Final Report

Topographical, Hydrological and Morphological Study using Mathematical Model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division

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Ministry of Water Resources
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Abbreviations

AAQ	Ambient air quality
ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BCSAP	Biodiversity Conservation Strategy and Action Plan
BCCSAP	Bangladesh Climate Change Strategic Action Plan
BIWTA	Bangladesh Inland Waterways Transport Authority
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BOD	Biological oxygen demand
BWDB	Bangladesh Water Development Board
CEGIS	Center for Environmental and Geographic Information Service
COD	Chemical oxygen demand
DAE	Department of Agriculture Extension
DC	Deputy Commissioner
DO	Dissolved oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DLO	District Live Stock Office
EC	Electrical Conductivity
ECA	Environmental Conservation Act
ECA	Ecologically Critical Area
ECC	Environmental clearance certificate
ECR	Environmental Conservation Rules
EIA	Environmental impact assessment
EMP	Environmental management plan
ESIA	Environmental and Social Impact Assessment
FGD	Focal Group Discussion
FPCO	Flood Plan Co-ordination Organization
FS	Feasibility study
FWIP	Future-with-Project
FWOP	Future-without-Project
GoB	Government of Bangladesh
GPS	Global Positioning System
GPA	Guidelines for the Project Assessment
GPWM	Guidelines for Participation of Water Management
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Components
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modelling
LGED	Local Government Engineering Department
LLP	Low Lift Pump
km	Kilometer
mg/l	Milligram per liter
MoEF	Ministry of Environment, Forest and Climate Change
MRTB	Ministry of Road Transport and Bridge
MSL	Mean Sea Level
NWRD	National Water Resources Database
NCA	Net Cultivable Area
NCS	National Conservation Strategy

NGO	Nongovernment organization
NEMAP	National Environmental Management Action Plan
O&M	Operation and maintenance
PCM	Public consultation meeting
PIA	Project Influence Area
PPM	Parts Per Million
PWD	Public Works Datum
RHD	Roads and Highway Department
RRA	Rapid Rural Appraisals
RRI	River Research Institute
ESIA	Environmental and Social Impact Assessment
SPM	Suspended Particulate Matters
SRDI	Soils Resources Development Institute.
SS	Suspended Solid
TDS	Total Dissolve Solid
THMMM	Topographical-Hydrological-Morphological Mathematical Model Study
WARPO	Water Resource Planning Organization
WHO	World Health Organization
WF	World Fish
WQS	Water Quality Standards

Glossary

Aman: Group of rice varieties grown in the monsoon season and harvested in the post monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, supplemental irrigation needed in places during dry spell.

Arat: Generally an office, a store or a warehouse in a market place from which Aratdar conducts his business.

Beel: A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.

Boro: A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.

Haor: A back swamp or bowl-shaped depression located between the natural levees of rivers and comprises of a number of *beel*s.

Jhupri: Very small shed for living, made of locally available materials. A type of house used by very poor community people.

Kancha: A house made of locally available materials with earthen floor, commonly used in the rural areas.

Kanda: Kanda is a land that forms undulation and a slightly higher than agricultural land. This type of land remains fallow or use as cattle grazing or crop thrashing in dry season.

Khal: A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.

Kharif: Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).

Kancha Toilet: The earthen made latrine consist of a hole without cover.

Low Land: Low Land which normally is flooded from 180 cm to 275cm deep of water during the flood season.

Medium Low Land: Medium Low Land which normally is flooded lesser than 180 cm during the flood season.

Rabi: Dry agricultural crop growing season; mainly used for the cool winter season between November and February.

Very Low Land: Very Low Land which normally is flooded deeper than 275 cm during flood season.

Water sealed: A water sealed latrine is simply a pit latrine that has a water barrier to prevent odor. These latrines are simply pits dug in the ground in which human waste is deposited.

Executive Summary

Project Background

The proposed project site is located in Sunamganj district of the north-east region of Bangladesh with complex hydro-ecologically wetland settings. Dirai and Sullah are two upazilas under Sunamganj district. These upazilas are naturally resourceful with rice and fish cultivation. Howeve, Dirai and Sullah upazillas in Sunamganj are very remote area because of lacking road facilities, especially Sullah upazilla. Dirai upazila headquarter is connected with national road network by RHD zila road, however, Sullah Upazilla headquarter not connected. Most of the people of these two upazilas can not avail to access national road network easily. Along the Madanpur-Dirai-Sullah road structure, the Madanpur-Dirai part is almost suitable for vehicular movement while Dirai-Sullah road portion not functional for traffic movement. The existing Dirai-Sullah road link connected between Dirai and Sullah upazillas. It is mentioned here that the existing Dirai-Sullah road link (Z 2807) has already been constructed only a few years ago. However, the fact is that the road is not fully serviceable for vehicular movement. It is still unpaved at many parts and approaches of most of the road structures have been damaged fully or partially or have not yet been constructed. Therefore, it is urgent to repair and improvements of the Dirai-Sullah road link for smoothing road communication facilities in this region. Since the road is constructed in environment profound wetland, there is also need to assess environmental impact and appropriate mitigation/enhancement measure for ensuring sustainability of the road and surrounding environment.

The location of the Madanpur-Dirai-Sullah road is low-lying area surrounded by beels, haors, rivers, khals and human settlements. During monsoon this area goes under water more than six months. Road embankment along the haors/beel will create obstacle to natural flow of water and the road embankment will be in danger because of wave actions. Besides, Road structures like bridges and culverts are constructed on the road across the natural drainage routes or any other appropriate locations to allow for free passage of flood water. Moreover, loss of bio-diversity and environmental quality degradation are likely to occur after construction of any road in the haors/beel region.

Under the above circumstances and to interconnect Dirai and Sullah two upazilas to national road network, the Roads and Highways Department (RHD), Sunamganj has taken initiatives to reconstruct of Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road to improve existing road communication facilities. In this connection, RHD has appointed River Research Institute (RRI) to conduct the Numerical model study and EIA study of the Project ‘Topographical, Hydrological and Morphological Study using Mathematical Model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division, Sunamganj’’.

Rationale of the EIA

EIA is a legal requirement of the DoE under provisions of the Environmental Conservation Act (ECA), 1995 and the Environmental Conservation Rules (ECR), 1997of Bangladesh. According to these rules, construction/reconstruction/expansion of flood control embankments, polders, and dykes etc., and construction/reconstruction/expansion of road (regional, national, & international) are fall into the Red category. Therefore, the proposed Madanpur-Dirai-Sullah Road (Dirai-Sullah portion) project is considered under the Red category. This EIA report will be required to get the site clearance as well as environmental clearance from DoE.

Aim of the study

The aim of undertaking the Environmental and Social Impact Assessment (ESIA) of the Madanpur-Dirai-Sullah Road (Dirai-Sullah portion) Road project under Sunamganj Road Division, Sunamganj is to provide baseline data/information, to determine the likely potential environmental impacts (beneficial and adverse) associated with the project activities and to provide mitigation measures. The ESIA is also provides an Environmental Management Plan (EMP) to mitigate and compensate the impacts.

Approach and Methodology

The EIA study has been conducted following the guidelines for study of water sector projects of the Water Resources Planning organization (WARPO), 2005. The methodology for the ESIA study includes literature review, reconnaissance field visits and discussions with government and non-government official regarding management of water bodies and road construction authorities and other officials, consultation with the stakeholders who are directly or indirectly impacted after the road implementaation, primary and secondary data collection, bounding, identifying Important Environmental Components (IECs), analyses of environmental, social and institutional data and compilation of a report incorporating an EMP. Impacts of the Dirai-Sullah road on the IECs pertaining to Physical environment, Environmental quality, Water Resources, Land Resources and Agricultural environment, Fisheries resources, Ecological resources and Socio-economic resources have been assessed.

Limitations

The communication barrier in project site is a major limitation of this study. The study site is in under water more than 6 months a year. Inundation of the working site, other wetland problems, hampered data collection during wet season and lack of road communication facilities including roads and vehicles are the major constraints during dry season.

Environmental and Social Baseline

The Environmental and Social Baseline (ESIA) of the Madanpur-Dirai-Sullah Road (Dirai-Sullah portion) road project has been established in respect of existing physical, biological and socio-economic environment in project site. The baseline condition is explained in this report in the following aspect:

Physical Environment

The Madanpur-Dirai-Sullah road link (Dirai-Sullah) Z 2807 has already constructed. However, currently some part of the Dirai-Sullah road is non-functional. As the road link is located in the hydrologically and environmentally sensitive low lying haor area, there involves a number of issues for damaging the road and road structures. The likely issues are the connectivity between the rivers and haors, existing hydrological flow regime including flush flood, the existing road alignment and road structures, design discharge and flood level of the road and road structures etc.

The lengthways of Madanpur-Dirai-Sullah road is about 45km from Madanpur to Sullah and the distance between the Dirai upazila headquarters and the Sullah upazila headquarter is about 20km. There are 20 road structures including Sullah Bridge at Dirai bazar. Most of the road structures and their approaches are damaged. Road pavement damage, partial damage or complete washing out of

approach road, non-functional bridges and culverts, damage of road embankment side slope and damage of approach embankment slope protection works, soil erosion from the road embankment are visible throughout the road stretch from Dirai to Sullah. Scattered small human settlements are located along both sides of the road. But there are also some road stretches where there is no such human settlement.

The physiographic unit of the study area is under Sylhet basin. It forms a prominent low-lying area containing numerous large, semi-natural wetlands like haors, baors, water fall etc. It is a lager, gentle, depression feature, bounded by the Old Brahmaputra floodplain in the west, the Meghalaya Plateau foothills in the north, Sylhet High Plain in the east and the Mehgna estuarine floodplain on the south. The geology of the study area consists of Quaternary deltaic sediments, which have been strongly influenced by tectonic movements on deep seated faults. The area lies on a tectonic block, which has been uplifted relative to the surrounding areas.

The study area is characterized by high earthquake prone site which falls under Zone-I and has a basic seismic coefficient of 0.08g and there is also fault line near the study area.

The average annual rainfall of the study area is approximately 4,000 mm and over 80% of the rain falls during the monsoon season from June to October. Climate is dominated by distinctive geographical characteristics of the region which ultimately plays a major role in determining the spatial and temporal distribution of rainfall, evapotranspiration and hydrology of surface and groundwater.

Climate Change

Trend of annual variations of the meteorological parameters were analysed for assessing the change in climatic factors. The major impact caused by climate change is the rise in temperature. The variation of mean annual temperature was recorded at Sylhet station. The average temperature is found to be gradually increasing in this area. In last 50 years, the mean annual temperature has experienced a rise of about 0.022°C per year. The increase in mean annual temperature affects the rate of evaporation and thus rainfall intensities. Spring season has been shortened and monsoon has been shifting towards May. These days, monsoon starts from the month of May and lasts up to mid -October. Due to such timing, water scarcity is often observed in the Boro season. This phenomenon affects the cropping patterns as well as the biodiversity and ecosystem of the study area. The rainfall intensities and patterns have also been changed and an extreme consequence it is affecting the study area. In the last 60 years the annual rainfall of the study area decreased by 1.165mm per year at Sylhet. Along with the other factors, average humidity also experienced a slight change. The average annual relative humidity increased 0.018% per year in last 55 years at Sylhet region.

Environmental quality

Baseline data for environmental quality monitoring has gathered on noise quality, air quality, water quality and soil quality in the project area. Noise and air quality of the project site are quite good. The water quality parameter including temperature, pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), Total Dissolve Solid (TDS), Resistivity, Salinity, Phosphate (PO4-), Sulphate (SO4-) and Nitrate (NO3-) were measured in-situ condition in the study area. The measured water quality parameter in surface water is within the standard value provided by DoE (ECR, 1997) in the study area.

Water Resources

The main source of inflow to the region is from the Barak River which enters Bangladesh at Amalshid. At the border, the Barak bifurcates to form the Surma and Kushiara rivers, the two main rivers of the eastern part of the region. These two rivers receive most of the flashy river flows which enter the region from the Meghalaya Plateau and Tripura Hills. Rainfall on the adjacent Indian state Magalaya largely affects flooding in the study area. Therefore, the Surma-Kushiyara basin (or haor area) receives water from the transboundary catchments of the Meghalaya, the Barak and the Tripura.

Siltation is a common issue in the haor area. The most of the rivers are very flashy in this region and the origins of the rivers are adjacent to hilly area of India. During heavy rainfall in the hilly region of India, water quickly moves towards the haor area of Bangladesh through a number of rivers and khals. This floodwater not only carries the water but also carry a huge amount of sediment. This sediment gets deposited over time on the river and canal beds and reduces the conveyance capacity more or less all of the water resources system within the haor area. During heavy rainfall in the hilly region, massive erosion is taken place on the exposed surface of the hill.

Many rivers pass through the low lying project area creating a complex network of rivers. The main rivers include the Surma, the Kushiyara, The Kalni and the Baulai. There are many tributaries and distributaries of the main rivers. The Dirai-Sullah portion of the Madanpur-Dirai-Sullah road runs along the Champti-Darain river and crosses the same river at Sullah upazila headquarter. There are a number of floodplain channels that drain water to the nearby rivers during the recession period of flood. The road is an obstruction to smooth drainage. There is no water level and discharge gauge station on the Champti-Darain river or on the Old Surma river. However, there are BWDB water level and discharge measurement stations on the rivers surrounding the project area.

The study area is frequently devastated by early flooding in terms of damage to crops, homesteads and different infrastructures. BWDB constructs low height submersible dams along the river to protect the crop damage by early flooding in the form of flash flood.

Land Resources and Agricultural environment

The project area is positioned in the agro-ecological zone of Sylhet Basin (4573 sq. km) (AEZ-21). The region occupies the lower, western side of the Surma-Kushiyara floodplain. The soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. Peat occupies some wet basin centres. The soils have a moderate content of organic matter and soil reaction is mainly acidic. The fertility level is medium to high. About 74% of the top soil texture of the haor region is clay to clay loam, 21% loam and the rest are silty loam, sandy loam and sand.

The study area lies within low lying haor areas surrounded by cultivable lands, some uncultivable lands and water bodies with a small amount of human settlements etc. Besides, there are hats, bazars and growth centres are also available. There is very small amount of commercial and industrial establishments are available as the study area is in haor area. The study area belongs to deeply flooded area (flood depth>1.8m) and cropping pattern is fallow-fallow-boro. The agricultural land is mainly vegetation type. Agriculture and fishing are the main output of the region. Cropping patterns are determined by the seasonal floods with rice is the major crop in this region.

Crop damage is a common phenomenon in the study area. The main causes of crop damage are flash flood, drainage congestion, heavy rainfall, drought as well as different natural calamities in the haor

regions. Flash flood and hail storm are common threat which causes crop damage in the study area. The siltation of the river and khals is caused rise of bed which directly influence for drainage congestion. The infestation of pest and diseases are also responsible for crop damage. The Dirai-Sullah road crosses the Old Kalni river and paralally run through Champti-Darain river. The BWDB constructs low height submersible dams along the river to protect the crop damage by early flooding in the form of flash flood. The cross-drainage works on the Dirai-Sullah road allows for passage of floodplain flow and flood spill of the Champti-Darain river from northeast to southwest and east to west direction during monsoon.

Fisheries resources

The study area of Madanpur-Dirai-Sullah Road project is an important source of fisheries. Old Surma River, Kalni River and Chamti-Darain River, Boram haor, Dhalar Haor, Chhayar haor, Bera Dohor haor etc. and inundated paddy fields are the open water fish habitat of the project area. This diversity of wetland habitats, seasonal inundation and fluctuation of water regime and connectivity of the haor with the Rivers, canal, khals, beels system make the haor suitable for capture fisheries production of this area. The Haors/beel of the project area provide the winter shelter for the mother fishery, and in the early monsoon these mother fisheries produce millions of fries for the entire downstream fishing communities.

Fish habitat is primarily classified under two categories such as capture fishery and culture fishery. River, beel and floodplain are considered under capture fish habitat. In the study area the most of the fish production is coming from capture fisheries whereas culture fisheries are limited. Fish production of the study area is mainly derived from capture habitat which includes river, beel and floodplain. Estimated total annual fish production in Dirai upazilla is about 7035.02 Mtons. The bulk of the inland fish production is coming from capture fisheries. A large number of fishing net/gears are used for fishing. Some common fishing gears in the study area are current jal, Berjal, Urainnajal, Tanajal, Thelajal etc.

There is a gradual decline in the production trend of capture fisheries over decade due to indiscriminate fishing, shrinkage of fish habitat, reducing depth of river etc. Silting up of beels and canals reduces the depth as well as water volume negatively impacting fish production. The exploitation pressure is very high in the haor areas. No care is taken as to the future of fish stock. Fishermen use sometimes nets with too small mesh gear to catch as much fish as possible gradual bringing many species to extinction. There is no effective enforcement of the fish conservation act. There is also decline in the natural production of fry and fingerlings in open waters during the decades due to indiscriminate fishing of brood stocks and spawn. Heavy drought also creates a major problem for fisheries. Besides, in the study area, water is found in lower parts of the haor where can only save the mother fish/ brood fish but some ill motive peoples are being harvesting the brood fish.

Ecological resources

The study area is situated in the northeast part of the country with unique hydro-ecologically characteristics. The study area consists of human settlement, haors, beels and river systems. The study area encompasses one of these bio-ecological zones, namely the Haor basin. Haor refers to a large natural depression where there are perennial water bodies (i.e., beels) that become part of a contiguous wetland during monsoon and remain disconnected by vast crop lands during the dry season. Due to its alternative wet and dry nature, the ecosystem offers two major livelihood options: fishing in the wet season (June-October) and cropping in the dry season (December-April). The haor is fed by small rivers draining the adjacent land and also by the rivers during flood season. During the

subsequent dry season, the water evaporates or drains away through the southern outflow to leave a diverse system of dry season water bodies. This seasonal variability of flow and water level in the haor area helps support a unique wetland eco-system. Both rivers and haors are made up of a complex of habitats whose diversity supports exceptionally rich fish faunas.

Cropland is major land type in all over the haor area including the study area. This land is mainly used for boro cultivation. Cropland supports various avifauna and reptiles. Human settlements with dense vegetation along with some well grown trees are exists in the study area. The tree species are common species characteristic of the district and include eucalyptus, plum, rain tree, koroi, neem, akasmoni, debdaru, acacia, mango, jackfruit etc. There is endangered species are not available at and around the project site.

Socio-economic environment

The study area mainly consists of Dirai and Sullah upazilla under Sunamganj district. The existing Dirai-Sullah road link connected between Dirai and Sullah Upazila. Eighty percent of the study area consists of Dirai and Sullah upazilla and rest of (only 15%) covers Habiganj and Netrokona. Seven unions of Dirai, four unions of Sullah, four unions of Habiganj and two unions of Netrokona district are included as a project impacted zone. The number of male and female population is almost equal in the project site. The gender ratio ranges from 93 to 109. The literacy rate in Dirai is 37.1% of which male literacy is 38.5% and female literacy is 35.8%. On the other hand, the literacy rate in Sullah is 34.3% of which male literacy is 36.4% and female literacy is 32.1%. About 13.3% to 22.5% households comprise of 8 more than members and the average size of the household in the study area ranges from 5.0 to 5.9 members. The highest concentration is in Daulatpur Union (5.9) and the lowest concentration is in Khaliajuri Union (5.0). Agriculture was reported by the local people is the mainstay of their mode of livelihood. About 9% to 19% of the total population in the study area engaged in agriculture. The engagement in industrial sector is negligible (0.02% to 0.47%) in the study area. However, no industries are found in the study area. Most of the households in the study areas are using tube-well water (groundwater) for drinking purpose. The number of Muslim person ranges from 21.23% to 94.4% of total population and about 5.57% to 78.76% are the range of Hindu person of total population in the study area. The number of employed person ranges from 11% to 21%, of total population, about 10% to 18% is engaged in household work (mostly women); about 5% to 9% of total population are not working.

