The Rules also set out differing requirements to be fulfilled in applying for an Environment Clearance under each of the four categories of projects, identifying the level of EIA required in each case.

The Environment Conservation Rules place construction/reconstruction/expansion of flood control embankments, polders, and dykes into the Red category.

Figure 2-1: Steps of Environmental Clearance Following DoE Guidelines

In order to obtain an Environmental Clearance Certificate for the project from the DoE, the following documents/ materials are to be submitted with the application:

- Feasibility Report for the Project (where applicable);
- Environmental Impact Assessment (EIA) Report;
- Environmental Management Plan (EMP);
- No Objection Certificate from relevant local authority (where applicable); and
- Other necessary information, (where applicable).

2.5 Environmental quality standards

Environmental quality standards for air quality, noise and water quality standards for Bangladesh are furnished in the following tables.

Table 2-1: Bangladesh standards for ambient air quality

(All values in micrograms per cubic meters)

Sl. No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dixide (SO2)	Carbon Dioxide (CO)	Oxides Nitrogen (NOx)
Ka	Industrial and mixed	500	120	5000	100
Kha	Commercial and mixed	400	100	5000	100
Ga	Residential and rural	200	80	2000	80
Gha	Sensitive	100	30	1000	30

Source: *Schedule-2, Rule 12, Environment Conservation Rules of 1997 (Page 3123. Bangladesh Gazette, 28 August 1997) (Translation from original Bengali).*

Note:

- Sensitive areas include national monuments, health resorts, hospitals, archaeological sites, educational institutions;
- Any industrial unit located in an area not designated as industrial will not discharge such pollutants which may contribute to exceeding the ambient air quality in the surrounding areas of category 'Ga' and 'Gha'; and
- Suspended particulate matters mean airborne particles having the diameter of 10 micron or less.

Table 2-2: Bangladesh standards for noise quality

Sl. No.	Area Category	Standard Values (all values in dBA)	
		Day	Night
Ka	Silent zone	45	30
Kha	Residential area	50	40
Ga	Mixed area (basically residential used for commercial and industrial purposes)	60	50
Gha	Commercial area	70	60
Umma	Industrial area	75	70

Source: *Schedule 4, Rule-12, Environment Conservation Rules, 1997 (Page 3127, Bangladesh Gazette, 28 August 1997) (translation from original Bangla).*

Note:

- Day time is considered as the time between 6 a.m. to 9 p.m.:
- Night time is considered as the time between 9 pm to 6 am; and
- Silent zones are areas up to a radius of 100 meter around hospitals, educational institutes or special establishments declared or to be declared as such by the government. Use of vehicular horns, other signals and loudspeakers is prohibited in silent zones.

Table 2-3: Bangladesh standards for water quality

Sl. No.	Best Practice based Classification	Parameters			
		pH	BOD (mg/l)	DO (mg/l)	Total coliform (number /100)
1	Source of drinking water for supply only after disinfecting	6.5–8.5	2 or less	6 or above	50 or less
2	Water usable for recreational activity	6.5 – 8.5	3 or less	5 or more	200 or less
3	Source of drinking water for supply after conventional treatment	6.5 – 8.5	6 or less	6 or more	5000 or less
4	Water usable by fisheries	6.5 – 8.5	6 or less	5 or more	-
5	Water usable by various processes and cooling industries	6.5 – 8.5	10 or less	5 or more	5000 or less
6	Water usable for irrigation	6.5 – 8.5	10 or less	5 or more	1000 or less

Source: Environmental Conservation Rule (ECR)'97

Note:

- In water used for pisiculture, the maximum limit for the presence of ammonia as nitrogen is 1.2 mg/l; and
- Electrical conductivity for irrigation water – 2250 µmhos/cm (at a temperature of 25°C); sodium less than 26%; boron less than 0.2%.

Chapter 3

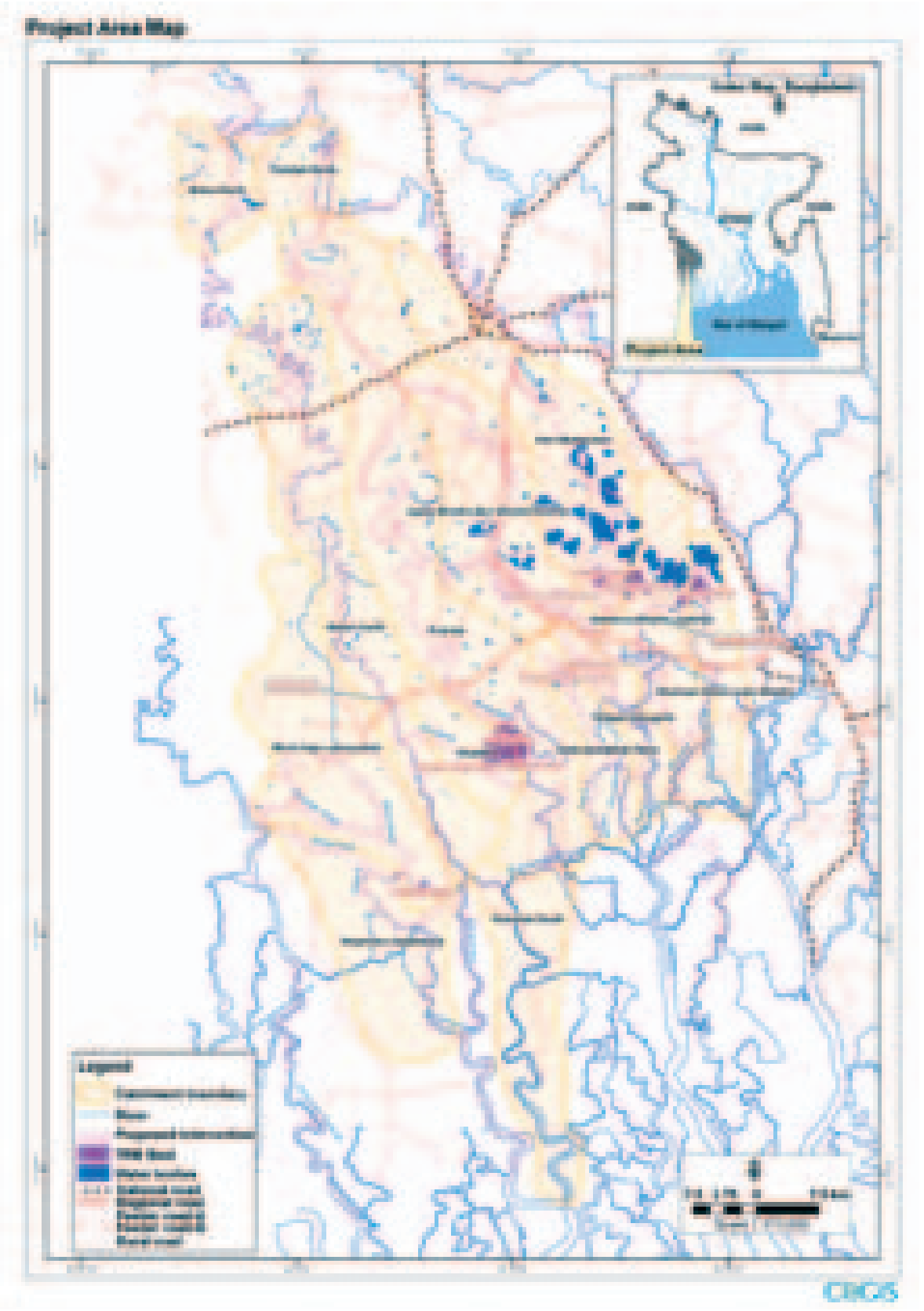
Project Description

3.1 Introduction

The Peoples' Plan of Action for Management of Rivers in Southwest Coastal Region of Bangladesh is a local level initiative to solve the problem of water logging and drainage congestion of Jessore-Khulna-Satkhira districts, which is located in the southwestern hydrological region of Bangladesh (Map 3-1). Since its inception, the project has undertaken a series of Public Consultation Meetings (PCMs) to define problems and collect suggestions from local level stakeholders for the proposed plan by Uttaran. Based on this accumulated knowledge from stakeholders, Uttaran drafted an 'Overall Peoples Plan' in October 2010. In this plan, a range of activities and interventions were identified, assessed in technical terms by the Institute of Water Modeling (IWM) and then proposed for IEE. An IEE has been executed by CEGIS (2010).

To solve the drainage congestion of Jessore, Khulna, and Satkhira districts, the following 11 catchment areas have been identified and considered in the Peoples' Plan of action for management of rivers of the southwestern coastal region of Bangladesh. Following table presents the catchment wise area and methodology applied for elicit ideas on respective catchments for preparing the people's plan.

Sl. No.	Name of Catchments	Catchment Area (Ha)	Methodology of People,s Plan
1.	Sholmari-Salta-Lower Bhadra	19,000	The proposed plan has been generated by using bottom-up approach during planning. Here, affected local people are the major decision makers or contributors of the plans. All interventions or concepts in the plan have been drawn through a participatory approach according to catchments. Participants have taken part at all levels in the decision making process. After completion of the proposed plan, the technical justifications have been tested by the IWM using the mathematical modeling approach. An IEE of the proposed plan has been executed by CEGIS.
2.	Hamkura-Bhadra-Joykhali	23,000	
3.	Hari-Mukteshwari	42,000	
4.	Upper Bhadra-Buri Bhadra-Harihar	37,000	
5.	Teligati-Ghengrile	10,740	
6.	Salta-Gunakhali-Haria	13,072	
7.	Kapotakshi	121,650	
8.	Shalikha	11,375	
9.	Betna	69,640	
10.	Morirchap-Labonyabati	45,000	
11.	Shapmara-Galghesiya.	32,000	
	Total catchment area=	**424,477**	



Map 3-1: Project area

3.2 People's plan

The following four aspects are the basis of the plan:

- Application of the Tidal River Management (TRM) concept
- Inter-river linking network
- Reviving of dead rivers, and
- Management of canals and beels inside polders

The plan regarding TRM, inter-river linking network and revival of dead rivers is basically river-centered which aims at rescuing the rivers and water bodies of the area. Management of canals and beels is a polder-centered plan, which aims at ensuring proper water management inside polders.

3.3 Stakeholder consultation

Keeping pace with the Participatory Water Management Instructions (nirdeshika), all relevant authorities were invited to take part in opinion-sharing meetings. Collection of the opinions of those who could play an active role in solving the problems was given particular importance. The dialogue system was practiced at the opinion-sharing meetings.

3.3.1 Description of the participants

- Local Members of Parliament (MPs)
- Upazila level officials and Union Parishads
- Representatives of the Bangladesh Water Development Board (BWDB), CEGIS and IWM
- Representatives of the Departments of Agricultural Extension, Land, Fisheries and others
- Representatives of NGOs and civil society, journalists, teachers, and lawyers
- Political leaders and representatives of different organisations that organise movements against these problems, and
- Affected farmers, representatives of landless people, fishermen, destitute people and women

At every meeting a paper was presented on a particular river Catchment. The participants gave their opinions on the paper presented. The Catchment-based plan was prepared based on the discussions.

3.3.2 Opinion-sharing meetings

Sl. No.	Date	Meeting place	Included Catchments	Number of Participants
1	October 01, 2009	Uttaran Training Centre, Tala	Kapotakshi, Salta-Upper Bhadra and Ghengrile Catchment	193
2	October 06, 2009	Parulia Union Parishad Auditorium, Debhata	Shapmara Catchment	56
3	October 30, 2009	Satkhira Officers' Club, Satkhira	Morirchap- Labonyoboti Catchment	65
4	November 05, 2009	Dalua Shaheed Ziaur Rahman College, Tala	Shalikha Catchment	47
5	November 13, 2009	Uttaran Training Centre, Tala	Salta and Ghengrile Catchment	74
6	December 06, 2009	Shaheed Zobayed Ali Auditorium, Dumuria	Sholmari, Hamkura-Bhadra Catchment	65
7	December 27, 2009	Ad. Abdur Rahman College, Binerpota, Satkhira	Betna Catchment	51

Sl. No.	Date	Meeting place	Included Catchments	Number of Participants
8	January 11, 2010	Inspecting Jethua Beel	Salta, Ghengrile, Shalikha and Betna Catchment	63
9	January 30, January 31, 2010	Uttaran Training Centre, Tala	Proposed 11 Catchments	78

3.3.3 People's thoughts

- The people of the Sholmari, Hamkura, Hari and Upper Bhadra Catchment under KJDRP and the adjoining Kapotakshi Catchment raised their voices to implement TRM.
- People are less conscious in the Gangrail-Salta-Shalikha and Betna Catchment about the implementation of TRM. However, intellectuals of this area were able to grasp the fact that it would be difficult to save the rivers without implementing TRM.
- People of the Morirchap-Labonyoboti Catchment and Shapmara Catchment, situated in the west and south of Satkhira town respectively, are insensitive towards the network of inter-river linking. The conscious citizens of Morirchap Catchment think that TRM could be introduced in this area.
- The hazards of the current situation cannot be prevented if the rivers are not rescued, and
- It is necessary to develop a system inside the polders for draining off water.

3.4 TRM, river linking network management and reviving dying rivers

The basic consideration of TRM is proper management of silt. The history of water management in the ancient times is mainly a history of silt management. When silt management was done properly, the production turned out to be very satisfying. In the middle ages the historians and tourists praised this country as a land of greenery and crops. This was because crops grew very well in silt-deposited soil. This is a country of silt. Local people understood well that without silt management system the present situation could not be overcome. The process of detaching silt from tidal wetland was suicidal.

By setting up an inter-river linking network, rivers of this area could be brought into life within a short time. Rivers, which are almost dead but have a thin link, should be saved on an emergency basis. Therefore, if the river network system can be strengthened, it would safeguard this region.

3.4.1 Sholmari-Salta- Lower Bhadra Catchment

A. Selection of TRM Catchment

Within the whole KJDRP area, Beel Dakatia is the Catchment area situated in the lowest part of the region. According to the survey report, TRM would be most successful here. People think that the Pashchim Beel in the upstream of the Shoula Sluice gate at the Upper Sholmari Catchment is the perfect place to implement TRM. Map 3-2 shows rivers and beels of the catchment to be intervened under the proposed project.

B. Inter-river link

- *Bhadra* River, which divided the polders 22 and 31, should be re-linked with the Lower Salta;
- The upstream area of the Upper *Sholmari* should be re-linked with the *Hamkura* River; and
- The *Shree* River of *Vabodaha* should be re-linked with the *Sholmari* River.

C. Reviving the dying rivers

The *Jhopjhopiya* River, which is on the verge of death, should be dredged, so that it could be revived again.

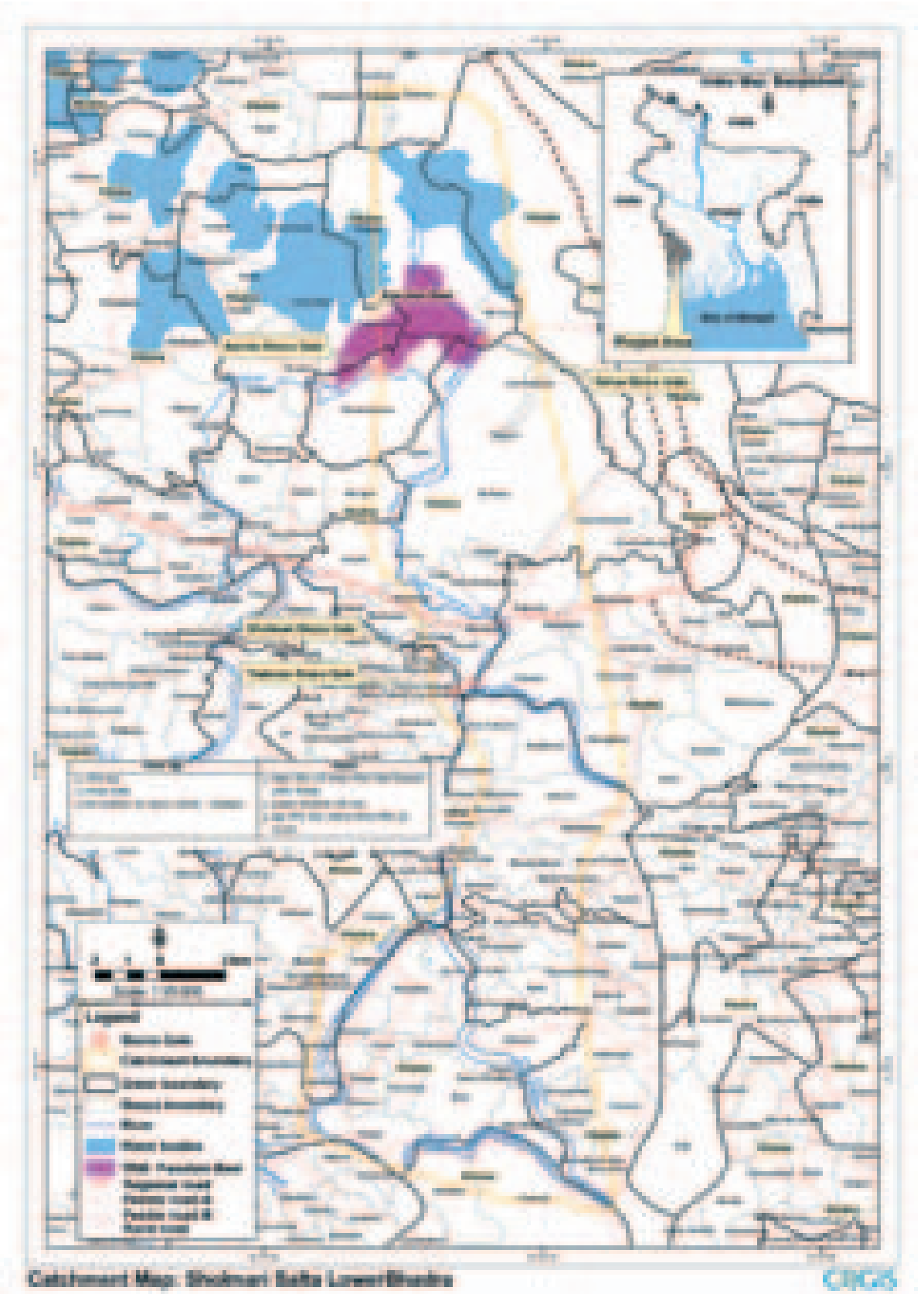
3.4.2 Hamkura-Bhadra-Joykhali Catchment

A. Selection of TRM Catchment

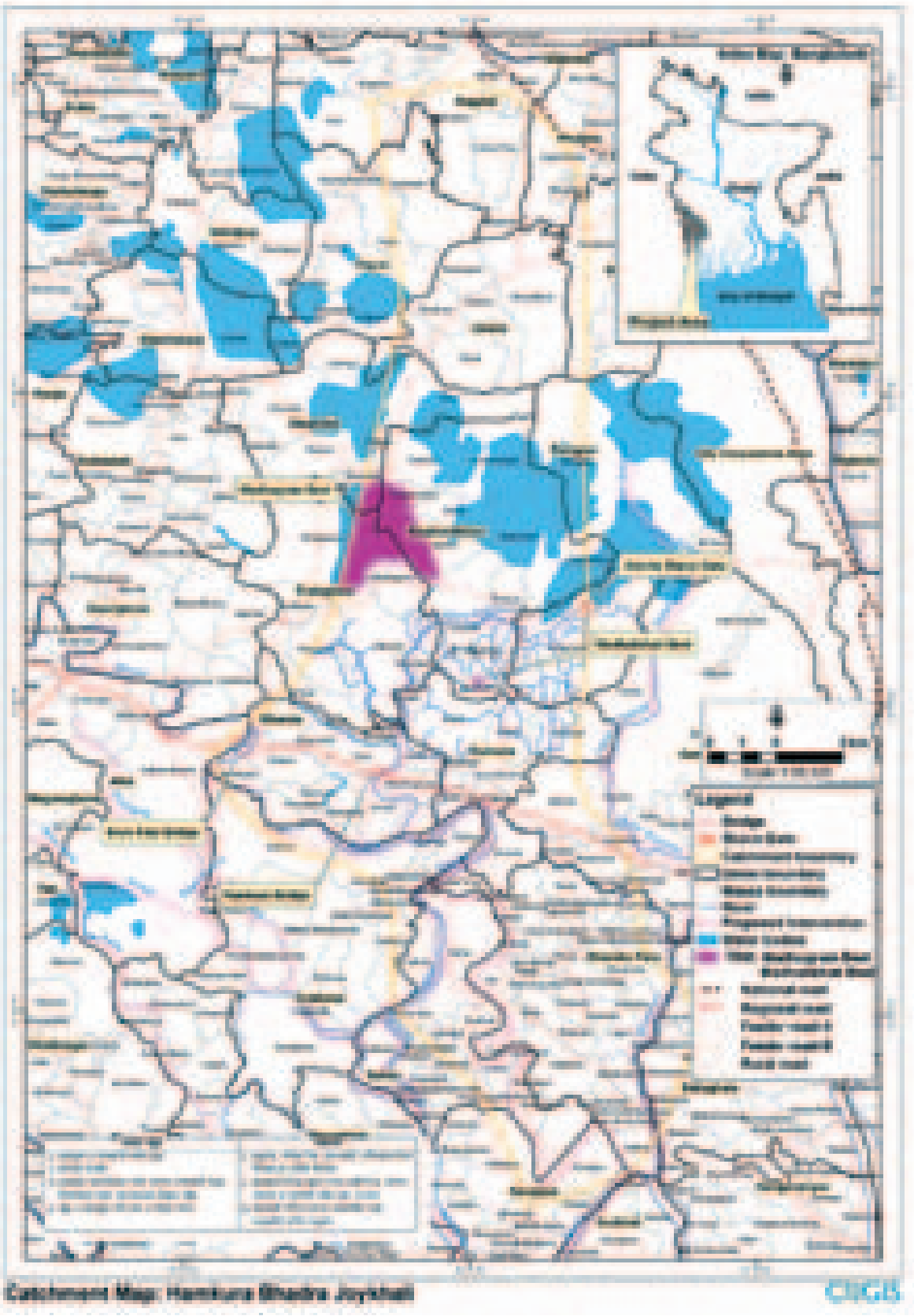
The local people have been demanding for a long time to bring the Hamkura River back to life by implementing TRM. The authority had thought of implementing TRM in Madhobkati Beel under the KJDRP project, but it had not been done for reasons unknown. According to the local people, the TRM concept can be applied in the following beels of the Hamkura river catchment: 1. Madhobkati Beel; 2. Madhugram Beel; 3. Pashchim Beel (situated on the west side of Ruprampur-Gajendrapur); and 4. Shinger Beel. Map 3-3 shows rivers and beels of the catchment to be intervened under the proposed project.

B. Inter-river link

- Re-link of the Bhadra with the Teligati, the Upper Salta and the Joykhali;
- Link of the Joykhali with the Ghengrile through the Kakmari River;
- Re-link of the Upper Sholmari, the Upper Salta and the Bhadra through Madhobkati Beel and polder no. 27/1; and
- Re-link of the dead Bhadra with the Lower Salta through polder no. 29.



Map 3-2: Proposed major interventions in the Sholmari-Salta-Lower Bhadra Catchment



Map 3-3: Proposed major interventions in the Hamkura-Bhadra-Joykhali Catchment

3.4.3 Hari- Mukteshwari Catchment

Map 3-4 shows rivers and beels of the catchment to be intervened under the proposed project.

A. Development of TRM activity in Beel Khukshiya

- The mud walls (gherberi) have to be removed from the beels so that more silt could get deposited in Beel Khukshiya;
- The rivers have to be linked with the Goda canal; the embankments at Fultola have to be made stronger; and embankments have to be built alongside the canal so that silt could reach the distant areas;
- The blocked canals have to be dredged;
- The peripheral embankment should be made stronger;
- In Bhayna Beel, an embankment should be built on the bank of the canals so that water from 26 beels could be drained out;
- The government should compensate the affected people and continue to implement TRM in this beel as long as possible; and
- The pillars of the incomplete bridge over the Sholegatiya should be removed and localities should be protected from river erosion.

B. Inter-river link

- The previous channel beside the regulator at Vabodaha should be opened and the Muktashwari River should be linked with the Hari River so that water from the upstream of the Vabodaha could be drained off. Thus, no pumping out of irrigation would be needed. A strong embankment should be built on the banks of the Dhakuriya sluice gate with the mud dug out from the Mukteshwari River. In this way, water can be preserved from the cross dam to the upstream of the Mukteshwari River in the dry season, and the area would be saved from inundation during the rainy season.

- The Amdanga canal of the Mukteshwari should be widened and linked with the Bhairab River and a regulator should be built at the link point.

- The Sree River facing Beel Dakatia should be made free, and through Beel Dakatia the Hamkura should be connected with the Upper Sholmari. A regulator should be built at the mouth of the closed Sree River beside the Vabodaha. The Horhorey sluice gate at the Sree River should be connected with the Thukra, Amvita and Sholua sluice gates. The soil dredged out from the river could be used for making the embankment strong and high. It should be made so high that water from the Vabodaha would not be able to inundate Beel Dakatia. As a result, the conflict between the two areas would end permanently.

Map 3-4: Proposed major interventions in the Hari-Mukteshwari Catchment

3.4.4 Upper Bhadra- Buri Bhadra- Harihar Catchment

Map 3-5 shows rivers and beels of the catchment to be intervened under the proposed project.

A. Implementation of TRM

- TRM should be implemented in Buruli and Pathra beels paying proper compensation to the landowners.

B. Reviving the dying rivers

- The Buri Bhadra and Harihar rivers should be revived through proper dredging.

3.4.5 Teligati-Ghengrile Catchment

Map 3-6 shows rivers and beels of the catchment to be intervened under the proposed project.

A. TRM plan

- TRM should be implemented in Kulbariya Beel by dredging the dead parts of the Ghengrile and Taltoli rivers.

B. Inter-river link

- The Teligati should be linked with the Bhadra which flows towards Dumuria; and
- The Kakmari should be linked with the Joykhali.

C. Reviving the almost dead rivers

- The Guachapa River should be revived and linked with the Salta-Gunakhali; and
- The Badurgachha River should be dredged and linked with the Upper Ghengrile River, and a sluice-gate has to be built at the link point.

Map 3-5: Proposed major interventions in the Upper Bhadra-Buri Bhadra-Harihar Catchment

Map 3-6: Proposed major interventions in the Teligati-Ghengrile Catchment

3.4.6 Salta- Gunakhali -Haria Catchment

Map 3-7 shows rivers and beels of the catchment to be intervened under the proposed project.

A. TRM plan

On both sides of the Salta River, there are several ideal beels where TRM can be implemented. Local people think that one of the two beels would be ideal for implementing TRM. These are: Kolachh Beel and Baintola Beel.

B. Inter-river link

- Re-link with the Haria River;
- Re-link of the Ghengrile River through the Taltoli River and building of a regulator at the link point; and
- Re-link of the Ghengrile with the Salta by dredging the Hatitana and the Mukundi of Magurkhali union and by building a strong and high embankment with the dug out soil.

C. Reviving the almost dead rivers

- The Guachapa River should be revived by dredging.

3.4.7 Shalikha Catchment

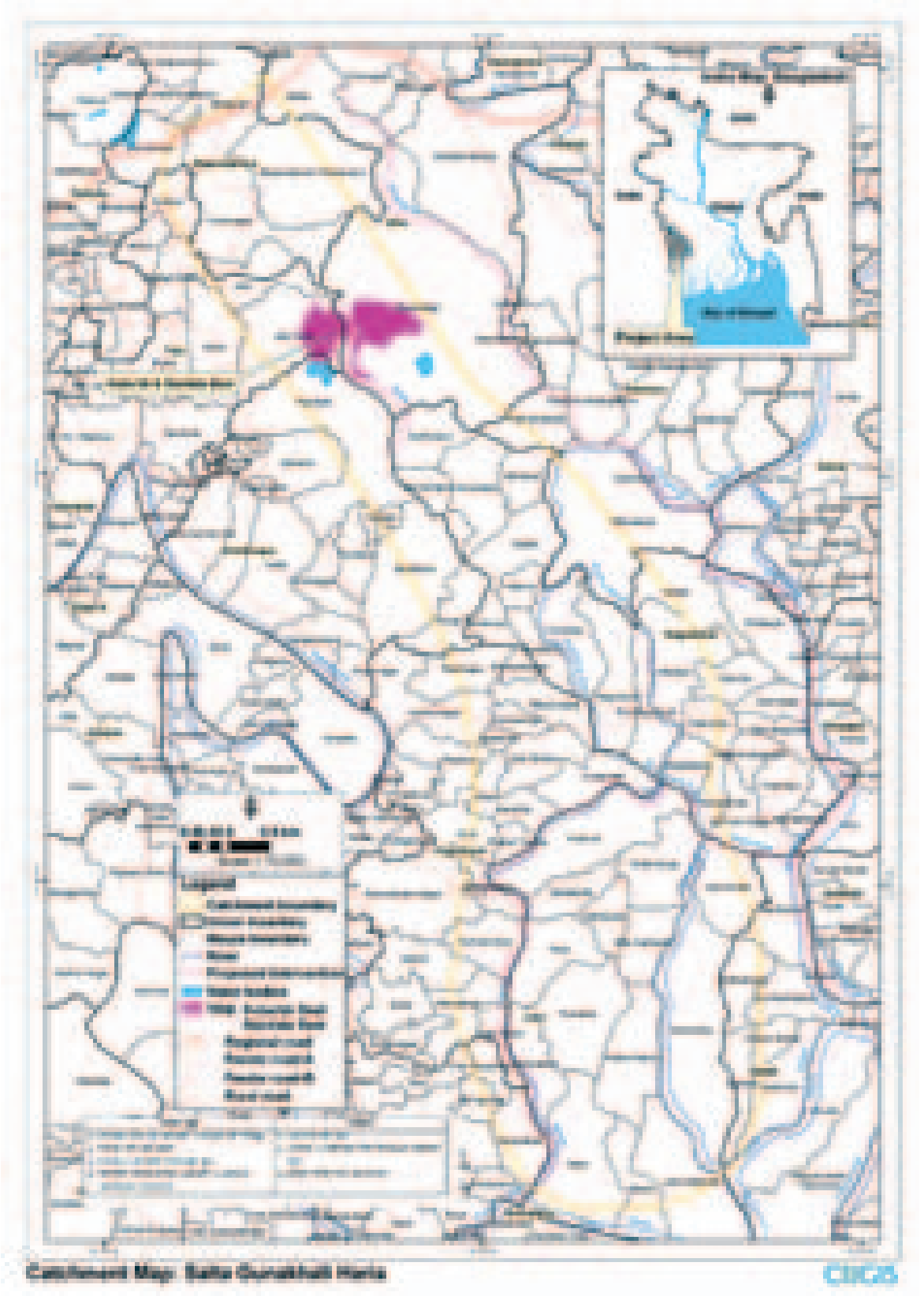
Map 3-8 shows rivers and beels of the catchment to be intervened under the proposed project.

Local people's opinion

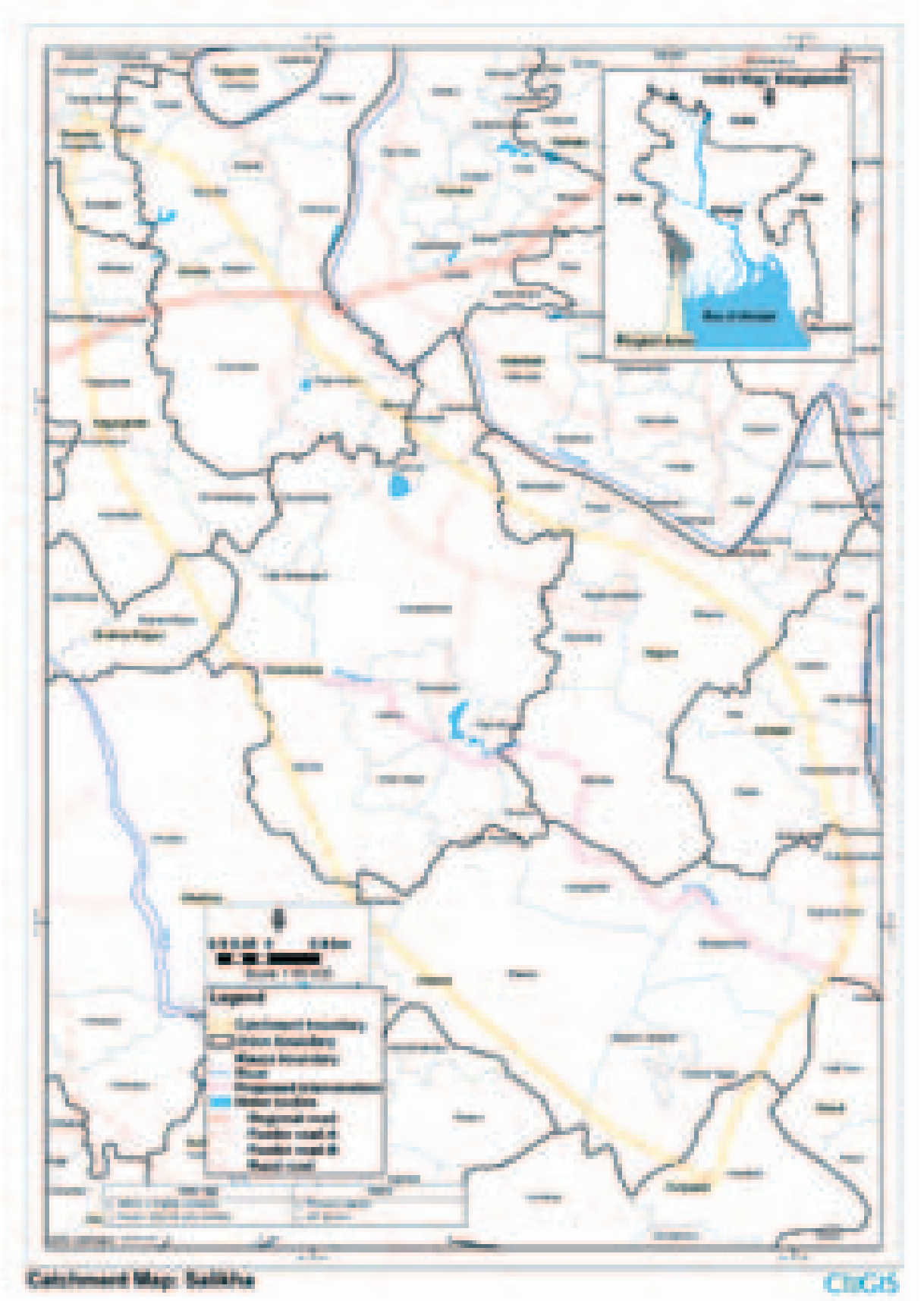
- Locals of the Shalikha and Pakuria Catchment area think that if canals are dug, sluice gates are made effective and water management is done properly, they can drain away water through the Betna River and pipe in saline water to the shrimp enclosures; and
- It is necessary to link the Shalikha and the Pakuria with the Kapotakshi.

A. TRM

TRM has not been popular in the area till now. The conscious people think that if TRM is implemented the residents of this area will be benefited.



Map 3-7: Proposed major interventions in the Salta-Gunakhali-Haria Catchment



Map 3-8: Proposed major interventions in the Shalikha Catchment

TRM-1

If the dead Kapotakshi River can be dredged from Boaliya to the upstream of the Shalikha sluice gate and TRM can be implemented in Pakhimara Beel, then the 15 vent sluice gate at the Shalikha would be ready to drain out water from the Shalikha river catchment.

TRM-2

The local people hope that the dead Kapotakshi can be revived if the Kapotakshi is dredged from the Katakhali kheya ghat through the old route to Hariharnagar Beel, which is 2 km upstream of the Pakuria sluice gate and TRM is implemented there.

B. Inter-river link

- Re-link of the Katakhali with the Indurkata of Paikgachha; and
- Re-link of the Minhaj River with the Kapotakshi and the Keruliya.

C. Reviving the dead rivers

- Re-excavation of the Shahebkhali River flowing towards Paikgachha from the Katakhali; and
- Re-excavation of the Morirchap River, upstream of the Baradal facing the Ashashuni.

3.4.8 Kapotakshi Catchment

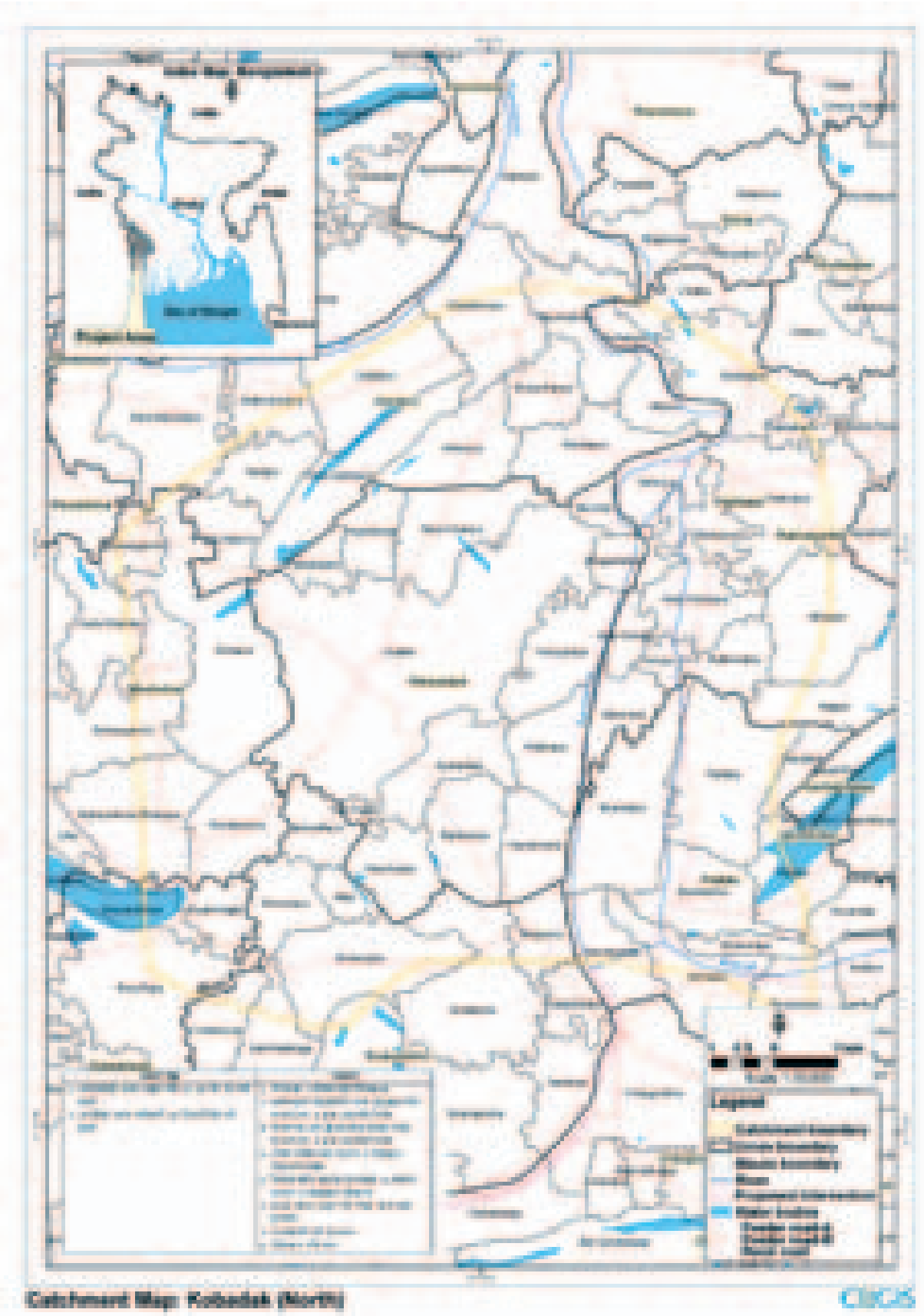
Maps 3-(9, 10 & 11) show rivers and beels of the catchment to be intervened under the proposed project.

A. TRM

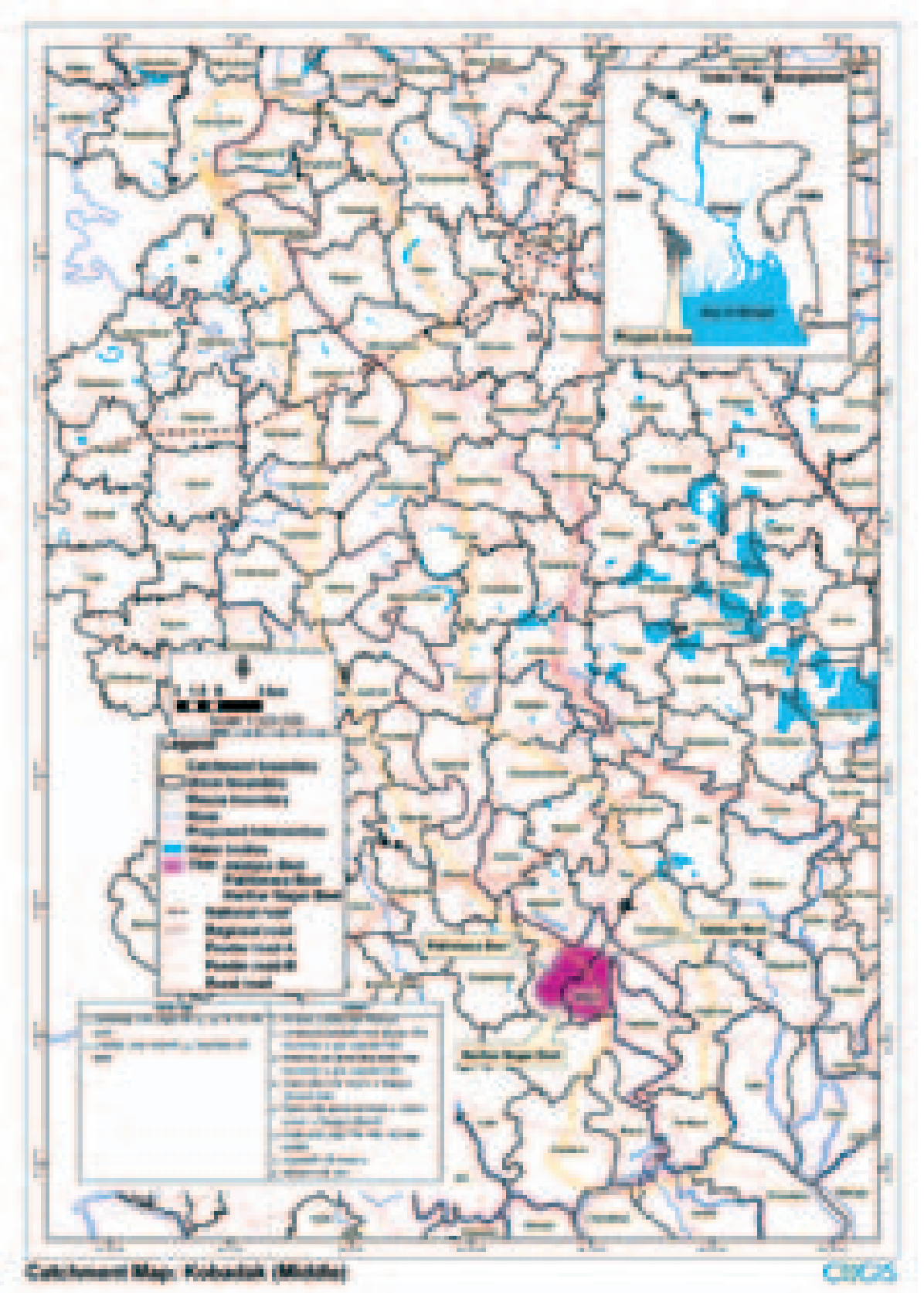
TRM implementation will be more successful in Pakhimara beel instead of Jalalpur beel in 2011. Pakhimara beel is deeper than Jalalpur beel. So, sufficient tidal water will enter this beel and at the same time Shalikha catchment will be benefited.

B. Inter-river link

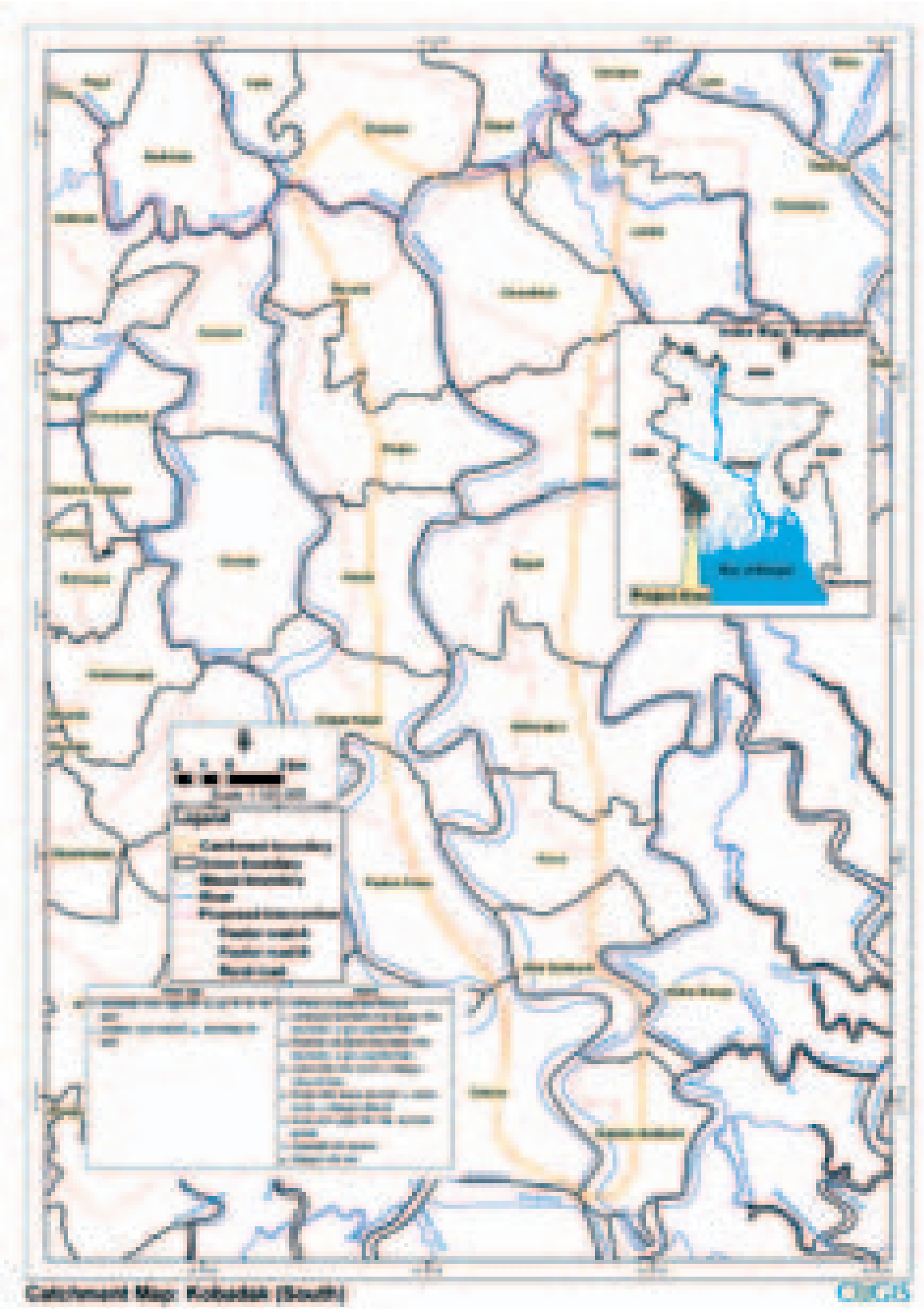
- The *Buri Bhadra* River should be linked with the *Trimohini* of *Keshobpur* and a regulator should be built at the link point;
- Re-link of the *Harihar* under the rail bridge at *Jhikorgachha* and a regulator should be built at the link point;
- The *Mukteshwari* should be re-linked with the regulator at *Jhikorgachha Sadar* through *Bukbhora Baor*;
- Re-link with the *Betna* River through *Joynagar- Krishnanagar*, and in both points more sluice gates should be built; and
- The *Kapotakshi* and the *Betna* should be linked through the *Tiyasha* River from the *Sharulia* sluice gate, and more sluice gates should be built at both points.