Stakeholder Consultation and Disclosure

Several public consultation meetings were conducted with the participation of local people, the representative of government and non-government authorities and elected representatives of Upazilla and Union porishad. Local people showed very positive attitude towards the proposed road project. They informed that the project will add a new dimension to their lives by smoothing roadway communication facilities in this area. The Dirai-Sullah road is very essential for the people of this area. The people of Dirai and Sullah upzilas are in desperate need of Dirai-Sullah road as there is no smooth roadway communication facility between Dirai and Sullah upazilas. Especially people of Sullah upazila feel them isolated due to lack of good roadway communication. They trust that the complete construction of the Dirai-Sullah road will bring great fortune to them. This road will play vital role in improving communication in that region and it will enhance the overall socio-economic condition of the region. Besides, accessibility of daily commodities not produced in theses upazilas will be increased after the full completion of construction work of the road. Emergency medical service could be availed after improvement of the road communication system. The representatives of Upazilla and union parishad and government and non-government authorities also expressed their

positive attitudes about the road reconstruction. They also suggested that the road project should not have any adverse impact on fish migration and fish population which is now on the decline due to overfishing. Public disclosure meetings have also been carried out for disclosing the impact of the Project and the Environmental Management Plan (EMP).

Impact Assessment

The ESIA study shows that the reconstruction of the Dirai-Sullah road project has both positive and negative impacts. Major environmental and social impacts caused by the project interventions as well as the proposed appropriate mitigation measures have been assessed.

Beneficial Impact

Implementation of the Dirai-Sullah road would play the progressive role in the road communication system in Sunamganj. The up-gradation and improvement of the road and road structures would be facilitated uninterrupted road communication systems between Dirai and Sullah upazilla, and it would avail to connect national road network systems. So, implementation of this road would ultimately enhance the communication systems in this region. Moreover, people of this region will get benefit in terms of reduced travel time and cost after the improvement of the road. The people of this area would also get benefit to access road in the monsoon and in dry season too that ensure all weather communication. Uninterrupted road communication systems would be enhanced tourism industries. The natural beauty of the haor is magnificent which would be attracted tourists in this region after implementation of the all-weather road.

Reconstruction of the road would be increased trade and commerce in this region. The agricultural products especially rice and fish are grown very well in the project site. The people have no easy access to markets beyond their localities. They completely depend on boats and other modes of locally available vehicles to transport and market their agricultural products in local markets. After completion of this road, it would be easier to transport agricultural products from Dirai and Sullah to other parts of the country. Small agro-industries would be introduced due to improvement of the road. With the improvement of the road communication system, employment opportunity will be increased significantly. Poverty alleviation would be increased through trade and commerce, employment opportunities, saving crop damage and so on.

Accessibility in health services would be enhanced with the improvement of the Dirai-Sullah road. The people of the project area have been suffering severe health threat due to lack of communication accessibilities. Especially, Sullah is completely disconnected from Dirai or Sunamganj sadar and therefore, any adverse situation patient even die. Improvement of the road would also enhance the availability of doctors, nurses and related medical equipment in hospitals/health centres.

After the road project implementation, the life style of the people would be improved remarkably and therefore, socio-economic condition of the area will be enhanced. The most of the beneficial impacts are in high significance, regional and long term in nature.

Adverse Impact

The ESIA study shows that the Dirai-Sullah road project has some adverse impacts. The major negative impacts on environmental components are related to water resources as the Dirai-Sullah road (Z 2807) is constructed in the low-lying haor/beel area. Water resources problems in haor area such as flush flood, wave action, flood level, siltation and bank erosion would be negatively impacted on the

proposed Dirai-Sullah road project. The other negative impact on the environmental component is land acquisition. The land has been occupied for construction of the existing road which mostly belongs to private owners but the land acquisition money didn't get land owners yet. Besides, the land use pattern in the study area has already undertaken considerable changes due to human interventions into the rivers such as existing Dirai-Sullah road, submersible roads, submersible embankments, homesteads and other infrastructure which would be negatively impacted in the project area. For improving the existing road, the land has been modified from low land to high land that is increase loss of biodiversity. Land use pattern in this area will be changed temporary during the construction of labour sheds, contractor's office and material stockyard. Fish habitat and fish production are likely to be declined during the construction work. Fish migration and fish diversity would be impacted as there is connectivity between rivers and haors therefore, adequate road opening for free passage of water is required. Traffic, excavation and filling operations may create some safety hazards for the local population as well as for the construction workers. Due to construction work and movement of heavy vehicle, air and water contamination and noise generation would be deteriorated at the construction site.

The ESIA study shows that the resultant potential impacts might be minimized through the mitigation/enhancement measures. The adverse environmental impacts can be addressed through proper planning and design of the components, monitoring of reconstruction works, and mitigation/enhancement measures. The EMP provides for mitigation of all identified impacts.

EMP Measures

The EMP has been outlined for safeguarding the implementation and monitoring of the mitigation measures of this project. For minimizing the adverse impacts, the following EMP has been made for the Dirai-Sullah Road link project:

- The location and the existing Dirai-Sullah road alignment may be kept as much as possible as present position for minimizing reconstruction cost of the road.
- Land acquisition money should be allocated in proper way and exact compensation rate should be provided as early possible as land owners didn't receive compensation money yet.
- The existing bridges and culverts over the road might be kept as they are since all of them allow passage of water flow. For safe passage of flood flow from an extreme event, six newly proposed road structures (5 culverts and a bridge) recommended by RRI Numerical Model study should be constructed at different locations along with existing road structures using proper engineering design.
- BWDB closer/submersible embankments will be required to prevent cropland from early flood flow/flush flood.
- Road embankment slope failure at unprotected locations and full or partial damage of slope protection works should be done in appropriate engineering consideration recommended by the RRI numerical model study. The compaction of the soil should be done appropriately during reconstruction of the road.
- Proper traffic safety measures and regulations may be followed especially near bazar sides such as Dirai Bazar, telephone Bazar, Sullah Bazar etc.
- Construction works will be deteriorated the water quality of the Champty-Darain river and the adjacent boram haor and chhayar haor. Solid waste from construction site should be control. Compliance with DoE standards during and after construction. Manage wastewater discharge and solid waste from establishment after construction.

- During reconstruction of the road, appropriate measures should be taken by RHD/contractor to protect fish habitat.
- Residues from construction materials and exudes from construction machineries into the water and soil should be reduced as much as possible by careful handling.
- Construction workers should be advised to protect natural resources and wild animals.
- To reduce human pressure on remaining biodiversity resources, an extensive awareness campaign for biodiversity conservation aimed at local communities within and around the project area should be implemented.
- Though the tree plantation has been done along the some part of the Dirai–Sullah road, there would be required tree plantation along the whole part of the road. To minimize the loss of terrestrial habitats within the project area, homestead vegetation and roadside vegetation should be retained or replanted wherever possible.
- Recommend the contractor to employ local people by giving priority to women and vulnerable groups. Ensure equal wages to male and female for equal amount and type of work.

1 Introduction

1.1 Background

The project site belongs to Sunamganj district of low-lying haor/beel area of the north-east region of Bangladesh. The Environmental and Social Impact Assessment (ESIA) study has been envisaged for the reconstruction of Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division, Sunamganj. The main objective of the project is to facilitate a smooth and uninterrupted road link between Dirai and Sullah upazila which ultimately smoothing road communication facilities in this north-east region. Dirai and Sullah upazillas are very remote area because of lacking road facilities, especially Sullah upazilla. Dirai upazila headquarter is connected with national road network by RHD zila road, however, Sullah Upazilla headquarter not connected. Most of the people of these two upazilas can not avail to access national road network easily. The existing road link Dirai-Sullah Z 2807 (Dirai-Sullah portion) is not suitable for vehicular movement. It is mentioned here that the construction of the Dirai-Sullah portion has started in about 2012 and the construction works has finished in 2016 even though the road not fully constructed. The situation is that the road is still unpaved at many parts and approaches of most of the road structures have suffered damage fully or partially. Even though the road is very unsuitable for vehicular movement, the people only use motor cycle in dry season and depend on waterways in wet season. Re-establishment of this road link will enable the people of the Sullah and Dirai of availing roadway communication facilities and will connect with national road network. With the purpose of interconnection of these two upazilas to national road network, the Roads and Highways Department (RHD), Sunamganj has taken initiatives to reconstruct of Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road to improve existing road communication facilities in this region.

The agricultural products especially rice and fish are grown very well in the project area due to the natural resources of the haor/beels. However, the area is isolated and far from development activities due to lack of communication facilities. The people of the project area have no easy access to markets beyond their localities. They completely depend on boats and other modes of locally available vehicles to transport and market their agricultural products in local markets. The people are also lacking in access to different amenities that has a tremendous impact on quality of life. After implementation of this road project, it will be easier to transport agricultural products from Sullah to other parts of the country. This road will connect Sullah upazila headquarter to the district town and rest of the country. The people of this region will get all weather road which increase business facilities and schools, madrasas and small industries will be benefited. As a result, socio-economic condition of the people which is indicated by quality of life will be enhanced significantly of this region.

The project site is conquered by floodplains with seasonally flooded tectonic depressions known as haors and beels. This site is hydrologically and environmentally sensitive area and positioned in the Old Surma, Baulai and Kushiyara-Kalni river catchments. The Surma-Kushiyara basin (or haor area) receives water from the transboundary catchments of the Meghalaya, the Barak and the Tripura situated to the north, east and southeast respectively across the border in India. The rainfall pattern of the upstream catchment has great influenced on the study area as rainfall on the adjacent Indian state Magalaya largely affects flooding in the project site. These upstream rivers are extremely flashy and carryout both the water and huge amount of sediment during excessive rainfall. Therefore, sudden

heavy rainfall in upstream catchment creates flash flood in this region which destroys agricultural products of large areas, causing death, damage to property, environmental pollution and damage to roads and bridges. Most of the cases, flood water comes into the haor very early in the monsoon and farmers do not get sufficient time to harvest their standing boro crop. Consequently, agriculture, fisheries, ecology and livelihood resources in this area are seriously affected as a result of sudden extensive rainfall.

The existing Madanpur-Dirai-Sullah road is run across the low lying haor area with unique hydro-ecological characteristics. During monsoon this area goes under water for six months and it becomes dries up generally after monsoon. Road embankment along the haors creates hindrance to natural flow of water and is endangered to wave actions too. Besides, the lateral connectivity between the rivers and the haors in the project site are major issues for fixing the Dirai-Sullah road link. Under this unique situation, the sustainability of the Dirai-Sullah road is the most challenging task and therefore, the reconstruction of Dirai-Sullah road link (Z 2807) should be planned carefully.

In view of the above mentioned facts and to fulfill the legal requirement of the project, a full-scale EIA is required for the reconstruction of Dirai-Sullah road link. The RHD has appointed River Research Institute (RRI) to conduct the mathematical model study and EIA study of the Project 'Topographical, Hydrological and Morphological Study using Mathematical Model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division, Sunamganj'.

1.2 Study area

The study area is located in Sunamganj district of the North East Region of Bangladesh. The northeast region forms a prominent low-lying basin compared to other parts of the country. The study area mainly consists of Dirai and Sullah upazilla under Sunamganj district. Dirai Upazila covers 420.93 sq. km area, located in between 24°39' and 24°53' north latitudes and in between 91°10' and 91°28' east longitudes. It is bounded by Dakshin Sunamganj and Jamalganj upazilas on the north, Sullah, Baniachang and Nabiganj upazilas on the south, Jagannathpur upazila on the east, Sullah, Khaliajuri and Jamalganj upazilas on the west. Whereas, Sullah is an Upazila covers of 260.74 sq. km area, located in between 24°34' and 24°49' north latitudes and in between 91°08' and 91°23' east longitudes. It is bounded by Dirai upazila on the north, Itna and Ajmiriganj upazilas on the south, Baniachang and Ajmiriganj upazilas on the east, Khaliajuri and Itna upazilas on the west.

The study area covers rivers, seasonal floodplain, haor/beel and human settlements **(Figure 1.1)**. The existing Dirai-Sullah road link (Z 2807) connected between Dirai and Sullah Upazilla. The Dirai-Sullah road links starts at Dirai (Esting -333102.00 m, Northing- 2742656.00 m) and ends at Sullah upazila headquarter (Esting-325060.24 m, Northing- 2729762.20 m). Dirai is connected with national road network while Sullah is totally isolated in terms of roadway communication facilities. It is mentioned here that the present study only focuses on the Dirai-Sullah part of the road as the Madanpur-Dirai part of the road is mostly suitable for traffic movement.The main water courses in the study area are the Surma, Surma-Baulai and Kushiyara-Kalni. From starting point of the road alignment at Madanpur to Sullah, it comes across many small rivers, khals, water bodies and distinct drainage routes. The Dirai-Sullah road follows an alignment along the Chamti-Darain river. The study area of the proposed project has been shown in the following Figure.

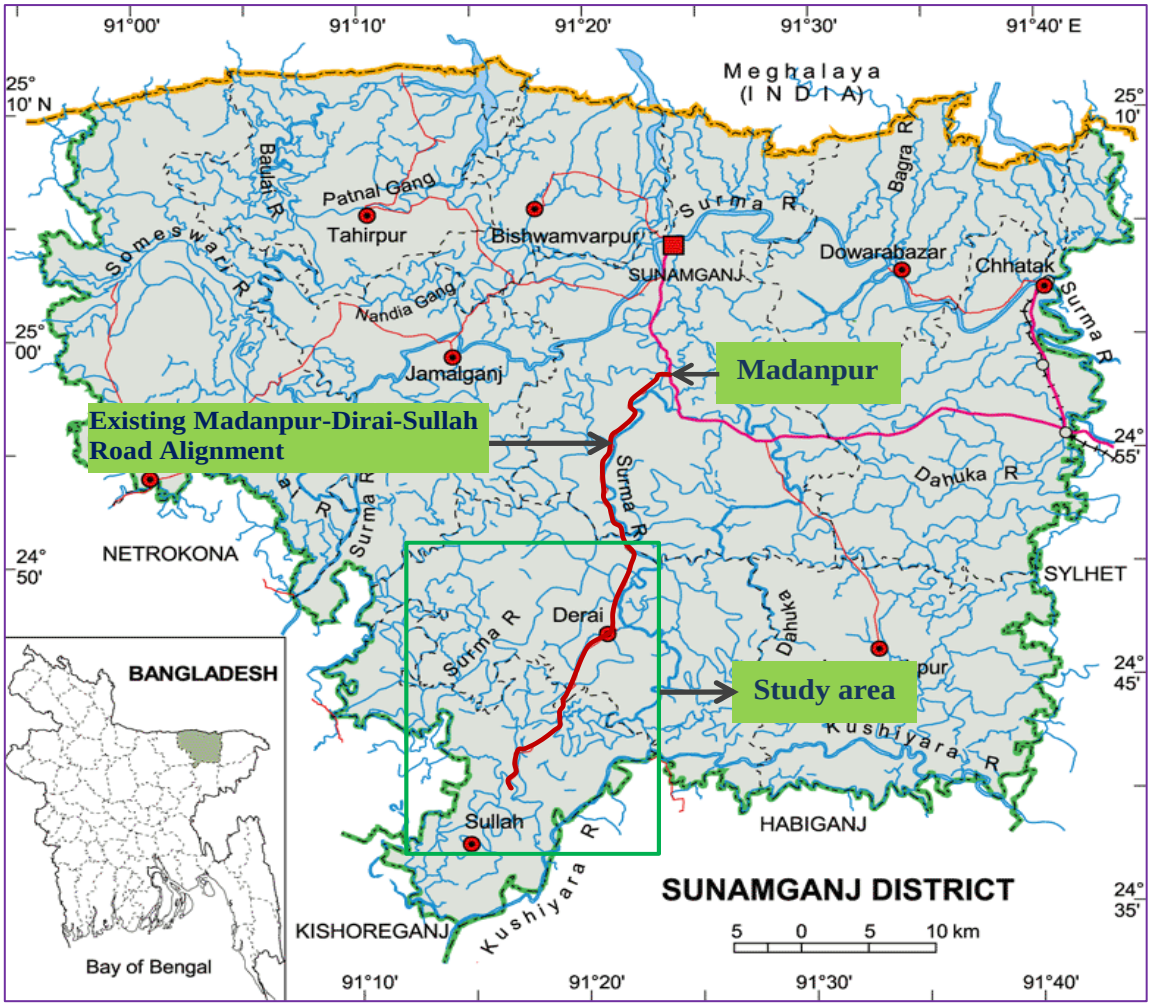


Figure 1.1: Study area of the Dirai-Sullah Road Project

1.3 Rationale of the EIA

The Department of Environment (DoE) is solely responsible with the mandate to regulate and enforce environmental management ensuring adequate EIAs of any project. Each Project Proponent shall conduct an IEE and/or EIA and is expected to consult and follow the DoE guidelines. The DoE is set up in the Environment Conservation Rules 1997. Depending upon the nature and environmental impacts, projects are divided into Green, Orange A, Orange B, and Red categories. According to this rules, construction/reconstruction/expansion of flood control embankments, polders, and dykes etc., and construction/reconstruction/expansion of road (regional, national, & international) are fall into the Red category. The Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road project is considered under the Red category of the Environmental Conservation Rules, 1997. So, an EIA requires determining the nature and extent of impact from implementation of this road Project.

1.4. Objectives of the EIA

The objectives of undertaking the Environmental and Social Impact Assessment (ESIA) of the proposed Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road Project under Sunamganj Road Division, Sunamganj are to provide baseline data/information, to determine the likely potential

environmental impacts (beneficial and adverse) associated with the project activities and to provide mitigation measures. The ESIA identify impacts from the project implementation on physical, ecological, biological and socio-economic environment of the project area, and to propose measures to avoid, minimize, mitigate, and compensate such impacts. The specific objectives of the proposed ESIA are:

- Assess the impacts on the physical environment (e.g. physiography and landforms, geology, climate and meteorology etc.), environmental risks (e.g. climate change, flooding, cyclone, seismicity, etc.), environmental quality (noise, air quality, water quality, sources of pollution etc.), water resources (major river systems, hydrology, drainage etc.), Land Resources and Agricultural Environment (Agro-ecological regions, land use, soil texture and organic matter content, farming practices, crop production constraints etc.), Fisheries resources (constraints and issues, fish habitat and diversity, fish production, fishing effort, Fish migration, etc.) and socio-economic environment (e.g. location, demography and household, housing tenancy, household size, gender ratio, literacy and education, public utilities including water supply, sanitation, economy and employment, etc.) related with the project activities.
- Public consultations with stakeholders regarding benefits, impacts, alternatives, mitigation measures and environmental management plans
- Identify major issues that may arise as a result of the proposed project on physical, ecological, biological and socioeconomic environment of the project area and provide a quantitative or qualitative assessment of magnitude of each impact.
- Recommend practical and site specific environmental mitigation and enhancement measures, and prepare environmental management and monitoring plan which will be required to obtain the environmental clearance from DoE.