Map 3-9: Proposed major interventions in the Kapotakshi North Catchment



Map 3-10: Proposed major interventions in the Kapotakshi Middle Catchment



Map 3-11: Proposed major interventions in the Kapotakshi South Catchment

Rivers and canals have to be dug in these alternative routes and strong and high embankments have to be built on both sides of the drainage canals with the mud. But these activities are not alternative to implementation of TRM and dredging of Kapotakshi. For proper utilisation of water, these alternatives will only play a supportive role.

C. Loop cut

From Magura to Jethua Bazaar, in Sagordanri and upstream areas an initiative of loop cut could be taken. This was not discussed much with the people. However, there are opinions in favour and against the matter.

3.4.9 Betna Catchment

Maps 3-(12 & 13) show rivers and beels of the catchment to be intervened under the proposed project.

A. TRM

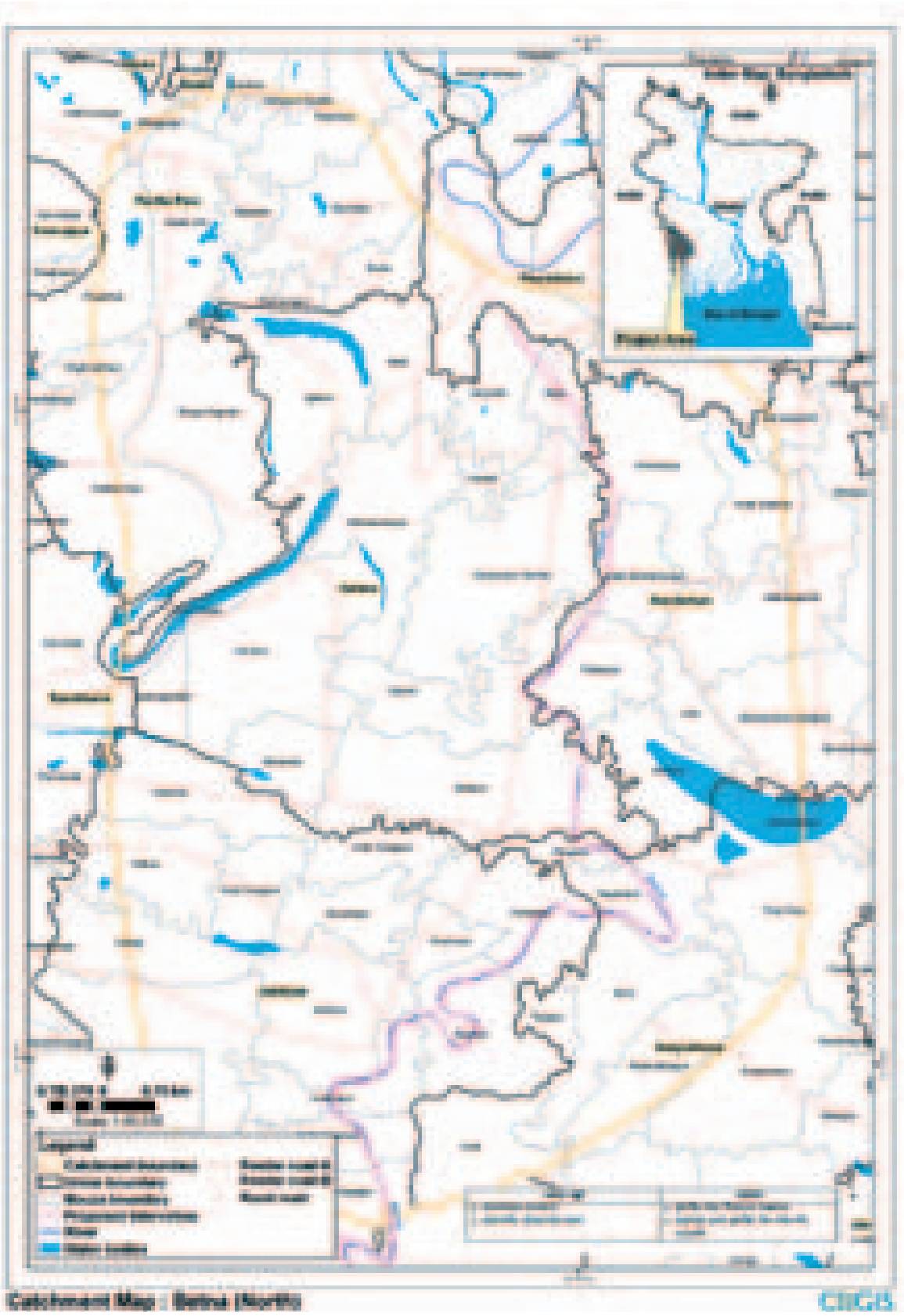
Both sides of the Betna river catchment, especially the whole eastern area is suitable for implementing TRM. Local people think that tidal water that still flows to Binerpota would make Kultiya beel, upstream of Binerpota bridge, fit for implementing TRM. For lack of initiatives TRM cannot be implemented in this dry season. It is uncertain whether Kultiya beel will get sufficient tidal water in 2011. In that case, a suitable beel could be identified in downstream areas to implement TRM.

B. Inter-river link

The new canal should be linked with the Betna River of Kolaroa and a regulator should be built at that point. This passage could be used for draining water from the upstream of the Kolaroa.

C. River dredging

The river has to be dredged from *Maheshpur* to TRM beel according to CS record.



Map 3-12: Proposed major interventions in the Betna North Catchment

Map 3-13: Proposed major interventions in the Betna South Catchment

3.4.10 Morirchap-Labonyoboti Catchment

Map 3-14 shows rivers and beels of the catchment to be intervened under the proposed project.

Proposal for *Morirchap* Catchment

A. Inter-river network: option-1

- Free connection with the Ichhamoti beside the sluice gates of Padmashakra, Balitha, Tikit and Kamalkathi. The riverside canals have to be dug according to the map. Roads and embankments should be built with the dug up soil; and
- The river has to be dredged from Balitha to the Khejurdangi sluice gate of Pran Shayer and the sluice gates have to be built at the link points or should be connected to the Betna River.

B. TRM: option -2

TRM should be implemented either in Dorgatola beel which is located in the west of Balitha Tromohona downstream or in Shovanali beel which is located in the downstream of the Tikit gate.

Proposals for *Labonyoboti* Catchment

A. Dredging of rivers

The *Labonyoboti* River should be dredged according to the map. Strong and high embankments should be built with the dug up soil on both sides of the river.

B. Inter-river link: option-1

Tide in the river must be controlled by the sluice gate. The system would have to be developed in such a way that the river water can be used for both rice cultivation and shrimp cultivation.

Option-2

A direct link with the *Ichhamoti* alongside the *Padmashakhra* gate and a link with the *Kholepetua* at the downstream should be established. For the periods of tide and ebb in the *Ichhamoti* and *Kholepetua* rivers, the *Labonyoboti* and other linked rivers will always be full of current. Thus, the rivers will live long.

Comments

As the *Ichhamoti* River is linked with the upstream river *Mathabhanga*, fresh water from the *Mathabhanga* flows into the *Ichhamoti*. This dry season water flow plays a vital role in increasing current, growing crops and saving the environment.

The *Ichhamoti* River could be saved from being filled up with silt if it could be inter-linked with this area. The river system linked with *Kholepetua* will also be benefited by this.

3.4.11 Shapmara- Galgheshiya Catchment

Map 3-15 shows rivers of the catchment to be intervened under the proposed project.

A. Inter-river linking plan

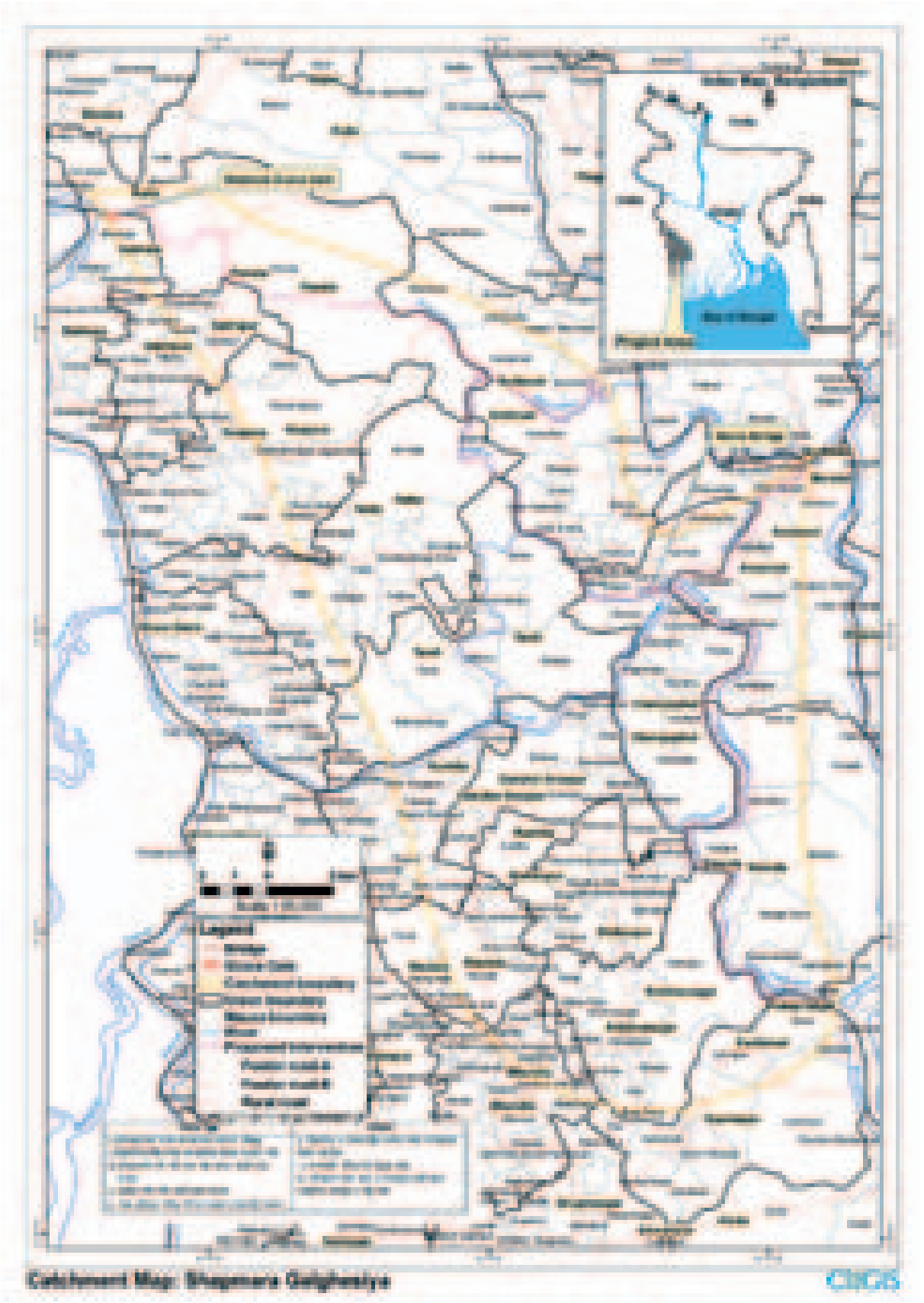
- Local people think that proper water management will develop in the area if by freeing the previous channel of the Bhatshala Sluice gate the Ichhamoti and Kholepetua rivers can be linked with that channel;
- By freeing the previous channel of the Tikiti and Morirchap sluice gates it should be possible to get it connected with the Morirchap. By removing the Gutiakhali embankment it should be possible to to get it reconnected with the Morirchap;
- The coastal embankment should be made stronger and higher with the soil dug from all rivers so that it could prevent tidal surges like the Aila. Sluice gates also have to be built in suitable places of the embankment to drain away water properly from inside; and
- Steps should be taken for afforestation and making roads on the embankment.

B. Reviving the almost dead rivers

- The *Haora* and *Galgheshiya* rivers should be dredged to become revived.

Annex 1 contains the Atlas of the all 11-catchment's maps with colour at larger size.

Map 3-14: Proposed major interventions in the Morirchap-Labonyabati Catchment



Map 3-15: Proposed major interventions in the Shapmara-Galghesiya Catchment

3.5 TRM Management

TRM management should be handled properly to get good results. There are two aspects in TRM: beel management and river management. Beel management is more important than river management. The points to be considered in the management of TRM are listed below:

A. Engineering issues

- Selection of a suitable beel;
- The area of the beel has to be proper so that river ecosystem can be maintained. The old approach of considering a river only as a drainage channel has to be changed;
- Selection of proper cut point through which tidal water would enter the beel;
- Removal of Gherveri dams, made for shrimp cultivation, from the beel;
- Dividing the beel into many compartments for even distribution of sediment;
- Dredging the canals filled with silt using excavator machine and building an embankment if necessary to make the silt reach the farthest land;
- Continuation of TRM implementation until the beel is filled with silt;
- Making the embankment higher and stronger so that floods or tidal surges like the Aila cannot damage it;
- If there is any upstream area of the beel where TRM is being implemented, steps should be taken to drain off water from that area;
- When TRM is in operation the localities, roads, markets and historical sites on the riverbanks could get damaged, therefore steps should be taken for preventing it; and
- Regular monitoring of TRM implementation programme.

B. Environment and production related issues

- Preserving a part of the beel, especially the lowest part, as wetland;
- Cultivating salinity tolerant species of rice, aquatic grass and crabs in the beel;
- Afforestation and vegetation on the embankment;
- Proper management of water of the beel in cultivating arid areas;
- Developing a natural fish bebosthapona (management) in the beel; and
- Involving the Department of Fisheries, Department of Agriculture and other relevant departments in TRM management.

C. Social issues

- Compensating the landowners with correct price for their products;
- Bringing landless people dependent on beel for their livelihood under the safety net programmes of the government or taking special measures for them;
- Forming a powerful beel management committee and keeping an office to run the activities;
- Involving the Local Union Parishad in TRM planning, implementation, operation and management; and
- Providing training to the beel management committee.

3.6 River management

- Leasing of detached, confined and filled up rivers have to be stopped.
- Dredging according to CS records after demolishing all types of encroachment from the rivers;
- Building of stronger and higher embankments and roads with the soil dug up from the rivers for preventing damage from tidal surge and inundation.
- Growing vegetables and planting trees on the embankment;
- Removing all unplanned structures incluidng bridges and culverts from the rivers and taking alternative measures so that the natural flow of the rivers would not be hampered;
- Building a stronger and higher coastal embankment to prevent river erosion, tidal inundation and sea level rise;

- Fishing in the rivers in harmful ways should be prevented;
- Continuation of an extensive monitoring system;
- Forming a Catchment-based social committee and giving them training; and
- Handing over the responsibility of river management to a specific ministry.

3.7 Management of canals and beels inside the polders

The environment, drainage system and other things are in a chaotic condition inside the polders. An extensive survey should be done to learn about what the present condition of sluice gates in this proposed huge area is and how that conditions can be improved. For doing this, assistance of technical experts is needed in some cases. In this report attempts have been made to explore the general problems of different areas and the way people want those problems to be solved.

Problems:

- Siltation on both sides of the sluice gates;
- Different types of technical problems of sluice gates and shortage of sluice gates;
- Unplanned internal shrimp enclosures;
- Navigation problem of drainage canals;
- The government has leased many canals as these are confined water bodies. There are several problems in the drainage passage including encroachment of drainage canals;
- In the drainage route many unplanned roads, culverts and other structures have been built;
- Conflict in using water and drainage of water between rice farmers and shrimp farmers;
- In most cases the sluice gates are run for the benefit of the owners of shrimp ghers;
- Local people are not involved in the management of the sluice gates;
- People enter into conflict among themselves regarding draining water in alternative ways. Sometimes they even go to the court for solving the problems;
- In the south of the proposed area, there are plenty of salt water shrimp ghers, as a result of which severe environmental degradation has taken place;
- In many places on the riverbanks there is no infrastructure for controlling water; and
- The coastal embankments are weakening for lack of maintenance. As a result of inundation during full moon, the pressure of the upstream water and tidal surge the weak points of the embankments collapse easily resulting in inundation of homesteads, canals and beels.

3.8 Management of canals and beels

By analysing these problems it has been realised that the infrastructures for draining out water are not properly maintained or used for people's benefit. People do not know who the owners of these structures are and who the responsible persons are for maintaining them. To control the internal water management system the following steps should be taken:

- Form a strong canal and beel management committee;
- Repair the sluice gates so that water can pass through easily;
- Build new sluice gates;
- Dismantle all kinds of encroachments from the internal canals. The canals should be dug deeply to ensure conservation of water in the canals during the dry season. Thus, dry season demand of water would be fulfilled and all aquatic flora and fauna including fish can survive;
- Preserve water in ponds, lakes and other water bodies;
- Cultivate local species of fish and rice in the beels;
- Develop friendly relations between fish farmers and rice farmers;
- Prevent drainage paths of water from being leased out;
- Establish inter-linking of different canals for correct drainage of water of high and low land and usage of water;
- Decide the fate of unplanned bridges, culverts, pipe gates, etc.; and
- Ensure proper maintenance of the coastal embankment and afforestation. Steps should be taken to build embankments or infrastructures on riverbanks where there are none.

3.9 The expected result from implementing people's plan

The local people are expecting the following results by implementing TRM, inter-river link, revival of dead rivers and proper water management inside the polders:

A. Drainage

- The rivers of the proposed area, both at the upstream and downstream, would be navigable all the year round; and
- Internal canals and sluice gates would be active.

B. Production

- The beels where TRM is being implemented will be filled and become high so that crops can be grown up to three times a year;
- There would be separate areas for cultivating rice and fish and water supply would be ample for cultivation;
- Rivers, canals, and other water bodies will be full of local species of fishes;
- Cattle breeding will be possible in the area;
- As waterways would be navigable again, businesses and communication would expand; and
- The river embankments could be used as roads. So, the economy of this area will be speeded up.

C. Environment

- Natural plants would grow on the riverbanks. The power of the rivers to produce plankton would be increased, and the rivers would be able to prevent tidal surge and inundation;
- The rivers and canals of the Sundarbans would be navigable and deposition of silt will decrease on the land;
- Underground water level would rise and water would be available on the surface;
- Shrimp cultivation in saline water would be reduced;
- The high land created by implementing TRM and high river embankments would be able to face the risks created by sea level rise;
- There will be enough water in rivers, canals, beels, and other water bodies. There will also be afforestation on riverbanks and reduction of selling trees in the localities – all of which would help to create a healthy environment;
- A healthy environment would be created in TRM beels, rivers, canals, localities and in the Sundarbans for preserving biodiversity; and
- The onslaught of water-borne diseases would be reduced.

D. Social system

- A water-based society will be developed where the social attachments would be permanent. For increasing production and creating stability in society, social bonds are very important;
- The conflict between fish farming and rice farming would be stopped; and
- The quality of lives and livelihoods of the poor and destitute people would be improved.

3.10 Risk factors in implementing the plan

In implementing a plan suitable for the south-western coastal area a lot of initiatives have to be taken. Without political will of the government, it would be difficult to implement this type of plan. The situation of the region is going beyond control, and there is no time for delay. So, the following risks should be resolved immediately:

- The government's arrangement of blocking rivers, canals, other water bodies and chars;
- Various unplanned structures built in the rivers and canals;
- The government's support to cultivate saline water shrimp without any control; and
- Old structural approach of the BWDB.

3.11 Conclusion

A regional plan is needed for the whole south-western region. Water management of the Ganges would be an important part of that plan which has not been included here. Planning and implementing the water management of the Ganges is a time consuming issue. The initiatives discussed in this report should be considered for taking up the feasibility study of the people's plan for management of rivers in the southwest.

Secondly, a proper plan could not be made with a single river, as the inter-river linking network protects the existence and navigability of the rivers. Though the problems of every river have been discussed individually in this report, importance has been given to inter-river linking network.

Needless to say, the TRM method and inter-river linking network system have opened a door of possibility for the whole coastal area. These methods can be implemented as adaptation processes in disaster management. These methods not only fit with the water policy, coastal policy, environment policy and participatory water management guide of the Bangladesh government, but can work also as a model to implement these policies.

According to experts, this method is not only applicable for Bangladesh but also in the coastal areas of other countries and through it Bangladesh can earn a lot of valuable foreign currencies.

Local people hope the government and the authorities concerned would come forward to implement the plan properly based on the demands and expectations of the people by involving them in the process.

Chapter 4

Environmental and Social Baseline

4.1 Meteorology

Meteorological data such as rainfall, evaporation, temperature, humidity, wind speed, and sunshine hours were collected and analysed for assessing meteorological resources that are directly related to water resources. These data were collected from the National Water Resources Database (NWRD) of WARPO, which mainly contained long series temporal data showing daily values for meteorological stations maintained by the Bangladesh Meteorological Department (BMD).

4.1.1 Rainfall

Rainfall or precipitation is one of the most important components of hydrological cycles. Rainfall not only creates surface runoff but also contributes to the stream flow. Like other parts of the country, rainfall is one of the important sources of surface water in the catchment area and in the present catchments river system. There are eight BWDB rainfall stations such as Chaugachha, Jessore, Benapole, Kalaroa, Keshabpur, Islamkathi, Binerpota, Kapilmuni, which are evenly spread over the proposed study area.

An attempt was made to collect 2009 rainfall data from BWDB. The data showed that the mean annual rainfall of the project area was about 1,640 mm while the maximum annual average rainfall was 1,730 mm at the Keshabpur station. On the other hand, the minimum annual average rainfall was 1,485 mm at the Islamkathi station. Both the mean annual and maximum annual rainfall was less than the national mean annual and maximum annual rainfall.

4.1.2 Evaporation

Water is transferred from the surface to the atmosphere through the process of evaporation and evapo-transpiration. Therefore, evaporation is another important component of the hydrological cycle which influences the overall water balance on the earth surface. In and around the proposed study area, there are three BWDB evaporation stations (Amla, Jessore and Binerpota) from where data were collected to estimate evaporation.

Like rainfall data, most recent evaporation data were also not readily available for the above-mentioned stations within the study area. The open water evaporation data of the study area experiences a significant variation ranging from an annual average minimum open water evaporation of 965 mm at Khulna to a maximum of 1140 mm at Binerpota (Table 4-1).

Table 4-1: Evaporation information in the study area

Station Name	Annual average (mm)
Jessore	990
Binerpota	1,140
Khulna	965

Source: BWDB

4.1.3 Temperature

There are three BMD meteorological stations (Jessore, Satkhira and Khulna) in the proposed catchments area. Data from these stations were considered for preparing the baseline of the proposed catchments area. As temperature varies widely from dry season to monsoon season, temperature data were analysed separately for the two seasons (dry season - November to May, and monsoon season - June to October) as per the NWMP guidelines. The study area is situated in warmer part of the country where the annual maximum average temperature varies from 26.0 0C to 36.5 0C within March to October. Annual minimum temperatures were recorded from November to February at a range between 11.0 0C to 26.0 0C. Increased cloud cover prevents extreme temperature intensity from June to September.

4.1.4 Humidity

The study area is located in the region of high relative humidity. Like other parts of the country, relative humidity during dry season is comparatively less than in the monsoon. The humidity data for the year 2009 in three meteorological stations (Jessore, Satkhira and Khulna) are presented in Table 4-2. The average humidity values of these three stations during dry season are almost the same and the calculated average humidity in this area is 76% while during monsoon season, the average humidity value varies between 86% and 87%. This shows no significant variation of humidity.

Table 4-2: Seasonal average relative humidity (%) in the study area in 2009

Station name	Station ID	Average relative humidity, 2009	
		Dry season (November–May)	Monsoon season (June-October)
Jessore	11407	77	86
Satkhira	11610	74	86
Khulna	11604	76	87
Average humidity in the study area		76	86

Source: BMD, 2009

4.1.5 Wind speed

The BMD records indicate a significant variation in the mean wind speed across the catchments area. The average wind speed at the Jessore station is 6.3 knots. The monthly average distribution of wind speed show a flat distribution from Khulna to Faridpur (3.3 knots) and Jessore with peaks in the month of the April. The wind speed distribution at the Satkhira station shows two peaks during April and August.

4.1.6 Sunshine hour

The study area experiences wide variations in the distribution of sunshine hours, ranging from a mean annual of 6 hours to a maximum of 7.5 hours in Jessore and Satkhira district. The sunshine hours in the monsoon season from June to September are much lower than during the rest of the year.

4.2 Water Resources

The water resources system in the catchments identified in the People's Plan for management of rivers in the southwest region is described in the following sections.

4.2.1 Sholmari-Salta-Lower Bhadra System

4.2.1.1 Present status

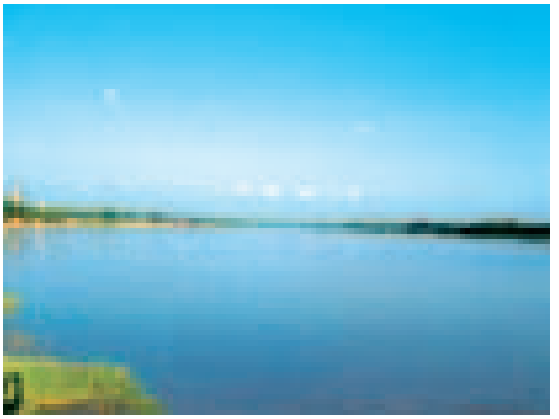
The famous Beel Dakatia is situated in the upstream of the river Upper Sholmari. Under KJDRP a 10-vent regulator (Picture 4-1) was built at the mouth of the Sholmari River to stop the river flow. The Lower Sholmari and the Lower Salta are dredged regularly to keep them alive. Water from the upstream is connected with the Lower Sholmari and the Lower Salta through the Rupsa River. The people had hoped that by this link the navigability of the rivers would remain regular for a long time. But water from the Gorai catchment is not available any more except in the rainy season. People reported that the navigability of these rivers had reduced significantly because of the pillars of the bridges over the Rupsa and the Batiyaghata.

Picture 4-1: 10-vent regulator at the Lower Sholmari

4.2.1.2 Major problems

1. The *Jhapjhopiya* River, linked with the *Lower Salta*, has died and the *Bhadra* River which divided polder number 22 and 31 has also died. So, water logging in that area has expanded.
2. The *Lower Salta* and the *Lower Sholmari* are also facing navigation problems. Launches, cargos and other big boats cannot pass through these rivers.
3. Water logging of the *Beel Dakatia* area is not very visible because of many mud walls (*gherveri*). After a heavy downpour lasting two or three days the lower part of this area goes under water and most of the mud walls (*gherberi*) are being washed away.
4. During the dry season farmers in most of the areas cultivate their land by draining out water.

Picture 4-2: Upper Salta River



Picture 4-3: Lower Salta River

4.2.2 Hamkura-Bhadra-Joykhali Catchment System

4.2.2.1 Present status

In this catchment, the *Hamkura*, *Bhadra* and *Joykhali* rivers are the main drainage channels. *Beel Dakatia* is situated in the upstream of the *Hamkura* River. About 15 years back (from 1991 to 1994), the people used to implement TRM in this beel on their own. Thus, the *Hamkura* and other associated downstream rivers became full of current. In 1994 the BWDB discontinued TRM.

4.2.2.2 Major problems

1. The *Hamkura*, the *Bhadra* and the *Upper Salta* are now dead rivers. The upstream of the *Joykhali* and *Kakmari* rivers have also died. As a result, water logging in those areas has expanded.

2. The *Hamkura* catchment area comprises low-lying land compared to other surrounding catchments. So, there is no alternative way to drain off water properly from this catchment. At present, most of the areas of the *Hamkura* catchment are linked with the *Upper Sholmari* River. Therefore, a problem has arisen regarding drainage of water from the *Sholmari* catchment.

3. Rice farming is not possible here during monsoon. In the dry season, farmers cultivate most of their agricultural land by draining out water from it.

Picture 4-4: Hamkura River

Picture 4-5: Hamkura sluice gate at the Hamkura River

4.2.3 Hari- Mukteshwari Catchment System

4.2.3.1 Present status

This river catchment is known as the *Bhabodaha*. In 1965, the biggest regulator of the coastal area was built in the river *Mukteshwari* (21+9 vent). No sluice gate was built at the *Shree* River which faces *Beel Dkatiya.* Instead, a dam was built to stop the river flow. Local people had implemented TRM in *Bhayna Beel* of this catchment from 1997 to 2000. In *Beel Kedariya* BWDB implemented TRM from 2001 to 2004, while in *Khukshia Beel* TRM has been in operation since 2006.

4.2.3.2 Major problems

1. Cultivation is not possible here during rainy season, but in the dry season farmers cultivate most of their agricultural land by pumping out water from it.

2. In Beel Khukshiya silt is being deposited near the cut point only, which was not expected.

3. The problem of water-logging at the upstream of 27 beels has not been solved.

4. Last year's cyclone Aila hit the coastal area which broke the TRM embankment and inundated the area.

5. In the lower part of Sholegatiya of Agorhati, habitats and homesteads have gone under water as the TRM embankment was broken.

6. The Hari and Teligati rivers are in navigable condition, as TRM has been implemented in Beel Khukshiya. But the downstream of the Ghengrile River is being filled with silt which hampers the implementation of TRM. As a result, water-logging of the Hari and Upper Bhadra river catchment areas cannot be prevented.

7. Every year people of Bhabadaha and Beel Dakatia are involved in bloody conflicts regarding drainage of water from the Bhabadaha area through Beel Dakatia.

Picture 4-6: Hari River

Picture 4-7: Mukteshwari River

4.2.4 Upper Bhadra- Buri Bhadra- Harihar Catchment System

4.2.4.1 Present status

The local people have implemented TRM in *Buruli* and *Pathra* Beel of *Upper Bhadra* catchment more than once. In 1998, CEGIS in its survey report recommended that two beels were ideal for TRM to be put into operation. But later no initiative was taken by the BWDB or other organisations to implement TRM in those two beels. Every year during dry season, a cross dam is built in Kashimpur to make the *Upper Bhadra* River silt-free. But it was not built or removed in proper time.

4.2.4.2 Major problems

1. The *Buri Bhadra* and *Harihar* rivers in the upstream are dying gradually.

2. Rivers are being filled up with silt because of mismanagement in building and removing the cross dam in Kashimpur.

3. Incessant rain lasting two or three days submerges the whole area.

4. Water from the *Kapotakshi* catchment enters into this catchment which increases water-logging.

5. The *Upper Bhadra-Harihar* river catchment is famous for growing vegetables and trading. In the dry season, it is not possible to carry vegetables and do business through waterways as a cross dam has been built in Kashimpur. Rivers have become fishless and irrigation has also been hampered.

6. As a dam is built in the dry season, water cannot be drained away from many areas. As a result, Boro cultivation is hampered.

Picture 4-8: Upper Bhadra River

Picture 4-9: Buri Bhadra River

4.2.5 Teligati-Ghengrile Catchment

4.2.5.1 Present status

The combined flow of the *Hari* and the *Upper Bhadra,* taking the name *Teligati- Ghengrile*, flows from *Kashimpur Trimohona* and meets the *Baroyaria* estuary. In the 1970s, a sluice gate and an embankment were built on *Kulbaria* at the upstream of the *Ghengrile*.

4.2.5.2 Major problems

As a cross dam is built in the *Upper Bhadra* river in the dry season and silt is not being deposited in *Khukshia Beel* at an expected rate, the downstream of the *Ghengrile* River appears to be in a deplorable state. The drainage of water from the *Teligati-Upper Bhadra* and *Hari* catchment depends on the navigability of the *Ghengrile* River. As the lower part of the *Ghengrile* River has become high with siltation, implementation of TRM in the *Hari* and *Upper Bhadra* rivers is at risk. Water-logging has expanded in the *Teligati-Ghengrile* catchment area.

1. The *Badurgachha Mohashoshan Ghengrile* River, facing the *Salta* and *Taltola* rivers, has been detached.
2. The *Badurgachha* which links the *Ghengrile* River with the *Teligati* has become a dead river.
3. As the *Hamkura* River is dead, the *Teligati* River is now disconnected from the *Bhadra* River.
4. The *Kakmari* River, which linked the *Ghengrile* with the *Joykhali*, is dead now.
5. The *Guachapa* River, which connects with the *Salta* River, is dying gradually.

Picture 4-10: Teligati-Ghengrile River

4.2.6 Salta- Gunakhali -Haria Catchment System

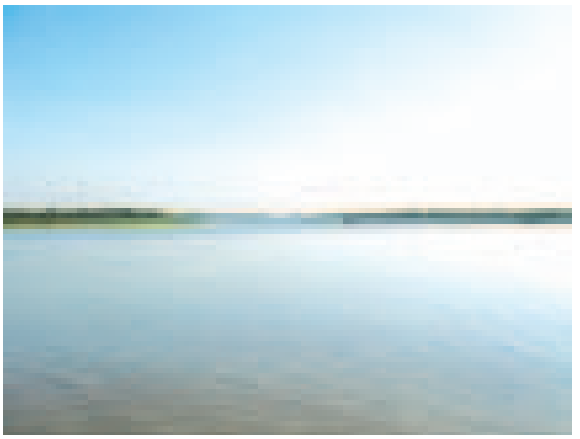
4.2.6.1 Present status

Water-logging of the *Salta* catchment area is gradually increasing. On both sides of the catchment numerous shrimp enclosures have been developed. This river is still alive because water flows through it to shrimp farms. If embankments and sluice gates are built in the upstream of the *Salta* and *Ghengrile* rivers, the *Salta* River would face problems. As a result, the branches would get detached, and the *Salta* would lose its navigability.

4.2.6.2 Major problems

1. The *Taltoli* and *Haria* rivers are detached from the *Salta* River.
2. At the *Langolmora Trimohini* point, the *Salta* and the *Gunakhali* are linked with the *Ghengrile* through the *Guachapa* River. This part of the river is dead now.
3. The *Salta* River is dying gradually as it is being filled up with silt.
4. Though the *Gunakhali* River is still navigable, within two or three years it would face the same fate as that of the *Salta*.
5. Water-logging in this catchment is gradually expanding and its intensity is increasing. This catchment was affected by the cyclone Aila.
6. There is a continuous conflict between the rice cultivators and the fish cultivators of the area.

Picture 4-11: Upper Salta river (disconnected)



Picture 4-12: Lower Salta river

4.2.7 Kapotakshi Catchment System

4.2.7.1 Present status

The *Kapotakshi* is an important river of the south-west region. This river meets the ocean. The fate of 20 lakh people of this catchment is dependent on this river. From *Raruli Katipara* of *Paikgachha* upazila, the lower part of *Kapotakshi* (82 km) became detached from the main *Kapotakshi*.

4.2.7.2 Major problems

From *Boaliya* of *Raruli Katipara* to *Katakhali Kheyaghat*, 18 km of the river is filled so heavily with silt that water cannot reach it even during high tide. The river from *Katakhali* to the *Chandkhali* is almost dead. At the upstream of the *Chandkhali* near Borodal, a branch named *Morirchap* from *Ashashuni* is linked with the *Kapotakshi*. This part of the *Morirchap* River is also going to die.

The river will rapidly die up to the *Amadi* point. Because of the existence of the *Koyra* River, which connects with the *Kapotakshi*, it is expected that from *Amadi* and downwards the condition of the river would not deteriorate so soon. The lower part of the *Amadi* River will be navigable because of the *Koyra* River which connects with the *Sibsa* River.

Picture 4-13: Kapotakshi River at Tala

Picture 4-14: Kapotakshi River at Paikgachha

4.2.8 Shalikha Catchment System

4.2.8.1 Present status

The *Shalikha* catchment is the smallest cathchment among the eleven drainage systems in the study area. This system drains about 11,375 ha of land, which is about 3% of the study area. The system comprises the *Dalua* and *Shalikha* rivers as its main drainage artery. These rivers collect water from land run off and drain it to the *Kapotakshi* River through the *Shalikha* regulator. Since the 1980s, the river started to decline in cross-sections with the reduction of its tidal volume. In the 1990s, the sedimentation in the *Shalikha* River impeded the drainage of its catchment area. In the second half of the 1990s, it became difficult to maintain the river section even by manual or mechanical dredging.

4.2.8.2 Major problems

The water drainage system of the dead *Shalikha* and *Pakuria* river catchments, connected to the area from the *Shalikha* sluice gate to the *Katakhali Kheyaghat* where the river is dead due to silt deposit, is now directed to the *Betna*. In the eastern part of the river, from the *Binerpota* Bridge to the *Gunarkati* Bridge, there are 8 sluice gates which have 21 vents. There are very few sluice gates to drain away water from the huge *Shalikha* and *Pakuria* catchment. Apart from that, these sluice gates are not very effective. Recently, the BWDB has taken the initiative to repair the sluice gates. It is heard that a khalashi has been appointed by the government to look after these eight sluice gates.

Picture 4-15: Shalikha River

4.2.9 Betna Catchment

4.2.9.1 Present status

The *Betna* is one of the big rivers in the area. It originates from the *Bhairab* River of *Maheshpur* Upazila Sadar. One hundred and fifty years (approx.) ago *Betna* became detached from the *Bhairab*. The *Betna*, at the upstream of the Kalaroa, has become a closed water body and drainage canal.

Each year 5/7 km of the river dries up starting from the upstream of the *Kalaroa* and tidal water cannot flow through the dead section. From the downstream of the *Binerpota* to the *Murarikati* of Jhaudanga, 20 km of the river is now on the verge of death. People can cross over another 20 km of the river during low tide simply on foot. During that time, only small boats can pass through the river.

4.2.9.2 Major problems

1. Every year, during monsoon, 20-25 km area of the catchment is flooded which requires relief operations. Water-logging has become a permanent problem of this area.

2. Water from the *Shalikha*, *Pakuria* and *Kapotakshi* canals in the east and from the *Noukhal* and *Pransayer* canals in the west as well as from the *Morirchap* catchment is creating pressure on the *Betna* catchment on the way to being drained off. For this reason water from the *Betna* area drains off slowly.

3. A number of sluice gates were required to drain away surplus water, but they were not built on both sides of the *Betna*. The existing sluice gates have lost their draining capacity due to the lack of maintenance.

4. The shrimp farmers had created a number of small pipe gates in the river embankment to take in salt water from the coastal rivers into their hatcheries. But when they repaired the embankment they did not make it as high as it was before. So, when the Aila hit the area, those points overflowed easily and a vast area became damaged by the cyclone.

Picture 4-16: Betna River during ebb tide

Picture 4-17: Encroachment of the Betna River by ghers and homesteads

4.2.10 Morirchap and Labonyabati Catchment System

4.2.10.1 Present status

The *Morirchap* and the *Labonyabati* are two different rivers. A part of the *Labonyabati* is also known as the *Kumrokhali* River. The *Labonyabati* is a branch of the *Ichhamati* River which originates from beside the 15-vent sluice gate of the *Padma Shakhra*. This river is divided into many branches at the downstream most of which are connected with the Morirchap. The *Labonyabati* flows through the *Bankal* canal and under the *Alipur* Bridge in Satkhira and then connects with the *Morirchap* River and *Pran Shayer* canal. This is the main stream of the *Labonyabati*. Other streams, known as *Kolkatar Khal, Shrirampurer Khal* and *Tiketer Khal* were linked with the *Morirchap*. A sluice gate was built at the

linking point. The *Marchchap* meets the *Betna* and the *Kholepetua* at the downstream.

The *Balitha Trimohona* is situated on *Ilarchar* in Satkhira. Here, the *Morirchap* is linked with *Pran Shayerer Khal*. A 15-vent sluice gate has been built at the upstream of *Trimohona* at the *Morirchap* River.

4.2.10.2 Major problems

1. After the sluice gate was built, silt was deposited on both sides of the gate which gradually made it totally ineffective in draining out water. So, the area under the 15-vent is totally dependent on the *Labonyabati* for draining out water.

2. From *Balitha* to the *Kamalkathi* sluice gate, 15 km of riverbed of the *Morirchap* became filled up with silt and the drainage system failed. On both sides of the river water-logging is turning into floods.

3. The water under the sluice gates of the west side of the river is now also flowing towards the *Labonyabati*.

4. However, as the *Labonyabati* catchment is higher than the *Morirchap* catchment, water cannot flow properly from the lower part into the higher part. So, water- logging problem of these lower areas of the *Morirchap* catchment cannot be solved. Because of this reason local people have built mud walls (*gherveri*).

Picture 4-18: Morirchap River

Picture 4-19: Encroachment of Morirchap River

Picture 4-20: Labonyabati River

Picture 4-21: Encroachment of Labonyabati River

4.2.11 Shapmara- Galgheshiya Catchment

4.2.11.1 Present status

The *Shapmara* River is another branch of the *Ichhamati*, which is located in *Bhatshala* of *Debhata* upazila. At the downstream, two branches of the *Shapmara* from *Katakhali* of *Badurtola*, *Haora* and *Shalkhali* flow down to the *Choumohona* of *Ujirpur* and the *Morirchap* of *Kamalkati* respectively.

4.2.11.2 Major problems

1. A sluice gate was built in *Bhatshala* to obstruct the free link with the *Ichhamati*.
2. By building sluice gates at *Kamalkati* and Tikiti of the *Morirchap*, the *Shapmara* was separated from the *Morirchap*.
3. *Shapmara* is not linked with *Kakshiali* anymore.
4. The flow of the *Gutiakhali* River, of *Ujirpur Choumohona*, towards *Morirchap* has been impeded by making a dam.
5. The *Haora (Habra)* riverbed is filled with silt and is dying gradually, and the *Galgheshiya* River is now facing navigation problems.
6. Thousands of hectares of cultivable land of this area are left uncultivated due to water-logging. During dry season, shrimp cultivation is hampered for lack of water supply into the '*gher*'.

Picture 4-22: Confluence of Ichhamati & Shapmara

Picture 4-23: Shapmara River

4.3 Climate Change Perspective

Climate change is happening and it is a reality. As a consequence, pronness of floods, droughts, storms/cyclones, salinity intrusion, etc has started showing the increasing trend along with associated potentials of devastation to crops, lives and livelihood and to infrastructures. Most victims of such changes are poor, they loss more but recover less. Climate change phenomena may cause moderate inceases in monsoon rainfall while moderate decrease in dry season rainfall. Bangladesh has been identified as one of the 27 most vulnerable countries likely to be adversely impacted due to global warming induced accelerated sea level rise. Sea levels will rise over the century by around half a meter (IPCC). Effect of sea level rise may increase inundated areas up to 3% (2030s) and 6% (2050s) primarily in coastal low lying areas. Brackish water area may increase by 6% and 2% respectively in dry and wet seasons based on A2 emission scenario by 2050.

4.4 Land Resources

4.4.1 Agro ecological region

As a part of a Land Resources Appraisal of Bangladesh for agricultural development, Bangladesh has been sub-divided into 30 agro-ecological regions and 88 sub-regions. The major components of these regions and sub-regions are physiography, soil properties, soil salinity, and depth and duration of flooding which are relevant for land use and for the assessment of present and future agricultural potential. The geographic area of the water management project of the south-western coastal region comprises three agro-ecological regions: (i) the High Ganges River Floodplain (AEZ-11), (ii) theGanges Tidal Floodplain (AEZ-13), and (iii) the Gopalganj-Khulna Beels (AEZ-14), Map 4-1. The Agro-ecological regions of the project areas are described below.

4.4.2 High Ganges River Floodplain

This region includes the western part of the Ganges River Floodplain which is predominantly high land and medium high land. Most of the areas have a complex relief of broad and narrow ridges and inter-ridge depressions separated by areas with smooth broad ridges and catchments.

There is an overall pattern of olive–brown silt loams and silty clay loams on the upper parts of the floodplain ridges and dark grey, mottled brown mainly clay soils on ridge sites and in catchments. Most ridge soils are calcareous throughout. The general soil types predominately include Calcareous Dark Grey Floodplain soils and Calcareous Brown Floodplain soils. Organic matter content in brown ridge soils is low and higher in dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low. The area of the study site in the High Ganges River Floodplain belongs to 11a: south-western and 11b: northern sub regions.

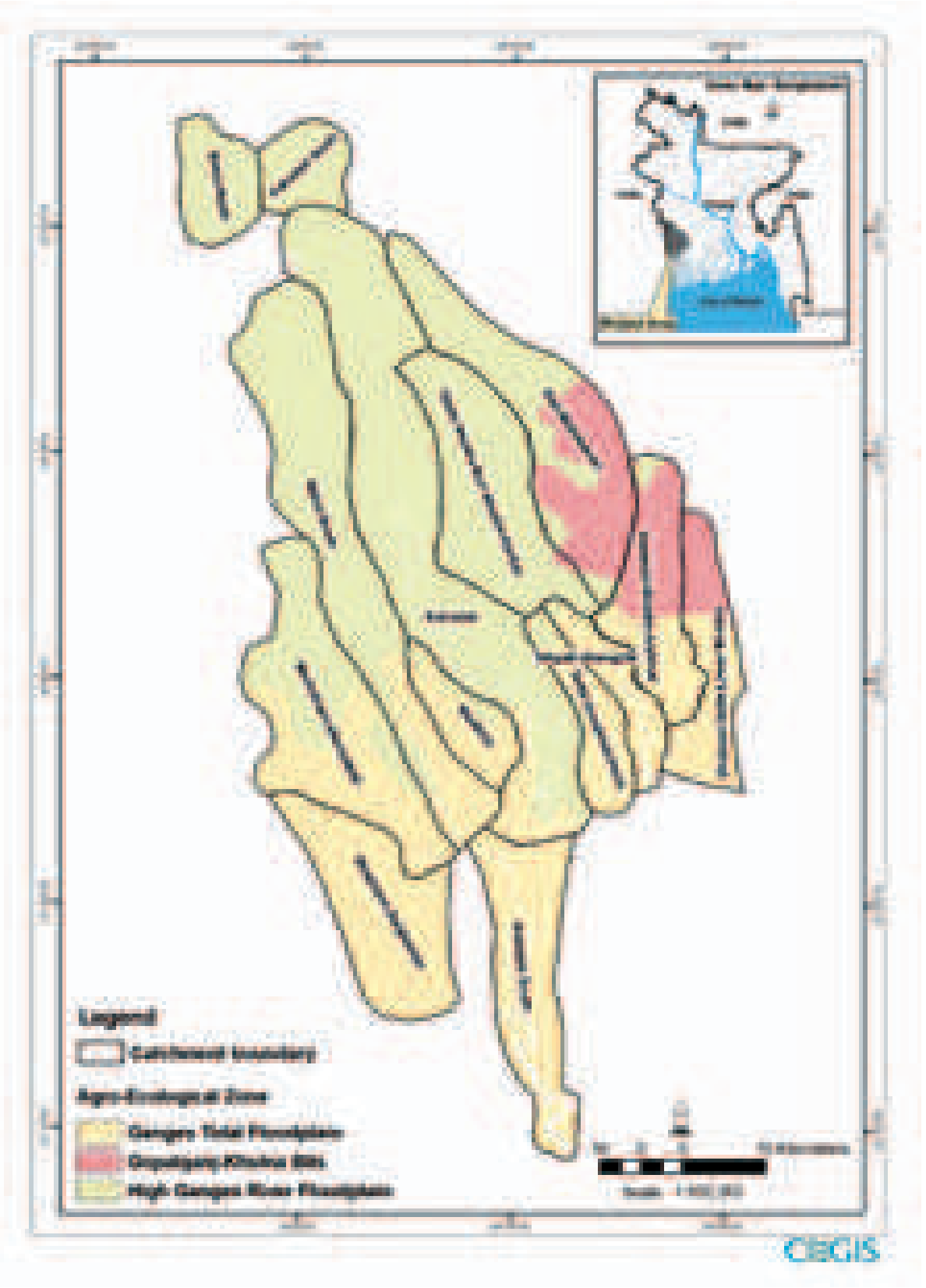
4.4.2.1 Ganges Tidal Floodplain

This region occupies an extensive area of tidal floodplain land in the south-west of the country. The Ganges Tidal Floodplain has low relief compared to the Ganges River Floodplain. The area is criss-crossed by innumerable tidal rivers and creeks whose banks generally stand less than a meter above the adjoining catchments. The whole of this zone lies within the cyclone zone. The main tidal rivers in the project areas are the Rupsa, the Bhadra, the Teligati, the Kapotakshi, the Ichhamati, the Betna, the Kumarkhali, the Upper Bhadra, etc.

Under natural conditions, this area used to be flooded at high tide, either throughout the year or during rainy season when rivers entering from the north brought in increased flows. In the southwest, the embankments have cut off this tidal flooding in places, but catchment sites are flooded by rain water which accumulates in the monsoon season. Most of the rivers are saline throughout the year in the west. In the east, they carry fresh water to the coast during rainy season, and only become saline in their lower courses during the dry season. Most of the eastern half of the unit is non-saline throughout the year. Therefore, tidal and seasonal flooding are mainly shallow, but the catchment centres in the north are moderately deeply flooded in the monsoon season. The Ganges Tidal Floodplain consists of three subunits namely, non-saline, saline and the Sunderbans.

There is a pattern of grey, slightly calcareous, heavy soils on riverbanks and grey to dark grey, non-calcareous, heavy silty clays in the extensive catchments. Non-calcareous grey floodplain soil is the major component of general soil types. Acid Sulphate soil also occupies a significant part of the area where it is extensively acidic during dry season. In general, most of the top soils are acidic and sub-soils are neutral to mildly alkaline. Soils of the Sundarbans area are strongly alkaline. The fertility level is generally high with medium to high organic matter content.

The Ganges Tidal Floodplain region occupies an extensive area of tidal floodplain land in the south-west of the country.



Map 4-1: Agro-ecological zone of the project area

4.4.2.2 Gopalganj-Khulna Beels

The region occupies extensive low-lying areas between the Ganges River Floodplain and the Ganges Tidal Floodplain. Almost level, low-lying catchments occupy most of the region with low ridges along rivers and creeks. The region has two sub-regions such as 14.a: Bil margins and 14.b: Bil centers.

Soils of the area are grey and dark grey acidic heavy clays overlying peat or muck at 25-100 cm. Soft peat and muck occupy perennially wet catchment centres. The general soil types include mainly peat and non-calcareous dark grey floodplain soils. Organic matter content is medium to high. Fertility level is medium.

4.4.3 Soil texture

Soil texture is the relative proportions of sand, silt and clay. It is very important for agricultural crop production. Soil texture in the study area varies from clay, clay loam and loam. The soil texture in each catchment of the study area is presented in Table 4-3.

Table 4-3: Soil texture of different catchments of the study area

Name of Catchments	Soil texture with depth(cm)	% of NCA		
		Clay	Clay loam	Loam
UpperSholmari- Lower Salta Catchment	Topsoil	65	35	-
	Subsoil	65	35	-
	Substratum	30	35	35
Hamkura-Bhadra-Joykhali	Topsoil	30	70	-
	Subsoil	40	60	-
	Substratum	30	30	40
Hari- Mukteshwari	Topsoil	38	42	20
	Subsoil	40	35	25
	Substratum	45	35	20
Upper Bhadra-BuriBhadra-Harihar	Topsoil	20	60	20
	Subsoil	25	45	30
	Substratum	20	55	25
Teligati-Ghengrile	Topsoil	50	50	-
	Subsoil	75	25	-
	Substratum	80	20	-
Salta-Gunakhali Haria	Topsoil	60	40	-
	Subsoil	50	50	40
	Substratum	30	30	
Kapotakshi Catchment	Topsoil	40	35	25
	Subsoil	45	30	25
	Substratum	50	30	20
Shalikha	Topsoil	55	30	15
	Subsoil	60	25	15
	Substratum	50	40	10
Betna Catchment	Topsoil	60	30	10
	Subsoil	65	25	10
	Substratum	60	30	10
Morirchap-Labonyabati	Topsoil	65	30	5
	Subsoil	65	25	10
	Substratum	70	20	10
Shapmara-Galgheshiya	Topsoil	50	35	15
	Subsoil	50	40	10
	Substratum	55	35	10

N.B. Topsoil =0-15cm; Subsoil=15-60cm; and Substratum=60-120 cm

4.4.4 Land types

Land type classification is based on depth of inundation of agriculture land during monsoon season in an average flood year. There are five land type classes as described in Table 4-4.

Table 4-4: Classification of land type on the basis of flooding for agriculture

Land Type	Description	Flooding depth	Flooding characteristics
F0	Highland	0-30 cm	Non flooded to intermittent
F1	Medium Highland	30-90 cm.	Seasonal
F2	Medium Lowland	90-180 cm	Seasonal
F3	Lowland	180-300 cm	Seasonal, but remains wet in early dry season
F4	Very Lowland	> 300 cm	Seasonal but remains wet in most of the dry season

The ranges of high land, medium high land, medium low land and low land are 2-18%, 66-90%, 0-20% and 4-7% respectively in the catchments areas of the project. However, the average percentages of land types are about 8.3, 81.9, 7.6 and 2.2 of the Net Cultivable Area (NCA) for high land, medium high land, medium low land and low land respectively. The distribution of land types under different catchments is shown in Table 4-5.

Table 4-5: Area in percentage of the land type in different catchments

Catchments	Area (%)				
	F0	F1	F2	F3	F4
1.Upper Sholmari- Lower Salta Catchment	12	66	15	7	0
2.Hamkura-Bhadra-Joykhali	10	70	20	0	0
3.Hari- Mukteshwari	18	82	2	0	0
4.UpperBhadra-BuriBhadra-Harihar	15	80	5	0	0
5.Teligati-Ghengrile	2	80	18	0	0
6.SaltaGunakh-ali Haria	5	90	5	0	
7.Kapotakshi Catchment	4	85	7	4	
8. Shalikha	6	78	10	6	0
9. Betna Catchment	10	85	5	0	0
10.Morirchap-Labonyabati	5	85	6	4	0
11.Shapmara-Galgheshiya	8	77	10	5	0
Study Area	25,328	2,49,392	23,359	6,915	0
% Area	8.3	81.9	7.6	2.2	0.0

Source: CEGIS Estimation from SRDI

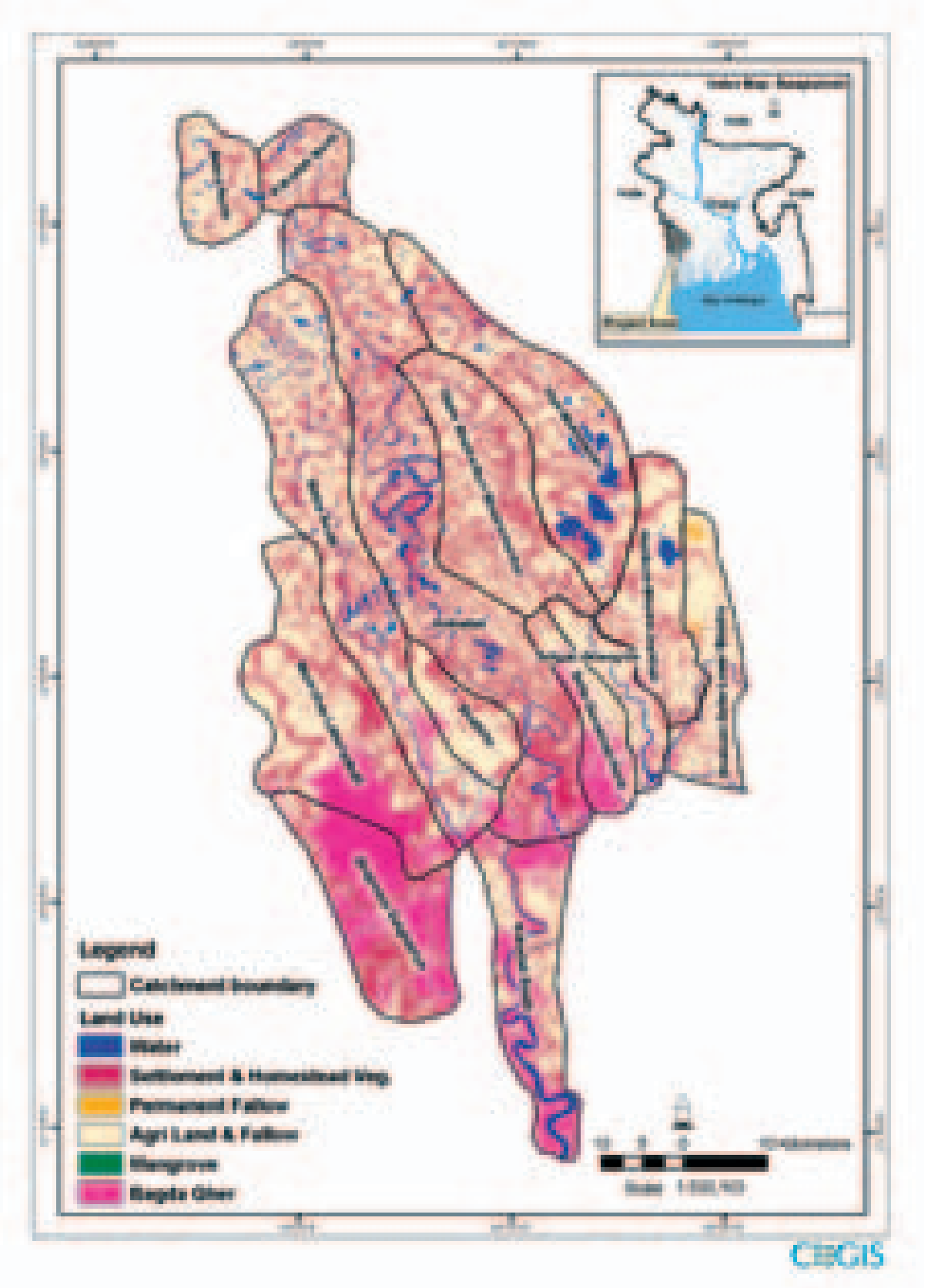
4.4.5 Land use

The total area of the water management project of the south-western coastal region of Bangladesh is 4,24,021 ha of which 3,04,656 ha is the NCA. The percentage of land utilisation for crop production is about 72%. About 20% and 8% of area are covered by settlements and water bodies (water bodies, ponds and rivers) respectively. The overall land utilisation for single, double and triple cropped areas are 44.8%, 42.8% and 4% respectively. About 8.4% of area remains fallow in the entire study site. The whole NCA is not being utilised currently for crop production, but a significant part of the area is being used for fish culture especially brackish water shrimp culture. A sizable area is also covered with fish (white)-cum paddy (T.Aman Local). The details on land use are presented in Table 4-6 and Map 4-2.

Table 4-6: Present land use of different catchments of the study area

Name of Catchments	Area (ha)							
	Gross	NCA	Single Crop	Double Crop	Triple Crop	Fal low	Settle ment	Water bodies
1.Upper Sholmari-Lower Salta Catchment	19,004	13,521	5,679	4,462	676	2,704	2,243	3,240
2.Hamkura-Bhadra-Joykhali	22,998	16,079	4,181	10,291	-	1,607	3,899	3,020
3.Hari- Mukteshwari	42,003	27,398	2,740	17,808	-	6,850	9,384	5,221
4.UpperBhadra-BuriBhadra-Harihar	36,999	23,433	11,716	10,545	-	1,172	11,699	1,867
5.Teligati-Ghengrile	10,741	8,463	5,501	2,116	-	846	1,025	1,253
6.SaltaGunakh-ali Haria	13,072	10,713	7,392	2,250	-	1,071	1,022	1,337
7.Kapotakshi Catchment	1,21,297	81,509	28,528	43,198	5,706	4,077	29,729	10,059
8. Shalikha	11,375	9,323	5,314	3,170	466	373	1,390	662
9. Betna Catchment	69,535	52,961	23,832	22,244	4,236	2,648	13,811	2,763
10.Morirchap-Labonyabati	44,995	35,622	23,510	9,261	1,069	1,782	7,689	1,684
11.Shapmara-Galgheshiya	32,002	25,634	3,845	19,225	-	2,564	4,631	1,737
Study Area	4,24,021	3,04,656	1,22,238	1,44,570	12,153	25,694	86,522	32,843

Source: CEGIS field estimation



Map 4-2: Land use map of the project area

4.5 Agriculture

4.5.1 Agriculture practices

The farming practices in the Water Management project of the South-Western Coastal Region of Bangladesh is complicated due to physical, biological, climatological and socio-economic factors. The siltation of rivers and channels cause drainage congestion/ water logging during monsoon and intrusion of saline river water during high tide, and natural calamities like cyclone, and surge etc. cause crop damage in the project area. Scarcity of sweet irrigation water during dry season is also responsible for the non expansion of agriculture farming practices. On the other hand, the availability of saline surface water creates favorable environment for brackish water shrimp as well as paddy-cum-white fish culture. However, Boro (HYV) rice cultivation is also practised in some areas of the project. Agro ecological environments are not uniform throughout the area. These different environments are suitable for cultivating different crops and adopting different cropping patterns under irrigated and non-irrigated conditions.

Farming practices largely depend on the cropping seasons. In Bangladesh, there are two distinct cropping seasons in a year. They are the Kharif and Rabi seasons. The Kharif season starts from March and ends in October. This season is influenced by the monsoon climate with high rainfall and temperature. Based on crop adaptability and crop culture, the Kharif season has been subdivided further into Kharif 1 (March-June) and Kharif II (July-October) seasons. Kharif-1 season is characterised by the uncertainty of weather of alternating dry and wet spells. But the Kharif-II comprises of wet and cloudy environment and is not favorable for high yields because of uneven distribution of rainfall, flooding depth, low solar radiation, high temperature and humidity. Rice is the predominant crop during this season due to submergence of soils. Among the rice crops, Aus is grown in Kharif 1 season and T. Aman in Kharif-II season. B. Aman occurs in both the seasons. In the project area, the practice of Aus is very limited.

The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the yield of crop. Rabi crops such as wheat, oil seeds (mustard, Til), vegetables are generally grown. Boro (HYV) rice crops are grown extensively in this season.

4.5.2 Existing cropping patterns

In the project area, single cropping patterns are dominant (44.8%) followed by double cropping pattern (42.8%). About 4% of area is occupied by triple cropping patterns. About 8.4% of the study area remains fallow. Recently, the fallow lands are being utilised for brackish water shrimp culture and fish (white fish)-cum- rice.

Fallow- T.Aman (Local)- Fallow cropping pattern covers most of the area (23.8%), which is followed by Fallow- Fallow Boro (HYV) cropping pattern (21.0%). The third and fourth highest cropping patterns are Fallow-T.Aman (Local)-Boro (HYV) and Fallow-T.Aman (HYV)-Boro (HYV) which occupy about 20.2% and 15.2% respectively of the Net Cultivable Area (NCA). A summary of the existing cropping patterns of the entire study area is shown in Table 4-7.

It is observed that in Kharif-I season, most of the area (88.8%) in this zone remains fallow (88.8%). Jute, vegetables and Aus cover about 4.4%, 3.3%, and and 3.5% respectively. In the Kharif-I season, Aus crop is practised. Both HYV and local varieties of Aus are used. Aus crops are practised either broadcast or transplanted depending on the availability of irrigation. Hence in Kharif-I season, T.Aus or B.Aus is collectively referred to as Aus only.

In Kharif-II season, T.Aman (Local) occupies about 44.5% which is followed by high yielding variety of transplanted Aman (HYV T.Aman). The percentage of this crop is 18.9%. In this season, about 36.6% of land remains fallow.

In the Rabi season, HYV Boro is the main crop which covers about 56.4% of the NCA. Some Rabi crops such as oilseeds, wheat, pulses, spices and potato cover about 2.5%, 2.1%, 0.8%, 2% and 0.5% respectively. About 32.2% of the NCA remain fallow in the Rabi season.

It may be mentioned that the area of shrimp has not been considered as agricultural crops. So, the cropping intensity has been calculated excluding the shrimp culture area.

The present average cropping intensity of the study area is about 143%

Table 4-7: Summary of the existing cropping patterns of the project area

Study Area	Kharif-I	Kharif-II	Rabi/Boro	Area (ha)	% NCA
All 11(eleven) catchments of the project	Fallow	T.Aman (HYV)	Vegetables	575	0.2
	Fallow	T.Aman (Local)	Boro (HYV)	61742	20.2
	Fallow	Fallow	Boro (HYV)	63,891	21.0
	Vegetables	Fallow	Vegetables	9,922	3.3
	Fallow	T.Aman (Local)	Fallow	72,555	23.8
	Fallow	T.Aman (HYV	Boro (HYV)	46,469	15.2
	Aus	T.Aman (HYV)	Oilseeds	7,512	2.5
	Aus	T.Aman (HYV)	Wheat	3,053	1.0
	Jute	Fallow	Pulses	2,291	0.8
	Jute	Fallow	Spices	6,103	2.0
	Jute	T.Aman (Local)	Potato	1,588	0.5
	Jute	Fallow	Wheat	3,260	1.1
	Fallow	Fallow	Fallow	25,692	8.4
Net Cultivable Area (NCA)=3,04,653 ha & Cropping Intensity=143%				**3,04,653**	**100**

The cropping patterns of 11 (eleven) different catchments are presented in Table 4-8.

It is observed that the dominant cropping pattern is Fallow- Fallow-Boro (HYV) which is followed by Fallow-T.Aman (Local)-Boro (HYV) in the Upper Sholmari- Lower Salta catchment area. In the Hamkura-Bhadra-Joykhali catchments, Fallow-T.Aman (Local)- Boro (HYV) occupy about 50% which is followed by Fallow-Fallow-Boro (HYV). The prominent cropping pattern of Hari-Mukteshwari is Fallow-T.Aman (Local)-Boro (HYV) which is followed by Fallow-T. Aman (HYV)-Boro (HYV). In the Upper Bhadra-BuriBhadra-Harihar catchment area, the dominant cropping pattern is Fallow-T.Aman (HYV)-Boro (HYV) which is followed by Single Boro (HYV) i.e. Fallow- Fallow- Boro(HYV). In the Teligati- Ghengrile catchment area, Fallow- T.Aman (Local)-Fallow occupy about 40% which is followed by Fallow-T. Aman (Local)- Boro (HYV) / Fallow-Fallow-Boro (HYV) patterns. The Fallow-Fallow-Boro (HYV) and Fallow-T.aman (Local)-Fallow cropping patterns cover about 40% and 25% respectively of the NCA in Salta-Gunakhali Haria. In the Kapotakshi Catchment Catchments area, Fallow-T.Aman (HYV)- Boro (HYV) and Fallow-T.Aman (Local)-Fallow cover about 26% and 22% respectively of the NCA. Three cropping patterns such as Fallow-T.Aman (Local)-Boro (HYV), Fallow-T.Aman (Local)-Fallow and Fallow-Fallow-Boro (HYV) cover more or less identical areas in the Shalikha catchment. In the Betna catchment area, the most prominent cropping pattern is Fallow-T.Aman (Local)–Boro (HYV) which is followed by Fallow-Fallow-Boro (HYV). About 20% area of this catchment is occupied by Fallow-T. Aman (Local)- Fallow pattern. In the Morirchap-Labonyabati catchments, T.Aman (Local) as a single crop occupy most of the area (46%) which is followed by Fallow-T.Aman (Local)-Boro (HYV) and Fallow-Fallow-Boro (HYV) which cover about 15% and 20% respectively. The Fallow- T.Aman (Local)- Fallow and Fallow- Fallow- Boro (HYV) are the two main cropping patterns in the catchments of Shapmara-Galgheshiya which occupy about 55% and 20% respectively of the NCA. The detailed catchment-wise cropping patterns are presented in Table 4-8.

Table 4-8: Existing major cropping patterns of the project area

Name of Catchment	Kharif-I	Kharif-II	Rabi/Boro	Area cover (ha)	% of NCA
1. Upper Sholmari-Lower Salta Catchment	Fallow	T.Aman(HYV)	Vegetables	406	3
	Fallow	T.Aman(Local)	Boro(HYV)	4,056	30
	Fallow	Fallow	Boro(HYV)	5,679	42
	Aus	T.Aman(HYV)	Oilseeds	271	2
	Aus	T.Aman(HYV)	Wheat	405	3
	Fallow	Fallow	Fallow	2,704	20
	Sub-total=			13,521	100
2. Hamkura-Bhadra-Joykhali	Fallow	T.Aman(Local)	Boro(HYV)	8,040	50
	Vegetables	Fallow	Vegetables	643	4
	Fallow	Fallow	Boro(HYV)	4,181	26
	Fallow	T.Aman(HYV)	Boro(HYV)	1,608	10
	Fallow	Fallow	Fallow	1,607	10
	Sub-total=			16,079	100
3. Hari- Mukteshwari	Vegetables	Fallow	Vegetables	548	2
	Fallow	T.Aman(HYV)	Boro(HYV)	7,671	28
	Fallow	T.Aman(Local)	Boro(HYV)	9,589	35
	Fallow	Fallow	Boro(HYV)	2,740	10
	Fallow	Fallow	Fallow	6,850	25
	Sub-total=			27,398	100
4. Upper Bhadra-BuriBhadra-Harihar	Vegetables	Fallow	Vegetables	1,172	5
	Fallow	T.Aman (HYV)	Boro(HYV)	9,373	40
	Jute	Fallow	Pulses	703	5
	Jute	Fallow	Spices	469	
	Fallow	Fallow	Boro(HYV)	5,858	25
	Fallow	T.Aman(Local)	Fallow	4,686	20
	Fallow	Fallow	Fallow	1,172	5
	Sub-total=			23,433	100
5. Teligati- Ghengrile	Fallow	T.Aman(HYV)	Vegetables	169	2
	Jute	Fallow	Spices	254	3
	Fallow	T.Aman(Local)	Boro(HYV)	1,693	20
	Fallow	Fallow	Boro(HYV)	2,116	25
	Fallow	T.Aman(Local)	Fallow	3,385	40
	Fallow	Fallow	Fallow	846	10
	Sub-total=			8,463	100
6. Salta-Gunakhali-Haria	Vegetables	Fallow	Vegetables	107	1
	Fallow	T.Aman(Local)	Fallow	2,678	25
	Fallow	Fallow	Boro(HYV)	4,714	44
	Fallow	T.Aman(Local)	Boro(HYV)	2,143	20
	Fallow	Fallow	Fallow	1,071	10
	Sub-total=			10,713	100

Name of Catchment	Kharif-I	Kharif-II	Rabi/Boro	Area cover (ha)	% of NCA
7. Kapotakshi	Vegetables	Fallow	Vegetables	4,075	5
	Jute	Fallow	Wheat	3,260	4
	Jute	Fallow	Spices	3,260	4
	Fallow	T.Aman(HYV)	Boro(HYV)	21,192	26
	Fallow	T.Aman(Local)	Boro(HYV)	11,411	14
	Aus	T.Aman (HYV)	Oilseeds	5,706	7
	Fallow	Fallow	Boro(HYV)	10,596	13
	Fallow	T.Aman(Local)	Fallow	17,932	22
	Fallow	Fallow	Fallow	4,077	5
	Sub-total=			81,509	100
8. Shalikha	Vegetables	Fallow	Vegetables	373	4
	Fallow	T.Aman(Local)	Boro(HYV)	2,797	30
	Fallow	T.Aman(Local)	Fallow	2,797	30
	Fallow	Fallow	Boro(HYV)	2,517	27
	Aus	T.Aman(HYV)	Oilseeds	466	5
	Fallow	Fallow	Fallow	373	4
	Sub-total=			9,323	100
9. Betna	Vegetables/	Fallow	Vegetables	2,648	5
	Jute	Fallow	Pulses	1,588	3
	Jute	Fallow	Spices	2,120	4
	Jute	T.Aman(Local)	Potato	1,588	3
	Fallow	T.Aman(Local)	Boro(HYV)	15,888	30
	Aus	T.Aman(HYV)	Wheat	2,648	5
	Fallow	Fallow	Boro(HYV)	13,240	25
	Fallow	T.Aman(Local)	Fallow	10,592	20
	Fallow	Fallow	Fallow	2,648	5
	Sub-total=			52,961	100
10. Morirchap-Labonyabati	Aus	T. Aman(HYV)	Oilseeds	1,069	3
	Fallow	T.Aman(Local)	Boro(HYV)	3,562	10
	Fallow	T.Aman(HYV)	Boro(HYV)	5,343	15
	Fallow	T.Aman(Local)	Fallow	16,386	46
	Fallow	Fallow	Boro(HYV)	7,124	20
	Vegetables	Fallow	Vegetables	356	1
	Fallow	Fallow	Fallow	1,782	5
	Sub-total=			35,622	100
11. Shapmara-Galgheshiya	Fallow	T.Aman(Local)	Boro(HYV)	2,563	10
	Fallow	T.Aman(HYV)	Boro(HYV)	1,282	5
	Fallow	T.Aman(Local)	Fallow	14,099	55
	Fallow	Fallow	Boro(HYV)	5,126	20
	Fallow	Fallow	Fallow	2,564	10
	Sub-total=			25,634	100
			Grand Total=	**304,656**	

Source: CEGIS estimation and field level observation and information from DAE, 2009-2010

4.5.3 Cropped area

Among all the crops, rice is the most dominant because of its adaptability to agro-ecological conditions prevailing in the country. Three varieties of rice crops, namely Aus, T. Aman and Boro, are grown in three crop growing seasons. The total annual cropped area of the project is 4,34,599 ha of which paddy covers about 3,76,131 ha. The area is about 86.5% of the total cropped area. The remaining 13.5% is occupied by different types of non-rice crops. Among the rice, the percentages of Boro (HYV), Aus, T.Aman (HYV) and T.Aman (Local) are 45.7%, 2.8%, 15.3%, and 36.2% respectively. A summary of the existing crop area under the project is presented in Table 4-9.

Table 4-9: Summary of crop area, total production and average yield

Crop name	Area (ha)	Production(ton)	Average Yield (ton/ha)	Production lost
Boro (HYV)	1,72,102	6,95,044	4.04	1,12,294
Aus	10,565	16,154	1.53	4,508
T.Aman (HYV)	57,609	1,44,814	2.51	25,438
T.Aman (Local)	1,35,855	2,23,201	1.64	49,954
Total Paddy	3,76,131	10,79,213	-	1,92,194
Jute	13,242	17,489	1.32	-
Oilseeds	7,512	7,585	1.0	-
Wheat	7,313	13,481	1.84	-
Pulses	2,291	2,820	1.23	-
Spices	6,103	25,444	4.17	-
Potato	1,588	22,232	14.0	-
Vegetables(S)	9,922	1,22,823	12.4	-
Vegetables (W)	10,497	1,47,653	14.0	-
Total Non-rice	58,468	3,59,527	-	-
Grand Total	**4,34,599**	**12,37,859**	**-**	**1,92,194**

Source: CEGIS estimation of 11 catchments of the study area.

Table 4-10: Catchment-wise crop area, production, yield level and production loss

Name Catchment	Name of crop	Cropped Area (ha)	Damage-free Area		Damaged Area		Total Production (m.ton)	Production loss (m.ton)
			Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
1.Upper Sholmari-Lower Salta	Boro (HYV)	9735	5841	4.75	3894	1.75	34560	11681
	Aus	676	338	2.0	338	0.7	1013	339
	T.Aman (HYV)	1082	757	3.0	325	0.8	2531	715
	T.Aman (Local)	4065	2642	2.1	1423	-	6544	1992
	Oilseeds	271	-	1.1	-	-	298	-
	Wheat	405	-	2.0	-	-	810	-
	Vegetables (W)	406	-	14.0	-	-	5684	-
						Sub-total paddy	**44,648**	**14,727**
2 Hamkura-Bhadra-Joykhali	Boro (HYV)	13,829	11,063	4.5	2,766	2.0	55,315	6915
	T.Aman (HYV)	1608	1,206	2.8	402	0.7	3,658	844
	T.Aman (Local)	8,040	5,628	2.0	2,412	0.8	13,186	2894
	Vegetables (W)	643	-	14.5	-	-	9,323	-
	Vegetables (S)	643	-	13.0	-	-	8,359	-
						Sub-total paddy	**72,159**	**10,653**
3.Hari-Mukteshwari	Boro (HYV)	20,000	16,000	4.5	4,000	1.9	79,600	10,400
	T.Aman (HYV)	7,671	5,368	2.8	2,303	0.8	16,872	4,607
	T.Aman (Local)	9,589	5753	1.8	3836	0.9	13807	3453
	Vegetables (W)	548	-	13.0	-	-	7124	-
	Vegetables (S)	548	-	12.0	-	-	6576	-
						Sub-total paddy	**1,82,438**	**29,113**
4.Upper Bhadra Buri Bhadra-Harihar	Boro (HYV)	15,231	10,357	5.0	4,874	2.1	62,020	14,135
	T.Aman (HYV)	9,373	5,811	3.0	3,562	0.8	20,283	7,836
	T.Aman (Local)	4,686	2,812	1.9	1,874	0.9	7,030	1,873
	Jute	1,172	-	1.8	-	-	2,110	-
	Pulses	703	-	1.3	-	-	914	-
	Spices	469	-	4.5	-	-	2,111	-
	Vegetables (W)	1,172	-	15.0	-	-	17,580	-
	Vegetables (S)	1,172	-	13.5	-	-	15,822	-
						Sub-total paddy	**89,333**	**23,844**
5.Teligati-Ghengrile	Boro(HYV)	3,809	3,135	4.8	674	2.0	16,396	1,887
	T.Aman (HYV)	169	115	2.9	54	0.6	368	122
	T.Aman (Local)	5,078	3,001	1.8	1,777	0.7	7,186	1,954
	Jute	254	-	2.0	-	-	508	-
	Spices	254	-	3.8	-	-	965	-
	Vegetable s(W)	169	-	15.0	-	-	2,535	-
						Sub-total paddy	**23,950**	**3,963**
6.Salta-Gunakhali Haria	Boro (HYV)	6,857	5,487	4.5	1,370	2.0	27,431	3,425
	T.Aman (Local)	4,821	3,182	2.1	1,639	0.8	7,993	2,131
	Vegetables (W)	107	-	14.0	-	-	1,498	-
	Vegetables (S)	107	-	12.0	-	-	1,284	-
						Sub-total paddy	**35,424**	**5,556**

Name Catchment	Name of crop	Cropped Area (ha)	Damage-free Area		Damaged Area		Total Production (m.ton)	Production loss (m.ton)
			Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
7.Kapotakshi	Boro (HYV)	43,199	32,399	5.0	10,800	2.2	1,85,755	30,240
	Aus	5,706	3,424	2.2	2,282	1.0	9,815	2,738
	T.Aman (HYV)	26,898	21,518	3.2	5,380	1.0	74,237	5,379
	T.Aman (Local)	29,343	21,714	2.0	7,629	-	49,531	9,155
	Jute	3,260	-	1.8	-	-	5,868	-
	Spices	3,260	-	4.0	-	-	13,040	-
	Oilseeds	5,706	-	1.0	-	-	5,706	-
	Wheat	3,260	-	2.1	-	-	6,846	-
	Vegetables (W)	4,075	-	14.0	-	-	57,050	-
	Vegetables (S)	4,075			-		48,900	-
	Sub-total paddy						**319,338**	**47,512**
8.Shalikha	Boro (HYV)	5,314	4,358	5.0	956	1.8	23,510	3,060
	T.Aman (HYV)	466	340	3.2	126	0.9	1,201	290
	T.Aman (Local)	5,594	3,916	2.2	1,678	0.8	9,957	2,350
	Aus	466	280	2.0	186	0.8	708	224
	Oilseeds	466	-	1.1	-	-	512	-
	Vegetables (W)	373	-	15.0	-	-	5,515	-
	Vegetables (S)	373	-	14.0	-	-	5,222	-
	Sub-total paddy						**35,376**	**5,924**
9. Betna	Boro (HYV)	29,128	22,720	4.8	6,408	1.8	1,20,590	19,224
	Aus	2,648	1,642	2.2	1,006	1.0	4,618	1,207
	T.Aman (HYV)	2,648	2,066	3.2	582	1.0	7,193	1,280
	T.Aman (Local)	28,068	19,648	2.3	8,420	0.9	52,768	11,788
	Jute	5,296	-	1.7	-	-	9,003	-
	Spices	2120	-	4.4	-	-	9,328	-
	Potato	1,588	-	14.0	-	-	22,232	-
	Wheat	2,648	-	2.2	-	-	5,825	-
	Pulses	1,588	-	1.2	-	-	1,906	-
	Vegetables(W)	2,648	-	14.0	-	-	37,072	-
	Vegetables(S)				-	-	33,100	-
	Sub-total paddy						185,169	33,499
10.Morirchap-Labonyabati	Boro (HYV)	16,029	12,503	4.0	3,526	1.9	56,711	7,405
	T.Aman (HYV)	6,412	4,681	3.0	1,731	0.9	15,601	3,635
	T.Aman (Local)	19,948	13,964	1.8	5,984	0.8	29,922	5,984
	Aus	1,069	642	2.1	427	0.6	1604	641
	Oilseeds	1,069	-	1.0	-	-	1069	-
	Vegetables (W)	356	-	12.0	-	-	4272	-
	Vegetables (S)	356	-	10.0	-	-	3560	-
	Sub-total paddy						1,03,838	17,665
11. Shapmara-Galghe shiya	Boro (HYV)	8,971	7087	4.2	1884	1.8	33156	39,22
	T.Aman (HYV)	1282	898	2.8	384	0.9	2860	730
	T.Aman (Local)	16,662	10862	1.9	5800	0.8	25277	6380
	Sub-total paddy						61,293	11,032
						Grand total=	**10,79,213**	**1,92,194**

Source: CEGIS estimation

The estimated paddy production that comes from the study area is about 10,79,213 m.tons and the estimated paddy production loss is about 1,92,194 m.tons.

4.5.4 Crop yield

The yield level of different crops of the project area under the study is closely associated with the level of input use and cultural practices. The yield level of different crops with high doses of inputs and good management is moderate to high and the production is fairly high. On the other hand, the yield of crops grown with less input is low. Besides, the affect of flood, drought, seasonal drainage congestion due to local rainfall, soil and water salinity, natural calamities, pest and disease infestation also influence the yield of crops.

The average yield levels of different crops in different catchment areas of the project, compiled on the basis of field surveys and information collected from the upazila offices of the Department of Agriculture Extension (DAE), are shown in Table 4-10 and a summary of all catchments is presented in Table 4-9.

4.5.5 Crop production

Total crop production has been calculated on the basis of damage-free area and damaged area. In damage-free areas, the normal yields of the crops have been considered along with the damaged yields from the damaged areas. This may be expressed as: Total crop production = damage-free area × normal yield + damaged area × damaged yield.

Major agricultural production comes from rice crops. The total annual paddy production stands at about 10,79,213 m. tons. Among the rice crops, Boro contributes 64.4 %, T.Aman (HYV) 13.4%, L.T.Aman 20.7% and Aus 1.5% of the total paddy production. A significant portion of agriculture production also comes from non-rice crops. The non-rice crop production includes wheat (13,481 tons), pulses (2,820 tons), oilseeds (7,585 tons), spices (25,444 tons), potato (22,232 tons), jute (17,489 tons), S. Vegetables (1,22,823 tons), and W. Vegetables (1,47,653 tons). It may be mentioned here that pulses include moog, lentil, gram, kheshari etc; oilseeds include mustard and sesame; spices include onion, garlic, dania, green chili, turmeric and ginger.

The details of existing crop production in the 11 (eleven) catchment areas are presented in Table 4-10 and a summary of the study areas is shown in Table 4-9.

Picture 4-24**:** Paddy field

Picture 4-25: Cauliflower field

4.5.6 Crop damage

The crop damage (production loss) has been calculated using the formula: Crop production loss= Total cropped area × normal yield - (damaged area ×damaged yield+ damaged free area × normal yield). Crop damage data of the last three years were collected from the field. It was observed that about 1,02,712 ha of agricultural lands were affected and as a result annual crop production loss (damaged) was about 1,92,194 m.tons. Catchment-wise annual paddy production lost along with area is shown in Table 4-10.

Generally, soil salinity adversely affects the growth of most crops and the magnitude of the damage is related with the degree of salinity. After the construction of polders during the 1960s, salinity reduced significantly. Presently, due to the withdrawal of water from the upstream at Farraka, the flow of water has reduced significantly and as a result the intrusion of saline water toward the countryside has enhanced soil salinity. The increased soil salinity has affected crop production seriously.

The crops grown in these areas are either fully or partially damaged by water congestion due to siltation of rivers, canals etc. Even part of the area remains fallow throughout the year due to severe siltation and non-functioning of regulators. The situation is serious in Tala, Dumuria, Shymnagar, Satkhira, Kalaroa, Koyra, Monirampur, Keshabpur, and Jhikargachha.

Recently, it is observed that most of the rivers in the study areas especially the Kapotakshi, the Betna, the Bhadra, the Hari etc. are badly silted up. In some places, the beds of the rivers are comparatively higher than the surrounding agricultural lands. In this situation, the water cannot drain out easily through sluice gates, especially in the monsoon season. In this situation, excess rain water cannot pass through the river resulting in water congestion and causing devastating damage to T. Aman (Local and HYV). Natural calamities such as hailstorms, cyclones like Ailar and Sidr, coastal cyclonic surges, etc have caused crop significant damage in the study areas.

During dry season, both soil and water salinity affect growth of Aus and Boro crops. It is reported that a considerable number of farmers practised Boro using groundwater with Shallow Tube Wells (STW). The ground water is also saline to some extent (EC 2-3 dSm-1). Due to continuous irrigation with slightly saline water, salt has accumulated in the surface which has increased salinity and resulted in crop damage. This may be due to the very low permeability of the heavy textured soil of the study area. This mostly happens during flowering stages of growth resulting in false grain. Thus Boro and Aus crops are damaged in the study areas.

4.5.7 Agricultural inputs

4.5.7.1 Fertilizers

The main input for crop production is fertilizer. It is well known that the soil's inherent ability to supply sufficient nutrients has drastically decreased with the increased intensity of cropping associated with the growing human demand for food and fiber. To increase and sustain crop productivity, use of chemical fertilizers is very essential. It is therefore, very important to develop management packages for the use of nutrient, soils and crops that enhance not only crop yield but also the quality of soil, water and air.

The fertilizer requirement has been estimated from field level survey and discussions with fertilizers dealers and farmers and with the upazila level officials of the Department of Agriculture extension (DAE). The ranges of fertilizers generally used in the study area for the last three years are given in Table 4-11.

Table 4-11: Range of fertilizers used (Kg/ha) in the study areas

Name of crops	Ranges of fertilizer applied (Kg/ha)				Remarks
	Urea	TSP	MP	Others*	
Boro (HYV)	150-200	50-100	30-60	Zn@7.5 kg/ha	Zinc Sulphate and gypsum are generally applied in the Boro (HYV) and T.Aman (HYV) fields @ 7.5 kg/ha and 100 kg/ha respectively. Now, farmers are also using DAP (Di-ammonium phosphate) which contains both nitrogen and phosphorus. In this case, the amount of Urea and TSP have to be reduced .In vegetables, cow dung and compost are being used in the project area to maintain optimum level of soil fertility.
Aus (Local/HYV)	120-150	25-50	20-40		
T.Aman (Local)	100-150	20-40	15-30		
T.Aman (HYV)	120-150	30-50	10-30	Zn@7.5 kg/ha	
Wheat	120-180	50-75	30-50		
Jute	60-80	-	-		
Potato	160-200	80-100	75-100		
Pulses					
Oilseeds					
Vegetables (W)	150-170	50-60	30-50	Cow dung	
Vegetables (S)	150-170	50-60	30-50	Cow dung	

*Source: CEGIS Estimation from field survey. * Indicates Zinc (Zinc sulphate/ Zinc Oxide) and Sulphur (Gypsum) fertilizers.*

The rate of fertilizer use per hectare varies considerably from farmer to farmer as well as location to location, cropping pattern and financial ability. Use of fertilizer is higher for high yielding varieties (HYV) of Boro, Aus and Aman, wheat and vegetables etc. which maintains an optimum environment for crop production under optimum level of moisture. In the south-western coastal region, farmers mainly apply fertilizers in an unbalanced way. Very limited number of farmers applied Phosphorus (TSP) and Murate of Potash (MP) for growing high yielding crops like Boro (HYV), Aus and Aman. Besides these, crops like wheat, oilseeds, spices potato, vegetables, sugarcane, and maize require a considerable amount of different types of fertilizers. Zinc and gypsum also are being applied for the intensive cultivation of rice. It is noticed that the farmers are using more nitrogenous fertilizers than phosphatic and potassium fertilizers. Cow dung and farmyard manures are also being used in vegetables.

It has been observed from field surveys and discussions with DAE officials and farmers that in almost all areas under the study, soil moisture remains favorable for nutrient uptake due to the onset of monsoon when T.Aman (HYV) crops are grown with moderate to high doses of fertilizers. In the early part of the Rabi season, various kinds of crops are practised

using post monsoon residual moisture. In this situation, moderate to high doses of fertilizers are being used. However, leguminous crops like pulses fix nitrogen in the soil and enhance its nitrogen content. So these crops need low doses of fertilizers. The growing period of Aus is comparatively shorter than that of T. Aman (HYV) or Boro (HYV). The yield potential of Aus is lower than that of T.Aman and Boro. So, fertilizer requirement of Aus is less than for those two rice crops. Crops like oilseeds (til and mustard etc.) and jute are grown in dry pre-monsoon seasons when rainfall is scanty and residual moisture is inadequate for nutrient uptake. Fertilizer uses in these crops are low.

4.5.7.2 Pesticides

The yields of rice and non-rice crops are seriously affected by pest and disease infestation which causes significant reduction (10-15% in general) of crop production. Farmers are desperate to control the attack of pests and spread of diseases. They generally spray insecticides and fungicides over affected crop fields. The detailed requirements (Kg/ha or ml/ha) of pesticides, are presented in Table 4-12.

Table 4-12: Requirement of pesticides, fungicides, herbicides and rodenticides

Study Area(ha)	Pesticides			Remarks
	Liquid (ml/ha)	Granular (kg/ha)	Powder (kg/ha)	
Boro (HYV)	400-500	7.5	-	Liquid pesticides are used once or up to three times for Boro and HYV T.Aman as foliar spray on leaves. Granular pesticides are generally applied in HYV Boro, and Aman (HYV) crops in the presence of standing water (5-7 cm) along with some urea as top dressing for maximum effectiveness. In vegetables Omite and Ripcord are generally used @ 1litre /ha.
Aus (Local/HYV)	300-400	-	-	
T.Aman (Local)	400-500	-	-	
T.Aman (HYV)	400-500	7.5	-	
Wheat	-	-	-	
Oil seeds	200-300	-	-	
Potato	-	-	1-2	
Rabi crops	-	-	-	
Vegetables (W)	300-500	-	-	
Vegetables (S)	300-500	-	-	

Source: CEGIS estimation from field survey &DAE

Stem borer, Brown Plant Hopper (BPH), Ear Cutting Caterpillars, Case Worm, Grass Hopper, Green Leaf Hopper, Rice Bug, Mites, Leaf Roller etc. are the common pests in the project areas. Stem borer infestation in paddy fields is found almost everywhere in the project area in all seasons. Every year, infestation of BPH causes crop damage especially in Boro rice. Rice Hispa infestation is common in the southern part of the South West and South Central regions of the project areas and causes considerable yield reduction. Rats also damage crops especially dry land crops (wheat, potato etc.).

Various kinds of diseases, Tungro, Sheath rot, Sheath blight, Leaf blast, Brown spot, etc are common in the project area. The farmers reported that virus, blight, mosaic, leaf curl, leaf spot etc. are the major diseases affecting mostly potato and vegetables crops.