1.5 Scope of Work

This report has prepared on the basis of a) primary field studies b) stakeholder meetings and c) secondary data on physical, biological, ecological, social and other relevant information collected from different organizations and different relevant books, literature etc. The following fundamental tasks have been done to meet the objective of the ESIA:

i) Collection and analysis of environmental data from primary and secondary sources (e.g. field survey by RRI personnel);

ii) Public consultation with the relevant stakeholders in Dirai and Sullah upazilla;

iii) Formation of the baseline of environmental condition of the Dirai-Sullah road project. The baseline data under following criteria has been categorized:

- Physical environment
- Environmental risks
- Environmental quality
- Water Resources
- Land Resources and Agricultural environment
- Fisheries resources
- Ecological resources
- Socio-economic environment

iv) Identification and assessment of the potential environmental impacts (both positive and negative) along with mitigation measures

v) Preparation of Environmental Management Plan (EMP) including mitigation, enhancement measures and monitoring plan.

1.6 Limitations

The communication difficulties are the major limitation of this study as the project site is an isolated area and there is no smooth communication either road or water transport. During dry season, lack of communication system including roads and vehicles are the constraints. Moreover, the study site is in under water more than 6 months a year. Inundation of the working site, other wetland problems, hampered data collection during wet season. A great effort was made during field visits, conducting FGD and PRA, and data collection using motor cycles, trawler, even walking for long distances to reach the stakeholders and organize meetings for the ESIA study. Moreover, ESIA studies need collection of detailed data and information of the resources for the full hydrological year covering both dry and wet seasons. The data are required for assessing the environmental and hydro-geomorphological consequences due to the given interventions. Baseline data along with results of hydro- morphological mathematical model study are used to complete this study that consumed time.

1.7 Study Team

A multidisciplinary team has been formed from RRI to carry out Environmental and Social Impact Assessment (ESIA) study of the reconstruction of Dirai-Sullah road link project. The following professionals are included in the team to carry out the EIA study of this project:

i. Engr. Pintu Kanungou, Chief Scientific Officer and Team Leader, RRI
ii. Dr. Engr. Fatima Rukshana, Senoir Scientific Officer and Principal Investigator, RRI
iii. Mr. Nayan Chandra Ghosh, Scientific Officer and Investigator, RRI
iv. Mr. Md. Moniruzzaman, Scientific Officer and Investigator, RRI
v. Engr. Sumiya Ferdhous, Scientific Officer and Investigator, RRI

1.8 Report Format

This ESIA report contains the following 9 chapters:

Chapter 1:	**Introduction**	: It describes the background of the project, Study area, Rationale of the EIA, objectives of the study, scope of the works and limitation of the study with a list of the EIA study team.
Chapter 2:	**Policy, Legal and Administrative Framework**	: It reviews the national legislative, regulatory and policy framework relevant to the ESIA study.
Chapter 3:	**Approaches and Methods**	: It presents the detailed approach and procedure applied to conduct the ESIA study. The chapter also describes data sources and methodology of data collection, processing and impact assessment.

Chapter 4:	**Description of the Project**	: It provides a simplified description of the Project including objectives and project area, alignment, design of the road and road structures, key activities, implementation arrangements, and other related aspects.
Chapter 5:	**Environmental and Social Baseline of the Project Area**	: It describes the existing environmental and social conditions in respect of water resources, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic aspects of the project area.
Chapter 6:	**Public Consultations and Disclosure**	: It provides details of the consultations held with the stakeholders at the project site. Also included in the chapter are the disclosure requirements for the EIA.
Chapter 7:	**Environmental Impacts Assessment and Mitigation Measures**	: It assesses the potential impacts of the proposed interventions on the environmental components. The chapter also proposes appropriate mitigation measures to eliminate, offset, or reduce the potential impacts.
Chapter 8:	**Environmental Management Plan**	: This chapter specifies the implementation arrangements for the mitigation measures identified during the ESIA study and described in the previous chapter. The EMP includes among others mitigation plan, an enhancement plan and the environmental monitoring plan.
Chapter 9:	**Conclusions and Recommendations**	: It concludes the study with recommendations.
	Appendixes	: Relevant documents included in Appendixes.
	References	: Details of all the citations listed in References.

2 Policy, Legal and Administrative Framework

2.1 Legal Provisions of the Government

Government of Bangladesh (GoB) has followed various acts, regulations and guidelines to ensure environmental safeguards in development investments. These legal documents have been reviewed during the preparation of this EIA. The implementation of this proposed Dirai-Sullah road project will be governed by environmental acts, rules, policies, and regulations. The relevant legal provisions, regulations, and standards for environmental assessment and management are briefly described below.

2.1.1 The National Environment Policy, 1992

The National Environment Policy was adopted by the Government of Bangladesh in 1992, with the aim to maintain ecological balance and overall development through protection and improvement of environment and to protect the country against any natural disaster. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment and need an initial environmental examination (IEE) and environmental impact assessment (EIA) before initiation of the project. The Policy delineates the Department of Environment (DoE), as the approving agency for all such IEE/EIAs to be undertaken in the country.

2.1.2 The National Water Policy, 1999

The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and groundwater, availability of water to all concerned and institutional capacity building for water resource management. The policy considers water as being essential for human development, socio-economic development, poverty alleviation and preservation of the natural environment.

Sub-clause (b) of Section 4.5 states that planning and feasibility studies of all projects (relevant to water resources management or development or have interference on water sector) will follow the Guidelines for the Project Assessment (GPA), the Guidelines for Participation of Water Management (GPWM), the Guidelines for Environmental Impact Assessment (EIA), and all other instructions that may be issued from time to time by the Government. Giving importance on the navigation sector, sub-clause (a) of section 4.10 states that if a project may cause disruption to navigation, adequate mitigation measures should be taken.

2.1.3 National Conservation Strategy (NCS) 1992

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.

2.1.4 The Biodiversity Conservation Strategy and Action Plan 2004

The Biodiversity Conservation Strategy and Action Plan 2004 (BCSAP) is a wide ranging and multi-

faceted plan, which is also closely related to the statements set out in the National Environment Policy.

The BCSAP 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.

2.1.5 National Environmental Management Action Plan (NEMAP) 1995

The National Environmental Management Action Plan (NEMAP) is a wide ranging and multifaceted 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 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 rate of environmental degradation;
- Improvement of the natural and built environment;
- Promotion of sustainable development; and
- Improvement in the quality of life of the people.

2.1.6 Bangladesh Climate Change Strategic Action Plan (BCCSAP), 2009

The Bangladesh Climate Change Strategy and Action Plan 2009 are built on the following 6 pillars:

Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services including health;

Comprehensive disaster management to further strengthen the country's already proven disaster management system to deal with increasingly frequent and severe natural calamities;

Infrastructure to ensure that existing assets are well maintained and fit-for-purpose and that urgently needed infrastructure is put in place to deal with the likely impact of climate change;

Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socio-economic groups, to underpin future investment strategies and to ensure that Bangladesh is networked with the latest global thinking on science and best practices of climate change management;

Mitigation and low carbon development to ensure low carbon development options and implement these as the country's economy grows over the coming decades and the demand for energy increases; and

Capacity building and institutional strengthening to enhance the capacity of government ministries and agency, civil society and the private sector to meet the challenges of climate change and mainstream them as part of development action.

2.2 Legal Framework

2.2.1 Water Resource Management Legislation

Panishampad Parikalpana Act (Water Resource Planning Act, 1992)

Under this Act, the government is authorized to set up a Water Resource Planning Organization (WARPO), which would prepare a master plan for the development of water resources and through a technical committee, advice all other agencies related to the issue of water resource development use.

The Embankment and Drainage Act 1952

This is an Act to consolidate the laws relating to embankment and drainage and make better provisions for the construction, maintenance, management, removal and control of embankments and watercourses or the better drainage of lands and for their protection from floods, erosion or other damage by water.

According to the Section 4 (1) every embankment, watercourse and embanked tow-path maintained by the Government or the Authority, and all land, earth, pathways, gates, berms and hedges belonging to or forming part of, or standing on, any such embankment or watercourse shall vest in the Government or the Authority, as the case may be.

The section 56 (1) states that, persons will be subject to penalty (500 taka or imprisonment if he erects, or causes of will fully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or will fully permits to be obstructed or diverted, any water course. This section could be applied to the person causing damage to the protective works.

The Ground Water Management Ordinance, 1985 (ORDINANCE NO. XXVII OF 1985)

This is an Ordinance to manage ground water resources for agricultural production. This act authorizes the Upazila Parishad to grant license for installing tube wells in their jurisdiction areas. It may grant the license if the Upazila Parishad is satisfied that the installation of the tube well applied for

a) Will be beneficial to the areas where it is to be installed, or
b) will not have any adverse effect upon the surrounding areas, or
c) otherwise feasible.

The Inland Water Transport Authority Ordinance, 1958 (E.P. ORDINANCE NO. LXXV OF 1958)

This is an ordinance to set up an authority for the development, maintenance and control of inland water transport and certain inland navigable waterways in Bangladesh. The authority is mandated to perform any other function such as, carrying out river conservancy work, including river training for navigation purposes and aiding navigation; drawing up programs on dredging requirements and priorities for the efficient maintenance of existing navigable waterways; and reviving dead or dying rivers, channels, or canals, including developing new channels and canals for navigation.

The Protection and Conservation of Fish Act, 1950 (BENGAL ACT XVIII OF 1950)

This Act provides power to the government to:

- Make and apply rules in any water or waters for the purposes of protection of fisheries.
- Prohibit or regulate the erection and use of fixed engines; and the construction, temporary or permanent, of weirs, dams, bunds, embankments and other structures.
- Prohibit the destruction of fish by explosives, guns, and bows in inland or coastal areas.
- Prohibit the destruction of fish by means of poisoning, pollution and effluents.
- Prescribe the seasons during which fishing is allowed.
- Prohibit fishing in all waters during spawning periods.
- Specify the officials with authority to detect breaches.

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”.

The Government Fisheries (Protection) Ordinance, 1959 (ORDINANCE NO. XXIV OF 1959)

This ordinance provides power to the government to declare any area as "Khas managed fishery" to bring it under the management and control of the government. No person shall fish in such an area without a valid fishing license issued by such authority as may be prescribed under the Act.

2.2.2 Environmental Legislation

Environment 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 summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities' 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. An appeal procedure does exist 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 Department of Environment (DoE) executes the Act under the leadership of the Director General (DG).

Bangladesh Environment Conservation Act (Amendment 2000)

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

Bangladesh Environment 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.

The Environment Conservation Rules, 1997

These are the first set of rules, promulgated under the Environment Conservation Act of1995 (so far there have been three amendments to this set of rules - February and August2002 and April 2003).

The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified 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 IEE and EIA according to categories of industrial and other development interventions.

The Rules are not explicit for water development projects. Rather, this is covered under the broader heading of "exploration, extraction and distribution of mineral resources" under the 'Red' category projects.

The DoE has issued EIA Guidelines and addresses the IEE and EIA for several sectors and activities. Each Project Proponent shall conduct an IEE or EIA and is expected to consult and follow the DoE guidelines.

Environment Court Act, 2000

The Environmental Court Act, 2000 provide for the establishment of environment courts and make rules for protection against environmental pollution. This act also provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of environment appeal court.

Bangladesh Wild Life (Preservation) Order, 1973 (P. 0. No. 23 of 1973) and Act, 1974

The Bangladesh Wild life Preservation (Amendment) Act 1974 provides for the following main effects:

- This Act provides power to the government to declare areas as game reserves, wild life sanctuaries and national parks to protect the country's wild life.

  This Act also provides legal definitions of the protected areas as follows:

  "game reserve" means an area declared by the government as such for the protection of wild life and increase in the population of important species wherein capturing of wild animals shall be unlawful;

  "national park" means comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed;

  "Wild life sanctuary" means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground

primarily for the protection of wild life inclusive of all natural resources, such as vegetation, soil and water.

Under this law hunting, killing, capture, trade and export of wild life and wild life products are regulated. The Act also designates a list of protected species and game animals.

Provided that the government may, for scientific purposes or for aesthetic enjoyment or betterment of scenery, relax all or any of the prohibitions specified.

2.3 Compliance with DoE Guidelines

The primary institution for environmental management is the Department of Environment (DoE) under the Ministry of Environment, Forest and Climate Change. The DoE is the authority with the mandate to regulate and enforce environmental management, including control of pollution of water resources and ensuring adequate EIAs. It is the primary institution for environmental management and setting and enforcement of environmental regulations. Its key duties related to the water sector include:

- Pollution control, including: monitoring effluent sources, ensuring mitigation of environmental pollution
- Setting Water Quality Standards (WQS) for particular uses of water and for discharges to water bodies
- Defining Environmental Impact Assessments (EIA) procedures and issuing environmental clearance permits - the latter being legal requirements before proposed projects can proceed to implementation
- Providing advice or taking direct action to prevent degradation of the environment
- Declaring Ecologically Critical Areas (ECAs) where the ecosystem has been degraded to a critical state. ECA status confers protection on land and water resources through a series of environmental regulations

The DoE has issued EIA Guidelines for Industries (this document was released in December1997) and addresses the IEE 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 Rules1997. 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 project, identifying the level of environmental impact assessment required in each case. The process of obtaining clearance from the DOE is presented in Figure 2.1. According to the Environment Conservation Rules, construction/reconstruction/expansion of flood control embankments, polders, and dykes etc., and construction/reconstruction/expansion of road (regional, national, & international) are fall into the Red category. Therefore, according to the DOE,

this proposed project is considered under the Red category of the Environmental Conservation Rules, 1997.

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)
- Other necessary information, (where applicable)

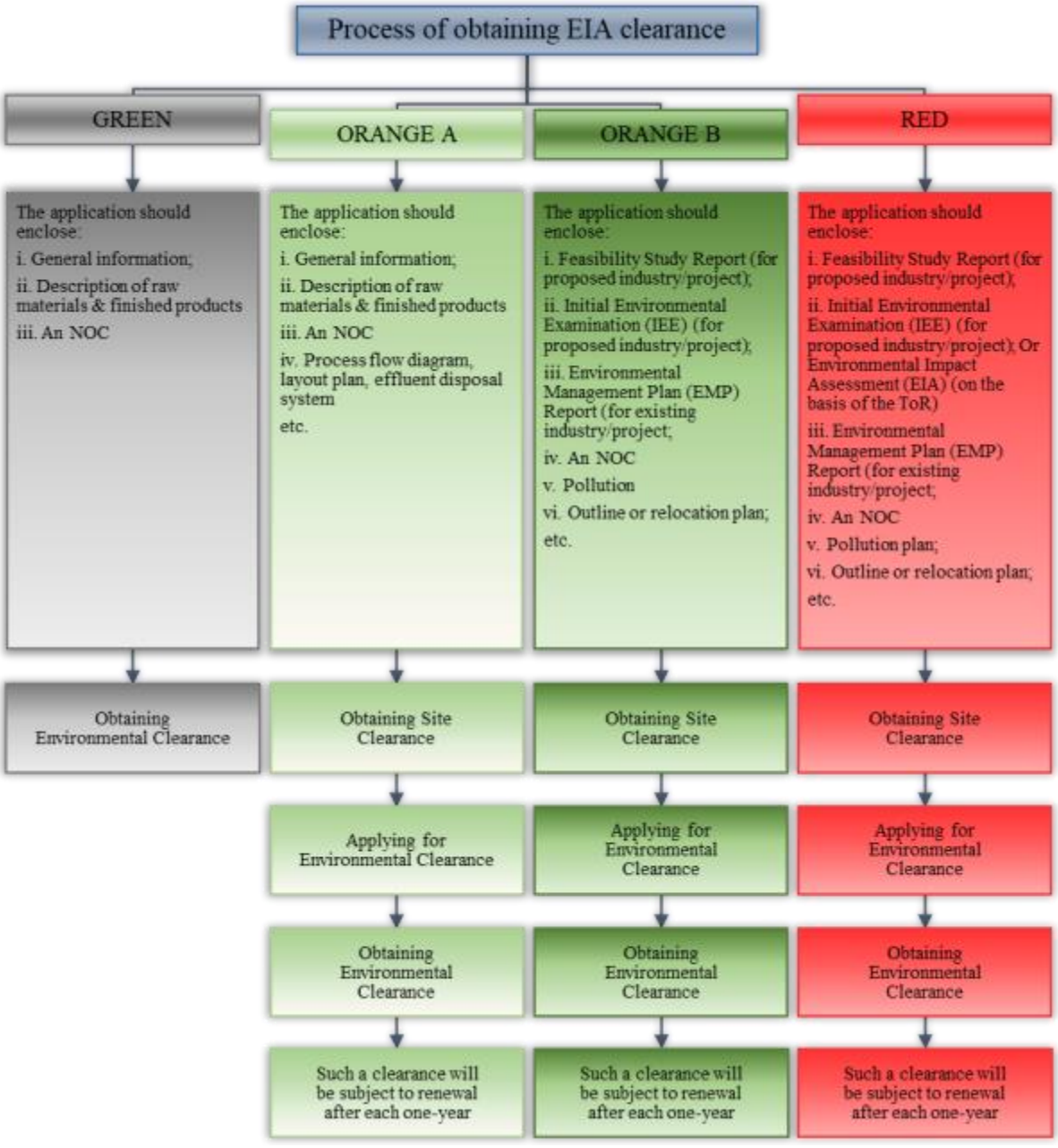


Figure 2.1 Steps involved in Environmental clearance following DoE Guideline

2.4 Environmental Quality Standards

Environmental quality standards for air quality, noise, odour, sewage discharge, industrial effluents, and industrial project emissions for Bangladesh are furnished in the following tables.

Table 2.1: Bangladesh Standards for Ambient Air Quality (AAQ)
(All values are in micrograms per cubic meters)

Sl No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dioxide (SO_2)	Carbon Dioxide (CO_2)	Oxides Nitrogen (NO_x)
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 area includes national monuments, health resorts, hospitals, archaeological sites, educational institutions

Any industrial unit not located at a designated industrial area will not discharge such pollutants, which may contribute to exceed the ambient air quality above in the surrounding areas of category 'Ga' and 'Gha'.

Suspended particulate matters mean airborne particles of diameter of 10 micron or less.

Table 2.2: Bangladesh Standards for Noise

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 and together used for commercial and industrial purposes)	60	50
Gha	Commercial area	70	60
Uma	Industrial area	75	70

Source: Schedule 4, Rule-12, Environment Conservation Rules, 1997 (Page 3127, Bangladesh Gazette, 28 August 1997) (Translation from original Bengali)

Note:
Day time is reckoned as the time between 6 a.m. to 9 pm
Night time is reckoned as the time between 9 pm to 6 am

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 horn, other signals and loudspeakers is prohibited in silent zones.

Table 2.3: Bangladesh Standards for Sewage Discharge

Parameters	Unit	Values
BOD	mg/L	40
Nitrate	mg/L	06-Sep
Phosphate	mg/L	25
Suspended Solid (SS)	mg/L	100
Temperature	°C	30
Coliforms	Number/100ml	1000

Source: Schedule-8, RuIe-I3, Environment Conservation Rules, 1997. (Page 3131, Bangladesh Gazette, 28 August 1997) (Translation from original Bangla version)

Note:

1. These standards are applicable for discharge into surface and inland water bodies.
2. Chlorination is to be done before Final discharge.

Table 2.4: Bangladesh Standards for Industrial Project Effluent

Sl. No.	Parameters	Unit	Discharge To		
			Inland Surface Water	**Public Sewer to Secondary Treatment Plant**	**Irrigable Land**
1	Ammonical nitrogen (as elementary N)	mg/L	50	75	75
2	Ammonia (as free ammonia)	mg/L	5	5	15
3	Arsenic (as As)	mg/L	0.2	0.05	0.2
4	BODs at 20 ℃	mg/L	50	250	100
5	Boron	mg/L	2	2	2
6	Cadmium (as Cd)	mg/L	0.05	0.5	0.5
7	Chloride	mg/L	600	600	600
8	Chromium (as total Cr)	mg/L	0.5	1	1
9	COD	mg/L	200	400	400
10	Chromium (as hexavalent Cr)	mg/L	0.1	1	1
11	Copper (as Cu)	mg/L	0.5	3	3
12	Dissolved oxygen (DO)	mg/L	4.5-8	4.5-8	4.5-8
13	Electro-conductivity (EC)	µmho/cm	1200	1200	1200
14	Total dissolved solids	mg/L	2100	2100	2100
15	Fluoride (as F)	mg/L	2	15	10
16	Sulfide (as S)	mg/L	1	2	2
17	Iron (as Fe)	mg/L	2	2	2
18	Total kjeldahl nitrogen (as N)	mg/L	100	100	100
19	Lead (as Pb)	mg/L	0.1	1	0.1

Sl. No.	Parameters	Unit	Discharge To		
			Inland Surface Water	**Public Sewer to Secondary Treatment Plant**	**Irrigable Land**
20	Manganese (as Mn)	mg/L	5	5	5
21	Mercury (as Hg)	mg/L	0.01	0.01	0.01
22	Nickel (as Ni)	mg/L	1	2	1
23	Nitrate (as elementary N)	mg/L	10	Not yet set	10
24	Oil and grease	mg/L	10	20	10
25	Phenolic compounds (as CeHsOH)	mg/L	1	5	1
26	Dissolved phosphorus (as P)	mg/L	8	8	15
27	Radioactive substance	To be specified by Bangladesh Atomic Energy Commission			
28	pH	mg/L	6-9	6-9	6-9
29	Selenium (as Se)	mg/L	005	0.05	0.05
30	Zinc (as Zn)	mg/L	5	10	10
31	Total dissolved solids	mg/L	2100	2100	2100
32	Temperature	OC (Summer) OC (Winter)	40 45	40 45	40 45
33	Suspended solids	mg/L	150	500	200
34	Cyanide	mg/L	0.1	2.0	0.2

Source: Schedule-10, Rule-13, Environment Conservation Rules, 1997. (Page 3132-3134, Bangladesh Gazette, 28 August 1997) (Translation from original Bangla version)

Note:

These standards will be applicable for all industries other than those which are specified under 'industrial sector specific standards'.

These standards will have to be compiled from the moment of trial production in case of industries and from the moment of the very beginning in case of projects.

These standards will have to be met at any point of time and any sampling. In case of need for ambient environment condition, these standards may be made stringent.

Inland surface water will include drains, ponds, tanks, water bodies, ditches, canals, rivers, streams and estuaries.

Public sewer means leading to fully fledged joint treatment facility comprising primary and secondary treatment.

Land for irrigation means organized irrigation of selected crops on adequate land determined on the basis of quantum and characteristics of waste water.

Table 2.5: Bangladesh Standards for Industrial Project Emissions

Sl. No.	Parameters	Values in (mg/Nm^3)
1	Particulates	
	(ka) Power station of capacity of 200 MW or more	150
	(kha) Power station of capacity less than 200 MW	350
2	Chlorine	150
3	Hydrochloric acid vapor and mist	350
4	Total fluoride (as F)	25
5	Sulfuric acid mist	50
6	Lead particulates	50
7	Mercury particulates	10
8	Sulfur dioxide	Kg/ton acid
	(ka) Sulfuric acid production (DCDA * process)	4
	(kha) Sulfuric acid production (SCSA * process)	100
	(*DCDA: Double conversion, double absorption, SCSA; Single conversion	
	single absorption)Lowest height of stack for sulfur dioxide dispersion:	
	(ka) Coal based power plant	275m
	500 MW or more	220m
	200 MW - 500 MW	14(Q)03
	Less than 200 MW	
	(kha) Boiler	11m
	Steam per hour- upto 15 tons	14(Q)03
	Steam per hour - more than 15 tons	
	(Q=$S0_2$ emission in kg/hour)	
9	Oxides of nitrogen	3 kg/ton acid
	(ka) Nitric acid production	50 ppm
	(kha) Gas based power stations	50 ppm
	500 MW or more	40 ppm
	200 - 500 MW	30 ppm
	Less than 200 MW	200 ppm
	(Ga) Metallurgical oven	
10	Kiln soot and dust	Mg/Nm-1
	(ka) Blast furnace	500
	(kha) Brick kiln	1000
	(Ga) Coke oven	500
	(Gha) Limekiln	250

Source: Schedule-10, Rule-13, Environment Conservation Rules, 1997. (Page 3135-3136, Bangladesh Gazette, 28 August 1997) (Own authentic translation from original Bengali).

2.5 Compliance with Donor Agencies Social Safeguard Policies (SSP)

2.5.1 Asian Development Bank's Social Safeguard Policies

Asian Development Bank (ADB) has had environment assessment requirements for more than 20 years and owns safeguard policy framework which is currently taken to consist of three operational policies, namely the Environment Policy (2002), the Policy on Indigenous Peoples (1998), and the Policy on Involuntary Resettlement (1995), together with their respective operations manual sections and guidelines.

ADB's safeguard policies are central to achieving sustained development and poverty reduction. The objective of these policies is to avoid, minimize or mitigate adverse environmental impacts, social costs to third parties or marginalization of vulnerable groups that may result from development projects. Safeguard policies prescribe; "do no harm" requirements that must be met for all ADB projects. Regarding the resettlement plan of a project, ADB provides that 'A satisfactory resettlement plan must include all 11 essential elements. The safeguard policies are at the front line of ADB's accountability mechanism and compliance review process, since these policies, if properly implemented, help ensure that third parties do not incur material damages, either directly or through environmental media, and thus have no basis for complaint.

All three safeguard policies involve a structured process of impact assessment, planning and mitigation to address the adverse effects of projects and programs throughout the project cycle. The safeguard policies require that: (i) impacts are identified and assessed early in the project cycle; (ii) adverse impacts are avoided, minimized, or mitigated; and (iii) affected people are consulted.

2.5.2 Compliance with World Bank Environmental Assessment (EA) Process

The World Bank introduced the Operational Directive on Environmental Assessment (OD4.00, Annex A) in October 1989. This comprehensive and detailed new policy mandated an environmental assessment for all projects that may have significant impacts on the environment. After two years of the Bank experience with environmental assessments, the operational directive was revised to broaden its scope and applicability. Recognizing that the projects aimed at achieving environmental objectives could sometimes have negative and unanticipated effects, the new revised guideline OD.4.01 was introduced which incorporates a new system of classifying projects according to the nature and extent of their environmental impact. The Bank uses the following three categories to signal the appropriate level of EA for any given project.

Category A: If the project is likely to have significant adverse impacts that are sensitive, diverse or unprecedented, or that affect an area broader than the sites or facilities subject to the physical area. EA for Category A projects examines a project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" condition) and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For Category A projects, the borrower is responsible for preparing an EIA report that includes an environmental management plan and a monitoring plan.

Category B: A proposed project falls under Category B if its potential adverse environmental impact on human populations or environmentally important areas including wetlands, forests, grasslands, and

other natural habitats- are less adverse than that of Category A projects. The scope of EA for Category B projects may vary from project to project, but it is narrower than that of Category A.

Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact. Beyond screening, no EA action is required for Category C projects.

As for social assessment, the Social Assessment Policies and Guidelines of the World Bank (G.P. 10.05: Social Analysis through Social Assessment) puts forward the overall objective sand prerequisites of social assessment. It also discusses the basic steps in the assessment process. In the context of possible resettlement of people who might be evicted from their own land or from public land (used in authorized or unauthorized manners), the World Bank Operational Directive No. 4.30 (on Involuntary Resettlement) provides necessary guidelines. These guidelines would assist in indicating the need for resettlement within the scope of the SIA and also help in preparing the Resettlement Framework and Resettlement Action Plan through subsequent studies.

2.6 GoB Laws on Land Acquisition

The principle legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Ordinance, 1982 (Ordinance II of 1982 with amendments up to 1994) and other land laws and administrative manuals relevant to land administration in Bangladesh. According to the Ordinance, whenever it appears to the Government of Bangladesh that any property in any locality is needed or is likely to be needed for any public purpose or in the public interest, the Government can acquire the land provided that no property used by the public for the purpose of religious worship, graveyard and cremation ground. The 1982 Ordinance requires that compensation be paid for (i) land and assets permanently acquired (including standing crops, trees, houses); and (ii) any other damages caused by such acquisition. The Deputy Commissioner (DC) determines (a) market value of acquired assets on the date of notice of acquisition (based on the registered value of similar property bought and/or sold in the area over the preceding 12 months), and (b) 50% premium on the assessed value (other than crops) due to compulsory acquisition. The 1994 amendment made provisions for payment of crop compensation to tenant cultivators. Given that people devalue land during title transfer to minimize tax payment, compensation for land paid by DC including premium largely remains less than the actual market price.

2.7 Administrative Framework

Roads and Highway Department (RHD) is responsible for implementing this project. The organization has long experience in implementing such projects with its own institutional resources. There are planning, design, implementation and Operation & Maintenance (O&M) sections to implement this kind of projects. It has also project evaluation section, which monitors and evaluates the implementation status of projects.

3 Approaches and Methods

3.1 Background

The ESIA study of the Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road Project, Sunamganj has been carried out following the ESIA Guidelines of the DoE in accordance with the ECR (1997) and Guidelines for Environmental assessment of Water Management Projects (WARPO, 2005). Primary and secondary data and other relevant information have been used to prepare the EIA of the project. Consultations were made with the stakeholders concerned including directly affected people, government officials, community representatives, and a wide range of potential beneficiaries of the project.

To conduct the ESIA study of the Dirai-Sullah Road project, a multi-disciplinary team has been formed having specializations in respective disciplines. Ideas, objectives and potential outcomes of the road project were shared among the team members through brainstorming. The ESIA team several times visited the study location in dry and wet season to identify the problems of the existing Dirai-Sullah Road physically and to observe the status of the resources of the study area to prepare baseline scenario. The study team has established baseline condition i.e. physical, biological, ecological and socio-economic environment of the project area during field visits. The baseline condition has required to recommend practical and site specific environmental mitigation and prepare and implement environmental monitoring plan during and after the project implementation. Field data collection has been done in different ways such as i) consultation with Government and non-Government officials and elected representatives, ii) Questionnaire survey, iii) Focus group discussion and iv) In-situ water test and soil samples collection for lab analysis. During field visit, the team equipped with GPS, digital cameras, laptop and in-situ testing apparatuses to facilitate collection of the primary data and related project information. The study team also visited different haors nearby project site such as Boram haor, Dhalar Haor, Chhayar haor, Bera dohor haor etc. Field maps were prepared based on satellite images and map also obtained from the RRI 'Morphological Model study' team.

3.2 The ESIA Process

The guideline for Environmental Assessment of Water Management Projects, developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by the WARPO in 2005 was followed for conducting the ESIA study **(Figure 3.1)**.

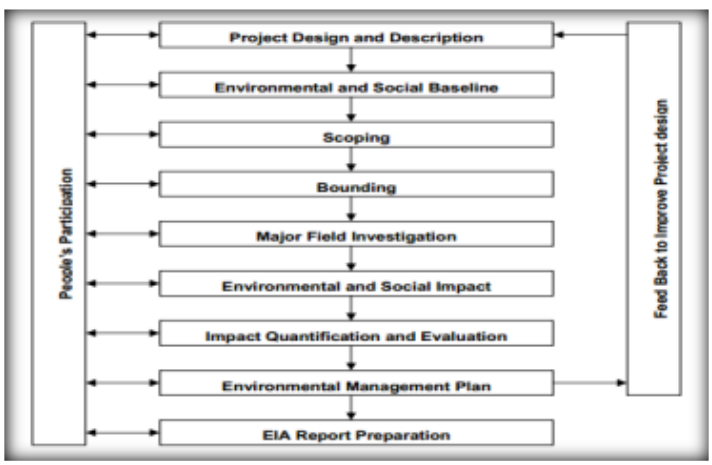


Figure 3.1: The overall process for conducting the ESIA (Source: WARPO, 2005)

According to WARPO (2005), the 9 step detailed EIA process has been followed for the proposed Dirai-Sullah road project that are briefly described below:

3.2.1 Project Design and Description

The existing Dirai-Sullah Road (Z 2807) connects between Dirai and Sullah upazilla in Sunamganj. However, the road has damaged at different parts fully or partially and the slope protection works and bridge/culverts are also impaired and therefore, the road is partially functional. The members of ESIA team and Morphology team of RRI interpreted and discussed about the Dirai-Sullah Road project intervention several times. Details of project design and description are described in the following Chapter 4.

3.2.2 Environmental and Social Baseline

To establish environmental and social baseline, firstly a reconnaissance field visit was conducted in the project area to identify the project location, exat condition of the existing Dirai-Sullah road and functional objectives to prepare an Initial Environmental Examination (IEE). After that a multidisciplinary ESIA study team was formed to conduct a full Environmental and Social Impact Assessment. The information has been collected from both primary and secondary sources to prepare the baseline condition of the ESIA study. Rapid Rural Appraisals (RRAs), Participatory Rural Appraisals (PRAs), Focused Group Discussions (FGDs) and interviews with key informants were conducted to collect data and information on the environmental and social aspects of the Project area. The RRAs, PRAs and FGDs have covered communities like teachers, traders, farmers, day labourers, servicemen, small traders, fisherman, boatmen and public representatives of local government institutions. During the visit, photographs and geographical coordinates (Longitude/ Latitudes) of different environmentally important locations have been collected using GPS. All qualitative and quantitative data and information, gathered from different surveys and secondary sources have been used appropriately in the preparation of the environmental and socio-economic baseline and presented in the Chapter 5 in this report.

3.2.3 Scoping

To identify the Important Environmental and Social Components (IESCs), a structured scoping process was considered which are expected to be impacted by the proposed Dirai-Sullah road interventions. Two steps were followed to achieve IESCs. Firstly, the individual professional of the ESIA team member prepared a preliminary list of the components pertaining to his/her discipline which could be impacted by the project. The second step included village scoping sessions where obtained opinion of the stakeholders on their perception about the environmental and social components which could be impacted by the project interventions. The preliminary list of the IECs was finalized with the help of the professional judgments of the multidisciplinary ESIA team and the opinions of the stakeholders.

3.2.4 Bounding

The area likely to be impacted both inside and outside of the project boundary was selected through a bounding process. River catchment boundaries, ecological boundaries, social & administrative boundaries and also temporal bounds referring time and duration of the proposed project activities

were considered for this ESIA. The project influence area (PIA) for this EIA has been established considering the maximum length of proposed all road alignments. The maximum proposed road length is 18.4 km which has been taken as the diagonal of the rectangle shaped actual project area. However, the project influencing area has been extended to four (04) times of the actual area from the project boundary to analyse the land use and identify environmental sensitive areas that may be affected due to secondary impacts.

3.2.5 Major Field Investigation

A number of field visits were made by the multidisciplinary study team members. As the project area is inundated by water 6 months a year, the ESIA study team visited the project site both in dry and wet season for observing the exact condition of the existing Dirai-Sullah road condition and the surrounding of the project site. The team observed the conditions of different communities and natural happenings, and collected data on most important and effective environmental components. The team has talked about the project and collected necessary data from the government official concerned regarding management of water bodies and road construction authorities and other government officials including Water Development Board (BWDB), Roads and Highways Department (RHD), Agricultural Extension Department (DAE), District Livestock Office (DLO), District Fisheries Office (DFO) in Sunamganj district and Dirai Upazilla Fisheries Office, Dirai Upazilla Agriculture Office and Sullah Upazilla Agriculture office. The study team has also talked about the project to elected representatives such as Chairman and vice-Chairman of Dirai Upazilla, Chairman and Women-member of Taral Union parishad, Dirai. Questionnaire survey and FGD have been held at different places of Dirai and Sullah Upazilla such as Badalpur, Maccharkhaira, telephone bazar, Khaya Ghat, Daudpur, Bholanagar, and Sullah Sadar etc. for securing people's participation.

3.2.6 Impact Assessment and Possible Computation

The Dirai-Sullah road link Z 2807 (Dirai-Sullah portion) has already existed but this road is not suitable for vehicular movement. According to RHD, the reconstruction of the road is required keeping the present road alignment almost as it is now. Therefore, the likely impacts of the proposed project intervention on each of the important environmental component (IEC) have been assessed under present condition, during reconstruction condition and after project implementation condition. The difference between the present condition and after the project implementation condition has taken as the impact of the proposed interventions of the IEC. Opinion of the local people obtained at the major field investigation stage has been duly considered at this stage.

3.2.7 Impact Quantification, Evaluation and Mitigation Measures

The assessment of effects and identification of residual impacts takes account of any incorporated mitigation measures adopted due to any potential impact of Project activities, and will be largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative (adverse) and positive (beneficial). The criteria for determining significance are generally specific for each environmental and social aspect but generally the magnitude of each potential impact is defined along with the sensitivity of the receptor. Generic criteria for defining magnitude and sensitivity used for the Project are summarized below.

The assessment of magnitude has been undertaken in two steps. Firstly, the key issues associated with the Project are categorized as beneficial or adverse. Secondly, potential impacts have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as: Duration of the potential impact; spatial extent of the potential impact; Reversibility; Likelihood; and Legal standards and established professional criteria.

Impacts of the proposed interventions on the IESCs, assessed in the previous stage, were quantified to the extent possible. Scores was assigned for negative impacts by minus (-) sign and for positive impacts by plus (+) sign. A scale of 1 to 5 has used for both negative and positive impacts considering magnitude, extent, and sustainability of beneficial impacts and reversibility of negative impacts.

The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in **Table 3.1**.

Table 3.1: Parameters for Determining Magnitude

Parameter	Major	Moderate	Minor	Negligible/Nil
Duration of potential impact	Long term (more than 35 years)	Medium Term Lifespan of the project (5 to 15 years)	Less than project lifespan	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and/ or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

Receptor sensitivity has been determined based on presence of features on the site or the surrounding area and review of the population (including proximity / numbers / vulnerability). Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table 3.2**.

Table 3.2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation
Medium	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low/Negligible	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation

Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the potential impact significance matrix shown in **Table 3.3**.