The pesticides are used in different forms such as granular, liquid and powder. Different types of pesticides such as Furadan (3G), Basudin (10G), Diazinon (10G), Sumithion (50EC).Sunfaran (5G), Omite (57EC), etc. are used to prevent pests and diseases both for rice and non-rice crops.

Farmers also use different types of herbicides such as Repit, Commit, Ronostar and super hit to control weed in their rice fields. To minimise weeding cost, herbicides are generally used in T. Aman and Boro crops. Rodenticides are used for control of rats in dry land crops such as wheat and potato.

4.5.8 Integrated pest management (IPM)

Recently, Integrated Pest management (IPM) is being practised in limited areas under the project. In this system, insects are controlled biologically. Farmers of the IPM areas use in an integrated way branches of trees, bamboo and jute sticks etc. to make favourable perches for birds in fields with standing crop. In this situation, birds generally catch insects for food and thus help to save crops from insect infestation. In this process, the beneficial insects responsible for destroying harmful insects are saved and thus crops are protected without having to apply pesticides.

Light trap is another technique for controlling pests under IPM. This system is used to attract insects in agricultural fields especially for HYV rice and vegetables. At the base of the light, a trap which is made usually of a steel sheet sloping downward, is attached. The light trap is installed on a water catchment. At night, when the light trap is emitting light, the insects of the surrounding fields become attracted to it and fall into the water and die. Thus, the insects that are harmful to crops are controlled without application of pesticides.

The IPM technique is mainly applied on rice (Boro-HYV) and vegetable crops. IPM is being practised in about 10-12% of the cultivated rice and vegetables fields in high and medium high land areas under the study. The impacts of IPM are very encouraging in the project areas. The Directorate of Agriculture Extension (DAE) is providing training on IPM to farmers in the study area.

4.5.9 Labour use

Most of the cultural practices for crop production in the study area are being done manually. So, agricultural labour is considered to be an essential input for crop production. The labour requirement is not equal throughout the year but varies from crop to crop. In the peak periods (November-January, April-May and July-August), labourers move from one place to another as the demand for their services is much more during this period than other times. The demand has been estimated based on field survey data on labour requirement (no./ha) for different crops in the project area (Table 4-13).

Table 4-13: Range of labour and seed requirement in the study area

Name of crops	Average labour requirement (No./ha)	Average seed requirement (kg/ha)
Local Aus/HYV	125-135	70-80
T.Aman (Local) lLLLLLocal)Local)	120-130	37.5
T.Aman (HYV)	150-160	40-45
Boro (HYV)	175-190	40-45
Wheat	100-120	135-150
Oilseeds	70-80	7.5-8.0
Potato	200-250	1500-1600
Vegetables(S)	200-240	5-7
Vegetables W)	210-250	5-7
Jute	130-145	7-8

Source: CEGIS Estimation

4.5.10 Seeds

The seed requirements estimated from the field survey of the project area are presented in Table 4-13. Crop seeds play a vital role in good crop production. There are some criteria for good seeds, e.g., the seeds must be free from disease infestation, have the germination ability of more than 85%, have the capacity for producing higher yield, able to produce improved crop cultivars etc. Generally, good seeds are available at the BADC office or recognised private companies, or with certified seeds dealers and recognised good seed producer farmers. Imported certified seeds are also available. The seed rates of different crops vary from crop to crop depending on size and management practice. The seed rates of crops also vary due to cultural practices.

4.5.11 Irrigation

Irrigation is normally provided with both surface water and ground water. The sources of surface water are rivers, channels, beels etc. Both LLP (Low Lift Pump) and traditional means are being used for surface water irrigation. Water is lifted using mechanical equipments, mainly low lift pumps and traditional lifting devices such as dones and swing buckets. Irrigation equipment is procured from the Upazila level offices of BADC, BRDB, the Bangladesh Krishi Bank (BKB), and other private agencies. Ground water irrigation is provided with the help of mainly STWs.

Irrigation is generally provided to Boro (HYV) rice crops. In the low lying areas, about 20% of the Boro (HYV) is being transplanted with residual standing water. In this case, seedlings are being transplanted on residual standing water. The crops are grown normally with residual moisture up to maximum tillering to panicle initiation stages. The crops then require irrigation, but the farmers cannot provide irrigation due to non-availability of surface water. In this situation, one or two shower of rainfall is sufficient to meet the water requirement of the crops. Some farmers provide supplementary irrigation with LLPs from surface water or STWs from ground water. The surface water of the Boro (HYV) fields generally dry up at the maximum tillering stage of growth (March-April). About 80% of Boro (HYV) fields entirely depend on ground water irrigation using STWs. Aus and T.Aman (both Local & HYV) crops depend on rain-fed condition.

4.5.12 Draught animal use

Cattle are the main source of draught power. In the study areas, about 40-50% of farmers practise the traditional mode of tillage for land preparation involving country plough, puddling and laddering which require substantial draught power. Proper tillage depth and timely land preparation are rarely achieved due to the shortage of draught power. The present draught animal requirement is about 60-65 bullock days/ha in T.Aman (HYV), 30-35 bullock days/ha for T.Aman (Local), 70-75 bullocks days/ha for vegetables and 35-45 bullocks days/ha for non-rice crop production.

4.5.13 Farm machinery use

Power tillers, low lift pumps (LLPs) and STWs are the main machineries used by farmers. Large farmers have their own power tillers, threshers, power sprayers etc. Medium and small farmers generally rent these machineries from others. Power tillers are used for ploughing; LLPs and STWs are used for irrigation purpose, and power sprayers are used for plant protection. The use of power tillers is increasing day by day in the study area due to shortage of healthy bullocks.

4.6 Fisheries

4.6.1 Background

Fish plays a major role in meeting the animal protein demand, foreign exchange earnings and socioeconomic development of the rural poor by alleviating poverty through employment generation in an agro-based country like Bangladesh. The inland fisheries sector of the southwest coastal districts of Bangladesh is highly influenced by brackish water shrimp farming though contribution from fresh water shrimp is not negligible. Shrimp culture as an industry has been contributing significantly to export earning, employment generation, poverty alleviation and the economic development of Bangladesh in recent years. Shrimp is one of the leading exportable products in the country, bringing about 500 millions of foreign currency yearly and contributing 3.78% in the GDP (Nupur, 2010).

The present study area falls in three coastal districts namely Satkhira, Khulna, Jessore (the three districts that are famous for both brackish and freshwater aquaculture practices) and a non-coastal district, Jhenaidah. Jessore is widely recognized as a place of hatchery and nursery and fish farmers of most parts of the country collect fish fry and post larvae (PL) from there. The project area is prone to tidal effect and preserves the brackish water environment in the lower reaches and fresh water environment in the upper reaches. The project area is crisscrossed by a large number of river systems among which the Kapotakshi, the Betna, the Bhadra, the Morirchap, the Hari-Mukteshwari, the Salta, etc are prominent. All these rivers carry saline water and influence areas mostly suitable for shrimp farming. The northeastern part comprises a mixture of shrimp and prawn farms. The project area consists of 11 river catchments from west to east, (i) Shapmari-Galghesiya; (ii) Morirchap-Labonyabati; (iii) Betna; (iv) Shalikha; (v) Kapotakshi; (vi) Salta-Gunakhali-Haria; (vii) Upper Bhadra-Buri Bhadra-Harihar; (viii) Teligati-Ghengrile; (ix) Hamkura-Bhadra-Joykhali; (x) Hari-Mukteshwari and (xi) Upper Sholmari-Salta-Lower Bhadra.

Fishery in the study area has two sectors: inland capture and inland culture. Inland capture fisheries exploit open water

areas of rivers and their tributaries, permanent wetlands called beels and seasonal floodplains. Inland culture fisheries include production from closed water bodies such as fish ponds and ditches, baors, brackish and fresh water shrimp farms and rice-cum-shrimp/ prawn farms.

The lateral movement of water is obstructed due to outlet structures set up on major khals and so silt deposition in the river beds has become aggravated. In addition, most of the khals that exist in the project area are silted up. Longitudinal fish migration along the rivers is constrained by the narrow and low depth of rivers as well as water regulatory structures and cross dams on the Bhadra River. Lateral migration is obstructed by the structures and rigid boundary of the shrimp and prawn farms. Flood lands and beels are mostly and in some cases khals have been turned into brackish water aquaculture or shrimp farms. Based on the field investigation it is estimated that around 78.5% of the overall shrimp and prawn farms of the project area comprises rice-cum-shrimp or prawn culture practice. On the other hand, brackish water aquaculture practice is expanding and thus environmental issues are becoming a high concern. Now a day, most of the land owners (farmers) are inhibiting shrimp farming as they are deprived of getting paddy due to high soil salinity or proper share from their lands. The project area has small to medium sized fish ponds where fish culture practice is traditional to improved traditional except Jessore part where pond aquaculture practice is modern technology oriented.

Net production rate of the riverine fish habitat is relatively lower in the project area than in other parts of the country. The shrimp production per unit area is, however, still rather low compared to other shrimp producing countries. The bulk of fish production comes from shrimp and prawn farms from pre-monsoon to monsoon (May to July) and from December to January respectively. The production trend has been declining gradually over the decades from open water capture fisheries sources of the project area. The water bodies are poor in fish biodiversity. The major causes of fish decline include habitat alteration, compartmentalisation of floodplains, unplanned installation and improper operation of different water regulatory structures and closures on rivers and canals, morpholological (siltation) factors, and indiscriminate fishing. Depletion of floodplain brood fish stock has been caused due to the replacement of flood land and beel habitats with shrimp farms. The aquatic environmental quality has degraded to some extent from brackish environment to saline environment due to long time stagnation. This supports saline tolerant fish species during dry season and fresh water species with lower diversity and composition during wet season. Post harvest fisheries activities are more or less satisfactory though extension services are inadequate and the fisheries management system is poor. Despite all this, the fisheries sector, particularly shrimp and to a lesser extent prawn farming, is contributing to a huge portion of the local economy as well as the national economy. Picture 4-26 shows the capture fish habitat of the project area.

Picture 4-26: Capture fish habitat

4.6.2 Problems and issues

While the gains in employment and export from shrimp farming are highly impressive, these have been achieved at considerable cost. Unplanned shrimp cultivation has brought about serious problems in the project area in terms of environmental sustainability. The major fisheries problems and issues so far identified during the baseline survey are as follows:

- Open water fish production is decreasing due to habitat loss, change of existing aquatic ecological condition and poor fisheries management;
- Fisheries biodiversity is declining due to indiscriminate and over fishing, e.g. use of harmful fishing gear, catching of post larvae and brood fish, overexploitation, morphological changes in rivers, etc;
- Shrinkage of open water fish habitats (both area and depth of perennial rivers, khals and beels) due to rapid siltation, encroachment, and transformation for shrimp culture (beel);
- Obstruction to feeding and spawning migration due to inadequate migration routes (silted and sealed khals) and rigid boundaries of the shrimp farms;
- Water regulatory structures on the rivers and khal outlets and middle point in some cases;
- Increasing soil salinity thereby reducing shrimp productivity;
- Lack of shrimp culture rotation and reluctance to use or unavailability of improved technology for shrimp cultivation;
- Adverse environmental spill-over in the form of loss of genetic diversity (e.g. loss or extinction of indigenous species of fish); and
- Various forms of social conflicts including uneven gains between gher (farm) owners and landowners, especially small land-owning households.

4.6.3 Habitat description

The estimated area of capture, brackish and fresh water aquaculture fish habitat of the project area is about 217,647 ha, which is around 51% of the gross area. Brackish water aquaculture is mostly practiced in low-lying tidal flood plains in the southern most reach, prawn farming is mostly practised in the northeastern reach and mixed culture of shrimp and prawn is mostly practised in the middle reach. Culture of white fish is associated in each type of culture practices. In case of shrimp farming, white fish includes natural fish that comes along with the flow as well as stocked fish species whereas in prawn farming white fish mostly depends on stocked fish. Pond aquaculture is usually practised in homestead ponds and in the floodplain by putting up rigid dykes, locally known as fish farms. In many areas, e.g. in Satkhira, Jessore and Khulna districts, private farmers have constructed light dykes along riverbanks for the dual purposes of agriculture and aquaculture. Some 1-2% of shrimp farms contain crab cultivation by partitioning the farm using bamboo made bana. Homestead ponds are mostly cultured traditionally with major carps, pangas and telapia.

Rice-cum-shrimp farming area is about 111,772 ha, which is 51.4% of the total fish habitat. It dominates over the fish habitats of the project area followed by rice-cum-prawn farming area (21.8%), shrimp farm (7.6%), river & khal (7.4%), prawn farm (4.2%), fish pond (3.3%), floodplain (2.8%), beel (1.2%) and baor (0.2%). As a whole, culture fish habitat constitutes about 88.5% of the total fish habitat while capture fish habitat comprises about 11.5%.

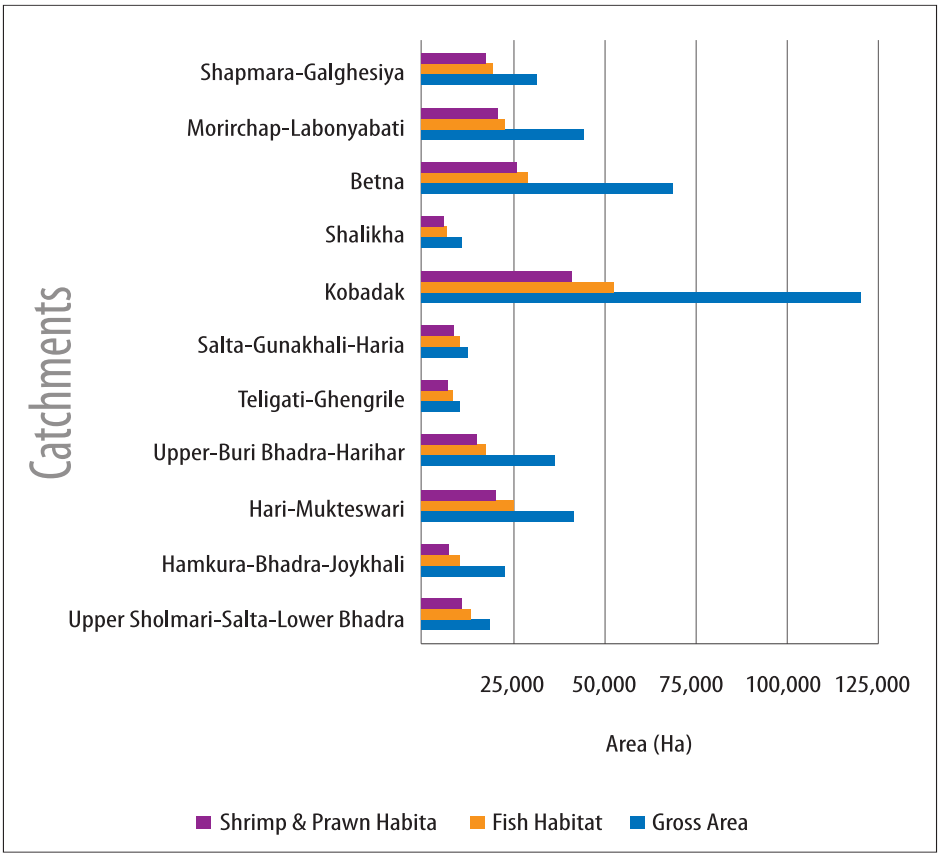
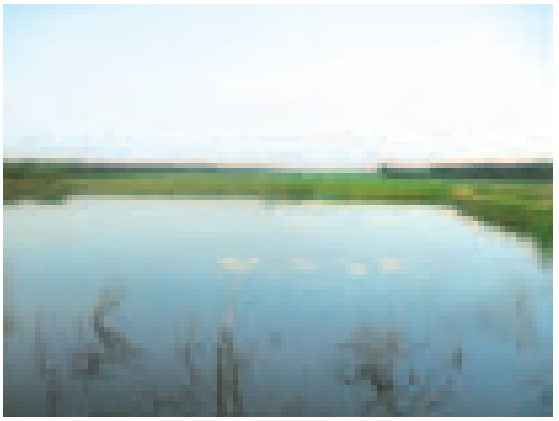


Figure 4-1: Comparison of fish habitats with gross area

Field observation and discussion with local people revealed (Figure 4-1) that compared to the gross area, concentration of shrimp farming practices is more in Teligati-Ghengrile catchment (59.3%) followed by Salta-Gunakhali-Haria (53.5%), Shapmara-Galghesiya (48.1%) and the lowest in the Hamkura-Bhadra-Joykhali catchment (4.8%). This may be due to low elevation and availability of required saline water from the rivers and tributaries. On the other hand, prawn farming practices is more concentrated in the Hari-Mukteshwari catchment (39.6%) followed by Upper Sholmari-Salta-Lower Bhadra (33.1%), and Hamkura-Bhadra-Joykhali (29.2%). It is the lowest in the Kapotakshi catchment (1.7%) perhaps due to availability of some upland flow and rainfall runoff. Figure 4-1 presents the fish habitat area for the corresponding gross areas of the catchments.

Shrimp farming of different catchments such as Betna, Kapotakshi, Shalikha, Hari-Mukteshwari, Salta-gunakhali-Haria and Upper Bhadra-Buri Bhadra-Harihar is more susceptible to water logging induced inundation than in the other catchments. The project area contains very low open water fish habitats which are confined to rivers and khald, and floodplains and beels. The catchment-wise major internal rivers of the project area include Shapmara, Galghesiya, Habra (Catchment i = C-i); Morirchap, Labonyabati, Ticketer khal (C-ii); Betna, Chengral (C-iii); Shalikha, Dalua (C-iv); Kapotakshi, Sibsa (C-v); Salta, Gunakhali, Haria (C-vi); Upper Bhadra, Buri Bhadra, Harihar (C-vii); Teligati, Ghengrile (C-viii); Hamkura, Bhadra, Joykhali (C-ix); Hari, Mukteshwari (C-x) and Sholmari, Salta, Lower Bhadra (C-xi). The project area is crisscrossed by a large number of khals of which major ones are Noakhal, Ticketer khal, Sarulia khal, Nurnia khal, Gopalpur khal, Baleswar khal, Sukno khal, Bagh Anchra khal, Gazasree khal, Batiaghat khal, Amtalar khal, Amvita khal, Burali khal, Pathra khal, Bahura khal, etc. The depths of most of the khals are insufficient for fish habitation and movement. Local people reported that the siltation rates in the khals are very high and range at the average of 5-6 cm in a year, which is increasing gradually and constricting the fish habitat area.



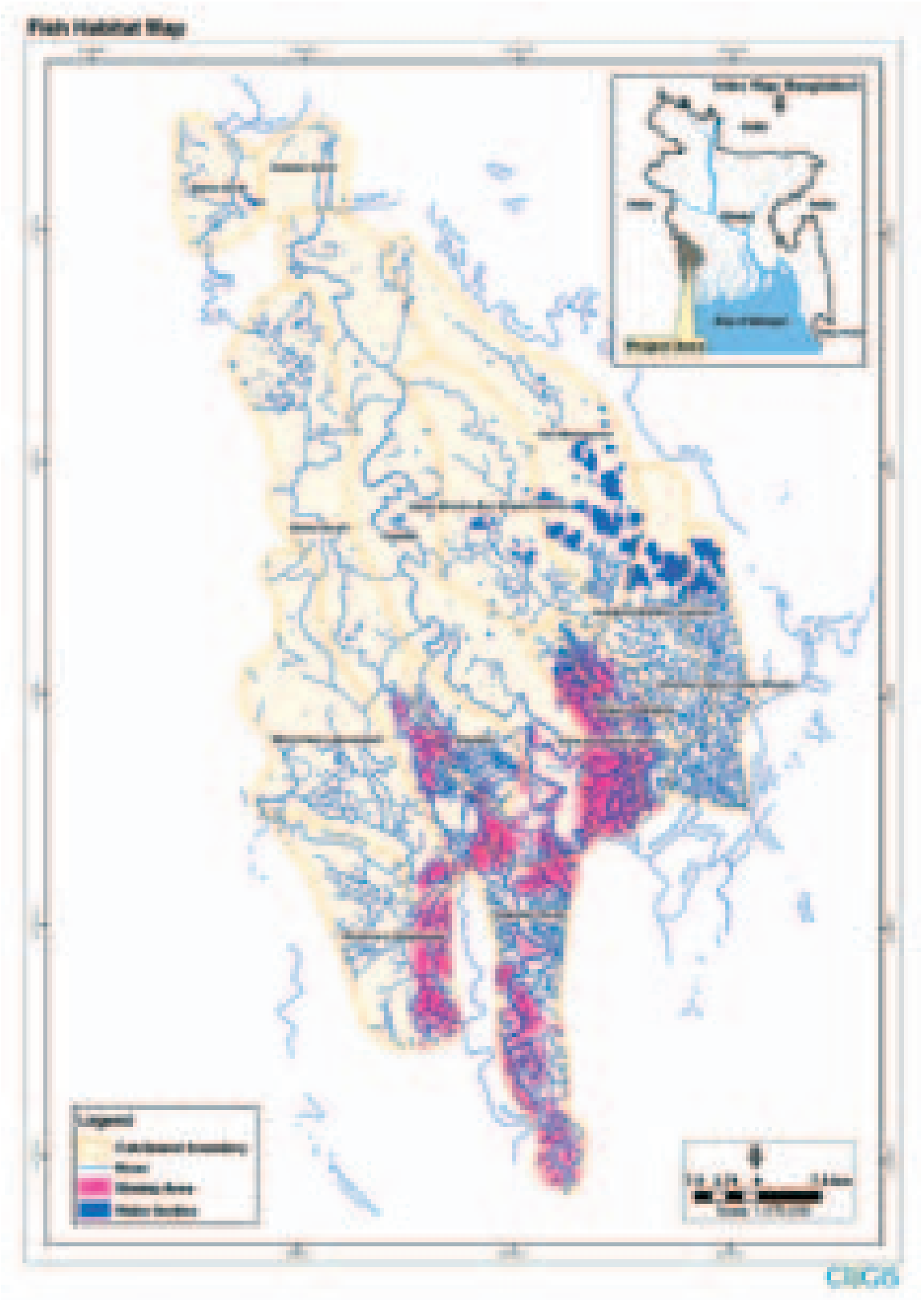
Picture 4-27: Pond aquaculture

Picture 4-28: Shrimp farms

Use of agrochemicals and pesticides in paddy land for higher agricultural yields is becoming a threat to the aquatic environment for fish habitation, especially for rice-cum-shrimp and fish culture. Picture 4-27 and 4-28 present the fresh and brackish water aquaculture fish habitats respectively, Map 4-3 shows different fish habitats and Table 4-14 present the different catchment-wise fish habitat areas within the project boundary.

Fishery type	Habitat type	Catchments: Habitat Area (Ha)											Habitat total
		US-Sa-LB	Hk-Bh-Jo	Hi-Mk	UB-BB-HH	Te-Gh	Sa-Gu-Hr	KK	Sk	Bt	Mo-La	Sp-Gl	
Capture	River & khal	1,600	1,170	646	450	1,125	1,029	6,166	361	1,585	1,038	1,018	16,188
	Floodplain	312	570	2,050	350	250	125	1,525	125	325	150	420	6,202
	Beel	55	450	1,560	150	-	65	275	25	75	5	-	2,660
Sub-Total=		1,967	2,190	4,256	950	1,375	1,219	7,966	511	1,985	1,193	1,438	25,050
Culture	Baor	-	-	-	27	-	-	325	-	-	-	-	352
	Fish pond	303	375	786	1,282	139	92	2,640	60	1,028	340	210	7,255
	Prawn farm	1,988	1,786	4,563	120	50	-	225	-	250	54	89	9,125
	Shrimp farm	1,396	241	1,096	1,052	796	1,096	3,852	373	2,398	1,782	2,564	16,646
	Rice cum prawn	4,294	4,921	12,056	1,456	846	2,143	1,835	1,398	10,592	5,343	2,563	47,447
	Rice cum shrimp	3,513	868	3,013	13,105	5,570	5,893	34,844	4,661	13,240	14,248	12,817	111,772
Sub-Total=		11,494	8,191	21,514	17,042	7,401	9,224	43,721	6,492	27,508	21,767	18,243	192,597
Catchment Total=		13,461	10381	25,770	17,992	8,776	10,443	51,867	7,003	29,493	22,960	19,681	217,647

Source: Field survey using GIS tools [US-Sa-LB: Upper Sholmari-Salta-Lower Bhadra; Hk-Bh-Jo: Hamkura-Bhadra-Joykhali; Hi-Mk: Hari-Mukteshwari; UB-BB-HH Upper Bhadra-Buri bhadra-Harihar; Te-Gh: Teligati-Ghengrile; Sa-Gu-Hr: Salta-Gunakhali-Haria; KK: Kapotakshi; Sk: Shalikha; Bt: Betna; Mo-La: Morirchap-Labonyabati and Sp-Gl: Shapmara-Galghesiya]



Map 4-3: Fish habitat area of the project boundary

4.6.4 Fish production

The shrimp production per unit area is, however, still rather low. The need for increasing the production rate by intensification of the culture methodologies is currently being emphasised. Capture fish production rate is also significantly lower in the project area than in other parts of the country. The estimated total fish production from both capture and culture sectors is 125,298 m ton of which the bulk portion of around 122,350 m ton (97.6%) comes from culture fishery while capture fish production of the project area is only 2,948 m ton (2.4%). In total, shrimp and prawn farms along with rice-cum-shrimp and prawn farms contribute about 77.7% which indicates an apparent dominance on other fisheries sectors. Another 24,580 m ton which is 19.6% of the total fish production, comes from the aquaculture ponds of the project area. Baors produce about 405 m ton which is 0.3% of the total production (Figure 4-2).

Crab is also produced in the shrimp and prawn farms and the estimated yield from the project area is about 225 m. ton. Besides, the rivers of the lower reach including Morirchap, Labonyabati, Shapmara, Kapotakshi, Sibsa, Galghesiys, Betna, etc. are abundant with post larvae (PL) of bagda and golda along with brackish water fish fingerlings. A substantial amount of PL and fingerlings is usually collected from these rivers, though it has been decreasing over the years.

The annual fish production trend from capture fisheries is declining at the rate of 3-5%. The production is declining mostly due to habitat loss, siltation of rivers and khals, change of existing aquatic ecological condition and poor fisheries management. On the other hand, adoption of improved technology in pond aquaculture practice is being emphasised gradually in the area. The habitat-wise fish production of the individual catchments is presented in Table 4-15 and Figure 4-3 presents the percentage of fish production for individual catchments. The figure shows that the catchment Kapotakshi grows the highest fish and shrimp (23.8%) while Shalikha produces the lowest (2.7%) of the total fish production of all catchments.

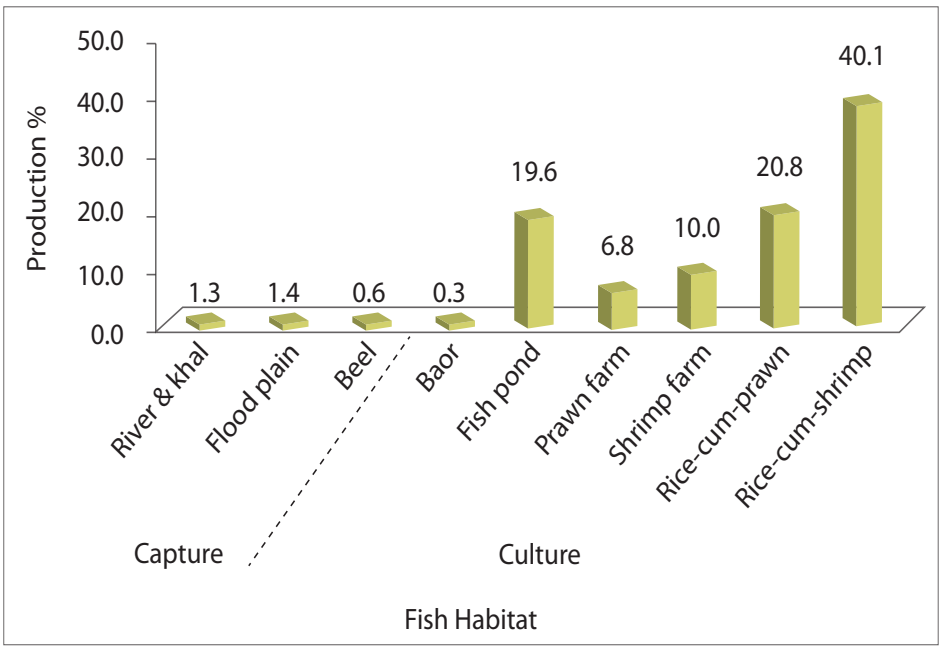


Figure 4-2: Fish production trend from different habitats

Table 4-15: Fish production from different habitats of the study area

Fishery type	Habitat type	Catchments: Fish Production (MT)											Habitat total
		US-Sa-LB	Hk-Bh-Jo	Hi-Mk	UB-BB-HH	Te-Gh	Sa-Gu-Hr	KK	Sk	Bt	Mo-La	Sp-Gl	
Capture	River & khal	160	117	65	45	113	103	617	36	159	104	102	1,619
	Floodplain	28	51	185	32	23	11	137	11	29	14	38	558
	Beel	16	131	452	44	-	19	80	7	22	1	-	771
Sub-Total=		204	299	702	120	135	133	834	55	210	119	140	2,948
Culture	Baor	-	-	-	31	-	-	374	-	-	-	-	405
	Fish pond	927	1,257	2,863	4,297	425	297	8,855	204	3,583	1,157	715	24,580
	Prawn farm	1,849	1,661	4,244	112	47	-	209	-	233	50	83	8,486
	Shrimp farm	1,047	181	822	789	597	822	2,889	280	1,799	1,337	1,923	12,485
	Rice cum prawn	2,362	2,707	6,631	801	465	1,179	1,009	769	5,826	2,939	1,410	26,096
	Rice cum shrimp	1,581	391	1,356	5,897	2,507	2652	15,680	2097	5,958	6,412	5,768	50,298
Sub-Total=		7,766	6,196	15,916	11,927	4,041	4,950	29,016	3,350	17,397	11,895	9,898	122,350
Catchment Total		7,970	6,495	16,617	12,047	4,176	5,083	29,849	3,405	17,607	12,013	10,037	125,298

Source: FRSS, 2008-09 and Upazila Fisheries Offices (UFOs) and field data

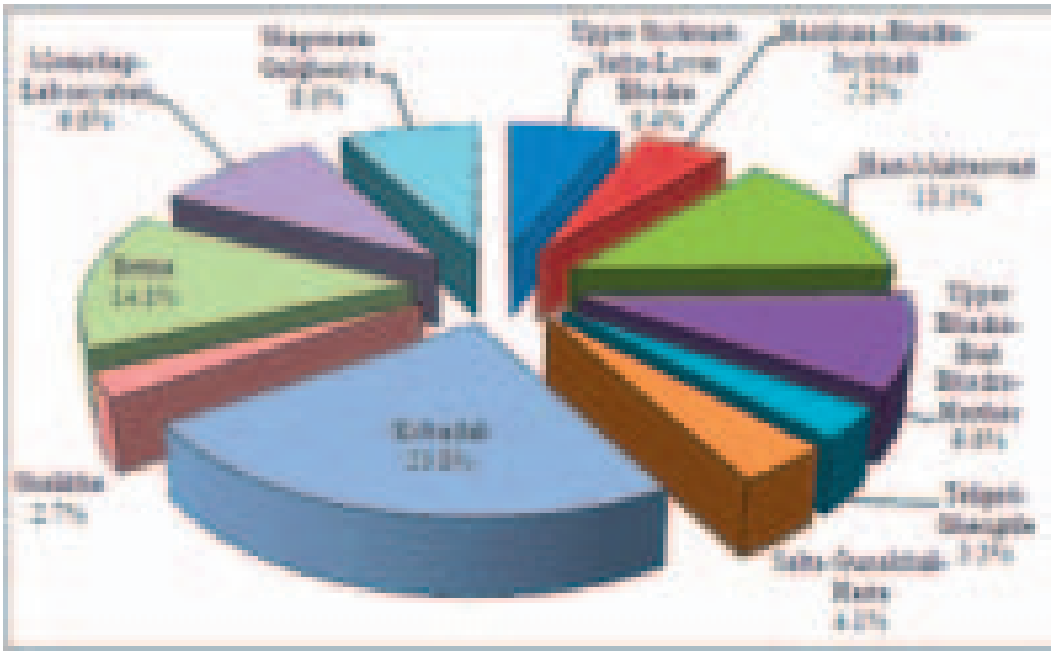


Figure 4-3: Catchment-wise percentage of fish production

4.6.5 Fish production rate

Thorough investigation of data from the relevant Upazila Fisheries Offices (UFOs) and FRSS, 2008-09, revealed that the yearly riverine fish production rate (100 kg/ha) of the project area is considerably lower than that of the national average (162 kg/ha). However, shrimp production rate along with associated white fish (750 kg/ha) is quite higher than that of the national average (668 kg/ha). Prawn production rate along with associated white fish (930 kg/ha) is almost similar to the area average and rice-cum-shrimp while prawn production rate along with associated white fish 450 kg/ha and 550 kg/ha respectively is almost similar to that of area average assessed by the UFOs. Fish pond production rate (3,388 kg/ha) is significantly higher than that of the national average (2,991). Figure 4-4 shows the fish production rates of the individual fish habitats of the project area.

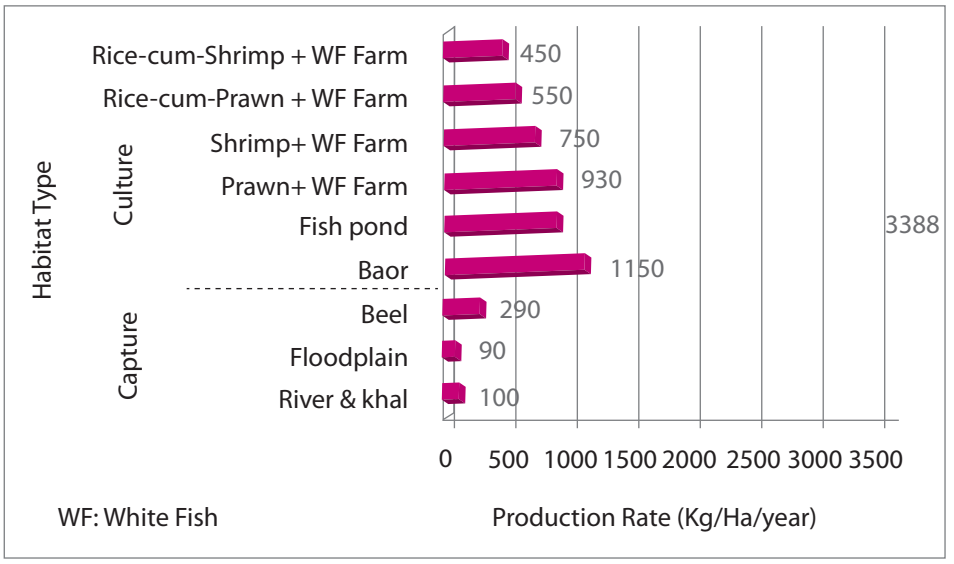


Figure 4-4: Fish production rate (kg/ha/year) of different habitats

4.6.6 Fishing Effort

About 5-10% households of the project area are engaged in fishing activities, of which 40% is commercial, 40% is subsistence level and 20% is occasional fisherman. Among the commercial fishermen around 70% are engaged in coastal and marine fishing. The rest of the commercial fishermen and subsistence fishermen mainly catch fish in the open water area of and around the homestead. Commercial, occasional and subsistence level fishermen annually spend 275 days (8-10 hrs/day), 150 days (6-7 hrs/day) and 120 days (5-6 hrs/day) in fishing activities respectively. Commercial fishermen are also involved in gher fishing as and when called upon by the farm owners. Local fishermen use Jaki jal, Kerrant jal, Vesal jal, Behundi jal, Ber jal, Dharma jal, Thela jal, fish trap, hook, etc. to catch fish. Picture 4-29 and 4-30 presents the fishing gear used in the project area.

Picture 4-29: Jhaki jal (Cast net)

Picture 4-30: Ber jal (Seine net) fishing

4.6.7 Brackish water and pond aquaculture

Brackish water shrimp farming starts from late February (just after Maghi Purnima) by releasing bagda PL and harvesting within the second week of May when it becomes big enough for sale. The second phase of bagda PL release in the same farm starts from the first week of June and harvests within the second week of September. Fry or fingerling of white fish in the shrimp farms are released in first week of September and harvested in December. Egg and fry of brackish water fish species enter into the shrimp farm while farmers fill the farm with saline water during spring tide. Golda PL are released in May and harvested in December and the associated white fish release and harvest are similar to shrimp farms. Compared to bagda PL, Golda PL is used more from river habitat. Local shrimp farmers reported that bagda riverine PL becomes big enough for sale within three months whereas hatchery PL becomes big enough for sale within two months. Hatchery PL mortality rate is around 50% while riverine PL mortality rate is 25%-30%.

The project area comprises of around 36,000 shrimp and prawn farmers and 10,000 pond aqua culturists. Kuchia (Monopterus cuchia) is also produced in the shrimp farms of the project area which has good market value at home and abroad.

4.6.8 Fish migration

Internal rivers and khals act as longitudinal and lateral fish migration routes as part of their life cycle. Fish migration in the project area is severely constrained by the rigid boundaries of shrimp farms and aggravation of river and khal beds. Limited migration of resident fresh water fish species of the project area and other riverine brackish water fish species usually occur from pre-monsoon period to monsoon period. The project area has lost its floodplains and beels as most of them are already converted into shrimp farms. Shrimp farms function as the breeding and feeding ground of most of the freshwater and brackish water fish species. However, most of the connecting khals either remain mud sealed or are closed by sluice gates in the pre-monsoon and early monsoon seasons.

4.6.9 Fish biodiversity

The study area is moderately rich in fish biodiversity with the amalgamation of fresh and brackish water fish species. But the trend is declining significantly. This is mostly due to habitat loss (both depth and area), transformation of floodplain and beels into shrimp farms, obstruction to the migration routes, unplanned fisheries management and indiscriminate

fishing, e.g. use of harmful fishing gear and over fishing, catching of post larvae and brood fish, etc. A checklist of the fishes of different habitats and the species of conservation significance reported by local fishermen are analysed to give a tentative overview of the fish biodiversity of the area.

Picture 4-31 shows some fish and prawn species of the project area. A list of the fishes of different habitats of the study area is given in Table 4-16.

Table 4-16: Indicative species diversity of different fish habitats

Scientific Name	Local Name	Habitat Type				
		River	Khal	Shrimp Farm	Rice-cum-Shrimp/ Prawn	Culture Pond
Lates calcarifer	Bhetki	P	P	P	P	A
Liza parsia	Pairsa	P	P	P	P	A
Mystus spp.	Tengra	P	A	P	P	A
Epinephelus lanceolatus	Bol	P	P	A	A	A
Plotosus spp.	Kine magur	P	A	A	A	A
Mugil corsula	Khorsula	P	P	P	P	A
Anabas testudineus	Koi	A	P	P	P	A
Nandus nandus	Bheda	P	P	A	A	A
Glossogobius guiris	Baila	P	P	P	P	A
Channa punctatus	Taki	P	P	P	P	A
Mastacembelus pancalus	Guchi Baim	A	P	P	P	A
Heteropneustes fossilis	Shingh	A	P	P	P	A
Puntius spp.	Punti	P	P	A	A	A
Colisha fasciatus	Kholisha	P	P	A	A	A
Leander styliferus	Icha	P	P	A	P	P
Mystus cavasius	Gulsha	P	P	P	P	A
Penaeus monodon	Bagda	P	P	P	P	A
Metapenaeus monoceros	Harina	P	P	A	A	A
Penaeus indicus	Chaka	P	P	A	A	A
M. rosesbergii	Golda	P	P	P	P	A
Hypophthalmichthys molitrix	Silver carp	A	A	P	P	P
Puntius gonianotus	Thai puti	A	A	P	P	P
Cyprinus carpio	Karfu	A	A	P	P	P

Scientific Name	Local Name	Habitat Type				
		River	Khal	Shrimp Farm	Rice-cum-Shrimp/ Prawn	Culture Pond
Telapia mosambica	Telapia	A	A	P	P	P
Labeo ruhita	Ruhi	A	A	P	P	P
Ctenopharyngodon idellus	Grass carp	A	A	P	P	P
Pangasias suchii	Thai pangas	A	A	A	A	P
Catla catla	Catal	A	A	P	P	P
Cirrhinus mrigala	Mrigel	A	A	P	P	P
Scylla spp.	Crab	P	P	P	P	A
Monopterus cuchia Monopterus cuchia Monopterus cuchia	Kuchia	P	P	A	P	A

Here, A=Absent and P=Present

Golda (Macrobrachium rosenbergii)

SIS (Small Indigenous Species)

Mud eel (Monopterus cuchia)

Crab (Scylla serrata)

Picture 4-31: Fish organisms of the project area

4.6.10 Species of conservation significance

A list of fish species that are locally unavailable (at least for the last 15-20 years) or have become rare as reported by the local fishermen, is given in the following table.

Table 4-17: List of species of conservation significance

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Nandus nandus	Bheda	✓	×
Macrognathus aculeatus	Tara baim	✓	×
Clarias batrachus	Magur	✓	×
Labeo ruhita	Ruhi	✓	×
Plotosus canius	Kine magur	✓	×
Anabas testudineus	Koi	✓	×
Heteropneustes fossilis	Singh	✓	×
Colisa fasciatus	Kholisa	✓	×
Puntius sarana	Shar Puti	×	✓
Chitala chitala	Chital	×	✓
Chirrhinus reba	Tatkini	×	✓
Wallago attu	Boal	×	✓
Pangasius pangasius	Riverine Pangas	×	✓

Source: CEGIS field study and local fisheries offices

4.6.11 Post harvest activities

Fish quality is still quite good for human intake. However, use of agrochemicals and pesticides, although much less now, is harming fish quality and causing fish diseases especially during September-November. After harvest, shrimp and prawn are sent to the nearby shrimp depot and white fish to the nearby fish arats. Small scale local fishermen sell the bulk of their catch directly to the buyers (Bapari) coming from nearby upazila towns, Satkhira, Jessore, Jhenaidah and Khulna. From the shrimp depot, a significant part of the shrimp/ prawn is purchased by the fish processing industries located in Satkhira, Bagerhat and Khulna. A small portion is consumed by the local people and the remaining large portion is sent to Dhaka on ice and in cartons. The bulk of the shrimps and prawns produced in the project area is exported to different European, American and Asian countries after being processed by different fish processing industries.

Crabs, produced in the project area are consumed less locally and the major portion of the production is exported. Almost every wholesale market has fish arats, and shrimp/prawn crab depots. Crab depots are mostly concentrated in the southern part of the project area. A large number of ice factories are present in the area. In and around the project area there are a number of shrimp and prawn hatcheries and nursing ponds but are still not adequate in number to meet the demand. Fish storage facility is also insufficient in the project area. Transportation facility is satisfactory and cell phone network is well established. Hence, fishermen are getting the actual price for their catches.

4.6.12 Fishermen lifestyle

The average daily income of inland subsistence level, occasional and commercial fishermen are Tk.150/-, Tk. 200/- and Tk.250/- respectively. The income of the artisanal fishermen is quite good but the traditional fishermen's income level is decreasing gradually. Consequently, they are changing their occupation. They are also vulnerable to frequent natural disasters such as cyclones, riverbank erosion, etc. Most of them are landless and live along the riverbank or on khas lands.

4.6.13 Existing fisheries management

Most of the unions of each catchment have no Fishermen Community Based Organizations (FCBOs). Moreover, existing FCBOs have very limited opportunity to bring positive changes in the traditional fisheries management system. Fishing right on existing fish habitats has already been established on behalf of the lessee, as most of the perennial water bodies generally give lease to the non-fishermen by the Deputy Commissioner's (DC) office. Enforcement of fisheries regulation is very weak. The Department of Fisheries (DoF) has very limited activities for fisheries resource conservation and management in this region. Some NGOs are working, but they are very much limited in extension services and brackish water aquaculture training.

4.7 Ecology

4.7.1 The Bio-ecological zone

IUCN, The World conservation Union, Bangladesh has divided the whole country into 25 Bio-ecological Zones of which three major Bio-ecological Zones fall inside the study area. These are as follows (Map 4-4).

4.7.1.1 The Ganges Floodplains

Most of the catchments of the study area fall in this zone. The only active floodplains in the south-west portion of the country are mainly situated in the Greater Jessore, Kustia, Faridpur and Barishal districts. This floodplain comprises of ridges, catchments and old channels. The Gangetic alluvium is distinguished from the old Brahmaputra, Jamuna and Meghna sediments by high lime content. The Ganges channel is constantly shifting within its active floodplain, eroding and depositing large areas of new char lands in each flooding season, but it is less braided than the channels of the Brahmaputra- Jamuna. Both plants and animals have adapted with the pattern of flooding. The floodplains are characterised by mixed vegetation. A huge number of stagnant water bodies and channels, rivers and tributaries support a habitat of rich biodiversity. Free-floating aquatic vegetation is commonly seen in most of the wetlands. Both cultivated and wild plants species are found in homesteads forest.