Table 3.3: Assessment of Potential Impact Significance

Magnitude of Potential impact	Sensitivity of Receptors			
	Very High	High	Medium	Low / Negligible
Major	Critical	Major	Moderate	Negligible
Moderate	Major	Major	Moderate	Negligible
Minor	Moderate	Moderate	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Subsequent to the impact assessment discussed above, appropriate mitigation measures have been proposed to avoid, offset, mitigate/reduce, or compensate for the identified impacts. Generally, impacts having moderate to critical consequence significance per the Table 3.3 require appropriate avoidance/ mitigation/compensatory measures to reduce the significance. Impacts having low to negligible significance can be left alone not needing any mitigation measures. Generally, preference is given to the avoidance of the impact with the help of options available for nature, siting, timing, method/procedure, or scale of any project activity. If avoidance is not possible, appropriate mitigation and control measures are proposed to reduce the consequence significance of the predicted impact. Finally, if impact reduction is not possible, compensatory measures are proposed.

3.2.8 Environmental Management Plan

If negative impacts assessed in the previous stage, the impact was picked up showing negative value and mitigation measures to be suggested for minimizing their affects. Similarly, positive impacts also

assessed in the previous stage, was picked up and enhancement measures be suggested for increasing their benefits. Compensation measures were suggested for negative impacts which could not be mitigated. An environmental monitoring plan was prepared for detecting changes taking place in the environmental and social components due to implementation of the proposed project. Finally, an environmental management plan (EMP) for the proposed Dirai-Sullah road project was prepared comprising the mitigation/ enhancement measures with environmental monitoring plan.

3.2.9 ESIA Report

The ESIA report of 'Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road Project, Sunamganj' has been prepared at the end of the study integrating all of the findings.

4 Description of the Project

4.1 Project Background

The project site is very isolated due to lack of communication facilities either roads or waterways. Dirai and Sullah are two upazila in Sunamganj district. People of these two upazilla are facing severe road commutation accessibilities, especially people of Sullah upazilla has detached from other upazillas and facing vulnerable life. Dirai is connected with Sunamganj-Sylhet regional highway (R280) by Madanpur-Dirai road. Dirai upazila headquarter is connected with national road network by RHD zila road. The LGED upazila roads connect the upazila headquarters with different markets, growth centers and other important places are submersible and remain operational only for light weight vehicles during dry season. In monsoon, these two upazilas are received floodwater coming from the transboundary catchments from India and become deeply flooded. The people of this region have to solely depend on waterway communication to move from one place to another in the monsoon. For vehicular movement, the condition of the existing Madanpur-Dirai-Sullah road link Z 2807 is not good enough either in monsoon or dry season, especially Dirai-Sullah portion. The Madanpur-Dirai-Sullah road link Z 2807 has connected with R280 regional road and linking between Sunamganj and Sylhet. Sylhet is connected with Dhaka, Moulvibazar and Jaintapur by national highway. On the other hand, Sunamganj is connected with different district and upazila headquarters by RHD regional and zila roads. However, the road link between the Dirai and Sullah upazila is not established completely yet. Therefore, re-establishment of the Dirai-Sullah road link (Z 2807) is essential to improve the existing road communication facilities.

4.2 Objective of the Project

The main objective of the proposed Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road Project is to facilitate smooth and direct roadway communication between Dirai and Sullah upazilla all the year round and in a whole smooth road communication system between Dhaka-Sunamganj-Dirai-Sullah and other parts of the country.

4.3 Project Location and setting

The project area belongs to Sunamganj district in the Northeast Region of Bangladesh. Sunamganj District with an approximate area of 460.60 sq. km is bounded by Khasia and Jaintia hills (India) on the north, Habiganj and Kishoreganj districts on the south, Sylhet district on the east, Netrokona and greater Mymensingh districts on the west. There are many haors and beels in Sunamganj district. The study area mainly consists of Dirai and Sullah upazilla in Sunamganj district. But, small portion of land area are included at Baniachong, Nabiganj Ajmeriganj upazilla in Hobiganj district and at Khaliajuri upazilla in Netrokona district (**Figure 1.1**).

Along the Madanpur-Dirai-Sullah road structure, the Madanpur-Dirai part is almost suitable for vehicular movement and therefore, only Dirai-Sullah road part has taken consideration according to RHD. The existing Dirai-Sullah road link connected between Dirai (Esting -333102.00 m, Northing- 2742656.00 m) and Sullah (Esting-325060.24 m, Northing-2729762.20 m) upazillas. This Dirai-Sullah road link runs through on Dirai, Taral, Habibpur and Bahara union (**Figure 4.1**). Moreover, the important places along the Dirai-Sullah road are Rajapur, Islampur, Machuarkhaira, Nayagaon, Dhanpur, Chandipur, Kashipur, Anandapur, Bholanagar and Sullah.

The Madanpur-Dirai-Sullah road is located in the low lying haor area surrounded by beels, haors, rivers and khals etc. Rivers, seasonal floodplain, haor/beel, khal and human settlements are the dominant physical features at and around the project site (**Figure 4.2)**. The main water courses in the study area are the Surma, Surma-Baulai and Kushiyara-Kalni. The villages are connected with each other by unmetalled roads some of which go under water during flood season. Most of the study area goes under water during monsoon. Thinly populated human settlements are present along both sides of the road and also along the bank of the rivers. There is also presence of well grown trees in the villages and some of the parts of the Dirai-Sullah road.

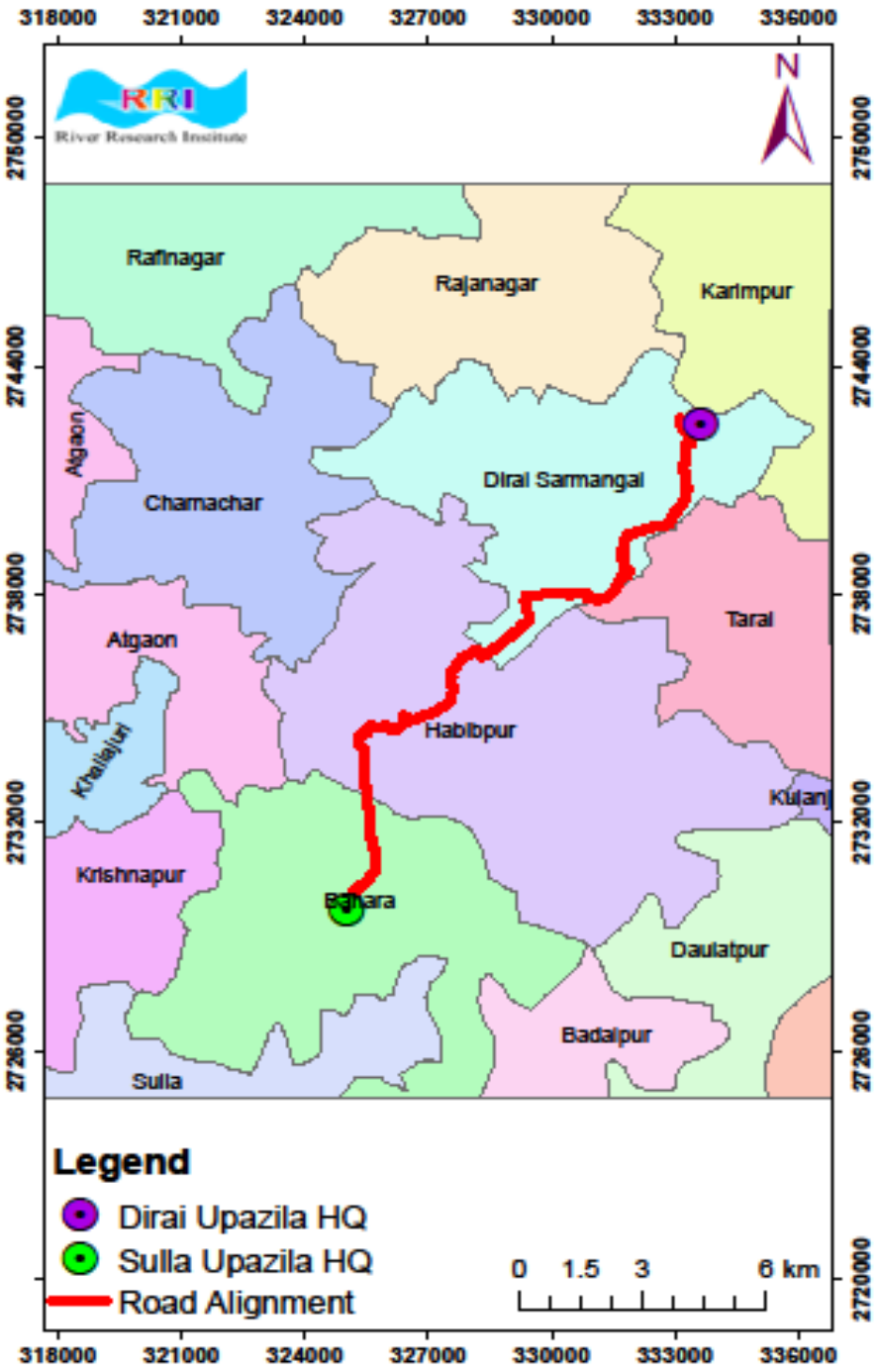


Figure 4.1: Existing Dirai-Sullah Road link (Z 2807)

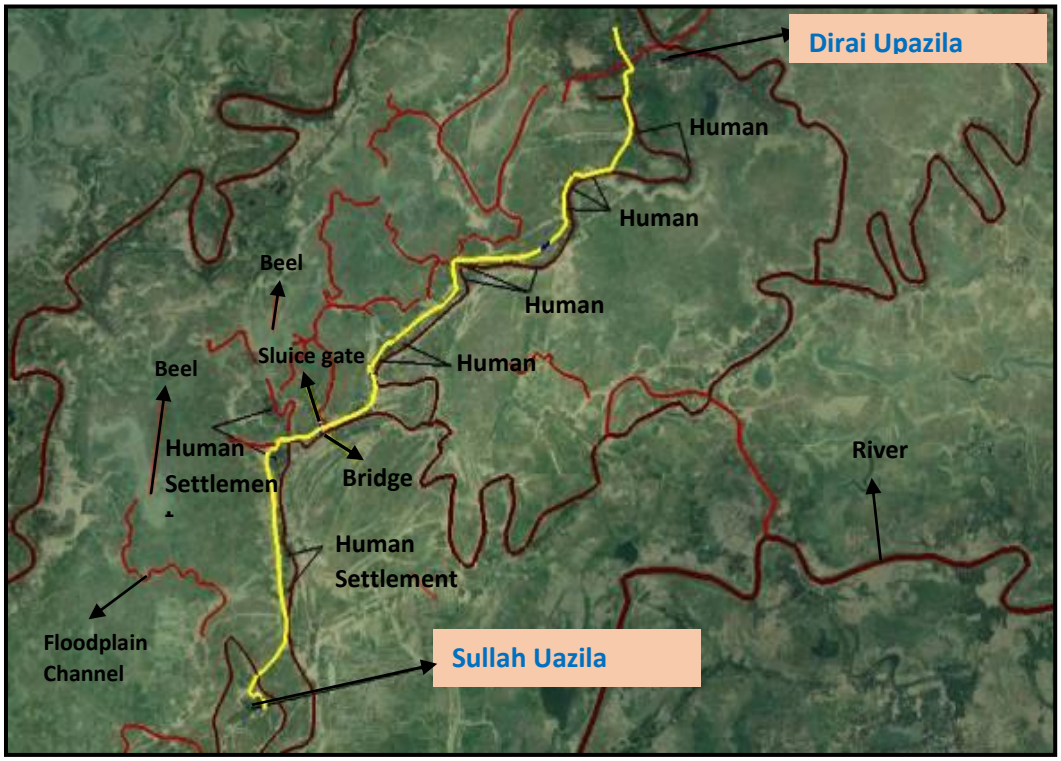


Figure 4.2: Physical features at and around the project area

4.4 Existing Road Network

The Madanpur-Dirai-Sullah road is mostly constructed by RHD under Sunamganj Road Division, Sunamganj. The existing road network of RHD, Sunamganj are shown in **Figure 4.3**. The existing road link between Sunamganj and Sylhet is a regional highway of RHD. Sylhet is connected with Dhaka, Moulvibazar and Jaintapur by national highway. Sunamganj is also connected with different district and upazila headquarters by RHD regional and zila roads. In addition, there are several upazila roads connecting Sunamganj with different important markets, growth centers etc. Dirai is connected with Sunamganj-Sylhet regional highway by Madanpur-Dirai road. But, Sullah is completely detached with nearby upazila headquarters as well as Sunamganj by RHD road.

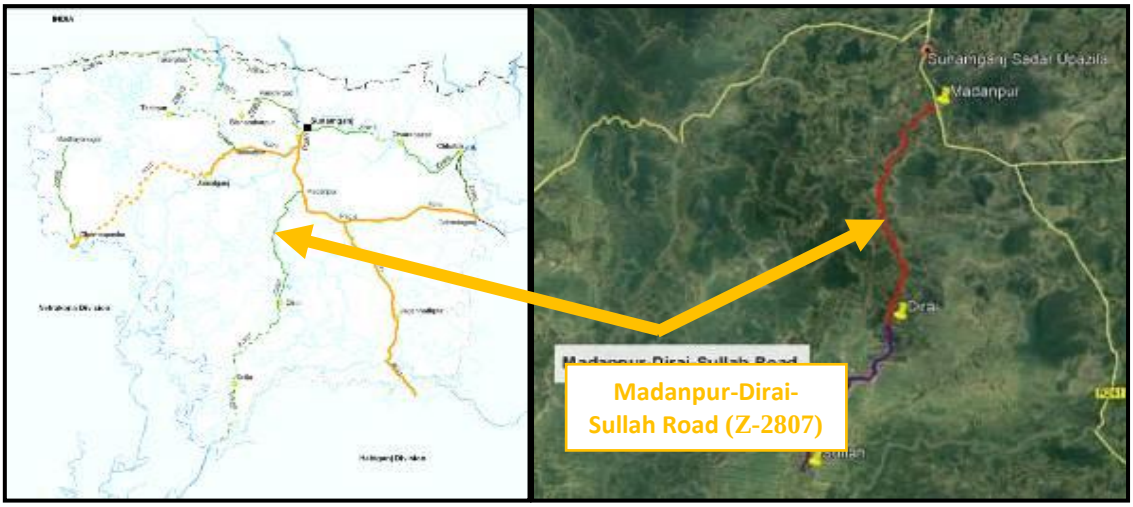


Figure 4.3: Existing road networks in Sunamganj by RHD

4.5 Present Status of the Road and Road Structures

The existing road link between Dirai and Sullah upazilla headquarter hasn't entirely been constructed yet. A number of bridges and culverts have already been constructed across different important drainage routes. However, the whole lengthways of Dirai-Sullah road link is not suitable for vehicular movement. Most of the road structures and their approaches are damaged. Road pavement damage, partial damage or complete washing out of approach road, non-functional bridges and culverts, damage of road embankment side slope and damage of approach embankment slope protection works, soil erosion from the road embankment are visible throughout the road stretch from Dirai to Sullah. The existing condition of Dirai-Sullah road link is described in detail to the following Chapter 5. The **Figure 4.4** shows the current physical condition of the road and road structures.

Figure 4.4: **Existing Physical condition of the Dirai-Sullah road and road structure**

4.6 Alignment of the proposed road

The Madanpur-Dirai-Sullah road has already been constructed. The Madanpur-Dirai part of the existing Madanpur-Dirai-Sullah zila road is suitable for vehicular movement and Dirai-Sullah part is not yet suitable for vehicular transportation. It is observed from the field visit that the Dirai-Sullah road link already exists in incomplete condition. As the road is already in place, it is better decision to keep the existing road alignment as it is. Beside, as the road passes through the vast low-lying area, there is no other better alternative alignment. Under this circumstance, three alternative alignments may be considered for subjective assessment including the existing one. It is to be noted here that all the three alternatives are similar except a little variation. Out of three alternatives, the road alignment is selected based on numerical model investigation results, field data analysis, and the judgment of community and relevant organizations.

Three alternative road alignments according to RRI numerical model study are summarized below:
Option-1 (Existing Road): The existing road alignment is considered as Option-1. As there is road gap at Nayagaon and Kashipur, the road alignment at these locations is considered along the BWDB channel closures that were in place during the field survey. However, a bit modification is made to keep the horizontal curve smooth. The total length of the road including road structures under this option is about 18.4km.The road alignment under this option is shown in **Figure 4.5**.

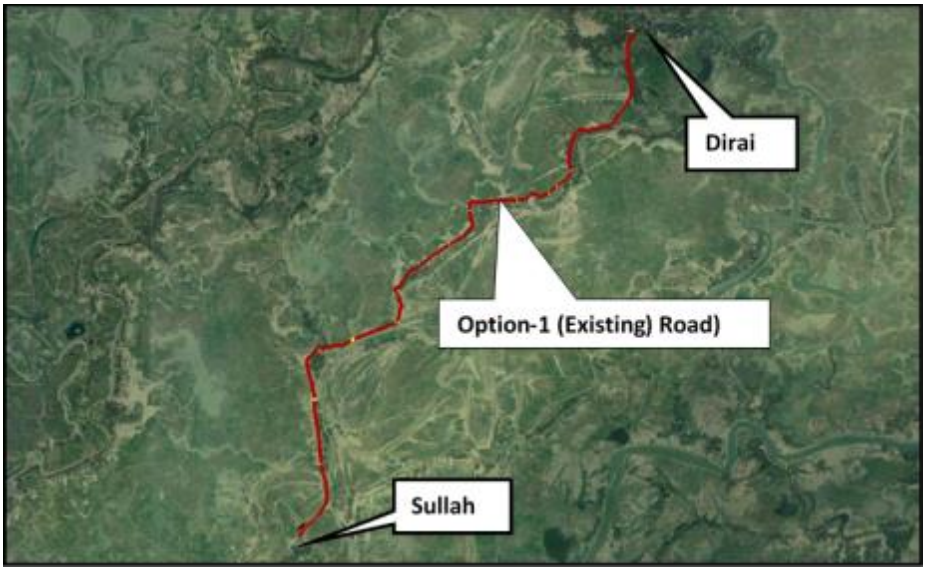


Figure 4.5: Alignment of the Dirai-Sullah road under Option-1

Option-2 : The road alignment under Option-2 follows the same way as in Option-1 except a little shift of the road position towards the west at about 614m (along the road) north from the bridge at Sullah upazila headquarter and to the south of the road gap at Kashipur. This shift in road position at these two locations has been considered for keeping the road away from the river bank as at present there is little or no setback distance between the road and river bank margin. The road alignment under this option is shown in **Figure 4.6**. The total length of the road (including road structures) under this option is about 17.7km (considering straight connection between two ends of the existing road at two road gap locations).