4.7.1.2 Gopalgonj-Khulna peat land

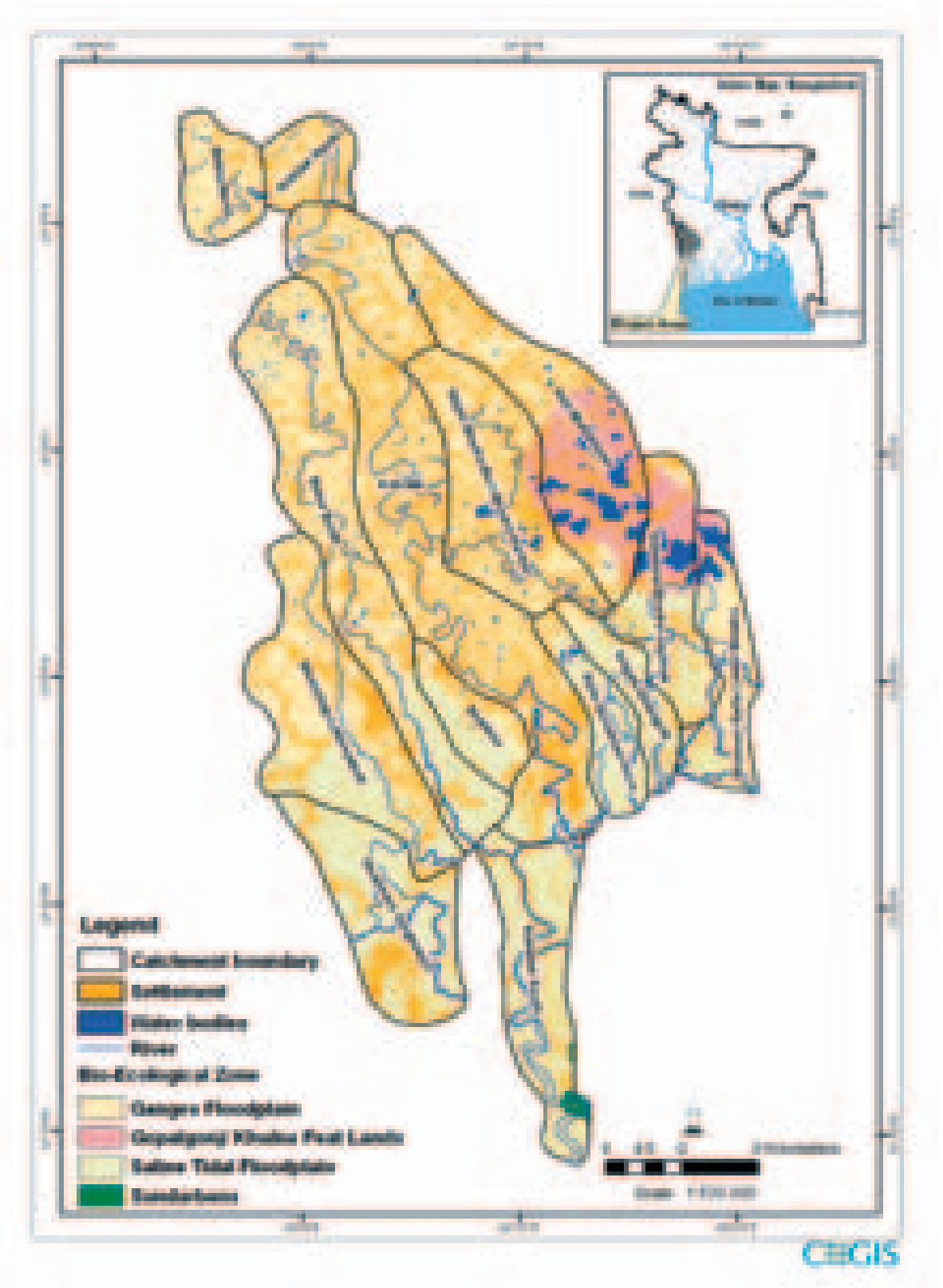
The lower part of the Hari-Mukteshwari and the upper part of the Hamkura-Bhadra-Joykhali catchments fall in this zone. This peat land is occupied by a number of low-lying areas between the Ganges river floodplains and the Ganges tidal floodplains in the south of Faridpur region and the adjoining part of Khulna and Jessore districts. The soil in this zone is potentially strongly acidic and low in essential plant nutrients. The catchments are deeply flooded by rain water in monsoon; however water is brackish to some degree close to Khulna. The floral diversity in this zone is quite limited. Due to lack of diversity in vegetation, the variety of faunal species and their population size in this zone are also less than enviable (Brammer, 2000). However, the diversity of bird species is relatively better in this zone (Rashid, 1980).

4.7.1.3 Saline tidal floodplains

Most of the area in Shapmara-Galghesiya and Salta-Gunakhali-Haria catchments, lower part of Morirchap-Labonyabati, Shalikha, Salta-Gunakhali-Haria, Hamkura-Bhadra-Joykhali and the Kapotakshi catchments fall in this ecological zone. The saline tidal floodplain has a transitional physiography, which is located in the southern part of the Southwest and South central region. It has a low ridge and catchment relief, crossed by innumerable tidal rivers and creeks. Soils are non saline throughout over a substantial amount of area in the north and east but they become saline in various degrees in the dry season in the south-west and are saline for much of the year in the Sundarbans. The rivers carry fresh water throughout the year to the east and north-east, but saline water penetrates increasingly further inland towards the west. Of the floral diversity, this zone has innumerable indigenous weeds in beel areas. Several types of palms and bamboo clumps grow in almost all the villages. This zone affords a very lucrative place for game birds which include geese, ducks, cranes, spines, jungle fowls etc. both in the Sundarbans and the beel and char areas. Moreover, the river network and expanse of beels abound with different species of fishes.

4.7.1.4 The Sundarbans

The south tidal lands is occupied by the Sundarbans, the world's largest mangrove forest consisting of about 330 species of plants, 42 species of mammals, 35 species of reptiles, 400 species of fishes and 270 species of birds. Salinity and tide-ebb provide a different type of ecosystem (mangrove ecosystem) in this region. Plants and wildlife species distribution is dependent on salinity. A little portion of the Kapotakshi (south) catchment consists of this type of ecosystem.



Map 4-4: Different bio-ecological zones along the study area

4.7.2 Ecosystems

The study area contains various landforms and ecosystems such as homestead gardens, croplands, fruit and wood tree gardens, urban areas, rural settlements, roadside and embankment vegetation, mangroves, rivers, khals, ponds, shrimp ghers, beels and depressions.

The study area occupies terrestrial as well as aquatic ecosystems. Except for settlement areas, the entire land area is used for two major purposes, one for paddy cultivation and the other for saline or fresh water shrimp and fish culture. Pictures 4-32 present the photographs of different ecosystems within the project area.

4.7.2.1 Terrestrial ecosystem

Among the terrestrial ecosystems, the major habitats found are: i) Homesteads/settlement ii) Agricultural land, and iii) Embankment and Roadside.

Picture 4-32: Major terrestrial habitat types found in the study area

Homesteads/Settlement

Settlement vegetation is the single most important plant community in terms of diversity inside the study area. This vegetation generally includes two types of plants: those cultivated for their economic value and those that are self-propagating. Settlement vegetation is not as diverse as natural forest since only economic species are cultivated. Settlement vegetation also plays a very important role in providing shelter for many wildlife species and due to the lack of natural forest in the project area, their importance as wildlife habitat is even greater.

Besides meeting food, fodder, medicine, fuel and other household requirements, settlement vegetation is the major source of timber and renewable biomass energy as the nearby forests are completely depleted.

Now a days settlement vegetation is badly affected as a result of the increasing salinity due to loss of connectivity of river channels with upstream flow and random use of the surrounding agricultural land for saline water shrimp culture.

Agricultural land

Agricultural land covers more than 60% of the study area. The whole area is used for rice culture once or twice a year, depending on the land type, with predominantly rain fed transplanted Aman (monsoon) and/or irrigated transplanted Boro (winter) rice. Although the cropland ecosystem is the least diverse amongst all, they have some importance as hunting and feeding ground for birds and other wildlife.

Road and embankment side

Roads and embankments are sparsely vegetated and less diverse than other types of plants. This type of habitat provides good shelter for indigenous bird species and some reptiles. The dominant species of the roadside are the Khejur (Phoenix sylvestris) and the Rain Tree (Albizia saman). Babla (Acacia nilotica) is the most common of all species found on the embankments and dykes.

4.7.2.2 Aquatic ecosystem

The study area occupies numerous rivers, khals and beels. Most of the rivers have lost connectivity with their destination for loss of depth due to frequent deposition of sediment and lack of upstream flow. The upper portion of the study area includes the Kapataskhi and Betna catchments. In connection with this a big number of beels, e.g. beel Dakatia, beel Khukshia, beel Bakar, beel Kedaria, Beel Kopalia etc. exist at Avaynagar, Manirampur and Keshobpur upazilas of the study area inside the Hari-Mukteshwari and Harihar-Bhadra-Joykhali catchments. A bigger portion of these beels are stagnant with rain water due to the loss of connection with rivers. Most of the beel area is now converted into pocket ghers (compartmental shrimp culture). These wetlands are mostly used for culture fisheries or even both paddy cultivation and fish farming. Every homestead in the rural area contains one or more perennial ponds which are used for daily household needs and for supporting non-commercial fish habitat.

During the past 10-20 years the changes from agricultural land to saline water shrimp farm (Chingri Gher) have had a direct impact on its dependent flora and fauna. The fluctuation or changes in the population dynamics of the biological diversity define the biomass productivity of the wetland. All of these aquatic habitats poorly abound in aquatic biodiversity.

Due to lack of adequate wetland plant products, human use of aquatic plant produces remain very low. Wetland plant products are minimally used for food, fodder, medicine and fuel material.

Picture 4-33: Major aquatic habitat types found along the study area

4.7.3 Biodiversity

4.7.3.1 Terrestrial flora

Homesteads/settlement vegetation

The most dominant species in the study area is the Rain tree (Albizia saman), which occupies a large percentage of the canopy cover. Other common species are, Amm (Mangifera indica), Supari (Areca catechu), Narikel (Cocos nucifera), Mahogany (Swietenia mahagoni) etc. Khejur (Phoenix sylvestris) is the indicative non-cultivated species found very commonly scattered all over the study area. The available homestead plant species are listed in Table 4-18.

Agricultural land

Agricultural lands are predominantly occupied by rain-fed transplanted Aman (monsoon) and/or irrigated transplanted Boro (winter) rice. The common agricultural weeds are listed in Table 4-18.

Road and Embankment Vegetation

The dominant species of the roadside are Khejur (*Phoenix sylvestris*) and Rain Tree (*Albizia saman*). Babla (*Acacia nilotica*) is the common of all species found on the embankments and dykes. Durba (*Cynodon dactylon*) and Bonjhaal (*Croton bonplandianum*) are common among the herbs.

4.7.3.2 Aquatic flora

Aquatic flora in the study area can be divided into communities based on a set of environmental conditions. The communities are as follows:

- submerged plants
- free-floating plants
- rooted-floating plants
- sedges and meadow, and
- wetland marginal plants

Of all the wetland plant communities in the project area, the submerged and rooted floating communities are the most prevalent. These plants begin their growth period with the rise of the water level at the beginning of monsoon and persist as long as the water is present. The Jhangi (*Hydrilla verticilata*) and the Water lily (*Nymphaea spp*.) are dominant species along with various grass species. The Madur Pata is a prominent marginal species found around Satkhira sadar, Kaliganj and Tala region. Hogla (*Typha spp.*) is available inside the beel peripheral region of Keshobpur, Avaynagar and Manirampur.

Among the free floating plant species, the Kochuripana (Eichhornia crassipes) is common in khals and ditches at the upper portion of the study area.

Villagers of some areas of Satkhira district (e.g. Nalta, Kaliganj) commercially cultivate the Paniphal (*Trapa spp.*) but in a small scale.

The rooted floating community is the dominant plant type in the wetlands of the project area and found both in perennial as well as seasonal water bodies. Sapla (*Nymphaea spp.*) is the most dominant species.

Some mangrove species like the Kewrah (*Sonneratia apetala*), the Hargoza and the Golpata (*Nipa fruticans*) are found along the river bank with continuous flow from the sea.

4.7.3.3 Terrestrial Fauna

The richness of terrestrial fauna species varies in different parts of the study area, although their density and numbers are not satisfactory. Most of the bird species are local whereas very few migratory birds are observed during the winter. Birds of prey were not observed in great numbers, although some Brahminy kites (*Haliastur indus*) and Crested Serpent Eagles were observed as residents.

Mammals are rare and all the bigger mammals have already disappeared with the disappearance of the forest patches.

Small mammals such as the Common mongoose (*Herpestes edwardsi*), the Bengal fox (*Vulpes bengalensis*), the Jungle cat (*Felis chaus*), the common house rat (*Rattus rattus*), the house mouse (*Mus musculus*) and bats are the major species. The common lizards found within the project area include the garden lizard (*Calotes versicolor*) and the common skunk (*Mabuya carinata*). The Yellow common monitor (*Varanus flavescens*) and the Bengal grey monitor (*Varanus bengalensis*) are rarely found. The population of snakes is not very rich as they have little shelter in this vast open landscape. Among the amphibian species, the Common toad (*Duttaphrynus melanostictus*) is the most common of all.

4.7.3.4 Aquatic fauna

The aquatic fauna of the study area is poorly abundant. The hydrological cycles and the presence of different wetlands provide a diversified habitat for all aquatic biota, especially fish. The life cycle of most of the aquatic or wetland related fauna is dependent on the riverine or wetland ecosystem's natural fluctuations and local rainfall and weather events.

Among amphibians, the skipper frog (*Euphlyctis cyanophlyctis*) is common and found in all wetland habitats. It has been most successful in adapting to the altered habitat. Bullfrogs were also commonly found in the past but are now disappearing from this area because of extension of saline water shrimp farming. There is a rare evidence of turtle species. Common aquatic snakes include the Checkered keel back (*Xenocrophis piscator*) and the smooth water snake (*Enhydris enhydris*).

Extension of aquaculture and agriculture in wetland, aquatic and water dependent birds have been severely affected by the alteration of the natural habitat. The common aquatic birds of the study area are the Little Egret (*Egretta grazetta*), the Great Egret (*Casmerodius albus*), the Indian Pond heron (*Ardeola grayii*), the Black bittern (*Dupetor flavicollis*), the Common teal (*Anas creecca*) etc.

Several species listed in the IUCN Red Data Book occur within the project area. These species include the Bengal fox (*Vulpes bengalensis*) and yellow common monitor (*Varanus flavescens*). In addition, some species found within the project area are listed in the schedules of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). Those listed are the Bengal gray Monitor (*Varanus bengalensis*), the small Indian Civet (*Viverricula indica*) and the Jungle cat (*Felis chaus*).

Table 4-18: Checklist of plant species with habitat distribution and abundance

Abundance code: VC – Very Common C – Common, R – Rare, VR – Very rare, O – Occasional, Ab - Absent

Naming Type			Abundance
Scientific name	Family	Local name	
Homestead & surroundings vegetation			
Acacia nilotica	Mimosaceae	Babla	VC
Adhatoda zeylanica	Acanthaceae	Bashok	C
Aegle marmelos	Rutaceae	Bel	C
Albizia lebbeck	Leguminosae	Sirish	VC
Albizia procera	Leguminosae	Silkaroi	C
Albizia richrdiana	Legminosae	Gogon Sirish	C
Anthocephalus chinensis	Rubiaceae	Kadom	C
Aponomyxis polystachya	Meliaceae	Rayna	R
Areca catechu	Palmae	Supari	VC
Artocarpus heterophyllus	Moraceae	Kathal	C
Artocarpus lacucha	Moraceae	Dephal	R
Azadirachta indica	Meliaceae	Nim	C
Averrhoa carambola	Averrhoaceae	Kamranga	C

Naming Type			Abundance
Scientific name	Family	Local name	
Barringtonia acutangula	Barringtoniaceae	Hijal	R
Bauhinia sp.	Caesalpiniaceae	Kanchon	R
Bombax ceiba	Bombacaceae	Shimul	C
Bambusa sp.	Gramineae	Bans	C
Borassus flabelifer	Palmae	Tal	C
Cassia fistulosa	Legminosae	Sonalu	R
Centella asitica	Umbelliferae	Thankuni	C
Citrus grandis	Rutaceae	Jambura	C
Citrus medica	Rutaceae	Lebu	C
Cleorodendrum viscosum	Verbenaceae	Bhat	C
Cocos nucifera	Palmae	Narikel	VC
Casuarina equisetifolia	Casurianaceae	Jahu	R
Dalbergia sissoo	Fabaceae	Sisso	C
Dillenia indica	Dilleniaceae	Chalta	R
Diospyros perigrina	Ebenaceae	gab, deshigab	C
Datura metel	Solanaceae	Dutura	C
Erythrina variegata	Leguminosae	Mandar	C
Erythrina ovalifolia	Leguminosae	Talimandar	R
Ficus benghalensis	Moraceae	Bot	C
Ficus rumphii	Moraceae	Hijulia	R
Ficus religiosa	Moraceae	Assawath	C
Ficus hispida	Moraceae	Dumur	C
Ficus sp.	Moraceae	-	C
Glycosmis pentaphylla	Rutaceae	Daton	C
Holarrhena antidysenterica	Apocynaceae	Kurchi	C
Jasminum sp.	Oleaceae	-	R
Litchi chinensis	Sapindaceae	Lichu	C
Mangifera indica	Anacardiaceae	Aam	VC
Mikania scandens	Compositae	Assamlata	VC
Mikania scandense	Compositae	-	VC
Moringa oleifera	Moringaceae	Sajna	C
Musa paradisiaca var. sapientum	Musaceae	Kala	VC
Ocimum americanum	Labiatae	Tulshi	C
Physalis minima	Solanaceae	Bantepari	C
Pongamia pinnata	Fabaceae	Karoch	C
Ricinus communi	Euphorbiaceae	Reri	R
Phoneix sylvestris	Palmae	Khejur	VC
Polyalthia longifolia	Annonaceae	Debdaru	R
Pithecolobium dulce	Mimosaceae	Daskhini babul, Jilapi Phal	C
Ruellia tuberosa	Acanthaceae	Patpaty	C
Streblus asper	Urticaceae	Sheora	C
Syzygium cumini	Myrtaceae	Kalojam	C

Naming Type			Abundance
Scientific name	Family	Local name	
Swietenia mahagoni	Meliaceae	Mahogoni	VC
Spondias dulcis	Anacardiaceae	Amra	C
Terminalia catappa	Combretaceae	Katbadam	R
Terminalia arjuna	Combretaceae	Arjun	C
Temarindus indica	Leguminosae	Tetul	C
Trewia nudiflora	Euphorbiaceae	Pitali/Latim	C
Vitex negundo	Verbinaceae	Nishinda	R
Zizyphus mauritiana	Rhamnaceae	Baroi	VC
Agricultural land Vegetation			
Acalypha indica	Euphorbiaceae	Muktajhuri	C
Achyranthes aspera	Amaranthaceae	Apang	C
Ageratum conyzoides	Compositae	Fulkuri	C
Alternanthera sessilis	Amaranthaceae	Sachishak	VC
Amaranthus spinosus	Amaranthaceae	Kata note	C
Calotropis gigantea	Asclepiadaceae	Akand	C
Chenopodium ambrosoides	Chenopodiaceae	Chapali ghash	C
Clerodendrum inerme	Verbenaceae	Bhant	C
Commelina benghalensis	Commelinaceae	Kanchira	C
Crotolaria retusa	Leguminosae	Ban-san	C
Croton bonplandianum	Euphorbiaceae	Banjhal	VC
Cuscuta australis	Convolvulaceae	Swarnalata	R
Cyanotis cristata	Commelinaceae	Kanaya ghash	C
Cynodon dactylon	Gramineae	Durba	VC
Cyperus cephalotes	Cyperaceae	Niratraba	VC
Cyperus sp.	Cyperaceae	-	VC
Dentella repens	Rubiaceae	Hachuti	C
Digitaria longiflora	Gramineae	Sadaphuli	C
Eleocharis atropurpurea	Cyperaceae	-	C
Eleusina indica	Gramineae	Panichaise	C
Eupatorium odoratum	Compositae	Assamlata	VC
Euphorbia hirta	Euphorbiaceae	Dudhialata	VC
Fimbristylis aphylla	Cyperaceae	Baranirbishi	C
Heliotropium indicum	Boraginaceae	Hatisur	C
Herpestis monniera	Scrophulariaceae	Brahmishak	C
Ipomoea fistulosa	Convolvulaceae	Dhol kalmi	C
Ipomoea stolonifera	Convolvulaceae	Sada kalmi	R
Justicia gendarusa	Acanthaceae	Nilnishinda	C
Leonurus sibiricus	Labiatae	Raktodrone	R

Naming Type			Abundance
Scientific name	Family	Local name	
Leucas lavendulifolia	Labiatae	Drone	C
Lindernia crustacea	Scrophulariaceae	Bhui	C
Ludwigia hyssopifolia	Onagraceae	-	C
Mimosa pudica	Leguminosae	Lajjabati	R
Nicotiana plumbaginifolia	Solanaceae	Bantamak	C
Phyllanthus disticha	Euphorbiaceae	Chitki	C
Physalis minima	Solanaceae	Futki	C
Rottboellia protensa	Gramineae	Barajati	R
Rorippa indica	Cruciferae	Bansarisha	VC
Rumex dentata	Polygonaceae	Bonpalang	VC
Sarcochlamys pulcherrima	-	Karabi	R
Scoparia dulcis	Scrophulariaceae	Bandhundi	C
Solanum khasianum	Solanaceae	Phutibegun	R
Solanum nigrum	Solanaceae	Titbegun	C
Solanum torvum	Solanaceae	Kakmachi	C
Solanum indicum	Solanaceae	Gothbegun	R
Tridax procumbens	Compositae	Tridhara	C
Triumfetta rhomboides	Compositae	Banokra	C
Vitex trifolia	Verbenaceae	Sagar nishinda	C
Xanthium indicum	Compositae	Hagra	VC
Mangrove Vegetation			
Sonneratia apetala	Sonneratiaceae	Keora	C
Sonneratia caseolaris	Sonneratiaceae	Ora	C
Nipa fruticans	Palmae	Golpata	O
Excoecharia aghalocha	Euphorbiaceae	Gewa	R
Acanthus ilicifolius	Acanthaceae	Hargoza	C

4.8 Socio-economic condition

The project area is located in Khulana, Satkhira, Jessore and Jhenaidaha districts. The project area consists of 22 upazilas with a gross area of 424,021 ha and a net area of 303,656 ha. Table 4-19 shows the percentage of the upazilas that fall within the project area.

Table 4-19: Unions within the scheme area by percentage

Sl. No.	Districts	Upazilas	Percentage of upazilas within project area
1	Khulna	Dumuria	100
2		Phultala	55
3		Daulatpur	10
4		Batiaghata	45
5		Dacope	3
6		Paikgachha	58
7		Koyra	48
8	Jessore	Keshabpur	100
9		Monirampur	100
10		Jessore Sadar	34
11		Abhaynagar	32
12		Jhikargachha	100
13		Sharsha	50
14		Chougachha	70
15	Satkhira	Tala	100
16		Kalaroa	86
17		Satkhira Sadar	100
18		Assasuni	74
19		Shyamnagar	10
20		Debhata	73
21		Kaliganj	55
22	Jhenaidaha	Maheshpur	35

Source: GIS estimation, CEGIS

4.8.1 Population distribution in the study area

The demographic scenario of the proposed project area is presented in Table 4-20. In the project area the total number of households is estimated at 869,815. The total population is 4,131,620 where males comprise 2,122,994 and female 2,008,626. The ratio of male and female in this project area is calculated to be 51.38:48.62. The average household size is 4.75 persons per household. The population density of the study area is approximately 1,022 persons per square kilometer. The average literacy rate (2001) of the study area is higher than the national average of Bangladesh (national rate is stated in the table).

Table 4-20: Demographic scenario of the scheme area

No. of total households	Population			Literacy rate (above 7 years)		
	Male	Female	Total	Total – 45.39	Male- 49.60	Female- 40.80
869,815	2,122,994	2,008,626	4,131,620	48.96	54.67	42.95
Percentage	51.38	48.62				

Source: BBS estimated data 2010

The age distribution of the population in the proposed project area is presented in Table 4-21. It is observed in the table that 44% of the population (age group between 0-14 years and above 59 years) is dependent on the remaining 56% (age group 15 to 59 years) who are able to do some work. So the dependency ratio is estimated to be 56:44.

Table 4-21: Age distribution of population

Age range													
0-4 Years		5-9 Years		10-14 Years		15-17Years		18-34 Years		35-59 Years		60+Years	
M	F	M	F	M	F	M	F	M	F	M	F	M	F
240795	222416	267679	248890	274585	245421	131240	98198	580157	673406	487361	390110	146716	124644
11		13		13		5		30		21		7	

Source: BBS estimated data 2010.

4.8.2 Employment opportunity and occupation

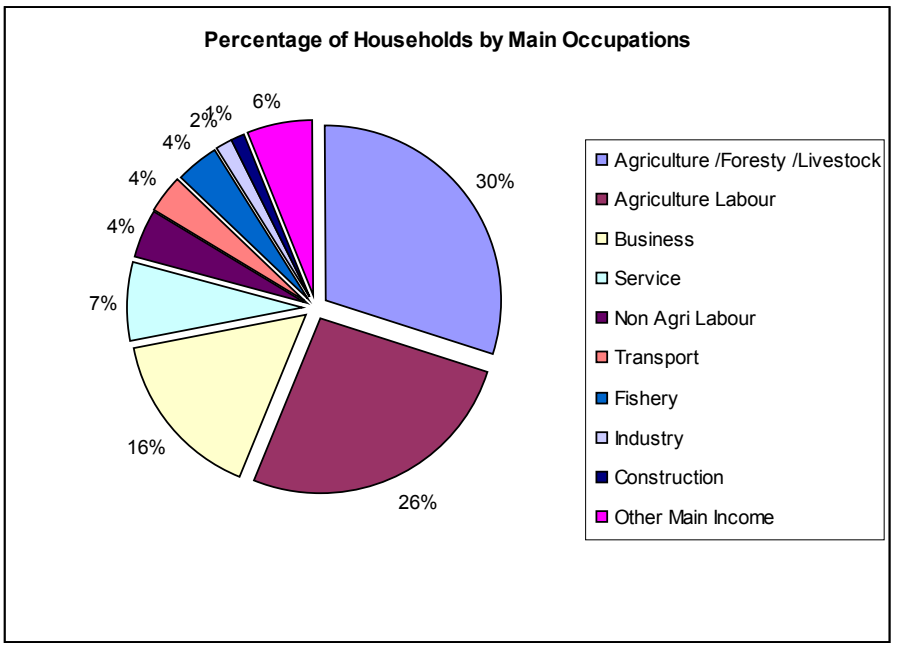
Employment opportunity in the proposed project area is presented in Table 4-22. The table shows that the the highest percentage (32%) of population include those involved in household work, followed by those not working (29%), and those involved in agricultural work (21%) and business (6%) respectively. A small percentage of some other occupations is also observed in the area.

Table 4-22: Population of the ages 10 years and above by main activity

Sl. No.	Main occupation by population	% of population
1.	Household work	32
2.	Not working	29
3.	Agriculture	21
4.	Business	6
5.	Looking for work	2
6.	Transport	1
7.	Industry	1
8.	Construction	1
9.	Service	1
10.	Others	6

Source: BBS estimated form 2010 data.

The primary occupations and main sources of income by household in the S-W proposed project area is presented in Figure 4-5. The table shows that the highest percentage (30%) of households reported are those having farming work (agriculture /forestry /livestock), followed by agriculture labour households (26%), and business households (16%). Some small percentage of other households is also shown in the figure.



Source: BBS estimated data 2010

Figure 4-5: Percentage of households by main occupation

4.8.3 Availability of labour and labour wage rate

Availability of both farm and non-farm male labourer is relatively high and medium in the project area respectively. The availability of female labourer is medium and low in the farming and non-farming sectors respectively. The wage rate of male labourers is relatively higher than that of female labourers. The average maximum and minimum wage rate for male and female labourers is reported in Table 4-23.

Table 4-23: Wage rate for male and female labor

Wage for	Male labour wage (taka)		Female labour wage (taka)	
	Ave. maximum	Ave. minimum	Ave. maximum	Ave. minimum
For farming activities	125	100	80	70
For non-farming activities	150	125	100	80

Sources: RRA by CEGIS

4.8.4 Population migration

Seasonal out migration from this area is observed in the project area for better employment opportunity,. Around 30% of labourers usually go to Khulna, Dhaka, Barisal, Chittagong etc. On the other hand, only farm-labourers migrate seasonally in the study area and usually come from Paikgachha, Koyra, etc. No permanent out migration is observed in the study area. Recently a significant number of households permanently migrated to the northern area of the project site. Mainly some SIDR/AILA affected people have migrated to urban areas such as the Khulna, Jessore, and Satkhira town areas after losing all movable and immovable properties.

4.8.5 Household income and expenditure

Annual income and expenditure of the percentage of households under six classified groups in the proposed project area are presented in Table 4-24. The income expenditure table shows that it is a relatively poor area as around 69% and 74% households reported that their income and expenditure levels were below 5,000 taka per month respectively.

Table 4-24: Households by income and expenditure group of the scheme area

Range (in taka)	Percentage of households	
	Income group	Expenditure group
< or = 12,000	10	12
12,000-24,000	28	26
24,000-60,000	31	36
60,000-1,08,000	21	18
1,08,000-2,40,000	6	6
> or = 2,40,000	4	2

Sources: RRA by CEGIS

4.8.6 Self assessed poverty status

The poverty status assessed by the villagers on the basis of their food security is presented in Table 4-25. The status is defined in three ladders, i.e. as deficit, break-even and surplus. Fifty percent of households reported to be at breakeven level year round followed by deficit and surplus levels at the same value (25%).

Table 4-25: Poverty status of the scheme area

Sl. No.	Poverty status	Percentage of household
1	Deficit	25
2	Break-even	50
3	Surplus	25

Sources: RRA by CEGIS

4.8.7 Housing condition

Housing condition is classified on the basis of housing materials used for the construction of houses. The percentage of households with four types of houses (BBS data) found in the scheme area is presented in Table 4-26. One can observe in the table that Kancha houses are the dominant type of houses in the study area. More than 10% of jhupri houses are reported in Jhikorgachha and Sarsha upazilas under Jessore district. Twenty percent or more houses are reported to be semi-pucca in Phultala, Daulatpur, Jessore sadar, Ahaynagar, Chaugachha and Satkhira sadar upazila area. Twenty percent or more houses are reported to be pucca in the Daulatpur and Jessore sadar upazila area.

Table 4-26: Housing condition in the scheme area

Upazilas	Jhupri	Kancha	Semi-Pucca	Pucca
Dumuria	2.54	81.58	8.10	7.78
Phultala	4.61	56.05	22.26	17.08
Daulatpur	7.84	48.07	21.65	22.43
Batiaghata	6.32	85.45	4.73	3.50
Dacope	4.82	89.81	2.97	2.40
Paikgachha	3.60	80.46	7.99	7.95
Koyra	1.50	94.45	2.02	2.03
Keshabpur	1.80	73.57	13.33	11.31
Monirampur	2.64	73.77	15.17	8.42
Jessore Sadar	7.10	50.40	20.64	21.86
Abhaynagar	4.71	61.11	23.52	10.66

Upazilas	Jhupri	Kancha	Semi-Pucca	Pucca
Jhikargachha	10.12	61.90	17.82	10.17
Sharsha	19.80	53.90	13.48	12.82
Chougachha	4.22	66.96	20.21	8.60
Tala	2.74	72.39	14.65	10.22
Kalaroa	9.24	64.00	17.48	9.28
Satkhira Sadar	4.37	62.55	19.69	13.39
Assasuni	3.32	83.51	7.75	5.42
Shyamnagar	2.36	91.37	2.85	3.42
Debhata	3.42	67.18	16.76	12.64
Kaliganj	2.55	80.70	8.77	7.98
Maheshpur	8.15	72.66	11.18	8.01
Total	**5**	**71**	**13**	**10**

Source: BBS, 2001

The current status of housing materials collected from local people during the RRA survey is presented in Table 4-27. The people reported that at present there were around 25% and 10% of semi-pucca and pucca houses respectively.

Table 4-27: Housing condition in the scheme area

Sl. No.	Housing status	% of households having
1	Jhupri	5
2	Kutcha	60
3	Semi Pucka	25
4	Pucca	10

Sources: RRA by CEGIS

Picture 4-34: Traditional house in project area

Picture 4-35: Traditional house in project area

4.8.8. Source of drinking water

The percentage of households with different sources of drinking water, according to the BBS report, is presented in Table 4-28. Seventy-nine percent of households draw water from HTWs for drinking purpose followed by pond and well water. However, it was reported by local people during the field visit that in almost 90% of cases now HTWs is the source of water.

Table 4-28: Source of drinking water in the scheme area

Sl. No.	Drinking water sources	Percentage of households used (source BBS)	Percentage of households used (source RRA)
1	Tap	2	-
2	Tube well	79	90
3	Well	8	-
4	Pond	8	3
5	Other (rain water, river water)	4	7

Sources: BBS and RRA by CEGIS

Picture 4-36: HTW in project area

Picture 4-37: Traditional latrine in project area

4.8.9 Sanitation facility

The sanitation facilities by percentage of households in the proposed project area (based on BBS and RRA reports) are presented in Table 4-29. One can easily draw a relative comparison between the two sets of data. It is reported through RRA that there are around 72% of households having ring slab and water sealed latrine facilities within the project area.

Table 4-29: Sanitation facility in the scheme area

Sl. No.	Toilet types	Percentage of households under each type	Toilet types by BBS	% of HHs reporting
1	Water sealed	18	Sanitary	38
2	Ring slab	72	Others	42
3	*Kacha*	9	None	20
4	No facilities	1	-	-

Sources: BBS and RRA.

4.8.10 Diseases in the project area

Incidence of common diseases in the project area are ranked as rank 1, rank 2 and rank 3, and presented in Table 4-30. Around 60% of households received treatment from paramedics /diploma doctors at village level, 20% of households from trained physicians, and 15% of households from quacks. Five percent of households are not getting any treatment facilities due to poverty (Table 4-31).

Table 4-30: Common diseases in the scheme area

Sl. No.	Disease	Ranking by incidence
1	Influenza/ common fever	2
2	Cough/cold	4
3	Diarrhea	5
4	Skin diseases	3
5	Gastric	1
6	Arsenic	6

Sources: RRA by CEGIS

Table 4-31: Source of treatment facilities for the project area people

Sl. No.	Source of treatment facilities	Percentage of households received
1	Trained physicians	20
2	Paramedics/ diploma physicians	60
3	Treatment by quacks and informal treatments	15
4	No treatment facilities at all	5

Sources: RRA by CEGIS

4.8.11 Electricity facility

According to the BBS report 2001, only 26% of households in the proposed project area have electricity facilities. During the RRA, however, the local people claimed that around 40% of households currently had electricity facilities.

4.8.12 Social overhead capital

4.8.12.1 Existing road networks

The communication system within the proposed project area is moderate. The regional highway from Khulna to Kushtia via Jessore is located on the north side of the project area. Another regional highway from Khulna to Satkhira also crosses the project area from east to west. A huge number and length of feeder road types A and B are observed respectively in the scheme area. Rural kancha roads are also observed within the study area (Picture 38). Many embankments surrounding the project area as well.

Picture 4-38: Rural road in project area

Picture 4-39: Ferry ghat in project area

4.8.12.2 Existing waterways

There are some major rivers namely the Shibsha, the Rupsha, the Kazibacha, the Pasur, the Bhairab, the Kapotakshi, the Betna etc. located within the proposed project area. These are tidal rivers with year round navigability. However these rivers, except for the Rupsa, the Kazibacha and the Pasur, have all silted up severely due to huge sedimentation and lost much of their navigability. One of the main rivers, the Kapotakshi, has silted up severely and in the rainy season rain water cannot drain properly from it. As a result huge areas of the Kapotakshi catchment remains water logged with rain water every year and the situation is worsening.

4.8.13 Educational status and academic institutions

The educational status of the project area is impressive. The literacy rate is higher than the national average (Table 4-32). The educational enrollment at different levels of school is presented in Table 15. It is observed in the table that at primary, high school and college levels the percentages of students are 28%, 28% and 43% respectively. Not attending students reported at primary, high school and college levels are 42%, 30% and 75% respectively. There is a primary school reported in each mauza, whereas secondary schools are 3-4 in number per union.

Table 4-32: Percentage of Students Enrollment within 5-24 years

Total no. of students	5 to 9 Years				10 to 14 Years				15 to 24 Years			
	Attending		Not attending		Attending		Not attending		Attending		Not attending	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1,817,913	30	28	22	20	36	34	17	13	15	10	32	43
	28				28				43			

Source: BBS

4.8.14. Land holding categories

According the the BBS report 2001, only 57% of the households own agricultural land in the proposed project area. The percentage of households by land holding categories compiled based on field investigation, is presented in Table 4-33.

Table 4-33: Percentage of households with different land ownership categories

Land ownership classes	Percentage of households
Landless/ No land (0 decimal)	12
Landless (up to 49 decimal)	22
Marginal (50-100 decimal)	28
Small (101-249 decimal)	24
Medium (250-749 decimal)	12
Large (750 + decimal)	02

Sources: RRA by CEGIS

4.8.15 Land price

The sale value of land in the project area is presented below in Table 4-34.

Table 4-34: Land sale value in the study area

Land categories	Average price (Tk.) per acre
Commercial land	5,000,000/-

Land categories	Average price (Tk.) per acre
Home stead land	5,000,000/-
Agricultural land (medium)	600,000/-
Agricultural land (low)	500,000/-
Very Low land	300,000/

Sources: RRA by CEGIS

4.8.16 Conflict between landowners and different professional groups

Major conflicts are observed within the project area. In the dry season, shrimp farmers want saline water from the river to enter the floodplain. However, farmers want to prevent saline water intrusion in their crop fields. So, a conflict often arises between the two groups over the question of maintaining and controlling saline water. Sometime this conflict leads to serious clashes. The conflict is usually resolved by informing local leaders and influential persons.

4.8.17 Disaster related information

Natural disasters like water logging, tidal floods, sedimentation and river siltation, salinity intrusion and erosion etc. create problems due to huge sedimentation in all the rivers in the study area. Catchment-wise natural disasters and their impacts are given in the following sub-sections:

4.8.17.1 Sholmari-Salta-Lower Bhadra

Table 4-35: Natural disasters and their impacts on Sholmari-Salta-Lower Bhadra

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every year	20	20	25	Aman
2	Tidal flood	Every year	10	20	100	Aman, Boro
3	Salinity intrusion	2010	100	100	50	Aman, Boro
4	River Erosion	2008	60	30	40	Vegetable land
5	Sedimentation & river siltation	Every year situation has deteriorated				

Source: FGD by CEGIS

4.8.17.2 Hamkura-Bhadra-Joykhali

Table 4-36: Natural disasters and their impacts on Hamkura-Bhadra-Joykhali

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	60	70	90	Aman ,vegetables
2	Tidal flood	Every Year	60	20	100	Aman, Boro
3	Salinity intrusion	2010	75	80	50	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Humkura River dead, Bhadra also about dead due to sedimentation				

4.8.17.3 Hari-Mukteshwari

Table 4-37: Natural disasters and their impacts on Hari -Mukteshwari

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	10	0	5	Aman
2	Tidal flood	-	0	0	0	-
3	Salinity intrusion	-	0	0	0	-
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	-	-	-	-	-

4.8.17.4 Upper-Buri Bhadra-Harihar

Table 4-38: Natural disasters and their impacts on Upper-Buri Bhadra-Harihar

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every year	25	10	25	Vegetables, Boro
2	Tidal flood	-	-	-	-	-
3	Salinity intrusion	every year	25	10	40	Vegetables, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Upper Bhadra is almost silted up				

4.8.17.5 Teligati-Ghengrile

Table 4-39: Natural disasters and their impacts on Teligati-Ghengrile

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	20	10	25	Boro, Aman, Vegetables
2	Tidal flood	Every Year	20	10	20	Aman, Boro
3	Salinity intrusion	Every year	100	50	50	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Teliganti and Ghengrail River is silted up gradually.	-	-	-	-

4.8.17.6 Salta-Gunakhali-Haria

Table 4-40: Natural disasters and their impacts on Salta-Gunakhali-Haria

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	10	0	10	Aman
2	Tidal flood	Every Year	60	50	80	Aman, Boro
3	Salinity intrusion	2007, 2010	20	50	60	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Rivers are gradually silting up	-	-	-	-

4.8.17.7 Kapotakshi

Table 4-41: Natural disasters and their impacts on Kapotakshi

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	60	50	80	Aman
2	Tidal flood	Every Year	80	40	90	Aman, Boro
3	Salinity intrusion	2010	100	60	100	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Kapotakshi River is almost silted up	-	-	-	-

4.8.17.8 Shalikha

Table 4-42: Natural disasters and their impacts on Shalikha

Sl. No.	Disaster type	Recent year (s) severely affected	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	25	0	20	Aman
2	Tidal flood	Every Year	10	0	10	Aman, Boro
3	Salinity intrusion	2010	-	-	-	
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Rivers are gradually silting up				

4.8.17.9 Betna

Table 4-43: Natural disasters and their impacts on Betna

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	60	50	80	Aman
2	Tidal flood	Every Year	80	40	90	Aman, Boro
3	Salinity intrusion	Every year	50	25	50	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Betna River is silting up gradually	-	-	-	-

4.8.17.10 Morirchap-Labonyabati

Table 4-44: Natural disasters and their impacts on Morirchap-Labonyabati

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water logging	Every Year	25	10	25	Aman
2	Tidal flood	Every Year	10	-	10	Aman, Boro
3	Salinity intrusion	Every Year after SIDR and AILA	50	25	50	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Rivers are silting up gradually				

4.8.17 Shapmara-Galghesiya

Table 4-45: Natural disasters and their impacts on Shapmara-Galghesiya

Sl. No.	Disaster type	Severely affected in recent years	% of area affected	% of HHs affected	% of yield loss	Major crops damaged
1	Water Logging	Every Year	10	05	10	Aman
2	Tidal flood	Every Year	10	-	10	Aman, Boro
3	Salinity intrusion	Every Year after SIDR and AILA	25	10	25	Aman, Boro
4	River Erosion	-	-	-	-	-
5	Sedimentation and river siltation	Rivers are silted up gradually	-	-	-	

4.8.18 Safety nets and poverty reduction measures in the area

Grameen Bank (GB), ASHA, BRAC, etc. are the national NGOs working in the proposed project area. All of the NGOs have credit programmes for poor people. There are also some government services like the VGF card, Bayoshka Bhata (allowance for the elderly), Bidhaba Bhata (widow's allowance) operating in the study area (*Sources: FGDs by CEGIS)*

Table 4-46: NGOs activities in safety nets and poverty reduction

Sl. No.	NGOs	Activities done	Approximate percentage of households covered
1.	Grameen Bank	credit	25
2.	BRAC	credit, health, education and sanitation	25
3.	Asa	credit	10
4.	CARE	credit	5
5.	GOs (Krishi Bank, VGF, VGD, Baysko Bhata, Protibandhi Bhata, Bidhaba Bhata etc.	credit and services	20

4.8.19 Cultural heritage/archeological sites

There are a lot of cultural heritage and archeological sites located in the project area. In Jessore area, the Dikdara Temple, the Rajgonj Bazaar Temple, the Boddhonath Tala Temple, the Rajgonj Shosan Mondir, the Monorampur Boro Mosque, the Dolkhola Temple, the Simjalar Mosque, the Chaugachha Jame Mosque, the Sourobpur Mosque, the Shakpara Mosque at Sagordari, the Residence and Temple of Michael Modhusudhon Datta, Sagardari, Keshabpur, etc. are some of the cultural and archeological sites. In Satkhira district, some of the cultural and archeological sites include the Parabaspur mosque at Soto Mia Pirer Majar in Mothirospur, the Nolta Majar Sharif (Khan Bahadur Ahasan Ullah's Majar), the Amiran Temple in Tarali union at Kaligonj, the Bangshipur Shahipur Mosque, the Shahipur Kalibari Temple, the Teulia Mosque, the Kashimpur Shoshan Temple beside the Kopatakkha River, the Temple at Kapilmoni etc. Khulna district also has a rich cultural and archeological background and in the project area the most prominent heritage are the Moszidkur Jame Mosque at Amadi union, the Katakhali Dorgha, and the house of Sir Profullya Chandra Ray (P.C. Ray).

Chapter 5

Important Environmental and Social Components

Important Environmental and Social Components (IESCs) likely to be impacted by the Southwest River Management Project of the Uttaran, were selected through a scoping process which included scoping meetings and field level village scoping sessions. The IESCs were selected on the basis of stakeholder interests and sensitivity of the IESCs to the proposed interventions.

IESCs selected in respect of water resources, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic condition and the rationale for their selection are presented in the following table.

Table 5-1: Resource-wise IESCs and rationale for selection

Resource	IESC	Rationale for selection
Water resources	Water logging	Water logging has been considered as IEC as most of the areas are inundated during rainy season. This inundation is due to huge cross boundary inflow, back water effects, unplanned construction of bridges, culverts and roads, malfunctioning of existing water control structures, and excessive rainfall. The proposed people's plan in the study area may change the intensity of water logging and hence it has been considered as an IEC.
	Drainage congestion	The proposed study area falls under the coastal embankment project under which coastal polders have been constructed since the 1960s. At the time of construction of all these polders a number of off-takes of internal canals in each polder were closed. Regulators and sluices were constructed on important canal off-takes under each polder. This plan for constructing regulators at important off-takes guided water management in terms of ensuring that drainage takes place from polders through defined routes. But the plan did not work as the drainage capacity of the rivers and internal khals has decreased due to sedimentation, unplanned construction of LGED roads, undesirable encroachment, conversion of khals into agricultural land, and deterioration of downstream river conditions. Moreover, these interventions disconnected low lying beel areas from the defined drainage route as well. Therefore, the drainage capacity of internal khals and drainage congestion may change with the implementation of the people's plan. As such, drainage congestion has been considered as an IEC.

Resource	IESC	Rationale for selection
	Sedimentation	Sedimentation is a common phenomenon at various locations of the main river networks which fall in the study area. Sedimentation is mainly caused due to the following: a) sediments are carried with upstream flood flow, b) sediments cannot be deposited in adjacent polder areas as these polders are surrounded fully by embankments, and c) back water flow. The project area is mostly composed of silty sand and agricultural activities have loosened the soil. The overland flow drags soil from agricultural land and deposits them in the riverbed due to backwater flow. Sedimentation due to the above-mentioned reasons over the years has increased the bed level of the river. The drainage capacity of the river will be changed as the project interventions are implemented and this will change the sedimentation rate. As such sedimentation in the main river has been considered as an IEC.
	Saline water intrusion	Currently, huge tidal volume intrudes into the channel through water control structures and over agricultural land. This saline intrusion will be impacted and changed after construction of the project and therefore, has been considered as one of the IECs.
	In-stream water resources	Ten to fifteen percent the study area comprises beels, khals, and sections of rivers and low lying areas. Presently, very little in-stream water resource is available during the dry season as these do not have adequate capacity to store water. Water used in the dry season mainly comes from the underground. So the water management interventions may change availability of in-stream water resources and have been hence considered as an IEC.
	Surface water availability	Like in-stream water resources in the channel network of each polder, the surface water availability of the main rivers at specified river reaches may change due to interventions during dry season and has been hence considered as an IEC.
	Wet season river water level	River water level in the main river is an important factor in flood inundation and proper drainage. The proposed intervention may change the wet season river water level and thus has been considered as an IEC.
Land Resources	Land Type	Land type may be improved due to the improvement of hydrological regime due to the construction of embankments and re-excavation of rivers and khals in the study area.
	Land Use	The construction of embankment and regulators may change the land use in the project area. The agricultural lands which are presently being used for shrimp culture may be used for agricultural crop production.
	Soil Salinity	In the south-western region of Bangladesh, the surface water salinity generally increases with the increase of dryness and reaches its peak during April-May and then decreases due to the onset of monsoon rainfall. In the dry season, some areas under the project are affected by soil salinity due to capillary rise of saline ground water which is unfavorable for crop production. In the dry season, most of the lands remain fallow or used for shrimp culture. The interventions of the project will decrease the soil salinity by preventing intrusion of saline water into agriculture fields. This situation may enhance crop production and reduce crop damage.
Agriculture	Crop production	Crop production is expected to increase due to decrease of soil salinity for construction, repair and maintenance of embankments and structures, and improvement of drainage congestion through re-excavation of rivers and khals due to implementation of project interventions. Hence, crop production may be increased.

Resource	IESC	Rationale for selection
	Crop damage	Crop damage is being caused mainly by the submergence, water logging/ drainage congestion due to siltation of rivers and channels, flash floods in the river due to heavy rainfall during monsoon season, and soil and water salinity as well as water stress (drought) during dry season. Boro (HYV) crops in low lying areas are also damaged due to early monsoon rainfall as well as flash floods in the river. Crop damage will be reduced if full interventions are implemented.
	Cropping Intensity	The project interventions will help to protect the area from submergence by saline water and change the hydrologic regime inside the project area, which may encourage farmers to change their cropping patterns. This will create a very favorable environment for increasing cropping intensity. Hence, it has been considered as one of the IECs.
Livestock resources	Livestock diseases	During monsoon season, the damp conditions in animal shelters lead to various kinds of diseases of bullocks and cows. Moreover, the unhygienic condition of courtyards during this season may cause diseases of poultry. These are the major reasons for including livestock diseases as one of the IEC.
	Feed and fodder shortage	Repeated flash floods/ seasonal floods damage crops, soil and water salinity in the field severely reducing the amount of straw and bran available for livestock. The animals may be most affected during monsoon season when they will be stall fed. Because of this reason, feed and fodder shortage has been considered as one of the IECs.
	Grazing land	Grazing land is difficult to find in the project areas. A few grazing lands are available along the roadsides, in scattered khas areas or in fallow crop fields. Soil salinity, brackish water fish culture and fish-cum-paddy cultivation, drainage congestion etc. are mainly responsible for reducing the grazing areas. It is for this reason that grazing areas have been included as one of the IECs.
Fisheries	Riverine fish habitat	Riverine fish habitats including rivers and khals act as the principal arteries of longitudinal and lateral fish migration and are suitable for most river fish breeders. Both brackish and sweet water fishes graze in the river. Rivers also act as the main suppliers of saline water by connecting khals to the shrimp farms of the project area. So, production and service functions of this habitat facilitate the local people in multiple ways such as, by providing the means of livelihood to fishermen community, facilitating protein intake of riparian people and raising shrimp farming. Substantial sedimentation and different man-made obstructions are aggravating the river and khal situation. Therefore, river habitat is becoming unsuitable for fish habitation limiting fish migration and constraining shrimp farming. Under the future without project condition, the river and khal situation will be further degraded while the situation is expected to be improved with project. Considering these aspects, riverine fish habitat has been chosen as an IEC.

	Beel fish habitat	Beels of the study area are mostly transformed either for shrimp or prawn farming or for agriculture. The remaining beels act as breeding and feeding grounds of indigenous species of fish and play an important role in the restocking of open water habitats. Perennial beels also act as brood stock. Some of the riverine fish species breed in the beels and propagate. Beel fish habitats of the project area are highly stressed as beel water is used for irrigation during the dry season and paddy is cultivated in the beel periphery. Without project condition, the existing ecologically and ichthyologically important beels are susceptible to rapid degradation. Therefore, the indigenous fish species are suspected to disappear from the area soon. With project condition, the scientifically planned TRM option will conserve some portion of the beel habitat. In this context, beel fish habitats have been considered as an IEC.
	Floodplain fish habitat	With project condition floodplain fisheries may be benefitted by the implementation of the interventions proposed under the river management project. Restoration of rivers, khals and other wetlands will facilitate the nutrient influxes to the floodplains and vice-versa. Without project condition, water logging will be created elsewhere and the already existing poor nutrient influxes will be further degraded. So, floodplain fish habitat has been considered as an IEC.
	Baor fish habitat	Baor fish habitat has deteriorated due to siltation, long time static condition, and pre-monsoon period delinked to the rivers and khals when SIS fish breed. Without project condition, the baor situation will become further degraded, but it is expected to improve with the project condition. Therefore, baor fish habitat has been taken as an IEC
	Fish migration	Natural and different man-made obstructions such as siltation induced hydro-morphological alteration, fish barricades, katha/komor, shore encroachment and densely covered macrophyte (water hyacinth) affect longitudinal and lateral fish migration. Fish migration could be disrupted further under the FWOP condition, while the project is expected to restore the fish migration routes. Hence, fish migration has been considered as an IEC.
	Shrimp/ prawn gher and pond	A vast area under fish ponds in the project location are cultivated with commercially important fish species. Prolonged water logging every year inundates a considerable number of shrimp and prawn farms as well as fish ponds and the owners incur immense loss from brackish and fresh water fish farming. Moreover, silted up khals cannot provide adequate and timely supply of saline water to the farms. Without project the situation will further worsen while it is expected that the water logging condition and the saline water supply system will improve under the FWIP condition. Therefore, shrimp/ prawn ghers and fish ponds have been selected as IECs.
	Fish species diversity	As a significant number of indigenous fresh water fish species are either endangered or threatened due to habitat losses, fish species diversity has been taken as an IEC.
	Capture fish production	Fish production that comes from different open water sources has been declining over the years due to habitat loss, unfavorable environment in terms of reduced dissolved oxygen (DO), low pH level and water temperature of the river stretch covered by dense water hyacinth and disruption of migratory routes. Fish production from these habitats is likely to improve under the FWIP condition. Therefore, capture fish production is considered as an IEC.

	Culture fish production	Fish productions that come from both shrimp/prawn ghers and from the fish ponds have huge potential. Production from these habitats has an increasing trend as the farmers are adopting improved technology. Prolonged water logging and congestion inundate the culture fish habitats and thus fish production is reduced severely. The proposed interventions are expected to increase culture fish production. Hence, culture fish production has also been considered as an IEC
Ecosystem	Terrestrial Ecosystems	Existing terrestrial vegetation (both homesteads and open land) of the study area, especially for the proposed TRM Catchment, is likely to be impacted due to saline water inundation and intrusion. Beside this, the proposed river dredging, loop cut and re-excavation activities may have an impact on terrestrial vegetation as well as terrestrial wildlife habitat. So, terrestrial ecosystems have been selected as an IEC.
	Aquatic Ecosystems	Some of the fresh water aquatic plants in stagnant rivers, canal and beels may be impacted by saline water invasion. Consequently, river re-excavation and saline water flow can change the existing aquatic vegetation coverage and population of dependent wildlife. Aquatic ecosystems have, therefore, been considered as an IEC for this study.
	Mangrove vegetation	Regular flow of sediment laden saline water through the river to the TRM Catchment may induce the growth of some common mangrove plant species along the riverside and beel margins which may provide shelter for wildlife and aquatic birds. Hence this has been selected as an IEC.
Socio-economic condition	Occupation and employment	Farming has been the prime occupation of the people in the study area. Without the proposed project, the scope for occupation in agricultur will further decrease. It is apprehended that the water logged area in the South- West region will be increased if the project is not implemented. With increase of water logging, the percentage of farming households has been decreasing due to more and more inundation of agricultural land. Farmers expect to shift from farming to unskilled day labour or to open water fishery for their livelihoods. Therefore, occupation as well as employment is very important with respect to the project interventions in the future.
	Income	The main source of income for the majority of households is agriculture. Land being inundated, income from crops is no longer expected to remain the main source. If inundation continues, agricultural income will gradually decrease with extended water-logging. Due to the proposed people's plan for the SW project the trend and scale of the income line will be increased with the project. Land will be more developed and free from water logging, intensive cultivation will be pursued and high value crops will be practised for higher income.
	Land price	The price of land depends upon the use and condition of the land. The present use of land in the water logged area is almost nil from the agricultural point of view. The land use is uneconomic from the fisheries point of view also. Inundated land is used for fishing by local people without care for development of either land or fisheries resources. So, the price of land here is very low now. The proposed people's plan for SW project will remove water logging problems, and favorably change the use and condition of land. This will enhance the price of land.
	Poverty	Deficit and break-even households were found in the baseline survey of the project area. This situation is likely to continue or even get worse if water logging continues to hamper agricultural activities and employment opportunities.

Quality of life indicators	Education	Closing of primary and secondary schools has been a rule rather than exception in the area. The reason for such closure is inundation of school premises and localities at different depths due to which children and adults cannot attend school. Communication links, such as rural roads, go under water for weeks and even months, preventing students from attending the classes. Students also suffer various water-borne diseases from using polluted water. These cause a serious break in study, leading to more drop-outs and less enrolment. Improvement of drainage situation by the proposed S-W project is expected to have a positive impact on education in the locality.
	Health	Health is a neglected component of the quality of life of the people. It is directly related to water logging and the economic condition of the area. Water logging is a direct cause of disease as well as inaccessibility of people to health centers. The proposed interventions are expected to ensure health facilities for the people directly and indirectly.
	Housing	Housing is a concern for better quality of life in the project area. Once water logging is removed, housing will get importance as it is a basic need. The proposed project may mitigate poverty in the area thereby improving the housing situation indirectly.
	Sanitation	Health and sanitation has prime importance in the national agenda of Bangladesh. Therefore, the programme covers most of Bangladesh. However, sanitation in the project area remains poor. The main reason is water-logging that prevents people from building sustainable sanitary facilities. So, the proposed project will encourage people to set up good sanitary latrines and adopt good hygienic behavior.

Chapter 6

Public Consultation and Disclosure

6.1 Introduction

The inhabitants of the southwest region of Bangladesh have been suffering from the deadly water logging hazard. For resolving such a widely discussed issue of national and international importance, Uttaran has come up with the programme for a 'People's Plan of Action for Southwest River Management' with the scientific assistance of CEGIS and IWM. The people's plan has been drawn up through a series of consultation meetings with different levels of stakeholders at different places. Uttaran and IWM have made the final selection of option by vetting the ones proposed at the consultation meetings. The final option for resolving the problem of the study area was disclosed at a public consultation meeting held at the office premises of Uttaran. CEGIS played an important role in this meeting as moderator and by sensitising the participants about the environmental and social consequences of the interventions.

6.2 Stakeholder consultation

Keeping pace with the Guideline for Participatory Water Management (GPWM), all relevant authorities were invited to take part in the opinion-sharing meeting for preparing the plan. Particular emphasis was given to collecting opinions of those who played an active and willing role in solving the problems. The opinion-sharing meetings under this programme were conducted through the dialogue approach. The following types of participants were considered as the potential key informants.

- Local Members of Parliament (MPs);
- Representatives of the Bangladesh Water Development Board (BWDB);
- Representatives of the upazila administration;
- Representatives of Local Government Institutes (LGIs);
- Representatives of the Departments of Agriculture, Land, Fisheries and others;
- Representatives of NGOs and civil society, journalists, teachers, lawyers;
- Political leaders and representatives of different organisations who mobilise action against these problems;
- Affected agriculture, fish and shrimp farmers, representatives of landless people, fishermen, destitute people and women; and
- Researchers and scientists from CEGIS and IWM.

In every meeting a paper was presented on a particular river Catchment and the participants shared their own opinions about it. The river Catchment-wise plan was formulated based on the discussions at the meetings.

6.3 Opinion-sharing meetings

Eight (8) consultation meetings were conducted in eight river Catchments. Stakeholders from the remaining Catchments were also invited to attend. The meetings helped to identify people's perception regarding the water logging induced problems and measures to resolve them. Uttaran and IWM vetted the measures scientifically and finalised the interventions. At a consultation meeting held from 30 to 31 January at Uttaran Training Center, Tala, Satkhira, the finally selected option and interventions were presented to the catchment stakeholders. CEGIS played a key role in this meeting. The following Table 6-1 presents a list of the consultation meetings and their venues.

Table 6-1: List of consultation meetings

Sl. No.	Date	Meeting place	Included Catchments	Number of Participants
01	October 01, 2009	Uttaran Training Centre, Tala	Kapotakshi, Salta-Upper Bhadra and Ghengrile Catchment.	193
02	October 06, 2009	Parulia Union Parishad Auditorium, Debhata	Shapmara Catchment.	56
03	October 30, 2009	Satkhira Officers' Club, Satkhira	Morirchap- Labonyabati Catchment.	65
04	November 05, 2009	Dalua Shaheed Ziaur Rahman College, Tala	Shalikha Catchment.	47
05	November 13, 2009	Uttaran Training Centre, Tala	Salta and Ghengrile Catchment.	74
06	December 06, 2009	Shaheed Zobayed Ali Auditorium, Dumuria	Sholmari, Hamkura-Bhadra Catchment.	65
07	December 27, 2009	Ad. Abdur Rahman College, Binerpota, Satkhira	Betna Catchment.	51
08	January 11, 2010	Inspecting Jethua Beel	Salta, Ghengrile, Shalikha and Betna Catchment	63
09	January 30, January 31, 2010	Uttaran Training Centre, Tala	Proposed 11 Catchments	78

6.4 Methodology of consultation

Uttaran and the Water Committee (Paani Committee) have been trying to prevent water-logging problem for the last 25 to 30 years. The people who were involved with Uttaran and the Water Committee were the inhabitants of this area and they were the ones who were facing the problem. With the help and coordination of Uttaran and the Water Committee a social network has been developed involving representatives of the people. This network was spread over different river Catchments. They played a key role in implementing the people's plan. With their help the following steps were taken:

- Inspection of every river Catchment and spot discussion with the local people;
- Inspection of the TRM of Jethua and Khukshia beels and discussion with the representatives of different river Catchments;
- Holding Catchment-based opinion-sharing meetings in coordination with the stakeholders;
- Information collection and literature review;
- Application of past experiences;
- Taking technical assistance from CEGIS and IWM;
- Holding a meeting to finalise the draft report; and
- Holding a validation meeting.

6.5 People's plan

The following four points were the basis of the plan:

- TRM planning
- Inter-river linking network
- Revival of dead rivers, and
- Management of canals and beels inside the polders

The plan regarding TRM, inter-river linking network and revival of dead rivers was basically river-centered which aimed at saving the rivers and water bodies of the area. The management of canals and beels was a polder-centered plan, which aimed at ensuring proper water management inside the polders.

6.6 People's thoughts

- People of the Sholmari, Hamkura, Hari and Upper Bhadra Catchment under KJDRP and the adjoining Kapotakshi Catchment raised their voices to implement TRM;
- People were less conscious in the Ghengrile-Salta-Shalikha and Betna Catchment about implementation of TRM. But intellectuals of this area were able to comprehend the fact that it would be difficult to save the rivers without implementing TRM;
- People of the Morirchap-Labonyabati Catchment and the Shapmara Catchment situated in the west and south of Satkhira town respectively, were enthusiastic about the concept of a network of inter-river linking. The conscious citizens of the Morirchap Catchment think that TRM could be introduced in this area;
- People were upset with the BWDB;
- The hazards of the current situation could not be prevented if the rivers are not dredged and revived; and
- It is necessary to develop a system inside the polders for draining off water.

6.7 TRM, river linking network management and reviving dying rivers

The key to successful TRM is proper management of silt. The history of water management is mainly a history of silt management. When silt management was done properly, production turned out to be very satisfying. In the middle ages, historians and tourists praised this country as a land of greenery and crops. This was because crops grow very well in silt-deposited soil. This is a country of silt. Local people have understood well that without a silt management system the present situation cannot be overcome. The process of detaching silt from tidal wetland was suicidal.

By setting up the inter-river linking network, the rivers of this area could be revived within a short time. Rivers that are almost dead but have a thin link should be saved on an emergency basis.

Chapter 7

Impacts and Environmental Management Plan

The impacts of the people's plan on the environmental and social components in the 11 catchments have been assessed against four types of interventions (TRM, inter-river linking, revival of moribund rivers through dredging or re-excavation, and loop cuts). Suitable EMP measures have also been suggested against both positive and negative impacts.

The impacts and the suggested EMP measures are in respect of water resources, land resources, agriculture, fisheries, ecosystems and socio-economic conditions. These are presented in the following tables.

7.1 Impacts and EMP Matrix: Water Resources

Table 7-1: Intervention 1: Tidal River Management (TRM)

Catchment Name	IECs	Type of potential impacts	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari – Mukteshwari 4. Upper Bhadra_ Buri Bhadra-Harihar 5. Salta-Gunakhali-Haria 6. Kapotakshi 7. Shalikha 8. Betna 9. Morirchap-Labonyabati 10. Shapmara-Galghesiya	Drainage Congestion	Drainage congestion is a major problem in this catchment area due to tidal penetration. During neap tide, water enters the catchments area through water control structures. However, during ebb tide the water cannot drain out to the main channels through connecting rivers due to different anthropogenic obstacles and reduced cross sections of different canals. Now after implementation of the above mentioned intervention the tidal penetration will be controlled and water will drain out smoothly. Earlier in an average year, drainage congestion occurred in 40-50% of the catchment areas. The remaining 50% of the project area used to be free from drainage congestion. Now after implementation of the proposed plans up to 85-90% of the total catchments area will become free from drainage congestion.	During dredging work, the beds of tidal creeks must be cleared for tidal water movement by following a day/ night tidal penetrating schedule by the contractor. These activities will facilitate quicker drainage. While designing peripheral embankments of any TRM wetland, the impact of sea level rise should be considered in determining embankment height.
	Water logging	About 30-35% of the catchment area has water logging problems. Water logging may continue if proper drainage does not take place to flush out rainwater. After implementation of the proposed plans, water logged area will be reduced to 20 to 25% of the catchment area.	During wet season, all types of water control structures should be kept open for runoff without any encroachment in its way. This can be achieved through proper union-wise monitoring.

Table 7-2: Intervention 2: Inter-River Linking

Catchment Name	IECs	Type of potential impacts	EMP
1. Hamkura-Bhadra-Joykhali 2. Hari –Mukteshwari 3. Upper Bhadra_Buri Bhadra-Harihar 4. Teligati- Ghengrile 5. Salta-Gunakhali-Haria 6. Kapotakshi 7. Shalikha 8. Betna 9. Morirchap-Labonyabati	In stream water resources	In-stream water resources mean that usable water resources can be diverted for other uses maintaining the environmental flow in the river or stream. Presently very little in-stream water resources is available. It will decrease day by day due to climate change and withdrawal of upstream river water by India. Under the FWOP situation in-stream water resource will be degraded and tend to dry up. Under the FWIP condition in stream water availability will increase and change the ecosystem succession positively.	All types of water control structures should be properly monitored by WMAs to keep the environmental flow of streams. If necessary, a Khalashi should be appointed for individual water control structures.
	Surface water availability	The depth of rivers, canals etc. of the catchments have been reduced due to siltation as water flow of those rivers and canals discontinued after the construction of cross bunds and sluice gates. Presently, the surface water availability during dry months is very low. It will remain in the same scale without project condition. Due to implementation of the re- connectivity of all rivers with the main rivers, the Catchment situation will be improved and availability of surface water will increase under the FWIP condition.	Maintenance dredging should be kept all the year round.

Table 7-3: Intervention 3: Reviving of Moribund Rivers through Dredging or Re-excavation

Catchment Name	IECs	Type of potential impacts	EMP
1. Hamkura-Bhadra-Joykhali 2. Hari -Mukteshwari 3. Upper Bhadra-Buri Bhadra-Harihar 4. Teligati- Ghengrile 5. Salta-Gunakhali-Haria 6. Kapotakshi 7. Shalikha 8. Betna 9. Morirchap-Labonyabati	In stream water resources	Presently, very limited in-stream water resource is available and it will not be changed under the FWOP condition. Under the FWIP condition, it will be improved as large volumes of water will enter from the Hari River. Due to re-excavation and inter connectivity of river and improvement of TRM in Beel Khushia TRM the in stream water situation will improve.	All types of water control structures should be properly monitored by WMAs to keep the environmental flow of streams. If necessary, a Khalashi should be appointed for individual water control structures.
	Surface water availability	The depth of rivers, canals etc. of the catchments have been reduced due to siltation as water flow of those rivers and canals discontinued after the construction of cross bunds and sluice gates. Presently, surface water availability during dry months is very low and will remain the same without project condition. Due to implementation of the re- connectivity of all rivers with the main rivers, the Catchment situation will be improved and availability of surface water will increase under the FWIP condition.	Maintenance dredging should be kept up all the year round.
	Water logging	About 30-35% of the catchment area has water logging problems. Water logging may continue if proper drainage does not take place to flush out rainwater. Now after implementation of the proposed plans, water logged area will be reduced up to 20 to 25% of the catchment area.	During the wet season, all types of water control structures should be kept open for runoff without any encroachment in the way. This can be achieved through proper union-wise monitoring.

Table 7-4: Intervention 4: Reviving of Dead Rivers through Dredging or Re-excavation

Catchment Name	IECs	Type of potential impacts	EMP
1. Hamkura-Bhadra-Joykhali 2. Hari –Mukteshwari 3. Upper Bhadra_Buri Bhadra-Harihar 4. Teligati- Ghengrile 5. Salta-Gunakhali-Haria 6. Kapotakshi 7. Shalikha 8. Betna 9. Morirchap-Labonyabati	In stream water resources	In-stream water resources mean that usable water resources can be diverted for other uses maintaining the environmental flow in the river or stream. Presently very little in-stream water resources is available. It will decrease day by day due to climate change and withdrawal of upstream river water by India. Under the FWOP situation in-stream water resource will be degraded and tend to dry up. Under the FWIP condition in stream water availability will increase and change the ecosystem succession positively.	All types of water control structures should be properly monitored by WMAs to keep the environmental flow of streams. If necessary, a Khalashi should be appointed for individual water control structures. After re-excavation, plantation should be started on both banks of dead rivers with ecologically friendly and morphologically erosion protected trees.
	Surface water availability	The depth of rivers, canals etc. of the catchments have been reduced due to siltation as water flow of those rivers and canals discontinued after the construction of cross bunds and sluice gates. Presently, surface water availability during dry months is very low and will remain the same without project condition. Due to implementation of the re- connectivity of all rivers with the main rivers, the Catchment situation will be improved and availability of surface water will increase under the FWIP condition.	Maintenance dredging should be kept all the year round. The set back distance should be maintained on both sides of rivers or canals. After reviving dead rivers, all right and left bank of rivers should be embanked considering the option of afforestation.

Table 7-5: Intervention 5: Loop Cut

Catchment Name	IECs	Type of potential impacts	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari –Mukteshwari 4. Upper Bhadra_Buri Bhadra-Harihar 5. Teligati- Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Galghesiya	Drainage Congestion	Loop cuts will un-bend rivers from their high meandering feature. It will reduce the river length and change the downstream flow direction of rivers. Loop cuts will increase flow velocity as well as sediment carrying capacity along the rivers. This change will reduce the scope of sediment trapping along certain lengths of the rivers and reduce drainage congestion by quicker drainage.	Keep provision of a boat pass on the off take of the loop cut
	Water logging	About 30-35% of the catchment area has water logging problems. Water logging may continue if proper drainage does not take place to flush out rainwater. Now after implementation of the proposed loop cuts, water logged area will be reduced up to 3%-5% of the total catchments area.	During wet season, all types of water control structures of loop cuts should be kept open for runoff water discharge without any encroachment in the way. This can be achieved through proper monitoring by WMAs members.

7.2 Impacts and EMP Matrix: Land Resources and Agriculture

Table 7-6: Intervention 1: Tidal River Management (TRM)

Catchment Name	IECs	Impact	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara Golgeshia	Land type	Land type will improve; Cropping pattern and crop production will increase; Crop diversification will increase; Livestock rearing will be improved; and The flood hazard to livestock will be reduced.	The sediments need to be distributed in such a way that the land surface will be more or less uniformly level
	Land use	There will be more land for agriculture Crop diversification will increase; Fuel, fodder and feed will increase; and Flood hazard to livestock will be reduced.	The land cannot be used for crop production during the TRM period. Landowners should be given compensation for their land;
	Salinity	Crop diversification will increase; and Soil salinity will decrease due to increase of upstream flow.	After successful execution of TRM, the land is expected to be high enough above normal flood level. However, precautionary measures need to be taken by constructing a peripheral dyke around the TRM area for preventing intrusion of saline water during tidal surge
	Cropping intensity	Cropping intensity will increase due to improved land type; and Cropping intensity will increase through crop diversification	Crop diversification should be introduced by selecting high yielding crop cultivars.
	Crop production	There will be more land under agriculture; Cropping intensity will increase and dwarf HYV crop cultivars will be introduced subsequently enhancing crop production; Crop diversification will increase; Fuel, fodder and feed will increase; Cropping periods and areas will be extended due to improved land type	During the TRM period, the landowners will not see any production. They should be given compensation for that period; High yielding salt tolerant crop cultivars should be practised; Crop diversification need to be introduced in consultation with the officials of DAE, BRRI and BARI for enhancing crop production.
	Crop damage	Crop loss from drainage congestion/ water logging will be reduced; Fuel, fodder and feed will be increased.	In spite of land development through TRM, there is a possibility of submergence of the land with saline water due to flash floods during tidal surges. A dyke should be constructed around the field for preventing intrusion of saline water. In this case, drainage channels should be created with required regulators. This will help to reduce crop damage.

Table 7-7: Intervention 2: Inter-River Linking

Catchment Name	IECs	Impact	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Galghesiya	Land type	Re-excavation of rivers and canals will improve land type due to improvement of drainage congestion/water logging; Increase crop diversification; Livestock rearing will be improved. The flood hazard to livestock will be reduced.	The dredge spoils should be placed where there is no possibility of disturbing surrounding agriculture lands.
	Land use	There will be more land under agriculture Crop diversification will increase;	The dredge spoils may be used for constructing roads or embankment-cum-roads on both sides of the rivers
	Salinity	Crop diversification will increase; Soil salinity will decrease;	Precautionary measures need to be taken by constructing a dyke on the riverside with the dredge spoils for preventing intrusion of saline water during tidal surge
	Cropping intensity	Improved land type will influence cropping intensity through crop diversification;	Crop diversification should be introduced by selecting different types of high yielding dry and wet land crop cultivars
	Crop production	Improved land type will help to bring more land under agriculture; Increased cropping intensity and introduction of dwarf HYV crop cultivars will enhance crop production; Fuel, fodder and feed will increase; Cropping periods and areas will become extended due to improved land type	High yielding salt tolerant crop cultivars should be practised; Crop diversification needs to be introduced in consultation with the officials of DAE, BADC, BRRI and BARI for enhanced crop production
	Crop damage	Crop loss from floods will reduce; Fuel, fodder and feed will increase; Cropping periods and areas will become extended due to improved hydrological regime.	Heavy rainfall may cause water congestion within the project area during monsoon season. In this case, a drainage channel should be made with sufficient regulators for removal of excess water from the field. It will help to reduce crop damage; There is a possibility of submergence of the land with saline water due to tidal surge. Embankments should be constructed with dredge spoils around the riverside for preventing intrusion of saline water

Table 7-8: Intervention 3: Revival of Moribund Rivers through Dredging or Re-excavation

Catchment Name	IECs	Impact	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykali	Land type	Land type will improve due to improvement of drainage congestion/ water logging situation; Crop diversification will increase; Livestock rearing will be improved; The flood hazard to livestock will be reduced	The dredge spoils should be placed where there is no possibility of disturbing surrounding agriculture lands
3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile	Land use	There will be more land under agriculture Crop diversification will increase; Fuel, fodder and feed will increase; Flood hazard to livestock will be reduced	The dredge spoils may be used for constructing roads or embankment-cum-roads on both sides of the rivers.
6. Salta-Gunakhali-Haria	Salinity	Crop diversification will increase; Soil salinity will decrease;	Precautionary measures need to be taken by constructing a dyke on the river for preventing intrusion of saline water during tidal surge
7. Kapotakshi 8. Shalikha 9. Betna	Cropping intensity	Improved land type will lead to an increase in cropping intensity through crop diversification	Crop diversification should be introduced by selecting different types of high yielding dry and wet land crop cultivars
10. Morirchap-Labonyabati 11. Shapmara-Galghesiya	Crop production	Improved land type will help to bring more land under agriculture; Increased cropping intensity and introduction of dwarf HYV crop cultivars will enhance crop production; Fuel, fodder and feed will increase; Cropping periods and areas will be extended due to improved land type	High yielding salt tolerant crop cultivars should be practised; Crop diversification need to be introduced in consultation with the officials of DAE, BADC, BRRI and BARI for enhancing crop production
	Crop damage	Crop loss from floods will be reduced; Fuel, fodder and feed will increase; Cropping periods and areas will become extended due to improved hydrological regime; Flood hazard to livestock will be reduced; Irrigated area will increase; The flood hazard to livestock is expected to be reduced	There is a possibility of submergence of the land with saline water due to flash foods during tidal surge. Embankments should be constructed with dredge spoils around the river side for preventing intrusion of saline water and reduction of crop damage; Similarly, heavy rainfall may cause water congestion within the project area. In this case, drainage channels should be made with required regulators for removal of excess water from the field. It will help to reduce crop damage

Table 7-9: Intervention 4: Loop Cut

Catchment Name	IECs	Impact	EMP
Kapotakshi	Land type	There will be a possibility of improvement of land type due to easy drainage of water	The dredge spoils should be put in a safe place so that agriculture lands will not be disturbed; The spoils may be used for the construction of roads/ embankments along the riverbanks
	Land use	There will be a possibility of more area coming under cultivation in the loop cut area; There will be a possibility of water congestion in the adjacent areas of dead/retired rivers.	Possible water congestion may be mitigated by constructing required number of regulators in the retired river length.
	Salinity	There will be a possibility of decreased soil salinity; Crop diversification will increase	Salt tolerant varieties should be introduced
	Cropping intensity	Improved land type may lead to an increase in cropping intensity	Proper soil management practices to cope with increased extraction of soil nutrients
	Crop production	There will be a possibility of more land coming under agriculture use in the adjacent area of the loop cut; In retired /dead river areas local water congestion during rainy season may have a negative impact on crop production; Increased cropping intensity and introduction of dwarf HYV crop cultivars will enhance crop production	Construction of necessary regulators and drainage canals and its smooth management may enhance crop production.
	Crop damage	Crop loss from flood in the area adjacent to the loop cut will be reduced; There will be a possibility of drainage congestion beyond the loop cut area (dead river) and crop damage may occur during monsoon season.	Drainage channels and regulators need to be constructed adjacent to the retired/dead rivers for improvement of drainage congestion

7.3 Impact and EMP Matrix: Fisheries

Table 7-10: Intervention 1: Tidal River Management (TRM)

Catchment Name	IECs	Type of potential impacts	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Golgesia	Riverine fish habitat	Suitable habitat will be created for riverine fish species; Fish grazing and breeding area will increase; Supply of saline water to the shrimp farms through connecting khals will be recovered	Fishing in the river near the cut point should be strongly restricted to avoid further exacerbation Preservation of at least 10% of the core beel area must be ensured for conserving brood fish for future generation and for sustaining fishery; Surface water irrigation should be limited at the level just after the resident fish species become vulnerable to natural hazards as well as to fishing mortality; For better quality of the baor habitats, connectivity with the river should be restored through re-excavation; TRM operation should be avoided during pre-monsoon spawning migration of indigenous fish species; Renovation of light dykes at the aquaculture habitats is needed to avoid sudden inundation by breaching of the dykes; Remaining beels should be brought under pile fishery to conserve brood fish and fish species diversity; Modern fish culture technology should be disseminated to farmers for boosting up fish production; As per people's intention to grow more crops and to be relieved from the curse of salinity effect on the environment, they should be facilitated with proper and adequate training on modern culture technic of rice-cum-prawn culture
	Beel fish habitat	The habitat area will reduce for beel fish species in general and brood fish species in particular; The remaining portion of the habitat will be susceptible to huge surface water irrigation and fishing pressure	
	Floodplain fish habitat	The habitat area will reduce in the TRM Catchments; Increased nutrient influxes will improve the quality of the remaining floodplain habitat	
	Baor fish habitat	Habitat quality is expected to improve	
	Fish migration	Longitudinal and lateral fish migration through rivers and khals respectively will improve but overland migration will be obstructed by peripheral embankments; Pre-monsoon fish breeding may be hampered as longitudinal fish migration will be obstructed by dams during the TRM period Spawning migration will be facilitated after the implementation period;	
	Fresh and brackish water aquaculture habitat	Inundation threat will be reduced after removal of the water logging problem; Pond water level will remain at a level suitable for fishery Shrimp ghers will get brackish water easily and culture fish production will increase	
	Fish species diversity	Riverine fish species diversity will be enriched; Beel species diversity may decline; Mingling of brackish and fresh water fish species may occur	
	Capture fish production	Capture fish productivity will increase; Beel and floodplain fish production will be hampered though fish productivity in these habitats will increase	
	Culture fish production	Shrimp ghers will get adequate saline water easily and culture fish production will increase; Reduced water logging problem in turn will facilitate culture fish production	

Table 7-11: Intervention 2: Inter-River Linking

Catchment Name	IECs	Type of potential impacts	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Galghesiya	Riverine fish habitat	The quality of riverine fish habitat will improve; River stream fish habitat will increase	Set bag net for fishing in the river should be restricted to avoid further intensified river aggravation; Beel connecting khals should be restored and prepared as a good drainage channel for free lateral migration by removing or repairing mal functioning structures; Structures (if required in the khal outlets) should be built as wide as possible for small indigenous fish species to pass through; Proper re-excavation is required for better functioning of the connectivity; Setting of cross fish pata and komor (fish barricades/Fish Aggregating Devices-FADs) should be restricted from the rivers and further installation needs to be restricted and monitored Upstream fresh water flow should be ensured to inhibit the mingling of brackish water fish species with that of fresh water; Implementation of the interventions should be done in a manner that would encourage people to opt for wet season farming; Use of agriculture inputs should be optimised and IPM arrangement should be regularised to the farmers for controlling pests/insects infestation to reduce the pollution level
	Beel fish habitat	Beel stagnation will be removed thus habitat quality will improve; Some beel connectivity might be restored	
	Floodplain fish habitat	Habitat quality will be improved as nutrient influxes will be pronounced due to flooding oscillation	
	Baor fish habitat	Inter river linking will improve the baor connectivity thereby the exchange of nutrients which will improve the habitat quality	
	Fish migration	The successive length of longitudinal fish migration will increase and improve; Pre-monsoon fish spawning migration will be aided	
	Fresh and brackish water aquaculture habitat	Inter river linking intervention will aid the removal of water logging problem and in turn relieve the aquaculture habitat from inundation risk; Wet season suitability of aquaculture fish habitat	
	Fish species diversity	Fish species diversity in different open water habitats particularly in the rivers and connectivity will be enriched; Brackish water fish species may be mingled with fresh water species	
	Capture fish production	Fish productivity of the capture habitats particularly of river habitat will increase due to the intensified habitat quality; Whatever stream habitat will be increased in turn will produce more fish	
	Culture fish production	Fish production from both pond and gher aquaculture will increase significantly as water logging induced inundation risk will be decreased; Fresh and brackish water aquaculture area will increase and in turn will yield more fish	

Table 7-12: Intervention 3: Reviving of Moribund Rivers through Dredging or Re-excavation

Catchment Name	IECs	Type of potential impacts	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Galghesiya	Riverine fish habitat	The area and quality of fish habitat will increase; Temporary disturbance will be created for benthic fish species	The spoils from the dredging activity should be managed so as not to hamper the connecting khals; The dredging period needs to be shortened as much as possible for reducing the disturbances to the benthic fish species; Upstream fresh water flow should be augmented to push down salinity front to ensure the fresh water environment in the study area; Along with the dredging of rivers, beel connecting khals should be re-excavated; Water regulatory structures should be built in a fish friendly manner and the existing mal functioning structures should be repaired
	Beel fish habitat	Beel connectivity will be restored as moribund rivers will be revived and in turn will have a role in enhancing the quality of habitats	
	Floodplain fish habitat	Flooding oscillation will be more frequent and unfettered and increased nutrient influxes would increase the habitat quality	
	Baor fish habitat	Possible restoration of the connectivity will aid the increase of nutrient influxes from both ends	
	Fish migration	Successive length of freed longitudinal fish migration will be improved; Lateral fish migration will be facilitated as revived rivers will open up the khals	
	Fresh and brackish water aquaculture habitat	Resultant relief from water logging induced inundation for both fresh and brackish water aquaculture. Habitat area will be risk free	
	Fish species diversity	Diversity, particularly the composition of fish species will be improved	
	Capture fish production	Overall fish production from capture habitats will increase as more water area will be created in the river	
	Culture fish production	Culture fish production will increase as habitats will be relieved from the inundation risk	

Table 7-13: Intervention 4: Reviving of Dead Rivers through Dredging or Re-excavation

Catchment Name	IECs	Type of potential impacts	EMP
Kapotakshi	Riverine fish habitat	Riverine fish habitat in the Kapotakshi River will increase and become suitable for fish species; The increased length of tidal influence will create more scope for nutrient influxes which in turn will improve the habitat quality	Beel connecting khals with these river reaches needs to be re-excavated for creating better lateral fish migratory routes and exchange of more nutrients; Cross fish pata and komor (fish barricades /Fish Aggregating Devices-FADs) should be removed from these river reaches and further installation should be restricted and monitored
	Fish migration	Longitudinal fish migration will improve; Larger migrant species will reappear	
	Fresh and brackish water aquaculture habitat	Brackish water fish habitat will be relieved from risk of water logging and inundation	
	Capture fish production	Fish productivity of the river will increase	
	Culture fish production	Culture fishery will be benefitted	

Table 7-14: Intervention 5: Loop Cut

Catchment Name	IECs	Type of potential impacts	EMP
Kapotakshi	Riverine fish habitat	Fish habitat area will be reduced and the cut up part will be turned into a semi-closed water fish habitat	Stagnation of semi-closed water body may deteriorate the water quality which in turn may have deleterious impact on fisheries. So, the opening of the water body needs to be maintained properly
	Fish migration	Longitudinal fish migration will be straightened and shortened but will reduce the fish resting places	
	Fish production	Fish production may be reduced due to loss of habitat area while closed water fish production will increase	

7.4 Impact and EMP Matrix: Ecosystems

Table 7-15: Intervention 1: Tidal River Management (TRM)

Catchment Name	IECs	Impact	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Golgeshia	Aquatic & terrestrial ecosystem	Fresh water vegetation in existing beels and rivers may be lost due to saline water inundation Homestead vegetation of the of beel periphery may be negatively impacted by saline water intrusion	Some suitable mangrove species like the Kewrah, Bain and Hargoza may be planted inside the beel periphery to make up for the loss of aquatic vegetation to some extent. Peripheral embankments should be properly constructed so that there is no leakage of saline water.

Table 7-16: Intervention 2: Inter-River Linking

Catchment Name	IECs	Impact	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Golgeshia	Terrestrial ecosystems	Terrestrial vegetation may be lost and wildlife may be disturbed due to habitat loss for excavation of linking canal	Avoid village groves, other vegetation and breeding seasons of local wildlife for digging location and time respectively The excavated soil should be placed carefully where possible loss of vegetation would be the minimum

Table 7-17: Intervention 3: Revival of Moribund Rivers through Dredging or Re-excavation

Catchment Name	IECs	Impact	EMP
1. Upper Sholmari-Lower Salta-Lower Bhadra 2. Hamkura-Bhadra-Joykhali 3. Hari-Mukteshwari 4. Upper Bhadra-Buri Bhadra-Harihar 5. Teligati-Ghengrile 6. Salta-Gunakhali-Haria 7. Kapotakshi 8. Shalikha 9. Betna 10. Morirchap-Labonyabati 11. Shapmara-Golgeshia	Terrestrial ecosystems and mangrove vegetation	Terrestrial vegetation may be damaged and wildlife habitat may be loss due to improper dumping of dredged soil Some mangrove species like the Kewrah and the Hargoza are expected to regenerate along the riverside	Dredged soil should be dumped where possible loss of vegetation would be the minimum

Table 7-18: Intervention 4: Revival of Dead Rivers through Dredging or Re-excavation

Catchment Name	IECs	Impact	EMP
Kapotakshi	Terrestrial ecosystems and mangrove vegetation	Terrestrial vegetation may be damaged and wildlife habitat may be lost due to improper dumping of dredged soil Some mangrove species like the Kewrah and the Hargoza are expected to regenerate along the riverside	Dredged soil should be thrown where possible loss of vegetation would be the minimum

Table 7-19: Intervention 5: Loop Cut

Catchment Name	IECs	Impact	EMP
Kapotakshi	Terrestrial ecosystems	Terrestrial vegetation may be lost and wildlife may be disturbed due to habitat loss for excavation of linking canal	Avoid village groves, other vegetation and breeding seasons of indigenous wildlife Excavated soil should be placed where possible loss of vegetation would be the minimum.

7.5 Socio-economic Condition

Table 7-20: Impact on ISCs and EMP

Sl. No.	ISCs	Baseline	Impact	Environmental Management Plan (EMP)
1.	Occupation and employment	30% of households are involved in farming activities and 26% of hhs are involved with agricultural day labour.	Due to implementation of the interventions, water logging will be reduced and involvement of farming household will be increased	Enhancement measures: Better agricultural fisheries extension services should be provided for better agricultural and fisheries practices and products to ensure better occupation and employment.
2.	Income	The wage rates of day labourers are Tk. 150-125 rang per day.	Due to implementation of the interventions, water logging will be reduced and involvement of day labourers will be increased. As a result, the demand for day labourers will be high. So the wage rate also will be higher.	Enhancement measures: Better agricultural extension services should be provided for better agricultural practices and wage rate should be ensured for daily labour.
3.	Land price	The sale value of agricultural land (low) is 500,000/- taka per acre.	Due to implementation of the interventions, water logging will be reduced and the land price will increase significantly.	Enhancement measures: When the land will be flood free, better agricultural extension services should be provided for better agricultural practices and land price should be ensured for farmers.

Sl. No.	ISCs	Baseline	Impact	Environmental Management Plan (EMP)
4.	Poverty status	25% households have reported as deficit level.	Due to implementation of the interventions, crop security will be ensured and the percentage of deficit households will be reduced.	Enhancement measures: need proper extension services on both agriculture and fisheries extension.
5	Land availability	People of the area occupied land in different dead rivers due to land scarcity.	Huge land will be needed while implementing the interventions, such as excavation or re-excavation of canals and dead rivers as well as embankment preparation for TRM Catchment. This will create a negative reaction among the local people.	Mitigation measures: Proper compensation should be given for the land which will need excavation or re-excavation for the project specially for the loop cut and revival of dead rivers.
6.	Quality of life	-	-	-
6a.	Education	42%, 30% and 75% of students are reported as not attending in primary, high school and college level respectively.	Due to implementation of the intervention, food security and income will be ensured and the basic need for education will be given emphasis by local stakeholders	Enhancement measures: need proper motivational services from departments and NGOs concerned.
6b.	Health facilities	Moderate	Due to implementation of the intervention, food security and income will be ensured and the basic need for health services will be given emphasis by local stakeholders	Enhancement measures: need proper motivational services from departments and NGOs concerned.
6c.	Housing	65% (60% kancha and 5% Jhupri) of households reported that their housing status was not satisfactory	Due to implementation of the intervention, food security and income will be ensured and the basic need for housing will be given emphasis by local stakeholders	-
6d.	Sanitation	10% of households reported that their sanitation status was not good	Due to implementation of the intervention, food security and income will be ensured and sanitation facilities will be given improved by local stakeholders	Enhancement measures: need proper motivational services from departments and NGOs concerned.

Chapter 8

Conclusion and Recommendations

Conclusion

The 11 proposed catchment areas and the adjacent drainage system have lost their water carrying capacity and have become much vulnerable due to huge sediment deposition. The water resources system in this area is gradually becoming non productive and destructive for the local community. The 'SW People's Plan' will be a positive initiative toward bringing a long term solution of the existing problem in that part of Bangladesh. The proposed people's plan for the study area will be a feasible, environment friendly and integrated approach to regional water resource management in the southwest region.

- Proper implementation of the interventions will improve the drainage capacity of all main channels of the study area and remove the huge sediment load from the river bed. Re-excavation of the dead rivers will allow it to drain out sufficient water to the downstream during rainy season and renew its normal tidal nature.
- Some of the interventions in the people's plan will help enhance the connectivity of link canals, khals and beels with the proposed catchment system. It will be helpful in removing water logging and drainage congestion which is severely hampering local agriculture and culture fisheries in the Catchment.
- The functionality of the southwest coastal region depends on tidal action. From this point of view, TRM practices will be the most effective measure for activating the downstream of the study area. The sequential long term TRM plan will change the path of sediment loaded flow and remove excessive bed siltation in downstream rivers. It will improve land quality, agricultural practices and fisheries habitats in the catchment area.
- The proposed loop cut will change the meandering nature of the river in the downstream and loosen the length of the river to remove flow abstraction and reduce sedimentation. However, without indigenous practices and community involvement, this intervention may create problems for the people of the downstream Catchment.

The people's plan aims to remove the devastating water logging problem from the study area especially from Jessore and Satkhira districts. All the measures will be taken to improve and maintain sufficient drainage conditions for the downstream river system. The present IEE study has found that except for a few temporary obligations, the proposed people's plan for management of the rivers of the southwest region of Bangladesh will be much effective.