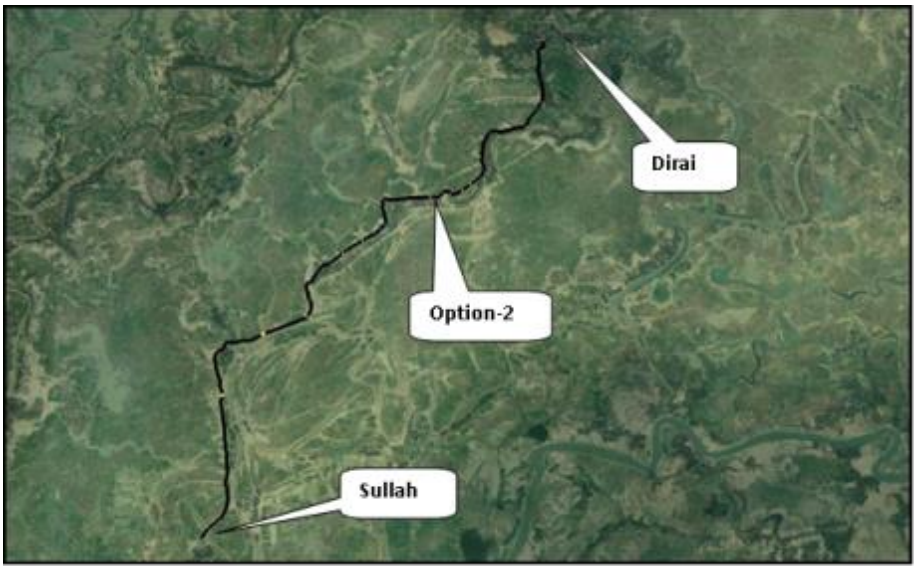


Figure 4.6: Alignment of the Dirai-Sullah road under Option-2

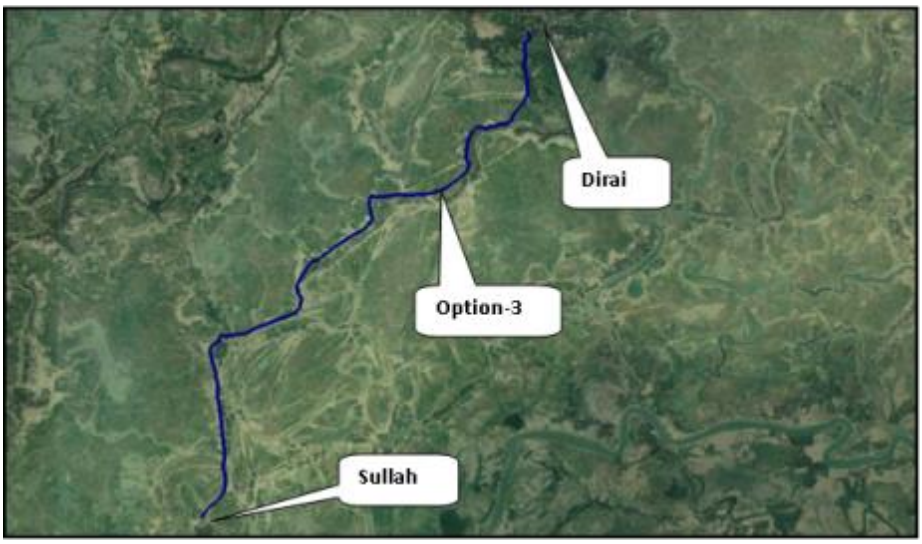


Figure 4.7: Alignment of the Dirai-Sullah road under Option-3

Option-3: The road alignment under Option-3 follows the same way as in Option-2 except that two road structures have been considered across two road gaps at Nayagaon and Kashipur. It is done to avoid blockage of natural connectivity between the river and the floodplain at these locations. The road alignment under this option is shown in **Figure 4.7**. The total length of the road (including road structures) under this option is about 17.834km.

Option-3 has been devised based on the outcomes of hydrological and hydraulic assessment of road alignment Option-1 and Option-2 with all existing road structures in place. Since 19 (nineteen) road structures have already been constructed at different locations, all these structures are kept as they are in this option. However, five additional culverts have been introduced with two bridges at two road gaps.

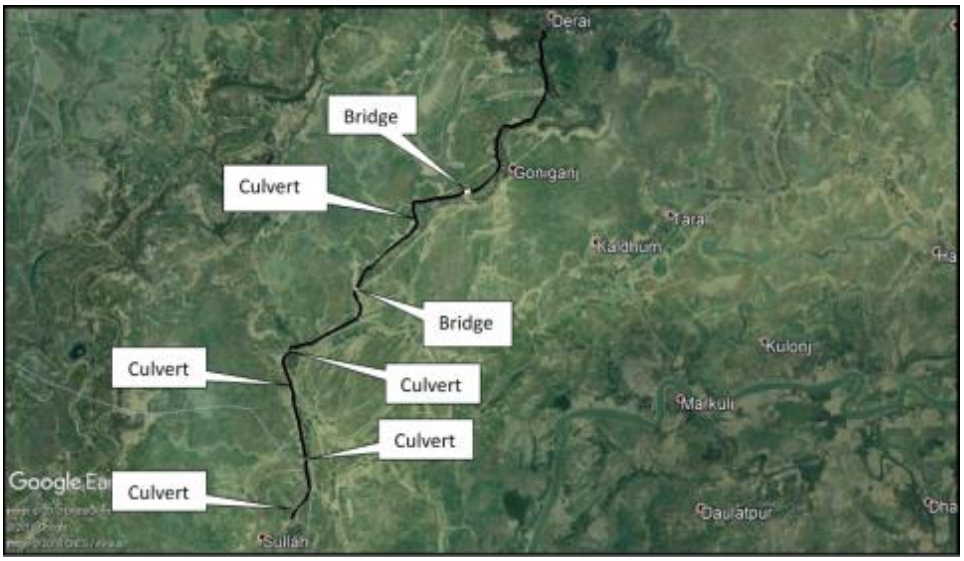


Figure 4.8: Location of the newly introduced road structures (Option-3)

The aim to introduce new road structures including two bridges at two road gaps is to maintain more or less natural flow regime. It will assist in safe passage of flood flow along the natural flow direction and will reduce pressure on the road during an extreme event or flash flood condition. Currently, BWDB as well as local people constructs temporary closures across the road openings to save crops from damage by early flooding. The implementation of these temporary closures may be continued with reasonable costs and efforts under this designed option.

4.7 Hydrological and Hydraulic Design of Road and Road Structures

The designed formation level of the Dirai-Sullah road by the RRI mathematical model study is summarized below:

The formation level of the road is obtained by providing freeboard over the design flood level. The recommended freeboard is 0.9 m. But, the road runs through a low lying area the most part of it is subjected to wave actions. In in this case, formation level will be as follows:
Formation Level = Design Flood Level + Freeboard or Wave Runup (higher one)

The calculated wave run-up is 1.12m which is higher than the recommended free board of 0.9m. Therefore, the formation level of the road = Design Flood Level (20 year flood level) + Wave Runup

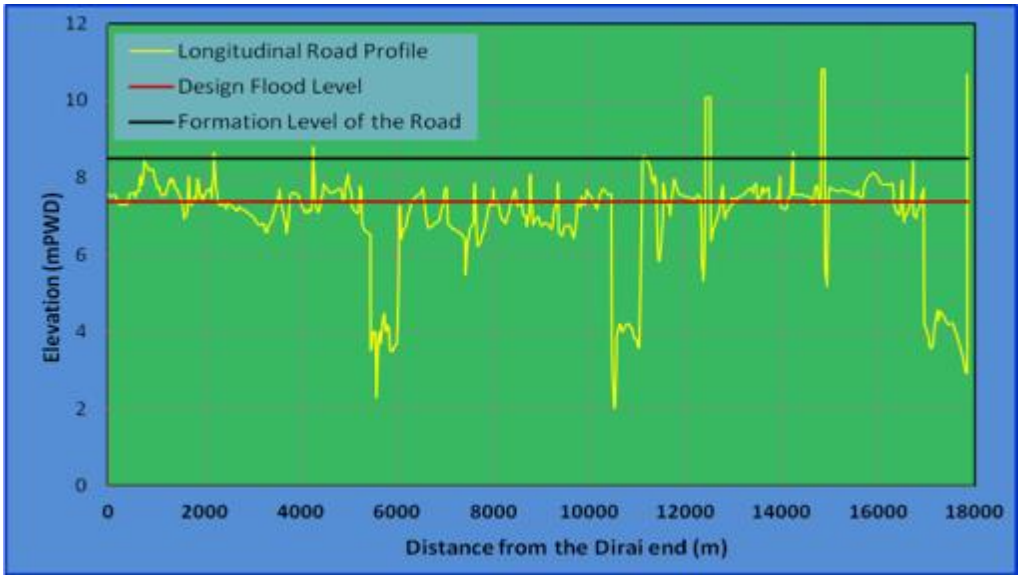


Figure 4.9: Existing road top level, design flood level and formation level of the road

The existing top level of the road (excluding major bridge locations), design flood level and formation level of the road is shown in **Figure 4.9**. The average flood level along the Dirai-Sullah road for 20 year discharge is 7.38mPWD. Therefore, formation level of the road is 8.5mPWD. It is evident from **Figure 4.9** that the existing top level of the road along the proposed alignment (Option-3) is somewhat lower than the design flood level for a number of road stretches. However, the existing top level of the road is

below the required formation level of the road throughout barring some existing structure locations. Water level along the road varies from 7.65cm to 7.70cm. The average water level is 7.675mPWD. The average water level profile along the road and hydrological scenario of option 3 provided by RR model study are shown in **Figure 4.10.**

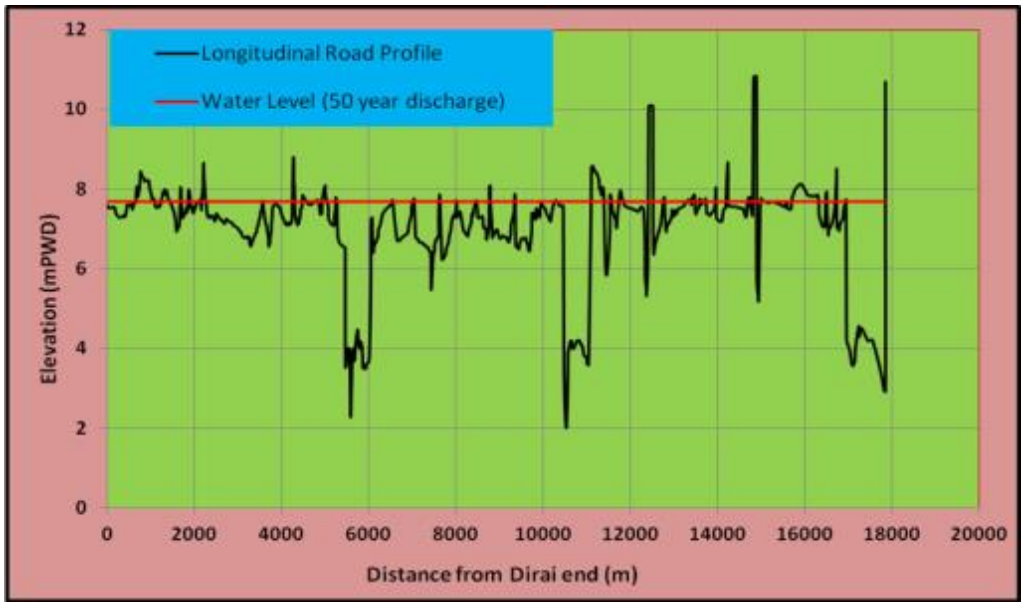


Figure 4.10: Water level profile along the existing Dirai-Sullah road for 50 year discharge in Option-3 condition

The model simulated flow velocity through the different existing structures varies from 0.28m/s to 0.71m/s for Option-3. The highest velocity in Option-3 condition is observed at Anandapur bridge. The difference between upstream and downstream water levels along the road and at the road structures indicates that the existing and proposed road structures are sufficient to drain the flood flow safely. The suggested structures should be designed considering the given through structure velocities with a factor of safety. There is also possibility of occurrence of parallel flow velocity along the approach embankment at a few structure locations. The flow velocity of the road structures including newly proposed bridges/culverts obtained from the RRI mathematical model study are given in **Table 4.1**.

Table 4.1: Through structure velocity and discharge in Option-3 condition for 50 year discharge

Structure description	Velocity (m/s) Average/Maximum	Discharge (m^3/s)
Rajapur culvert (3 vent)	0.3/0.33	25
Rajapur culvert (2 vent)	0.32/0.33	18
Islampur culvert (1 vent)	0.3/0.30	8
Nayagaon culvert (1vent)	0.28/0.28	8
Nayagaon culvert (1vent)	0.33/0.33	10
Nayagaon culvert (2 vent)	0.36/0.39	20
Nayagaon bridge (103m)	0.52/0.57	188

Dhanpur culvert (3 vent)	0.4/0.43	37
Dhanpur culvert (1 vent)	0.31/0.31	8
Chandipur culvert (1 vent)	0.32/0.32	9
Chandipur culvert (2 vent)	0.53/0.56	31
Kashipur culvert (3 vent)	0.46/0.50	36
Kashipur culvert (1 vent)	0.38/0.38	10
Kashipur bridge (76m)	0.43/0.46	169
Darain culvert (3 vent)	0.51/0.56	45
Bholanagar bridge	0.62/0.70	251
Giridhar Culvert (3 vent)	0.55/0.59	53
Giridhar culvert (1 vent)	0.48/0.48	14
Giridhar culvert (1 vent)	0.43/0.43	12
Anandapur culvert (2 vent)	0.51/0.55	27
Anandapur bridge	0.62/0.71	270
Sukline culvert (1 vent)	0.46/0.46	13
Angaruabari culvert (1 vent)	0.44.0.44	12
Angaruabari culvert (2 vent)	0.5/0.53	28
Sullah culvert (3 vent)	0.41/0.45	34
Sullah bridge	0.48/0.53	305

RRI Numerical model results shows that Option-3 is the best among three considered options as it will allow for safe passage of an extreme flood discharge with relatively low flow velocity through the structures. But, there is a strong public demand for entirely closing the existing road gaps at Nayagaon and Kashipur. Based on the model results, it would not be wise to close both the gaps as they convey large volume of flood discharge collectively. Therefore, the proposed bridge at Kashipur may be omitted to meet the public demand. In order to compensate for this to some extent, the proposed bridge opening at Nayagaon may be increased by 20m to 30m.

4.7.1 Navigational Clearances

Considering the type of navigational routes, BIWTA has identified the minimum vertical and horizontal clearance for free navigation. The rivers, khals and drainage routes in the project site do not fall either Class I to Class IV according to BIWTA navigational route classification. No minimum vertical and horizontal clearance is specified either by BIWTA or by RHD for the road bridges. Therefore, in determining appropriate navigational clearance local requirements for the passage of fishing boats, market boats, coal or stone barges etc. should be taken into account.

Four bridges including bridge at Dirai and Sullah have already been constructed over the existing Dirai-Sullah road. For newly suggested bridge at Nayagaon (cahinage 5.4 km), the calculated navigational clearance, scour at the abutments and pier scour level are 1.50, 9.70 and 7.59 mPWD respectively.

4.7.2 Design Life

The proposed road and structure (bridges) is designed for a life of 50 years.

4.8 Earthquake

The road location is characterized by High earthquake prone site and falls under Zone-I. Seismic coefficient of this zone is 0.08g.

4.9 Land Acquisition Cost

The length of the existing Dirai-Sullah road link is 20km. The road area is mainly floodplain used for agriculture and fishing which mostly belongs to private owners. However, the land owners still didn't receive money for their lands. Therefore, compensation for land should be paid as early as possible to the land owners with the prevailing rates of land in discussion with the Land Acquisition Department of District Commissioner, Sunamganj.

4.10 Activities during existing road condition, construction and post-operation phases

The activities to repair and improvements of the Dirai-Sullah road link intervention will be done in three phases namely present condition, reconstruction and project implementation. Works under these three groups are following:

Present condition (pre-construction) phase

- Survey and design data collection for improvement of the road works and bridges/culverts
- Hydraulic design of the road and road structures
- Mobilization of construction materials and equipment by heavy vehicles.
- Construction of labour shed/stock yard.
- Distribute land acquisition money
- Storage of construction materials at stockyard.
- Instalment of water and sanitation facilities.
- Instalment of Garbage disposal system.
- Discussion with local stakeholders about the project and interventions.
- Display of billboard at construction site for public awareness.

Reconstruction phase

- Earth work for construction of the improvement of the existing road and bridges/culvert with new introduced bridges/culverts.
- Compaction of soil for construction of road.
- Piling and R.C.C works along with cutting, bending and binding of rods as per specification to construct bridges.
- River Training Works (RTWs) /Protective Works.

- Road Embankment Slope Protection Works.
- Plantation of Timber/Fruit plant along the both sides of the road.
- Close monitoring of construction work by the RHD officials.
- Selection of the suitable route for the proposed road and location and number of structures;
- Hydraulic design of the road / bridges

Project implementation phase

- Any adverse impacts on erosion, deposition, flooding, navigation in the upstream or downstream of the proposed route and bridges due to construction by RHD
- Morphological changes in the vicinity of the route / bridge and River training works by RHD
- Operation and Maintenance by RHD.
- Implementation of EMP and monitoring by RHD in some extent with assistance of BWDB and DAE.

5 The Baseline Environmental Conditions of the Project area

The environmental conditions including Physical, Biological, Ecological and Socio-Economical Environment of the proposed Madanpur-Dirai-Sullah road link (Dirai-Sullah portion) project are describes in this chapter. The ESIA study team carefully observed the existing Madanpur-Dirai-Sullah road link during the field survey and find out likely causes to damage the road and road structures from different sources. The study team has talked about the project and collected necessary data from the government official concerned regarding management of water bodies and road construction authorities and other government officials. The study team has also talked about the proposed project to elected representatives such as Dirai Upazilla Chairman and Vice-chairman, Taral Union Parishad Chairman, Dirai and Women member, Tarol Union Parishad. Questionnaire survey and Focus group discussion have been held at different places in Dirai and Sullah Upazilla. In-situ water quality has been tested by the study team at different places in the project site. The study team visited Old Surma river, Kalni River and Dirain-Chamty river at and around project site. Different haors/beel at and around project site like Boram haor, Dhalar Haor, chhayar haor, Bera Dohor haor etc. are also visited by the study team.

The information provided in this section is based on:

(i) Primary field investigation by RRI personnel
(ii) Stakeholder meetings resulting from the Public Consultation process undertaken by RRI personnel
(iii) Collected secondary data on physical, biological, ecological, social and other relevant information from different sources.

The project influence area (PIA) for this EIA has been established considering the maximum length of all proposed road alignments. The existing Dirai Sullah road length is 18.4 km which has been taken as the diagonal of the rectangle shaped actual project area. To cover the sufficient receiving of environmental condition in accordance with the impacts of the Project, four (04) times of area added with actual project area as the PIA.

5.1 Physical Environment

The Madanpur-Dirai-Sullah road link (Dirai-Sullah) Z 2807 has already constructed. However, the fact is that currently some part of the Dirai-Sullah road is non-functional. As the road link is located in the hydrologically and environmentally sensitive low lying haor area, there involves a number of issues for damaging the road and road structures. The likely issues are the connectivity between the rivers and haors, existing hydrological flow regime including flush flood, the existing road alignment and road structures, design discharge and flood level of the road and road structures etc. The existing road and road structures like bridge and culvert over the river and khal can cause changes in river hydraulics and morphology in the vicinity of the structure which likely to have huge impacts on environmental quality of the area.