Recommendations

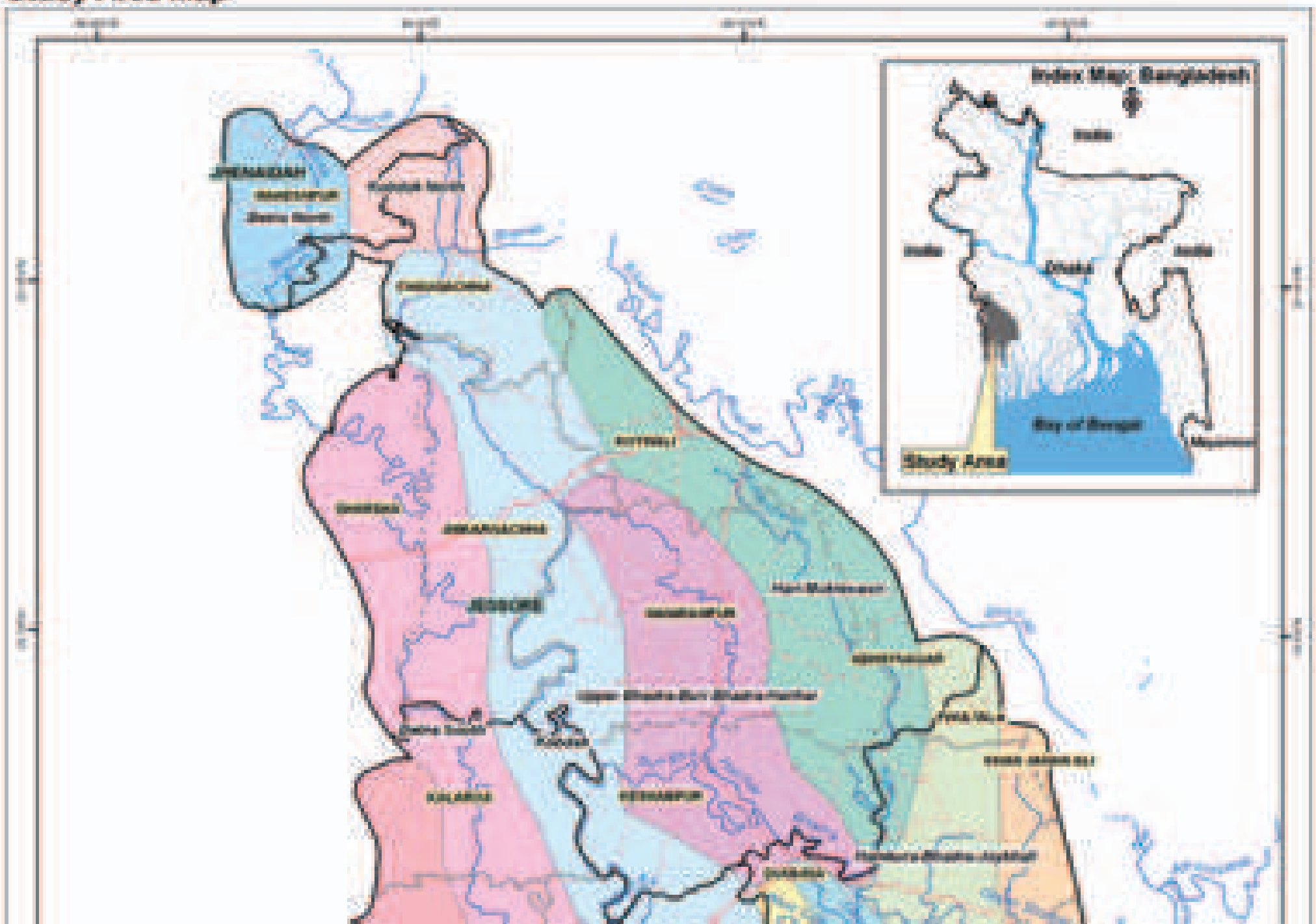
Effective solution of the water resources problem in the southwest coastal region of Bangladesh will depend on planned and systematic implementation of the proposed interventions that will integrate local knowledge. It will also depend on the following:

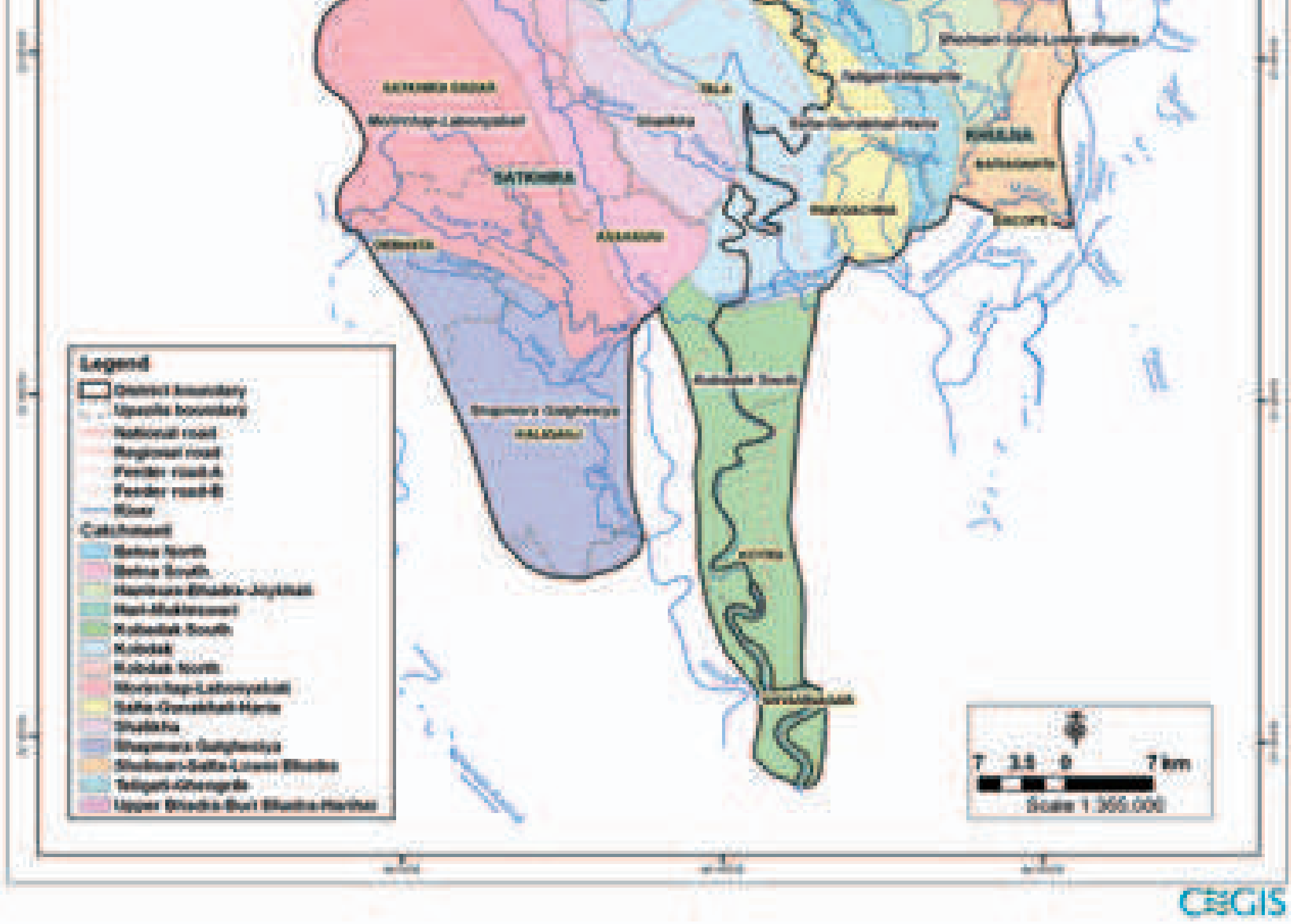
- A long-term plan should be established to cover the time effective implementation of all proposed interventions. It is highly recommended that while implementing the proposed interventions, another study should be urgently done to look into the functionality of the related water resources systems and to start planning for sustainable operation and maintenance.
- Intensive environmental and socio-economic monitoring will be essential for improving the efficiency of the drainage and flood management operation in the SW region.
- Knowledge sharing will be required in planning and implementation.
- TRM operation should be continuous, i.e., TRM operation can be started in the next beel before it is stopped in another. The appropriate size of the beel and the duration of operation must be assessed technically beforehand.

- At least 10% of area at the lowest part of each beel should be reserved as perennial water body for fish habitation in all seasons. The area would remain connected with the river ensuring that certain portions of the beels remain fish habitats at all times.
- The establishment and operationalisation of local Water Management Committees would be useful for coordinating the activities of water resources management and for facilitating participation of local stakeholders in the decision making process.
- While implementing the people's plan in the SW region, further EIA/SIA studies will be needed for sustainable environmental management in the coastal region.

Annex-1-Catchment Wise Plan Map

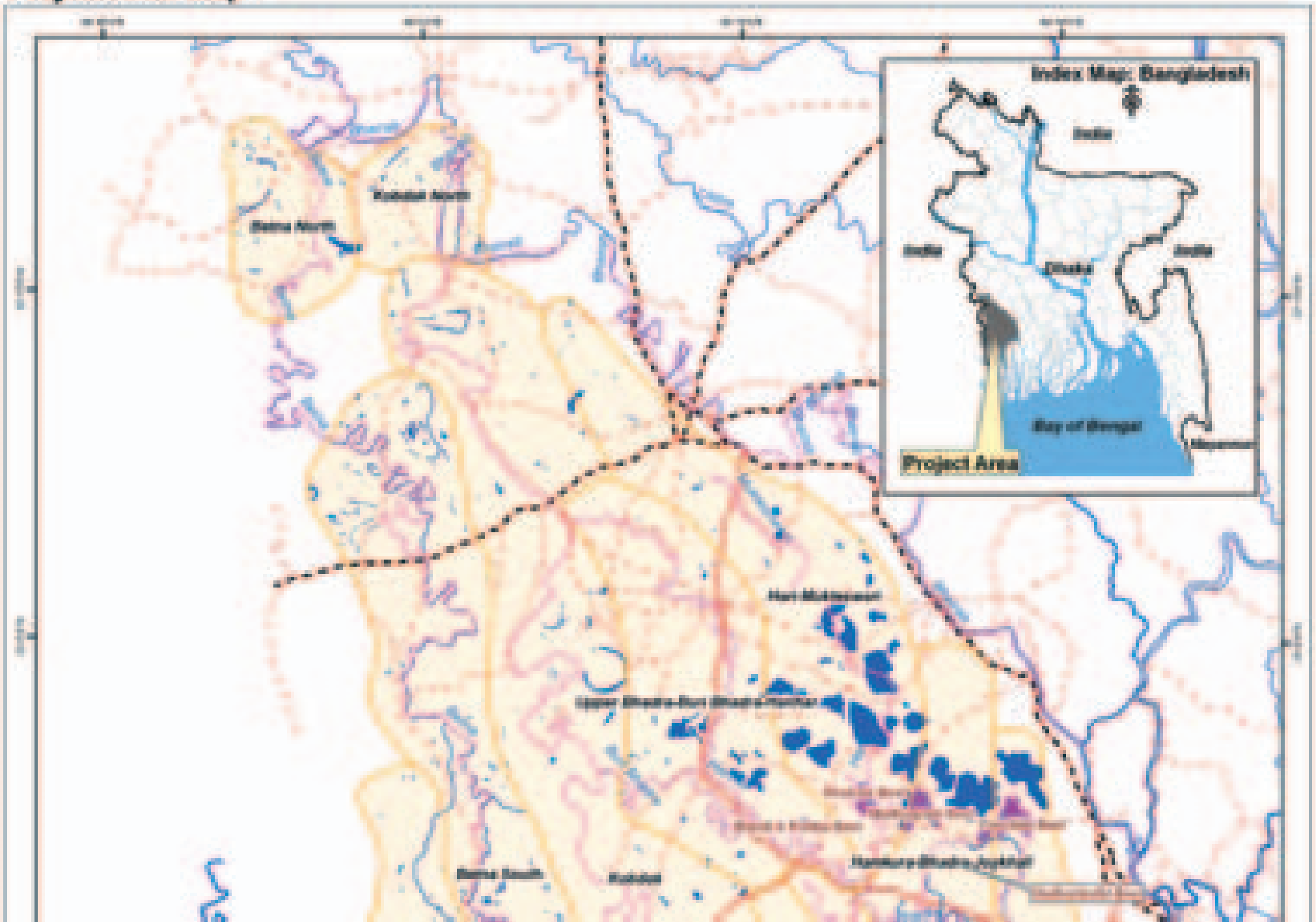
Study Area Map

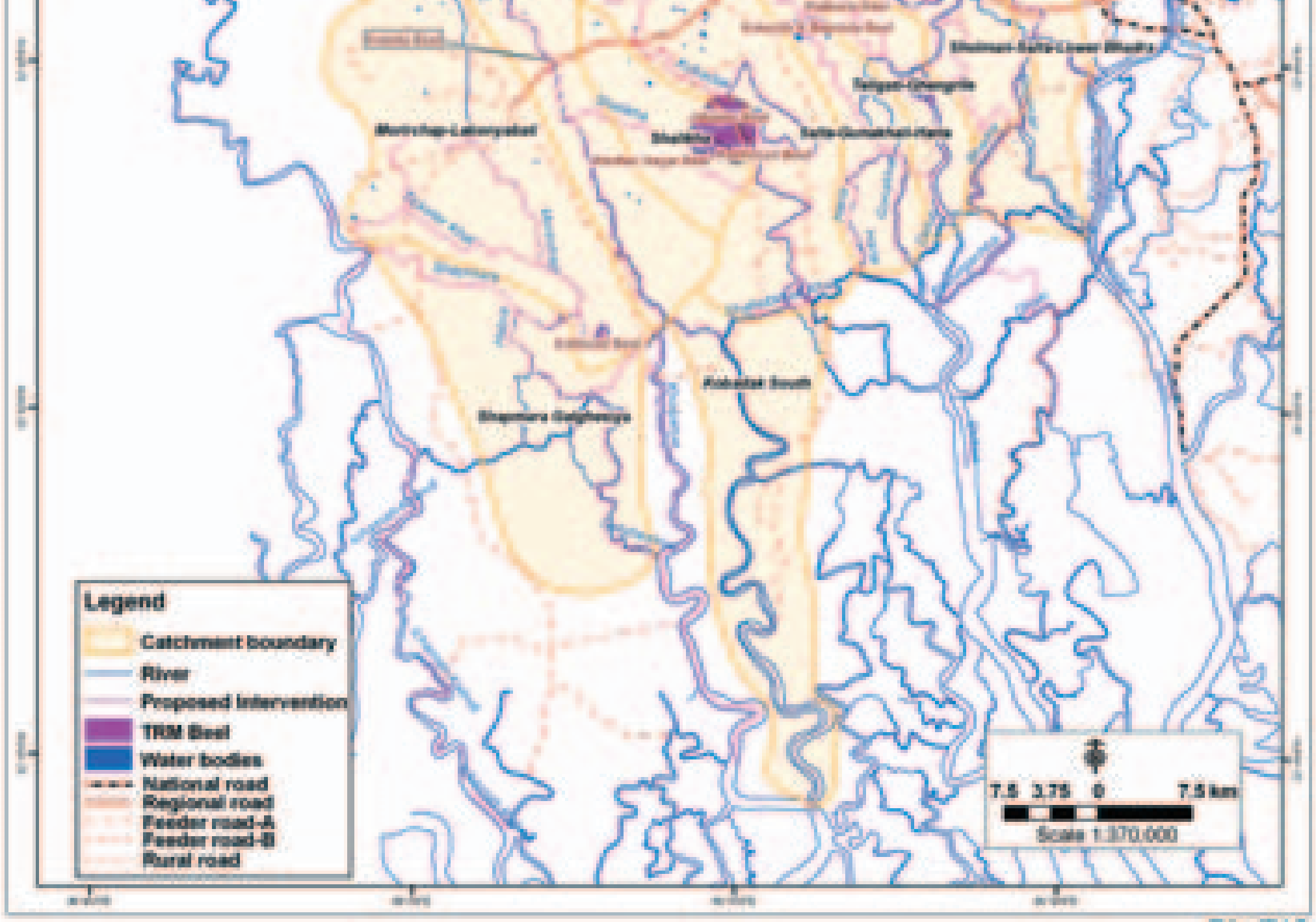




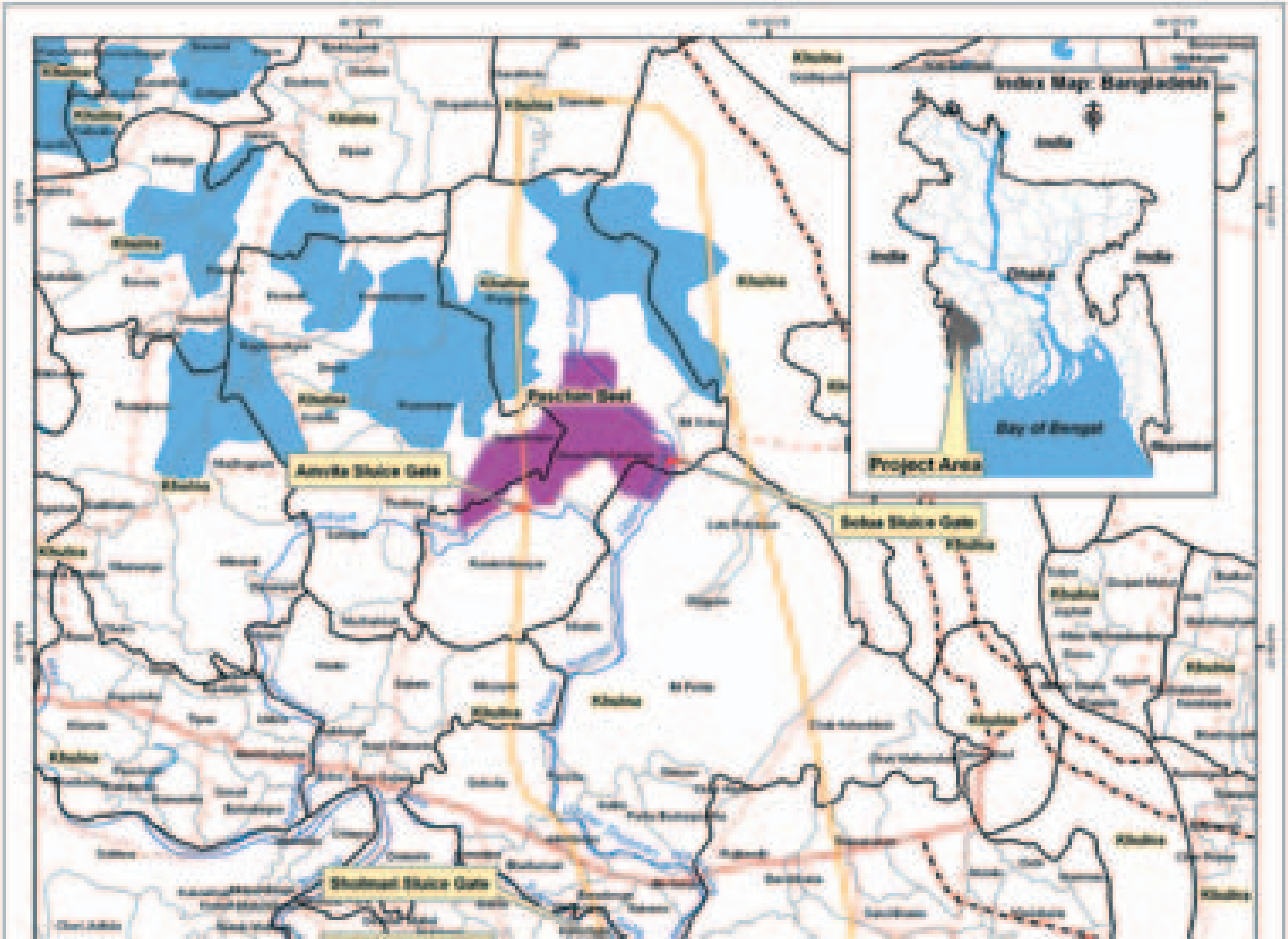
Map 1-1: Location of the study area

Project Area Map





Map 3-1: Project area



Index Map: Bangladesh
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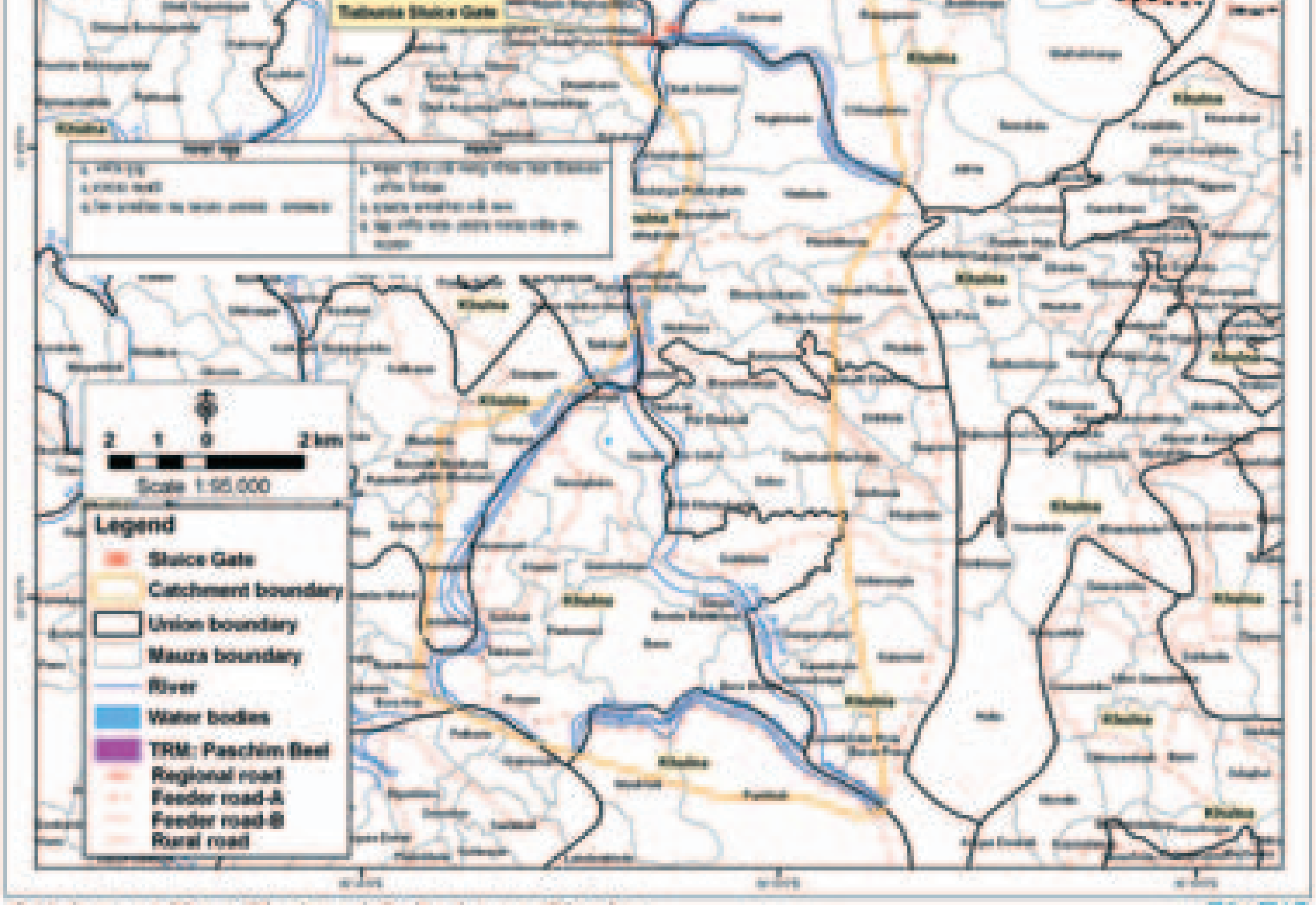
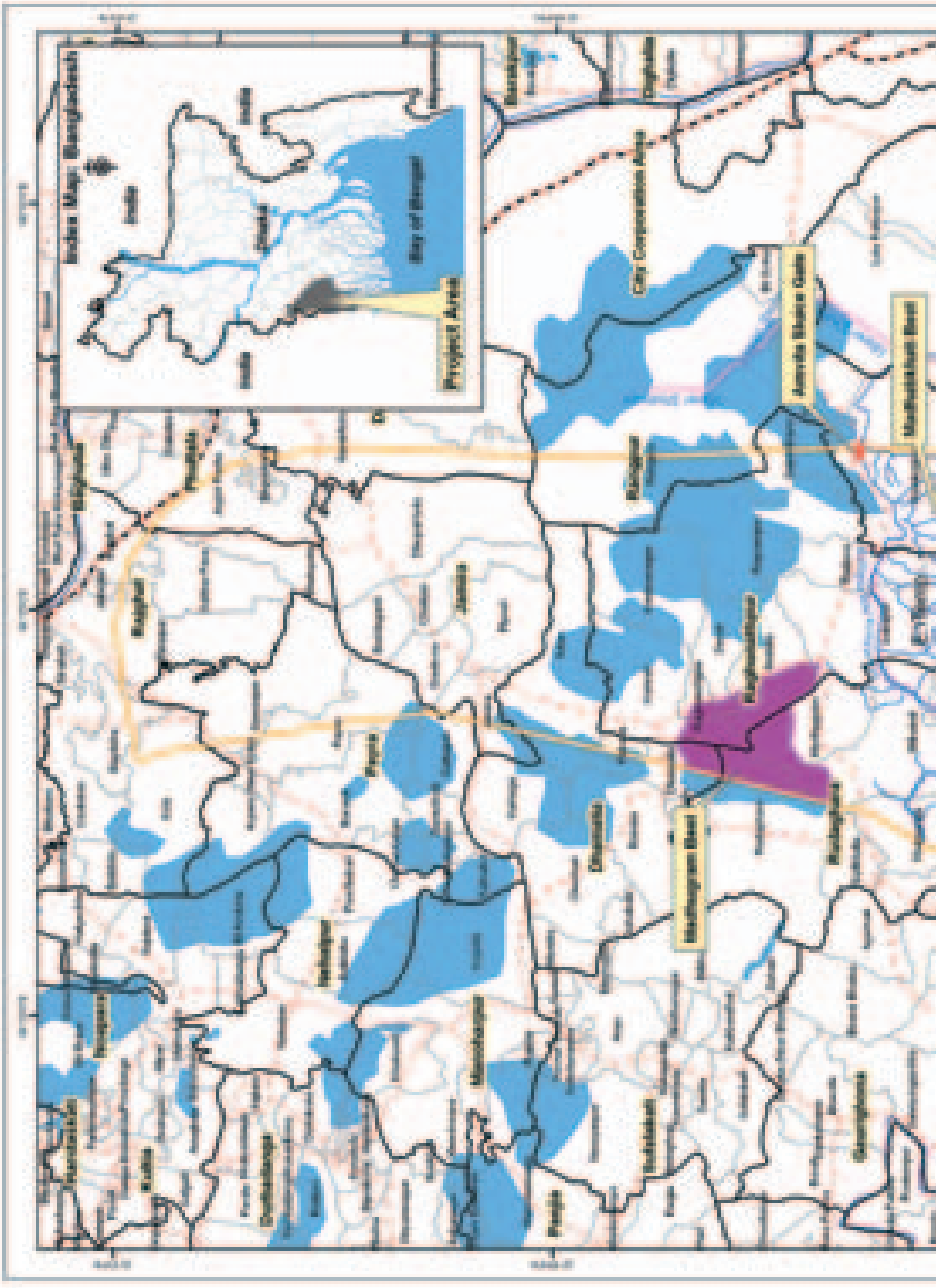
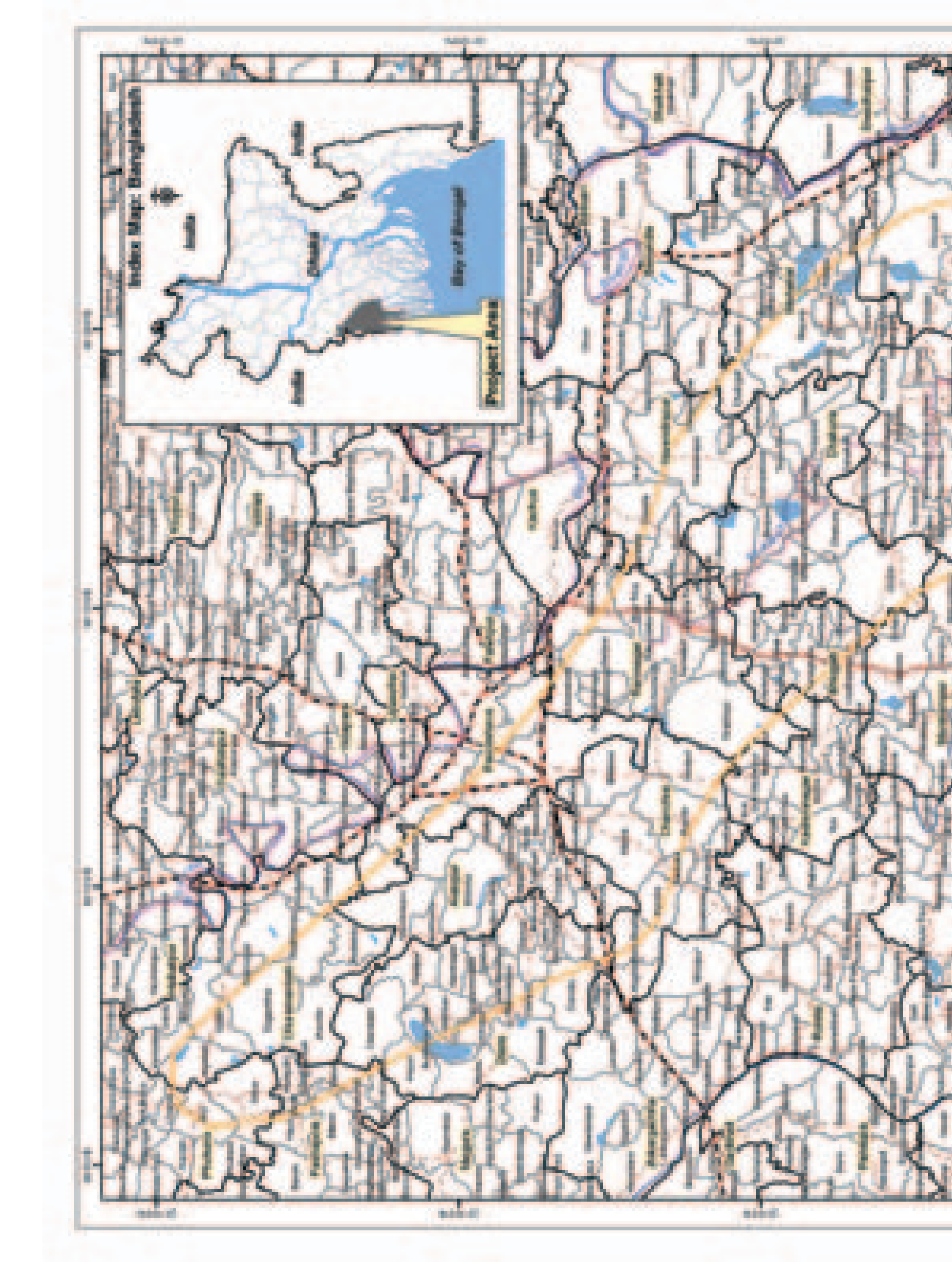
Dhaka
Bay of Bengal
Project Area
Khulna

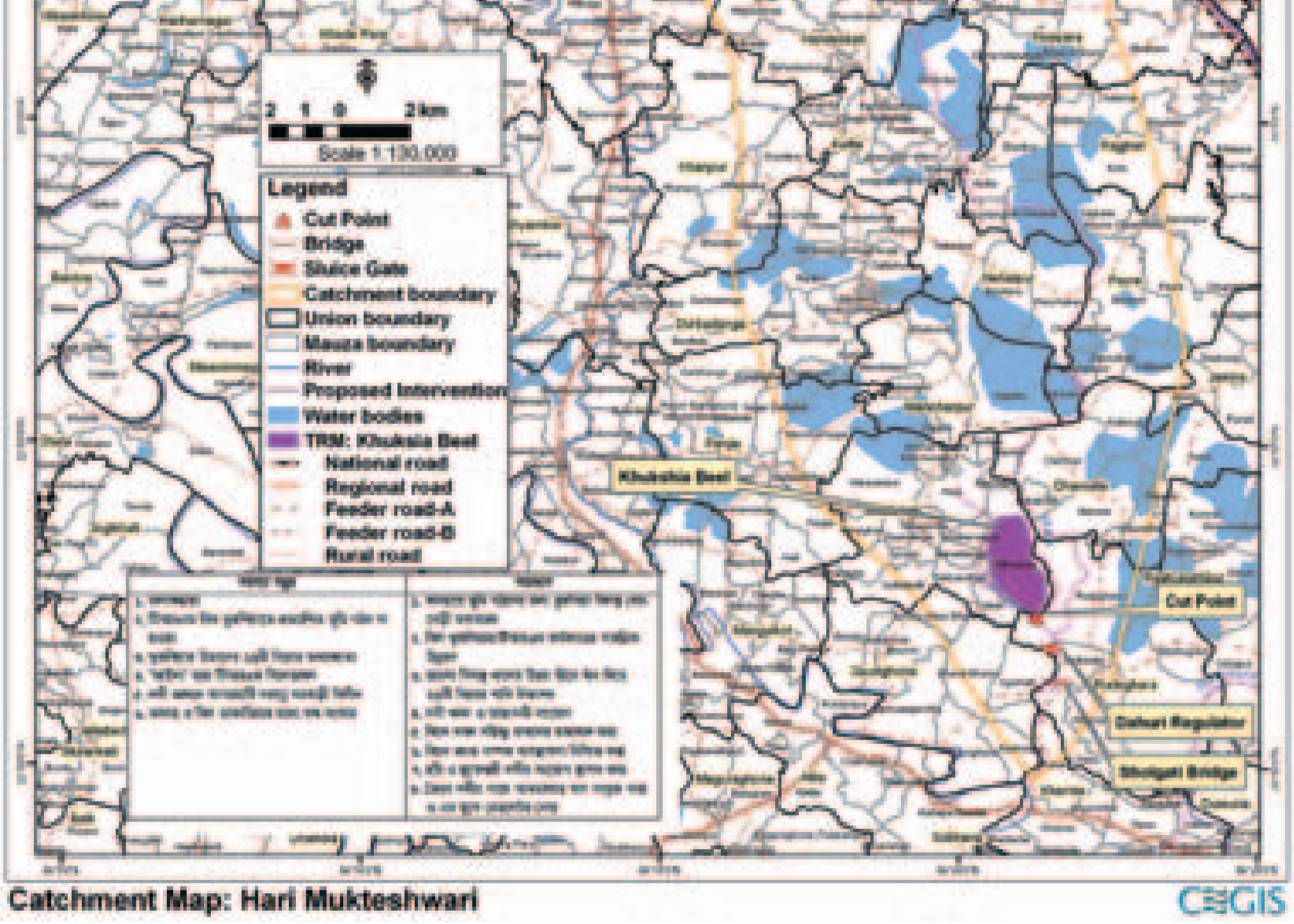


Map 3-2: Proposed major interventions in the Sholmari-Salta-Lower-Bhadra Catchment



Map 3-3: Proposed major interventions in the Hamkura-Bhadra-Joykhali Catchment





Map 3-4: Proposed major interventions in the Hari Mukteshwari Catchment


Index Map
Project Area
Legend
Bridge
State Capital
Catchment Boundary
Urban Area
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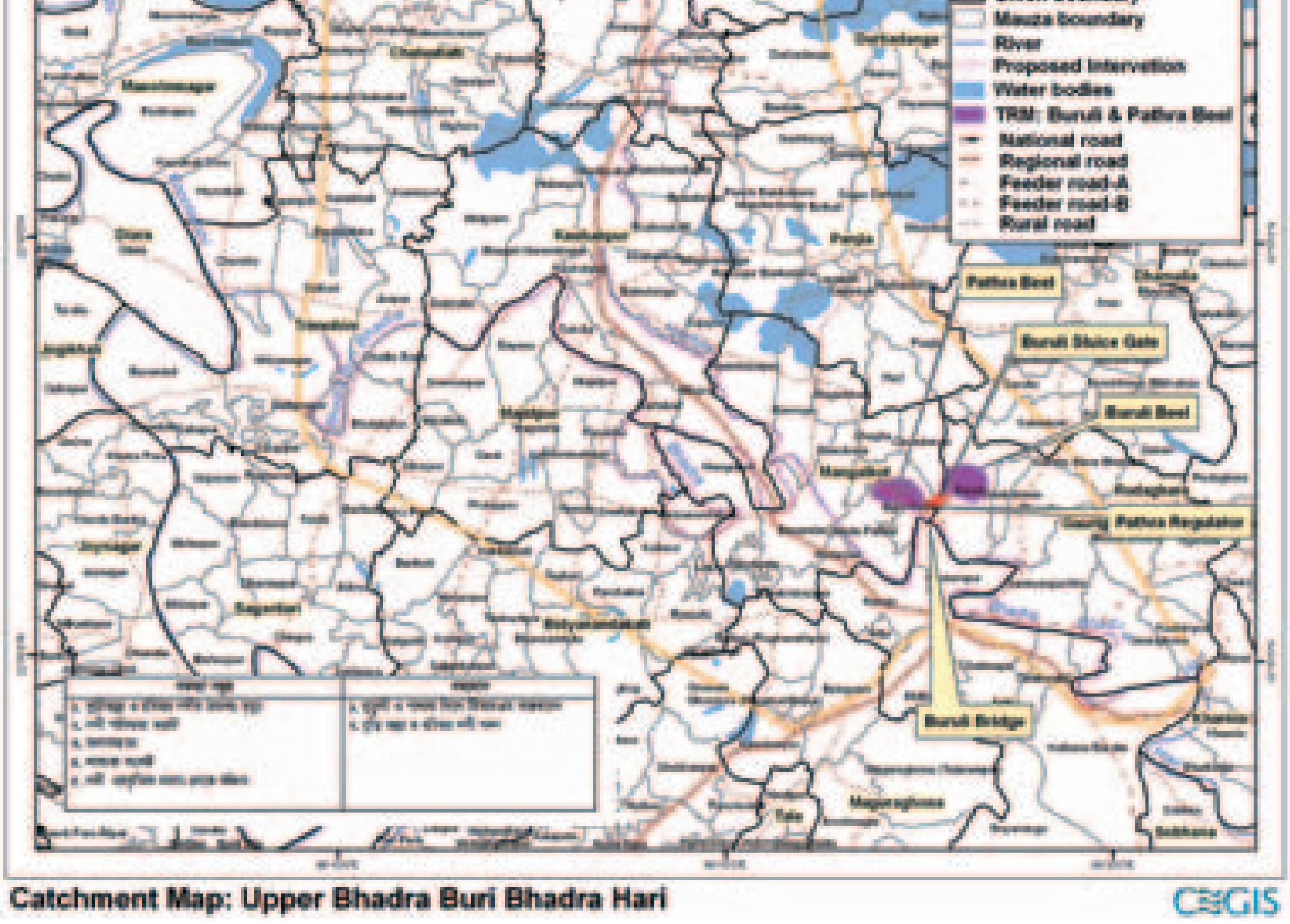
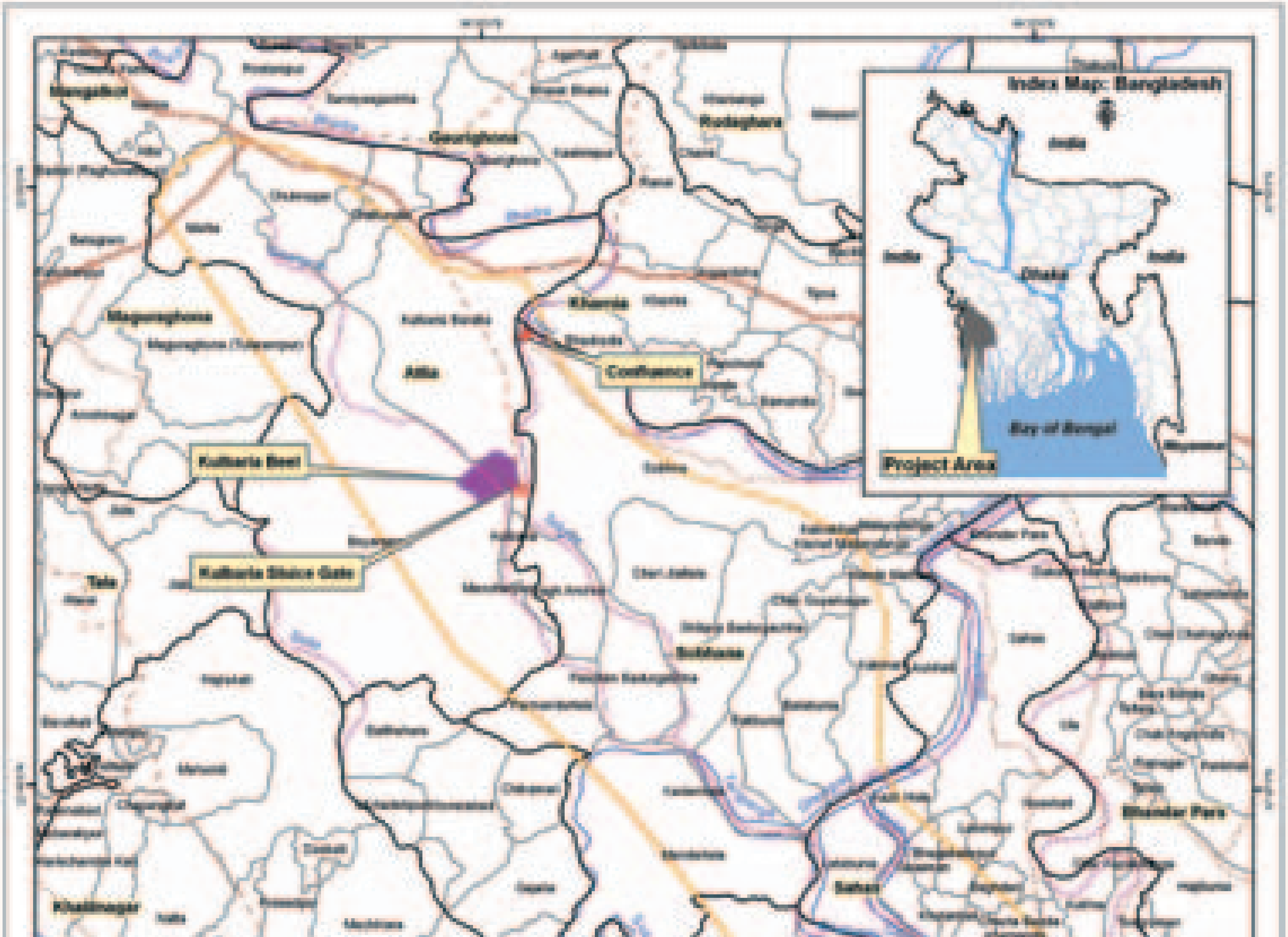
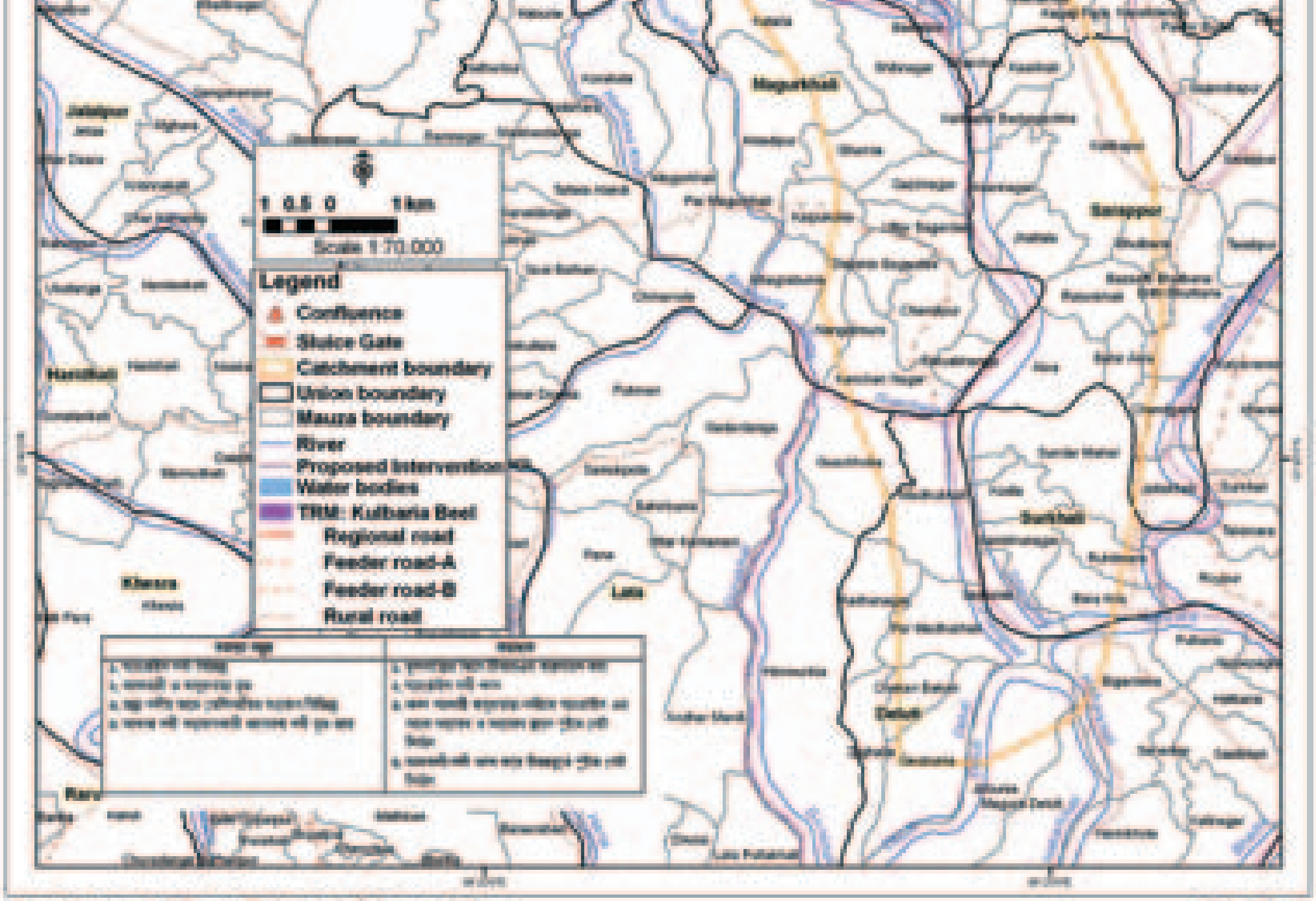
0
2
4
km



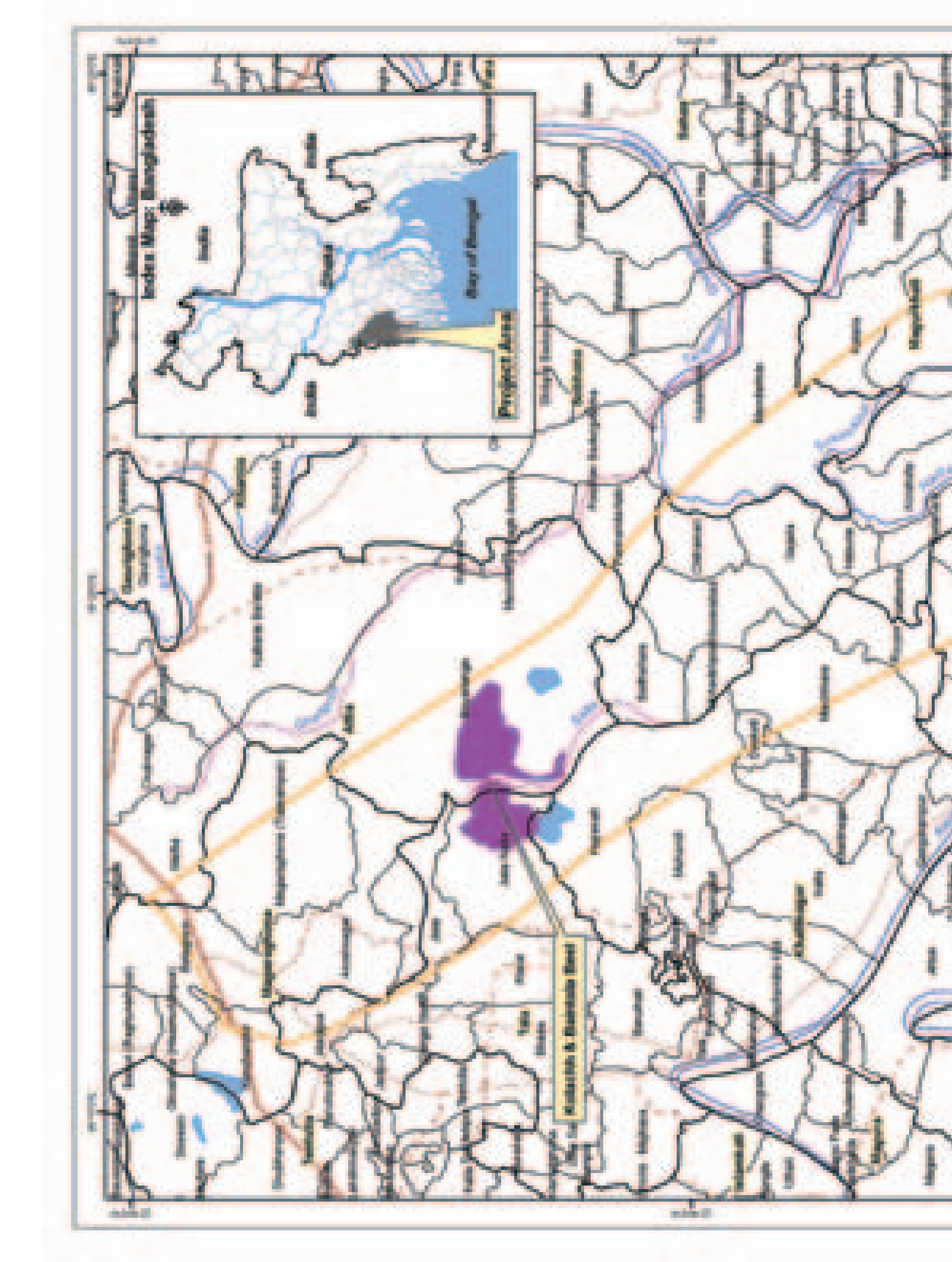
Map 3-5: Proposed major interventions in the Upper Bhadra-Buri Bhadra-Harihar Catchment

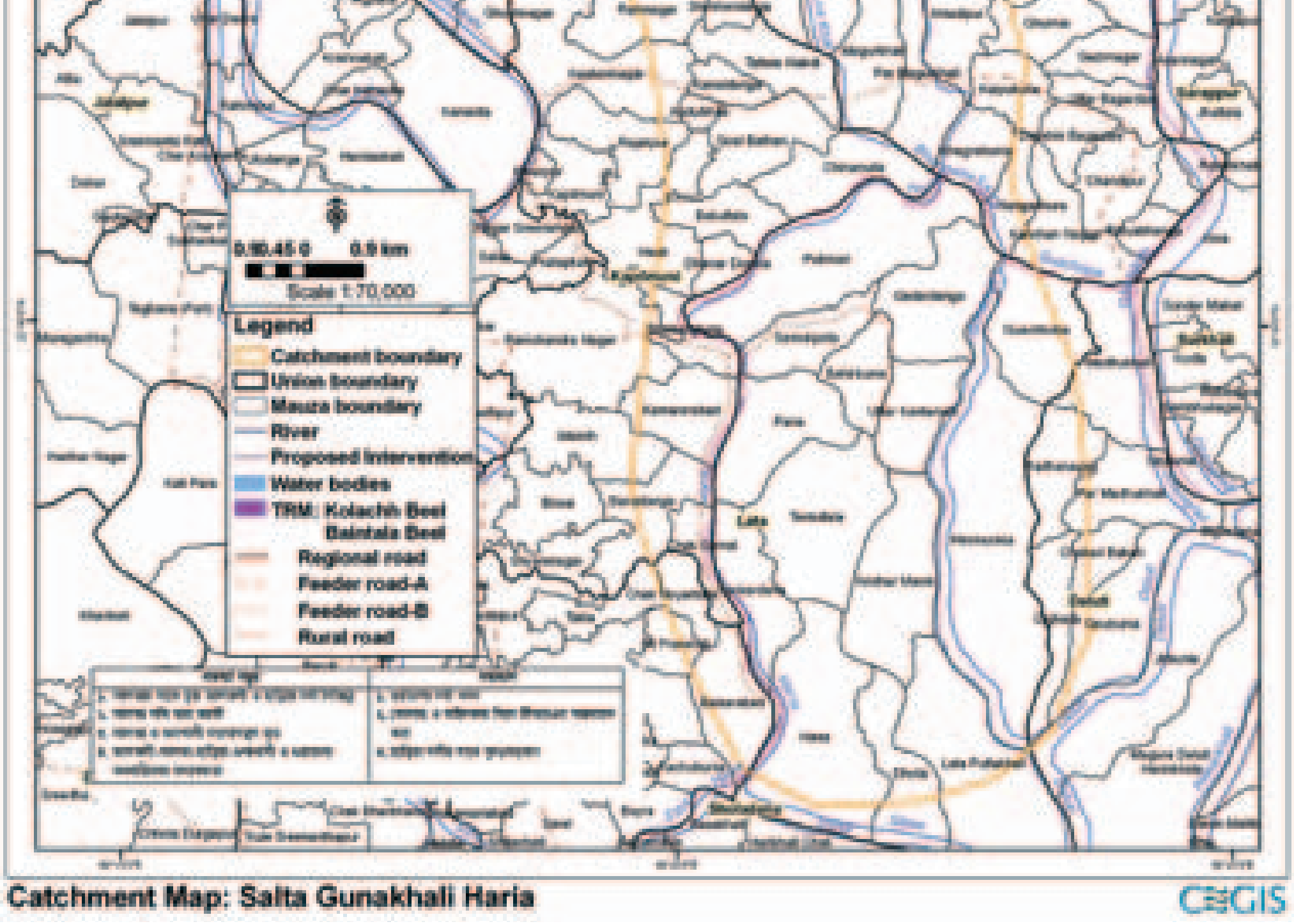


Index Map: Bangladesh
India
Dhaka
Bay of Bengal
Project Area
Kalbaria Beel
Kalbaria Sluice Gate
Confluence
Atlia
Khornia
Magurghona
Gourighona
Rudaghora
Sobhana
Tala
Bhandar Para
Sahas
Khalilnagar



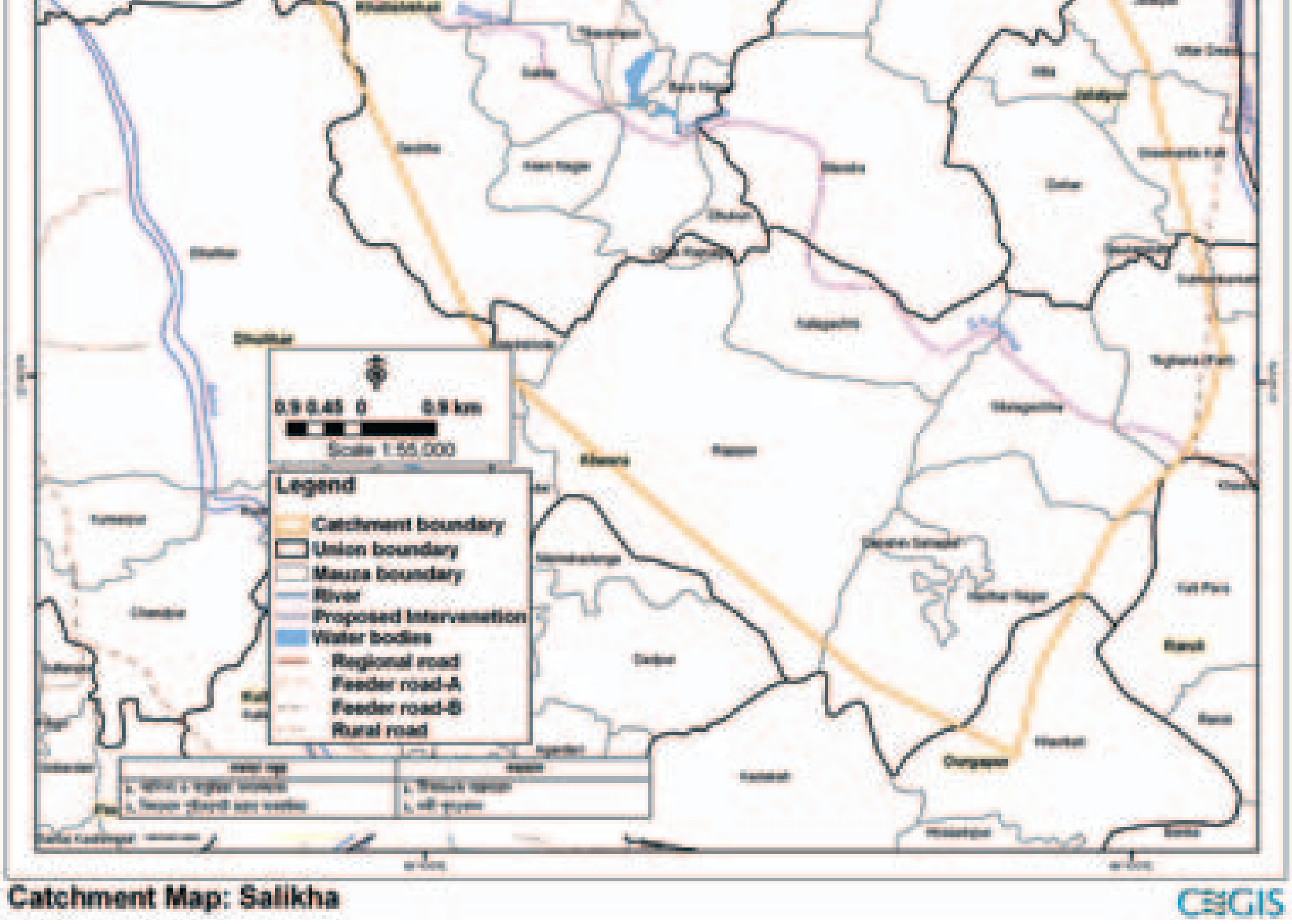
Map 3-6: Proposed major interventions in the Upper Teligati-Gengrile Catchment



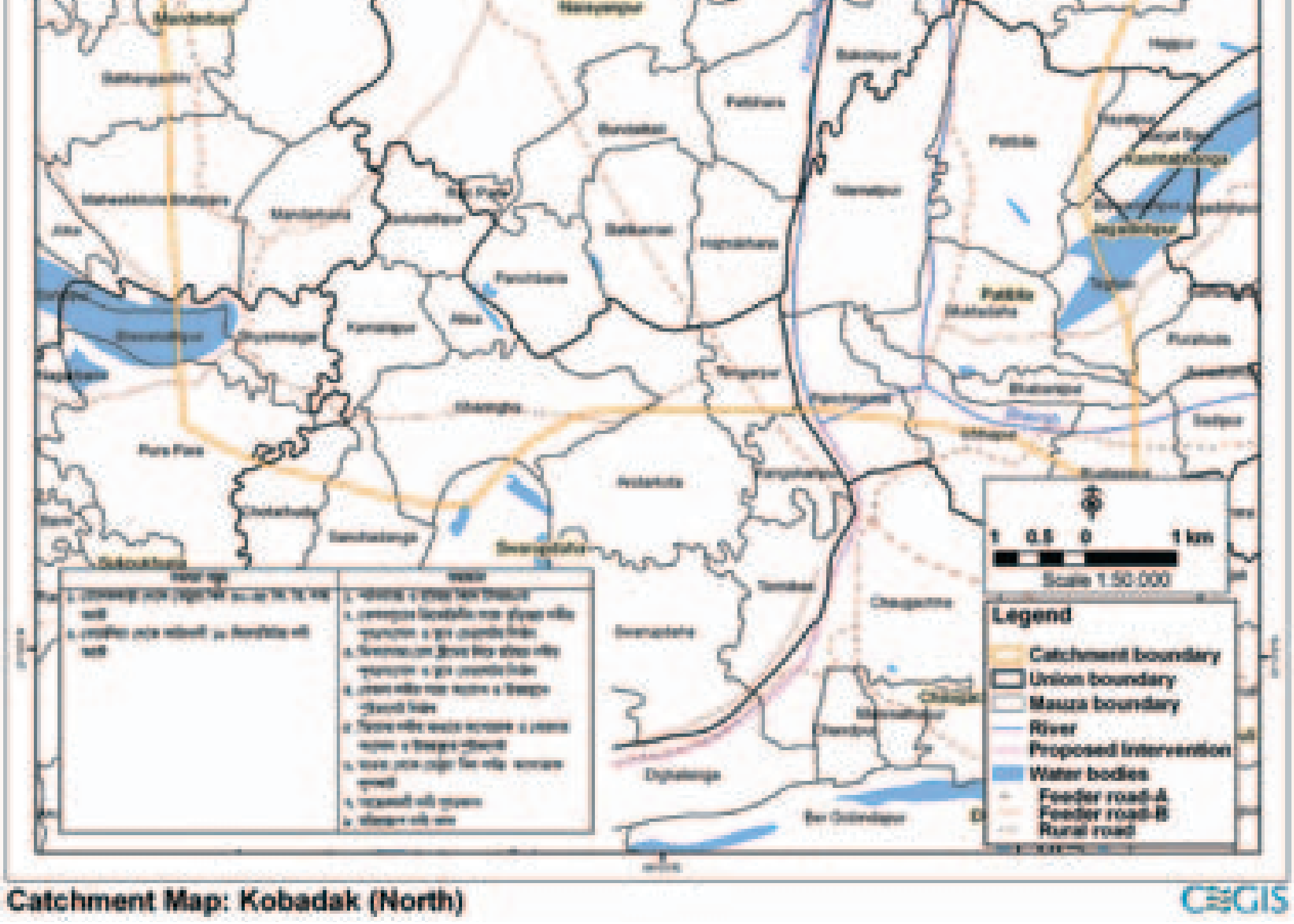


Map 3-7: Proposed major interventions in the Upper Salta-Gunakhali-Haria Catchment

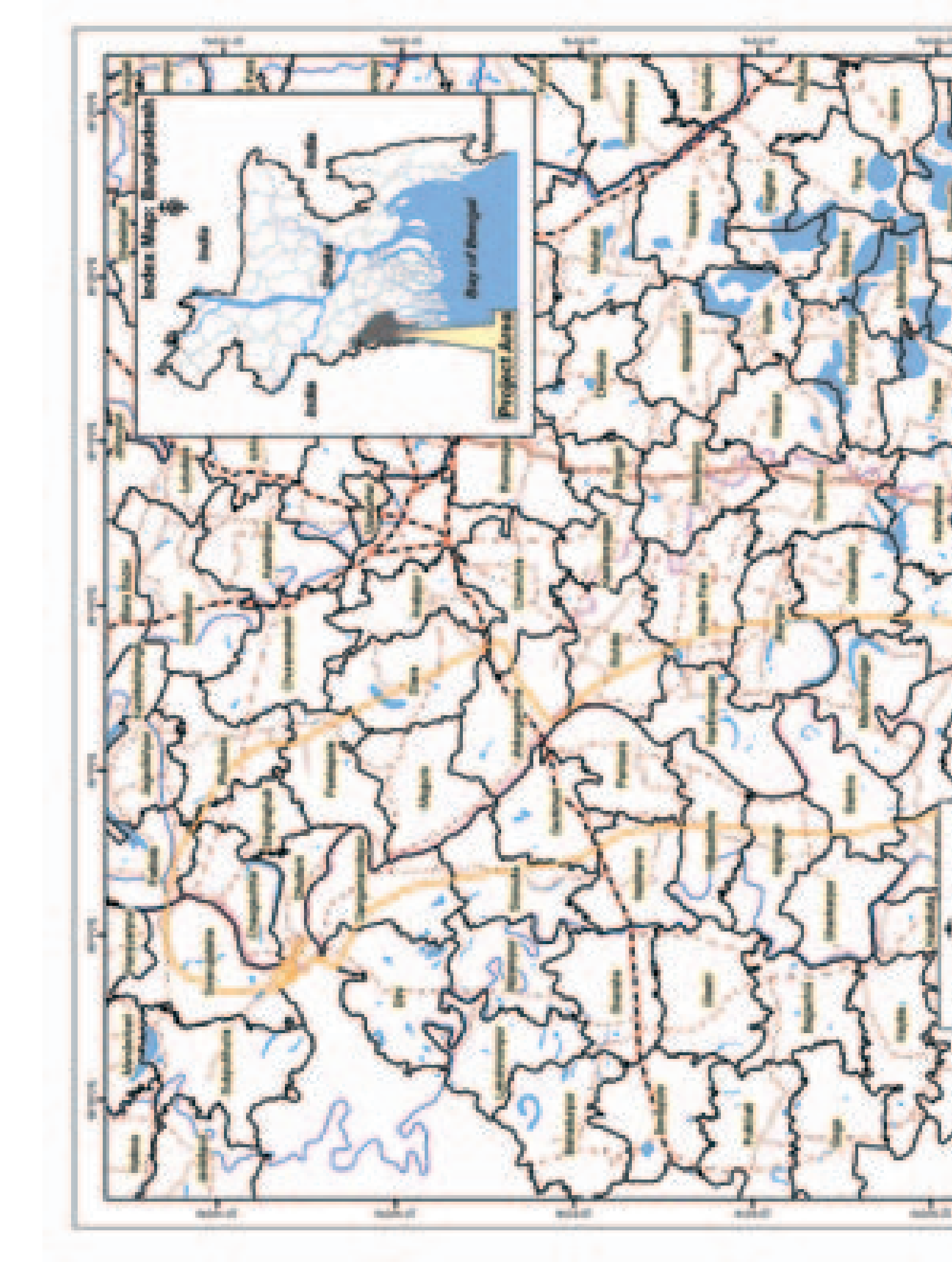

India in Map - Bangladesh
Project Area

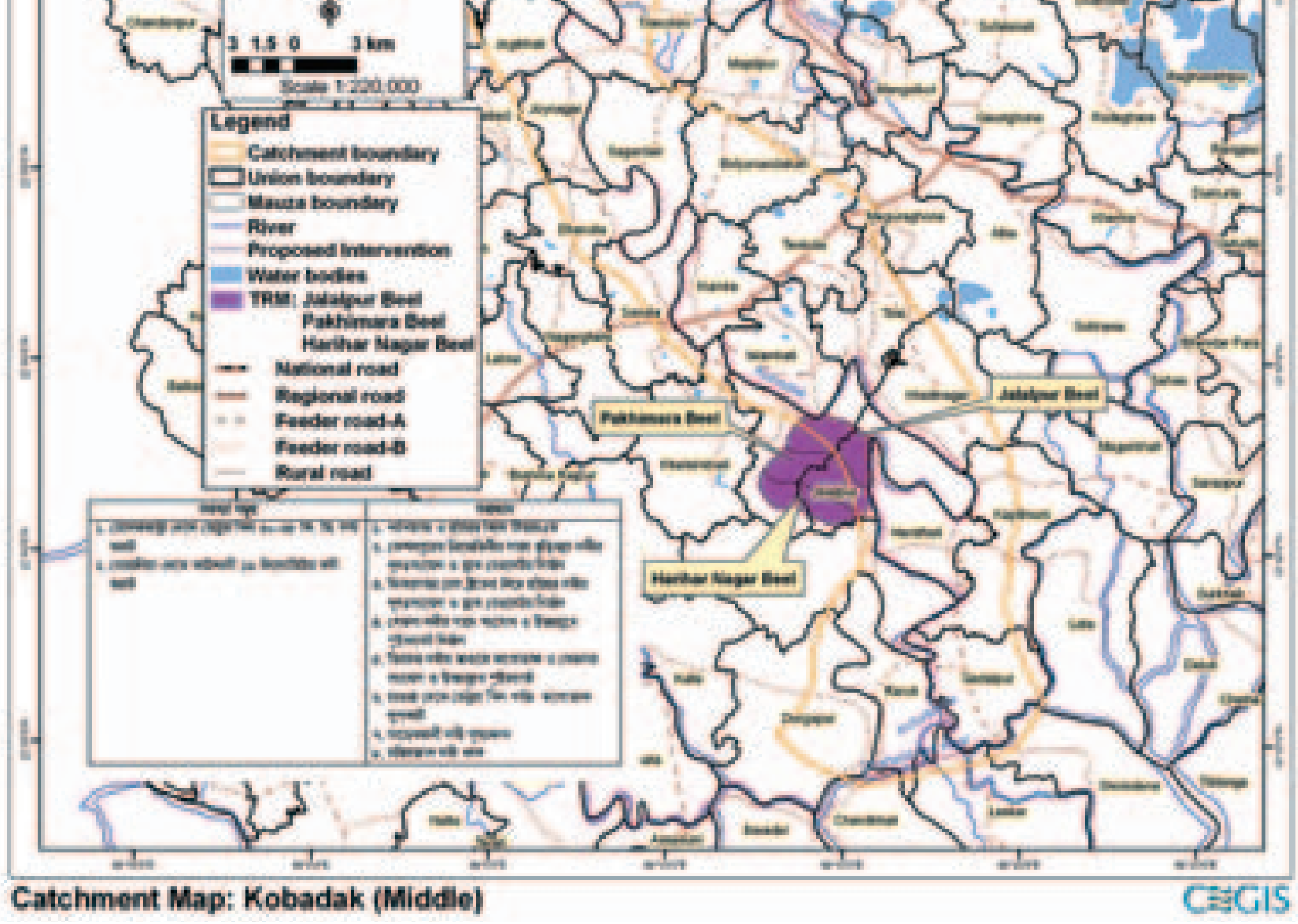


Map 3-8: Proposed major interventions in the Upper Shalikha Catchment



Map 3-9: Proposed major interventions in the Kapotakshi North Catchment


India
Bangladesh
Bay of Bengal



Map 3-10: Proposed major interventions in the Kapotakshi Middle Catchment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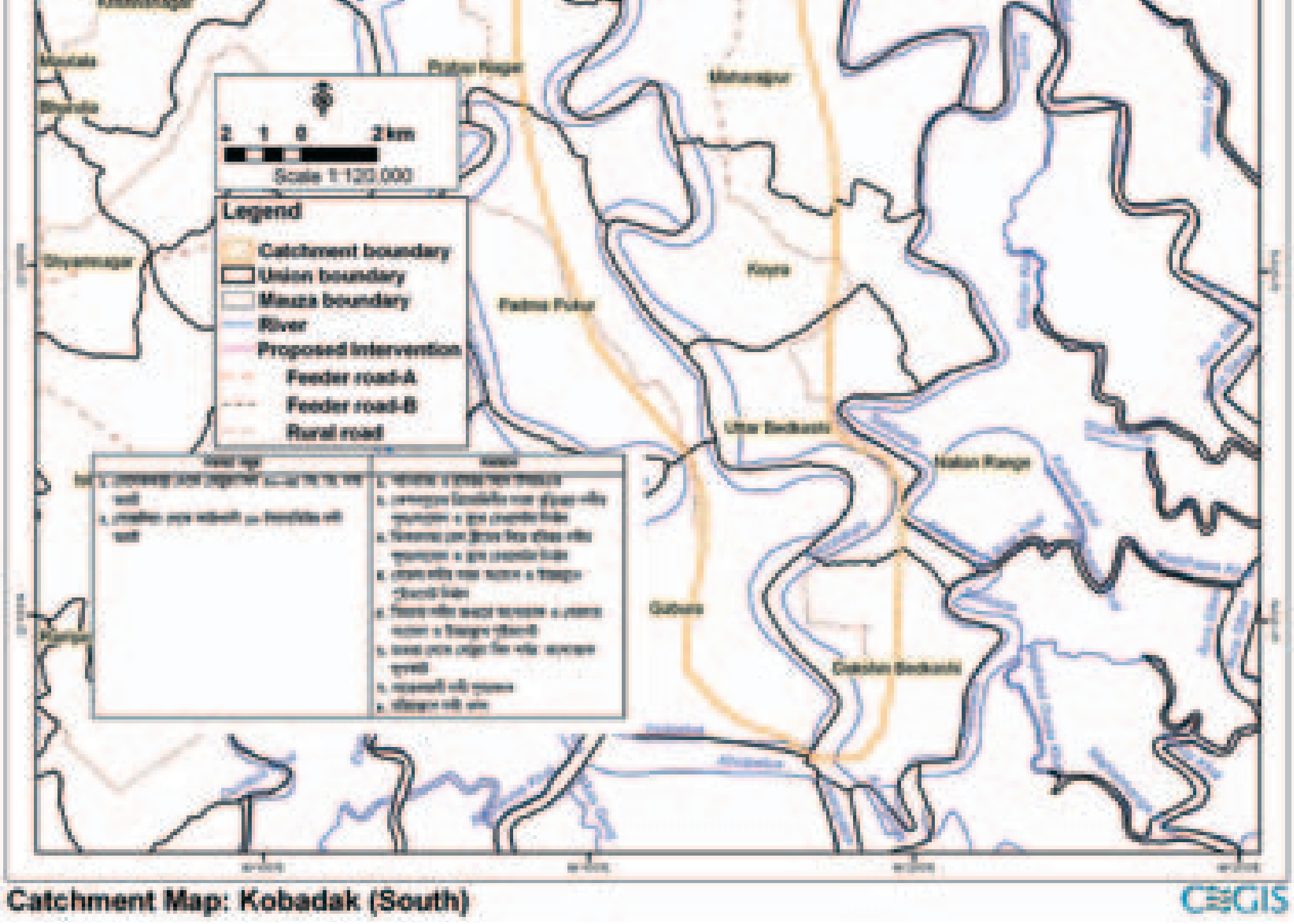
India
Dhaka
Bay of Bengal
Project Area
Chandkhali
Sreeula
Lata



Map 3-11: Proposed major interventions in the Kapotakshi South Catchment

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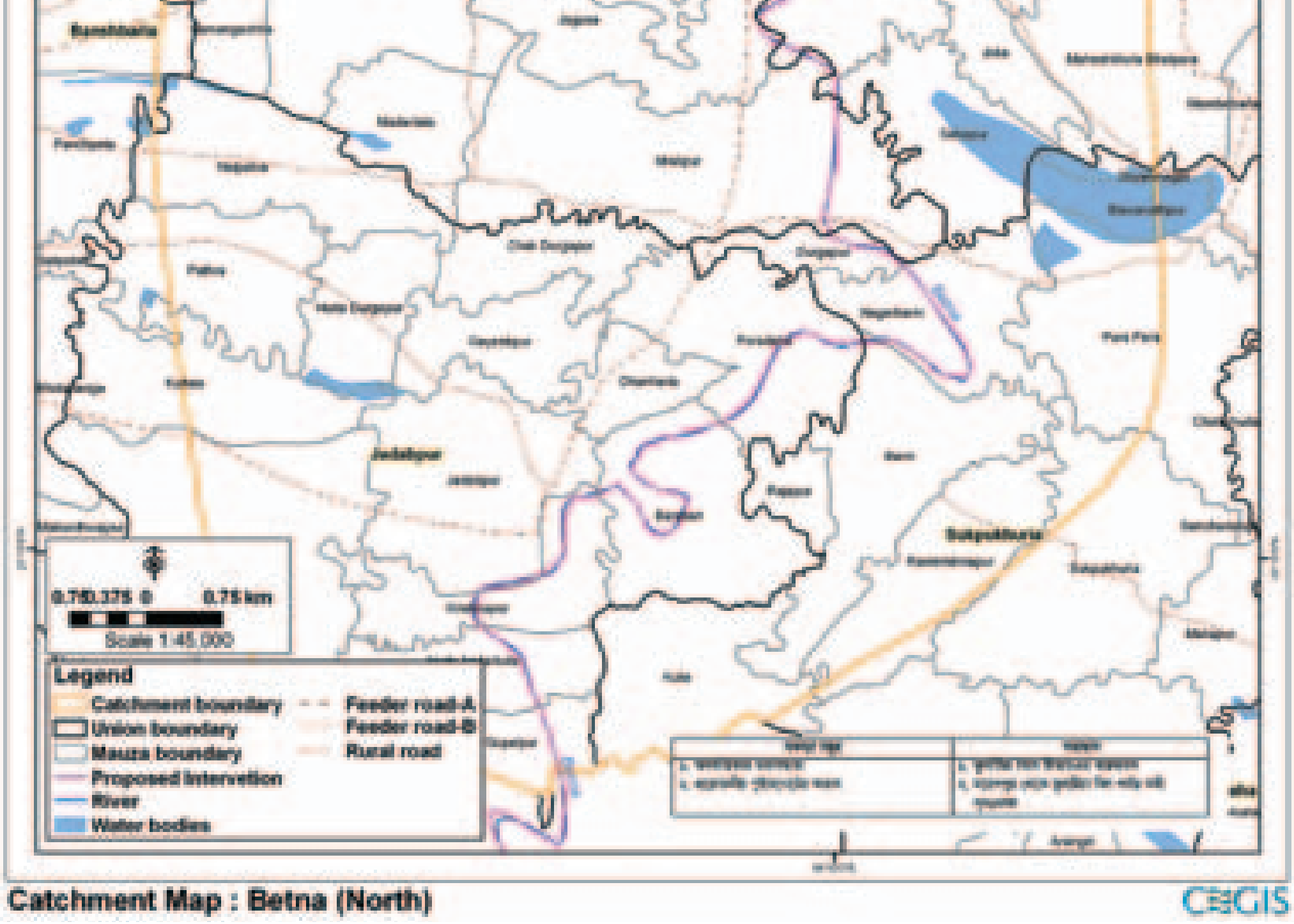
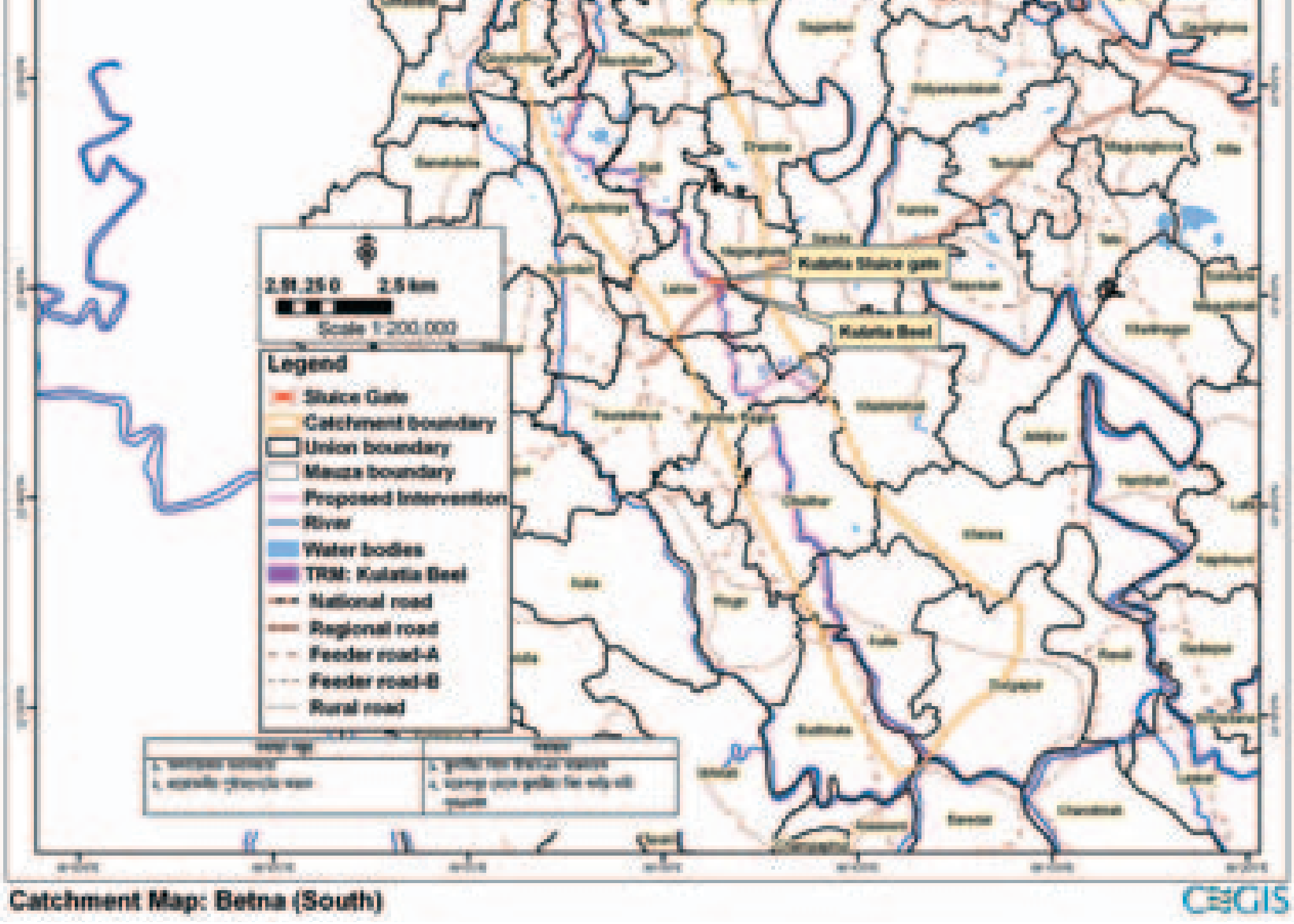
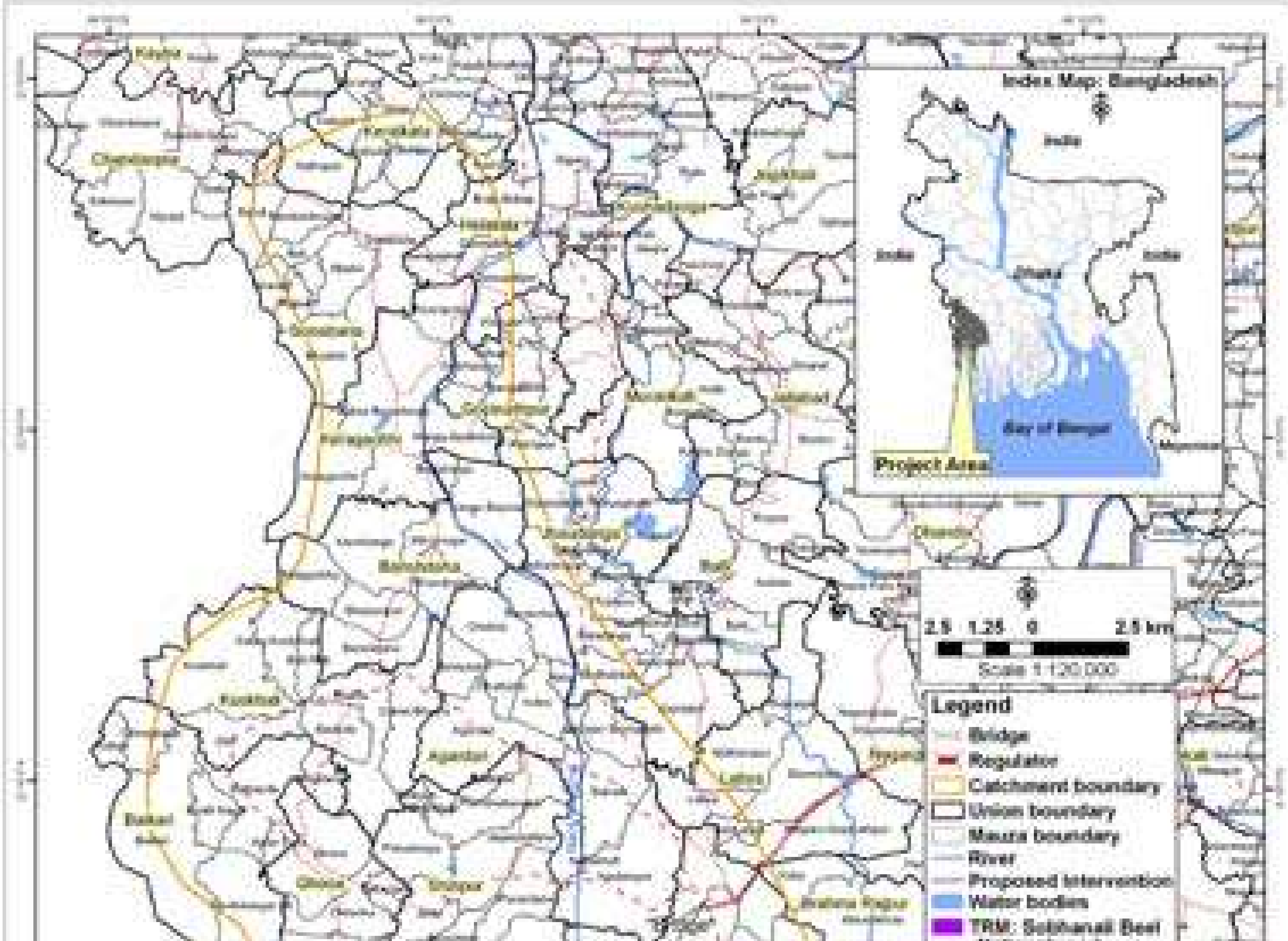
Dhaka
Bay of Bengal
Project Area
Padma Para
Nalitha
Mandarbari

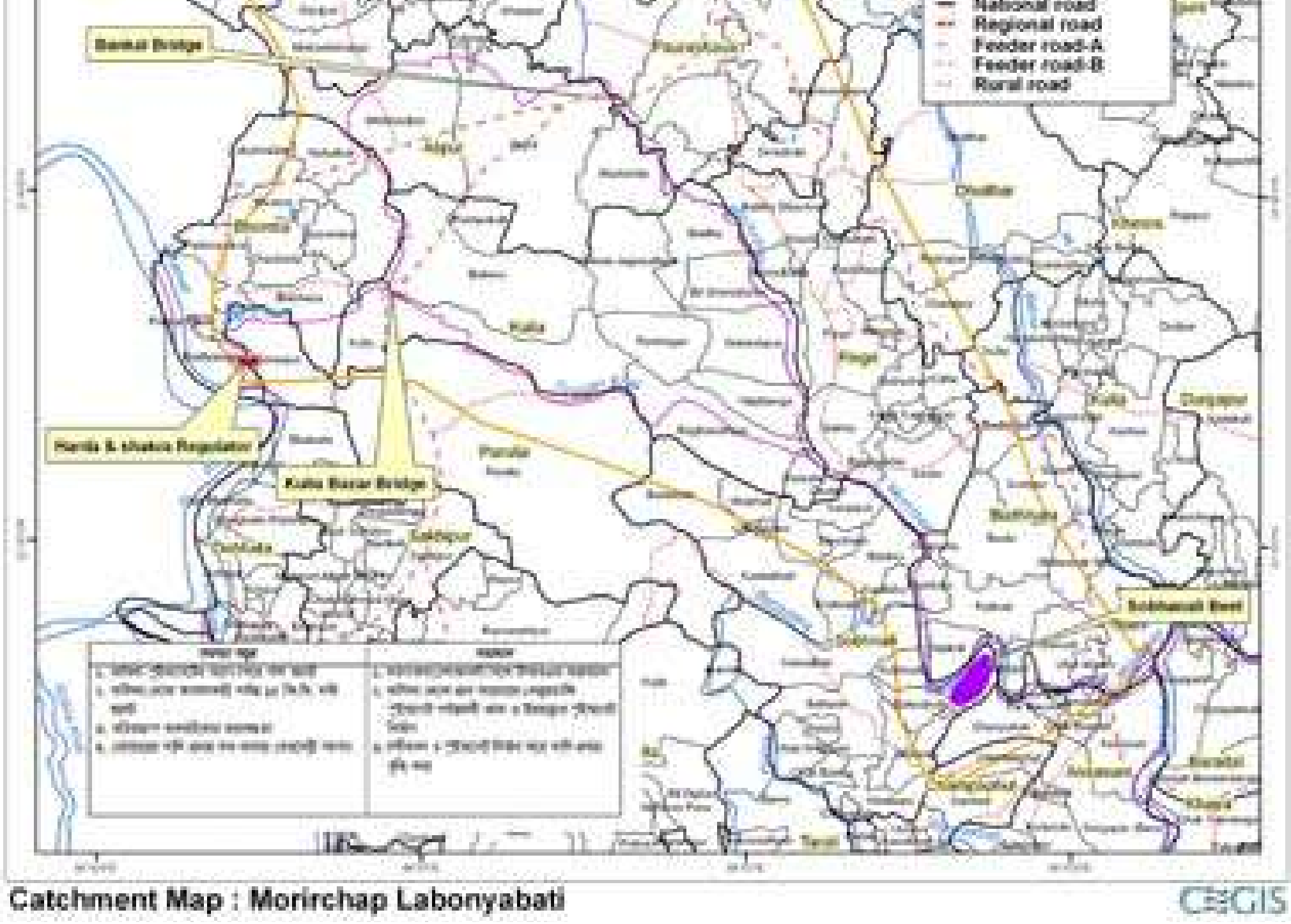


Map 3-12: Proposed major interventions in the Betna North Catchment

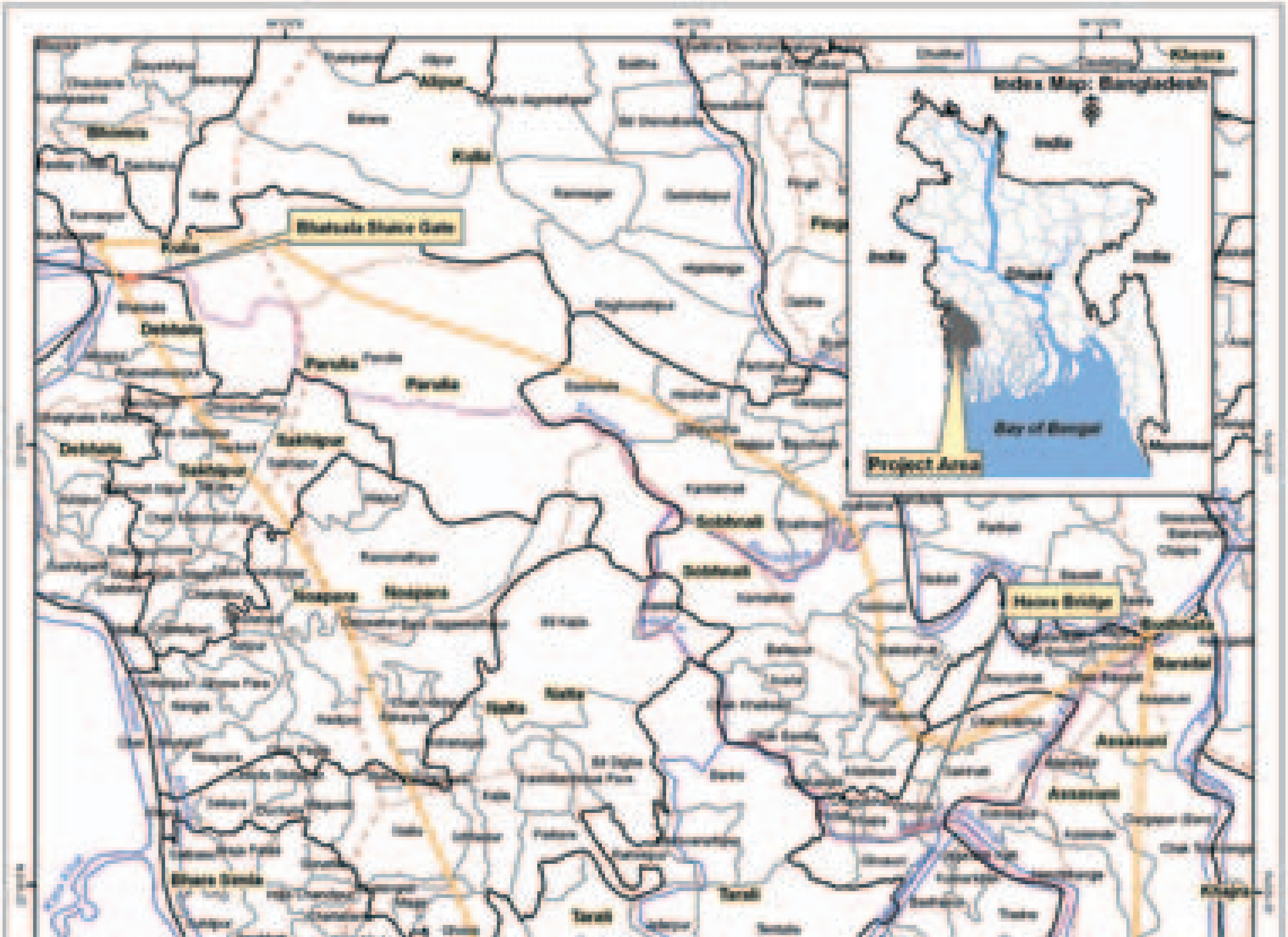


Map 3-13: Proposed major interventions in the Betna South Catchment


Index Map: Bangladesh
India
India
India
Dhaka
Bay of Bengal
Project Area
2.5 1.25 0 2.5 km
Scale 1:120,000
Legend
Bridge
Regulator
Catchment boundary
Union boundary
Mauza boundary
River
Proposed Intervention
Water bodies
TRM: Sobhanali Beel



Map 3-14: Proposed major interventions in the Morirchap-Labonyabati Catchment


Index Map: Bangladesh
India
Bay of Bengal
Project Area

Map 3-15: Proposed major interventions in the Shapmara-Galghesiya Catchment

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