5.1.1 Existing Physical condition of the Dirai-Sullah road and road structures

The lengthways of Madanpur-Dirai-Sullah road is about 45km from Madanpur to Sullah and the distance between the Dirai upazila headquarters and the Sullah upazila headquarter is about 20km. There are 20 road structures including Sullah Bridge at Dirai bazar. Most of the road structures and their approaches are damaged. Road pavement damage, partial damage or complete washing out of approach road, non-functional bridges and culverts, damage of road embankment side slope and damage of approach embankment slope protection works, soil erosion from the road embankment are visible throughout the road stretch from Dirai to Sullah. Scattered small human settlements are located along both sides of the road. But there are also road stretches where there is no such human settlement. The **Figure 5.1** and **Figure 5.2** show the current physical condition of the road and road structures.

Figure 5.1: Existing Physical condition of some parts of the Dirai-Sullah road link

The road is constructed locally available native soil nearby the road and road structures. The road is constructed only a few years ago, however, the borrow pits are still clearly visible. From field visit it is observed that the road embankment fill material is not collected much away from the road and topsoil has been used for road construction. The top soil in the project area consists of an upper alluvial cohesive deposit of very soft to medium stiff silty clay and clayey silt mixed with varying amount of fine sand. The fill material used for construction of the road is poor quality.

Along the Dirai-Sullah road, the road surface is not paved all over the place and at some locations the road has gotten damaged. Most of the constructed bridges and culverts have lost connection with the road due to full or partial damage of approaches. CC block have been used as cover layer material for protection of road embankment against wave action and parallel current. CC block protection works are found at all vulnerable stretches of the road. There is also evidence of damage of protection works throughout this part of the road. As some locations the damage condition is severe. The road top level varies to some extent and at places top level of the approach embankment is much lower than the bridge or culvert top level. There is evidence of substantial settlement of approach road pavement and removal of soils from approach embankment. At some stretches the road top level is low enough to be overtopped by an extreme flood event. Settlement of road pavement or road top level is also noticeable elsewhere other than that at approaches of some road structures. Removal of soils from road side slopes is visible at different locations throughout the road.

There are 19 road structures (bridge/culvert) over the existing Dirai-Sullah road. Among the 19 road structures, three are bridges and sixteen are culverts. A list of existing bridges and culverts along the Dirai-Sullah road as obtained from field survey is given in Table 5.1.

Table 5.1: List of existing Bridges and Culverts over the Dirai-Sullah road link

Sl. No.	Start Position/ End Position	Length (m)	Bridge/ Culvert	Location	Comments
1	333138.42E, 2740320.33N /333123.93E, 2740306.64N	19.94	Culvert	Rajapur	Situated on a paved road stretch along the neck of river bend.
2	333017.01E, 2740170.94N /333007.79E, 2740161.25N	13.38	Culvert	Rajapur	On a paved road stretch along the neck of river bend. 120m southwest of the above culvert.
3	332840.81E, 2739889.20N /332836.79E, 2739883.45N	6.96	Culvert	Islampur	On a paved road stretch along the neck of river bend. Only 90m away from the river.
4	331752.65 E, 2738718.55N /331751.03E, 2738711.93N	6.82	Culvert	Nayagaon	On a paved road stretch and 150m away from the river.
5	331400.65 E, 2738335.77N /331394.81E, 2738331.37N	6.83	Culvert	Nayagaon	On a paved road stretch and 270m away from the Champti river.
6	331201.91 E, 2738196.60N /331190.37E, 2738190.18N	13.2	Culvert	Nayagaon	On a paved road stretch and 280m northeast from the Dhanpur Kararper.

Sl. No.	Start Position/ End Position	Length (m)	Bridge/ Culvert	Location	Comments
7	330449.84 E, 2738030.85N /330430.43E, 2738027.51N	19.7	Culvert	Dhanpur	On an unpaved road stretch. About 268m west from the Dhanpur Kararper.
8	329675.89 E, 2737995.54N /329669.11E, 2737994.61N	6.84	Culvert	Dhanpur	On an unpaved road stretch. 760m west from the above culvert.
9	329280.14 E, 2737796.30N /329280.80E, 2737789.51N	6.82	Culvert	Chandipur	On an unpaved road stretch.
10	328774.99 E, 2736968.25N /328758.16E, 2736958.15N	19.62	Culvert	Kashipur	On an unpaved road stretch.
11	328303.62 E, 2736649.40N /328297.91E, 2736645.65N	6.83	Culvert	Anongram Kashipur	About 548m southwest from the Kashipur culvert.
12	327443.20 E, 2735114.10N /327426.04E, 2735104.31N	19.75	Culvert	Darain	On a paved road stretch.
13	326469.10 E, 2734721.63N /326382.84E, 2734685.50N	94.16	Bridge	Bholanagar	Paved road on both sides and no approach road. Three span bridge.
14	325299.55 E, 2734150.44N /325297.95E, 2734143.83N	6.80	Culvert	Giridhar Anandapur	On a paved road stretch
15	325346.15 E, 2733889.84N /325347.52E, 2733883.17N	6.80	Culvert	Giridhar Anandapur	On a paved road stretch
16	325473.05 E, 2733291.32N /325471.32E, 2733228.347N	64.0	Bridge	Anandapur	Unpaved road on both sides for a distance. T three span bridge.
17	325582.14 E, 2731940.69N /325582.14E, 2731933.88N	6.81	Culvert	Sukline	On a paved road stretch. Damaged approach on both sides
18	325602.35 E, 2731702.48N /325602.55E, 2731695.67N	6.81	Culvert	Angaruabari	On a paved road stretch
19	325186.38 E, 2730179.93N /325126.51E, 2730107.44N	94.16	Bridge	Sullah	Unpaved road on both sides to some extent. Five span bridge.

Figure 5.2: Existing Physical condition of the road structures of Dirai-Sullah road link

Due to strong public disagreement, several natural drainage routes along the Dirai-Sullah road which no bridge or culvert is constructed yet. According to the resident, these drainage routes allow large volume of pre-monsoon flood water to enter into crop land and cause widespread damage to crops. The major two natural drainage routes at Dhanpur and Kashipur where no structures is constructed so far. At these locations the road is aligned along the existing BWDB closure for preventing the crop from being damaged by early flooding. Moreover, RHD has closed several drainage routes by constructing road across the same. At a few locations the set back distance between the road and nearby river bank margin is very less.

The identified faults in road and slope protection works at different locations are summarized below:

- Damage of road embankment side slope
- Settlement of road pavement or road surface
- Crack in the road pavement
- Partial removal of soil from the road embankment sometimes together with part of road pavement
- Erosion at the toe of the road embankment
- Sliding of embankment material
- Settlement of cement concrete blocks placed on road embankment slope
- Sliding of cement concrete blocks and
- Displacement of cement concrete blocks from their original positions.

5.1.2 Physiography and Landforms

Physiographic of an area is classified based on the combination of the geological material in which particular kinds of soil have formed and the landscape on which they occur. The haor area comprising of seven districts which are classified in eleven physiographic units, based on agroecological regions of Bangladesh prepared by Food and Agriculture Organization (FAO). The units are Northern and Eastern Piedmont Plains, Northern and Eastern Hills, Sylhet Basin, Eastern Surma-Kushiyara Floodplain, Old Brahmaputra Floodplain, Young Brahmaputra and Jamuna Floodplain, Active Brahmaputra-Jamuna Floodplain, Old Meghna Estuarine Floodplain, Madhupur Tract, Middle Meghna River Flood plain and Akhaura Terrace.

The physiographic unit of the study area is under Sylhet basin. It forms a prominent low-lying area containing numerous large, semi-natural wetlands like haors, baors, water fall etc. It is a lager, gentle, depressional feature, bounded by the Old Brahmaputra floodplain in the west, the Meghalaya Plateau foothills in the north, Sylhet High Plain in the east and the Mehgna estuarine floodplain on the south. Its greatest length, both E-W and N-S, is just over 113 km. Numerous beels, large swamps and haors cover this saucer-shaped area of about 7250 sq. km. The slope of the Brahmaputra floodplain is about 12cm/km. In north-south direction the length of the Sylhet basin is about 80km. The Sylhet city is about 20 m higher than the floor of the Sylhet basin. The Old Surma River is flowing 5.5 m above than the land level of the Baulai River. The trend of land levels in Bangladesh is sloping from north to south, but different characteristics are observed in north east region. The surface profile shows that the land slopes in the Sylhet basin are in reverse direction. This phenomenon is well supported to the higher subsidence rate in the northern part of the basin. The bottom of the Sylhet basin is elongated in the north south direction, with a deeper bottom and very steep slopes at the northern edge. The slopes of both east and west edges are milder and vary from 15 to 30 cm/km with a flat bottom several kilometres wide. The rivers entering into the basin from the east and the west and flowing over the side slopes in the east-west direction, turn towards the south while they flow over the flat bottom of the basin. On the contrary, the slope of the basin bottom is in the reverse direction.

The sinking of this large area into its present saucer-shape seems to be intimately connected with the uplift of Madhupur Tract. The region appears to be sinking at a rate of approximately 2cm per year (Rashid, 1991) and has sunk 9 - 12 m over the last several hundred years (Morgan and McIntire, 1959). This area is still undergoing persistent subsidence. In addition to the hills located along the southern spur

of the Shillong Massif, a number of hillocks, locally known as Tila, form minor but morphologically distinct, ranges around Sylhet in northeastern Bangladesh. These elevations, as for instance Kailas Tila, Dupi Tila and the tilas at Beanibazar, east of Sylhet, are generally built up of Plio-Pleistocene clastic sediments and reach maximum elevations of about 60m above MSL. It is regularly flooded during the monsoon.

5.1.3 Geology

Geology of Bangladesh is generally dominated by poorly consolidated sediments deposit over the past 10,000 to 15,000 years (Holocene age). The geology of the study area consists of Quaternary deltaic sediments, which have been strongly influenced by tectonic movements on deep seated faults. The area lies on a tectonic block, which has been uplifted relative to the surrounding areas.

Bangladesh is divided into two major tectonic units: i) Stable Pre-Cambrian Platform in the northwest and ii) Geosynclinal basin in the southeast. A third unit, a narrow northeast-southwest trending zone called the hinge zone separates the above two units almost through the middle of the country. This hinge zone is currently known as palaeo continental slope. Stable Pre-Cambrian Platform refers to the stable shelf of the Bengal Basin. It is the part of the basin that lies on the west and northwest of the line joining Calcutta and Mymensingh. This line is frequently referred to Calcutta-Mymensingh gravity high, which represents the hinge zone of the basin or the basin ward extension of the stable shelf. In Bangladesh part of the Bengal Basin, the stable shelf can be divided into three major zones. They are Dinajpur slope, Rangpur Saddle and Bogra slope. It is composed of continental crust overlain by Cretaceous (144 to 66 million years ago) to recent sediment. However, in isolated basins on the stable shelf, there is Permo-Carboniferous (360 million years to 245 million years ago) sediments with considerable amount of coal. The thickness of sedimentary column on the stable shelf of Bengal Basin varies from less than 200m to 8,000m. A large part of the basin is covered by Sylhet limestone of Eocene age (58 million years to 37 million years ago).

The Sylhet Trough, which underlies most of the northeast region, is a sub-basin of the Bengal Basin and consists of 13-20 km thickness of alluvial and deltaic sediments underlain by much older genesis and granitic rocks. Sylhet Trough is situated on the southern side of the Shillong Massif and corresponds to the vast low lands of Surma Valley with numerous swamps (haors) where absolute elevation marks even below the sea level. It is a sub-basin of the Bengal Fore deep in the north-eastern part of Bangladesh and is characterised by a very pronounced, vast, closed negative gravity anomaly up to 84 mgl (Milligal). Shillong Massif forms the northern boundary of Sylhet Trough while the great Dauki Fault separates the trough from the Massif. The Trough is bounded on the east and southeast by the sub-meridional trending folded belt of Assam and Tripura as the frontal deformation zone of Indo-Burman Ranges. Indian Platform bounds the trough from the west while it is open in the southwest to the main part of Bengal Basin. It is an oval shaped trough about 130 km long and 60 km wide. Sub-meridional trending anticlinal folds of Chittagong-Tripura Folded Belt gradually plunge northward to the Sylhet Trough. In cross-section the Sylhet Trough is sharply asymmetrical with comparatively gentle southern and steep faulted northern slope. Dauki Fault with 5 km wide fault zone forms the contact between Shillong Massif and Sylhet Trough. The evolution of Sylhet Trough includes (i) a passive continental margin (Pre-Oligocene) to (ii) a foreland basin linked to the Indo-Burman Ranges (Oligocene and Miolene) to (iii) a foreland basin linked to south-directed over thrusting of Shillong Plateau (Pliocene-Holocene). The anticlinal folds

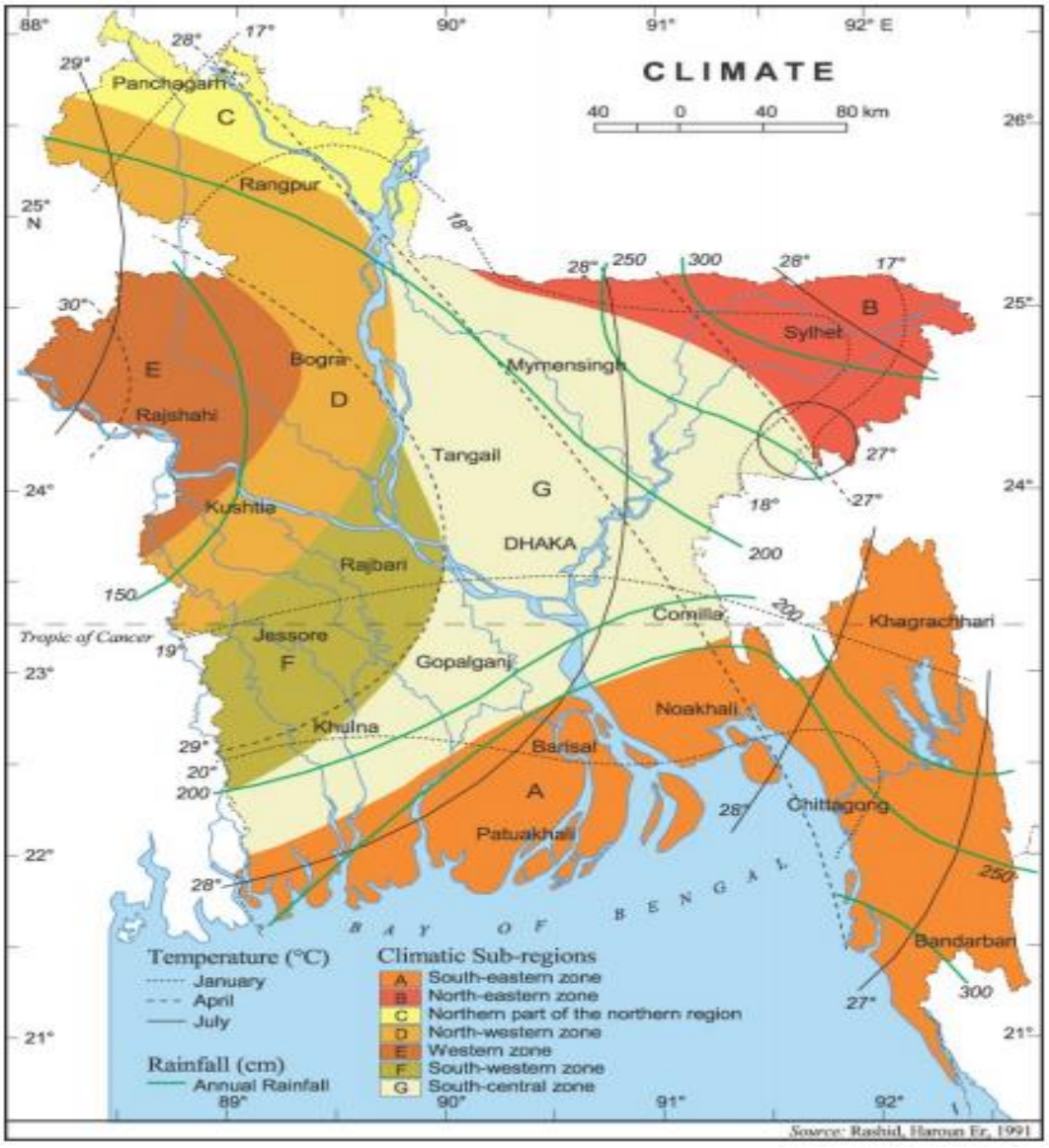
of Habiganj, Rashidpur, Bibiana, Maulvi Bazar, Katalkandi, Fenchuganj, Harargaj, Patharia, Beani Bazar (Mama Bhagna) and Kailas Tila, which occupy the southern rim of Sylhet Trough have sub-meridional trend in contrast to sub- latitudinal trending Chhatak, Jalalabad, Sylhet, Dupi Tila and Jatinga structures. These two structural trends form a syntaxial pattern at the north-eastern tip of Sylhet Trough. The Neogene sediments have excellent development in Sylhet Trough while the Paleogenes are at greater depths.

5.1.4 Climate and Meteorology

Climate of the study area is characterized by the sub-tropical monsoon as the northeast region of Bangladesh is located entirely to the north of the Tropic of Cancer. The sub-tropical monsoon results intense regional and orographic rains caused by the interface of the mist air masses incoming from the Indian Ocean through the Bay of Bengal with a predominant northeastern direction and the steep and high hills located at the foothills in the states of Assam, Meghalaya and Tripura in India. The hydro-meteorological seasons of this region are generally classified into 4 categories. These are 1) Pre-monsoon season extending from April to May; 2) Monsoon season from June through September; 3) Post-Monsoon season from October to November; and 4) Dry season from December through March

The average annual rainfall of the study area is approximately 4,000 mm and over 80% of the rain falls during the monsoon season from June to October. Climate is dominated by distinctive geographical characteristics of the region which ultimately plays a major role in determining the spatial and temporal distribution of rainfall, evapotranspiration and hydrology of surface and groundwater.

The project area is located in the north-eastern (B), according to Climatic sub-regions of Bangladesh (**Map 5.1**). The average annual rainfall in the study area is 4000mm. It rains in this area throughout the year. From June to October the rainfall is very high. Winter rainfall is very low. The temperature varies in summer from 40^{o}C to 30^{o}C whereas the same in winter are 18^{o}C and 10^{o}C respectively. The yearly average humidity is 79% where maximum 88% in July and minimum 65% in February. Annual average sunshine is 6.4 hour/day where maximum is 8.4 hr. /day in February and minimum 3.6 hr. /day in July. In the project site annual mean wind speed is 7.3 km/hour. Monthly average wind speed varies from 2.1 km/hour to 8.8 km/hour. However, extreme wind speed recorded 168 km/hour. Average annual evapotranspiration is 1550 mm/year (Minimum 103 mm in December and maximum 162mm in March).

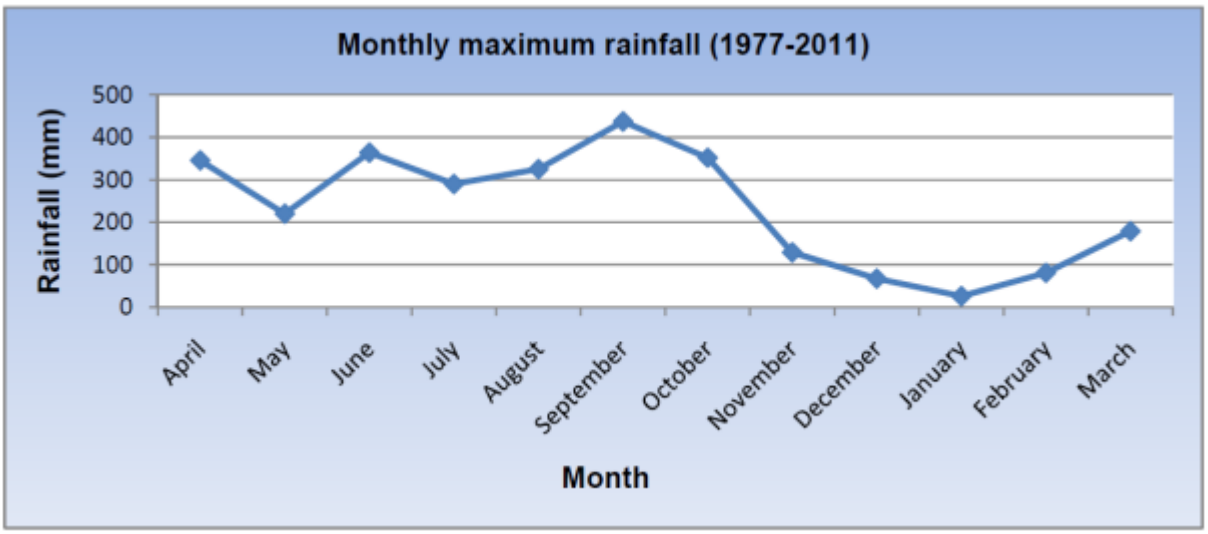


Map 5.1: Climatic sub-regions of Bangladesh

Information of different meteorological parameters i.e. rainfall, temperature, relative humidity, wind speed, evaporation and sun shine hours have been collected from National Water Resources Database (NWRD) of the Bangladesh Meteorological Department (BMD) at Sylhet station and CEGIS report on EIA study of Kalni Bridge. To complete understanding on the meteorological system of the study area, meteorological parameters are described in the following sections.

Rainfall

The monthly maximum rainfalls (1977-2011) have shown in **Figure 5.3.** These data were collected from the BMD station of Sylhet (1977-2011) showed in CEGIS report on EIA study of Kalni Bridge. The Figure has shown significant rainfall occurred during the months of April to November. On the other hand, very low rainfall occurred during the month of December to March. The maximum rainfall ever recorded in the study area is 420 mm in the month of September. The mean annual rainfall is about 4005mm, which is a very high side compared to the national average of 2300mm. Annual rainfall, however, have shown considerable variability from year to year. The rainfall also varies considerably within a year. Over 80% of the rain falls during the monsoon season from June to October. The average annual rainfall in Jamalganj upazila is 4000m.

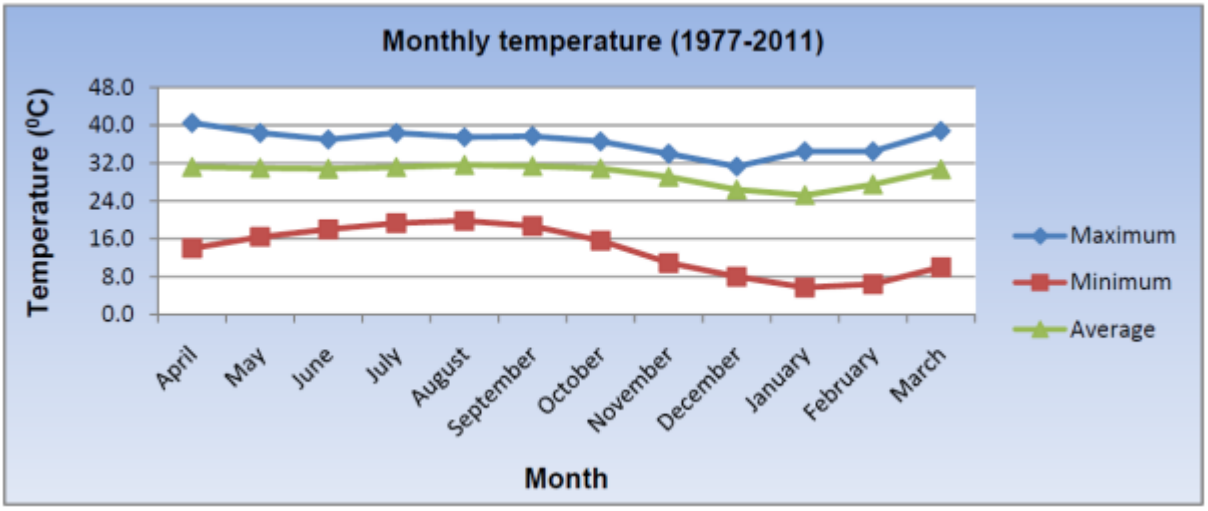


Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.3: Monthly variation of maximum rainfall in the study area

Temperature

The monthly variation of maximum, average and minimum temperature for last 35 years (1977-2011) has shown in **Figure 5.4**. The Data have shown that the monthly maximum temperature varies from 32.0°C to 40.1°C whereas the monthly minimum temperature varies within the range of 6.2°C to20.6°C. The highest monthly temperature is found as 40.1°C (April) whereas the lowest monthly temperature is 6.2°C (January). The average temperature is steady and is around 32°Cduring the month of March to October. Temperature falls from November to reach minimum value in January and then rises again in February and reached to maximum in March.

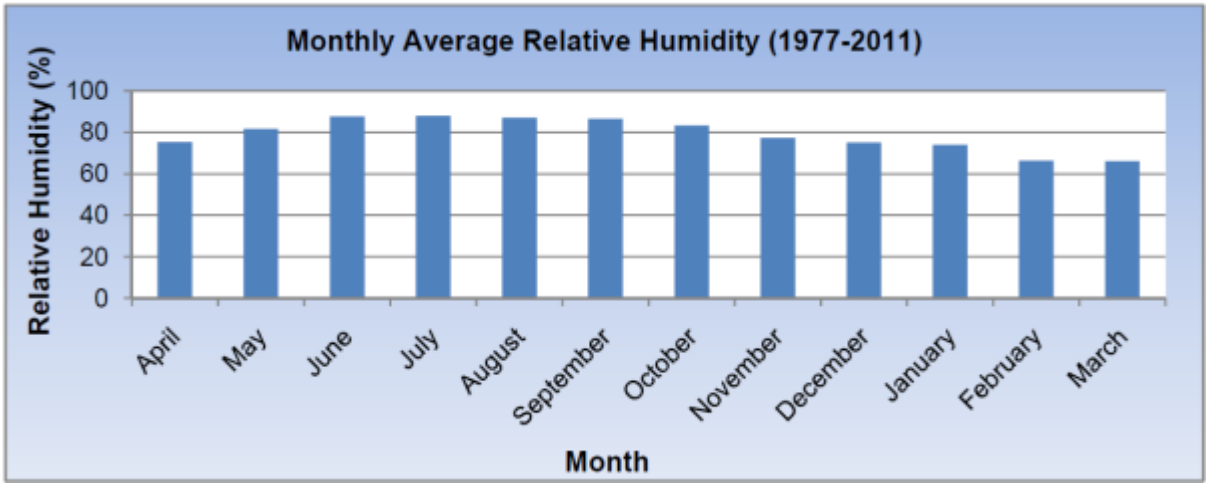


Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.4: Monthly variation of maximum, average and minimum temperature in the study area

Relative Humidity

Monthly average relative humidity of the study area varies from 63% to 84%. Figure 5.5 have shown the monthly average relative humidity of the Sylhet station for the last 35 years (1977-2011). It has been clear from the Figure that the study area is considered as humid during the month of May to October (>80%).



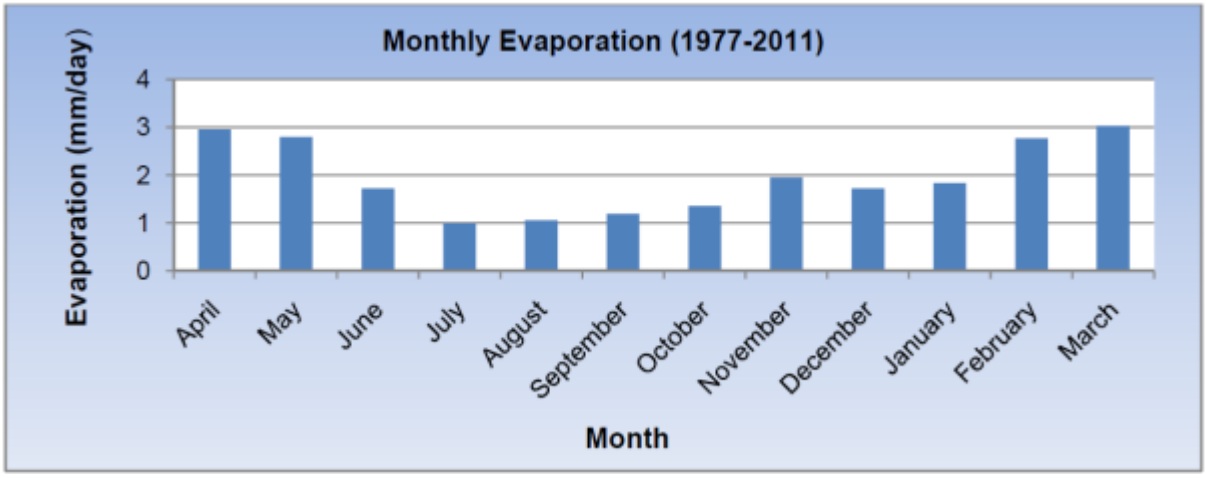
Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.5: Monthly variation of average relative humidity in the study area.

Evaporation

Monthly average evaporation rate of the Sylhet station is shown in **Figure 5.6**, which shows that the evaporation rate of the area is lower as throughout the year the evaporation rate is less than 3mm/day. The evaporation rate of the area varies from 1-3mm/day. Evaporation rate is relatively higher during the

month of January to May and lower during June to January. The rate is maximum in March and minimum in July.

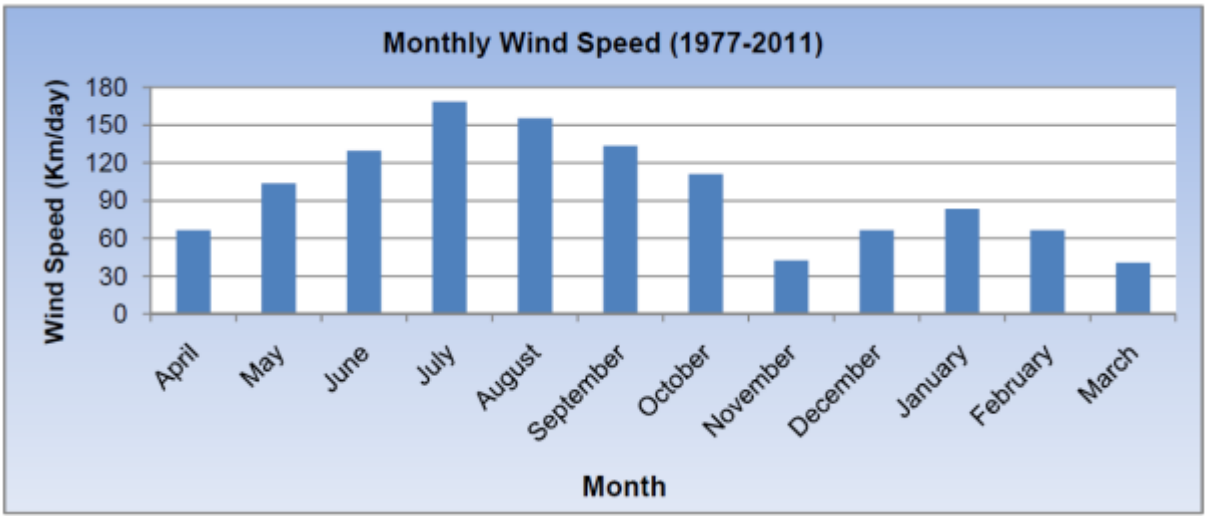


Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.6: Monthly variation of average evaporation in the study area.

Wind Speed

Monthly average wind speed of the study area varies from 42-169km/day. Wind speed is minimum in March (42km/day) and maximum in July (169km/day). Wind speed increases from march to July and then decreases up to November. Then increases up to January and decreases to March. The monthly variation of the wind speed for the last 35 years (1977-2011) is shown in **Figure 5.7**.

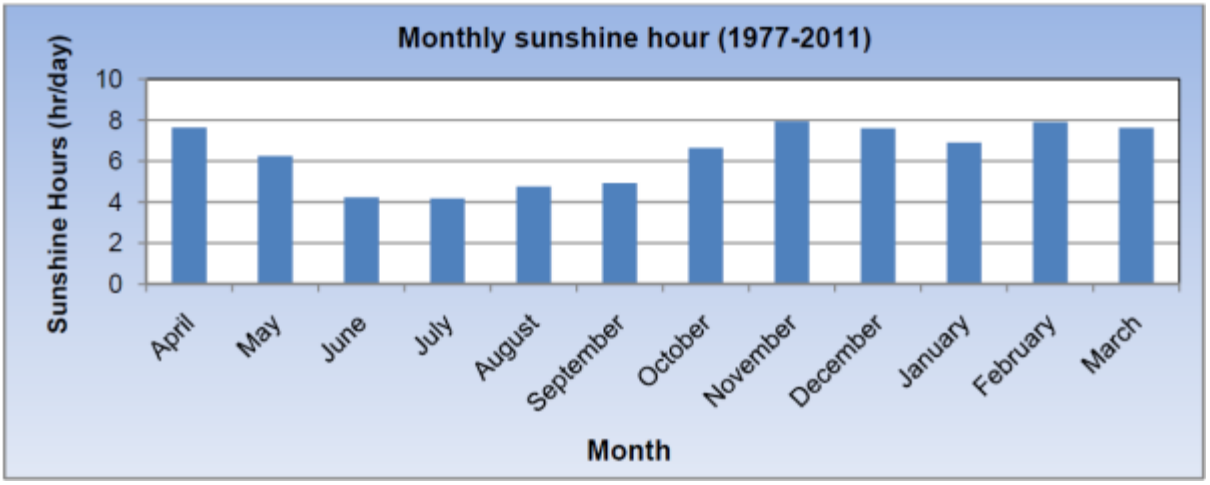


Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.7: Monthly variation of average wind speed in the study area

Sunshine Hour

Monthly average sunshine hour for the Sylhet station is shown in **Figure 5.8** for the last 35 years (1977-2011). According to the Figure, the average sunshine hour varies from 4.1-7.9hour/day with its maximum value in November and minimum value in July. Sunshine hour is larger during October to May and lower during June to September. The data were collected from the BMD station at Sylhet and showed in CEGIS report on EIA study of Kalni Bridge.



Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.8: Monthly variation of average Sunshine hour in the study area.

5.2 Environmental risk

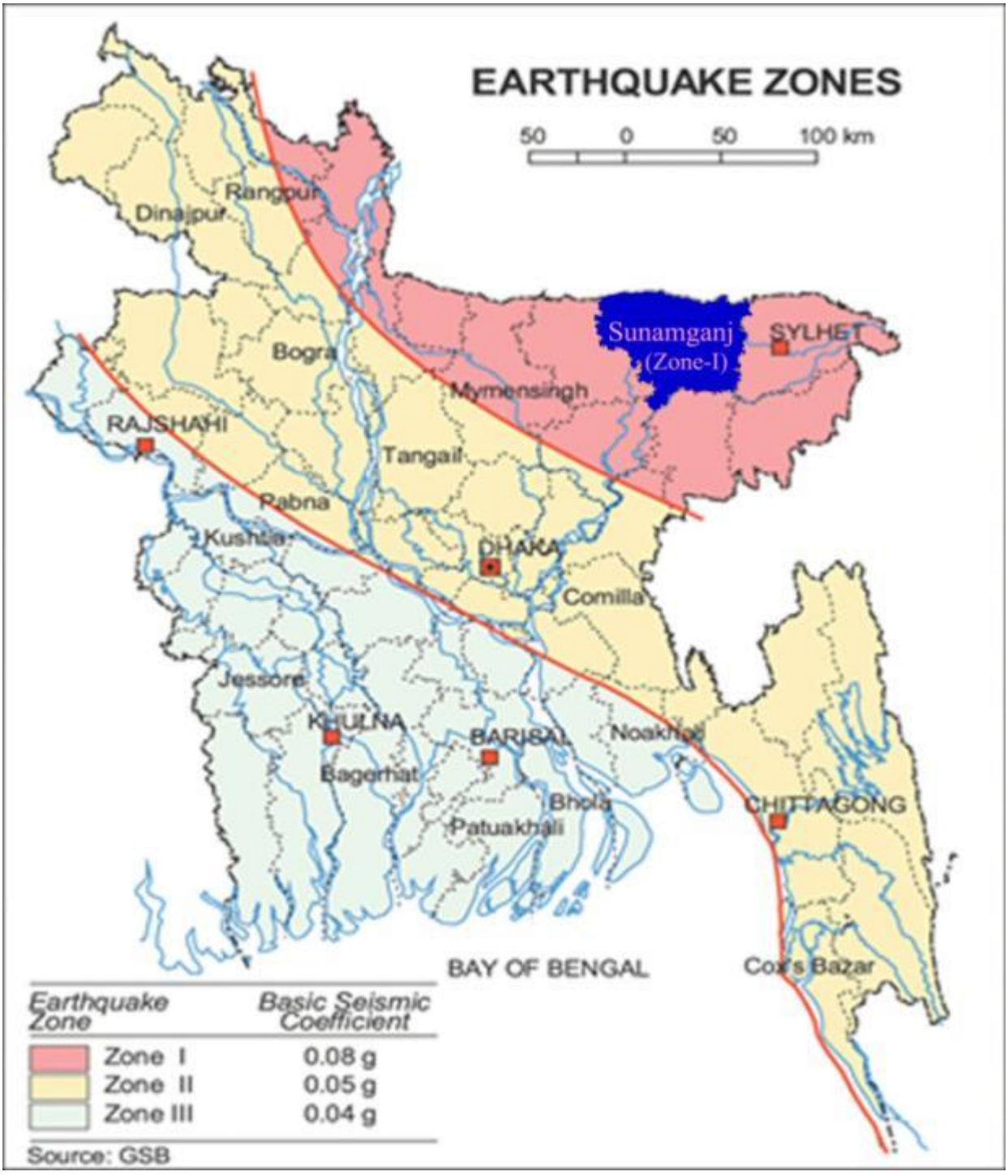
5.2.1 Seismicity

Bangladesh has continually been one of the seismically active regions of the world, and has experienced numerous large earthquakes during the past 200 years. Tectonic framework of Bangladesh and adjoining areas indicate that Bangladesh is suited adjacent to the plate margins of India and Eurasia where devastating earthquakes have occurred in the past. Depending on the geological structure, Bangladesh has been divided into three generalized seismic zones: zone-I, zone-II and zone-III (**Table 5.2** and Map 5.2). The basic seismic co-efficient of these three zones are 0.08, 0.05 and 0.04, respectively. There are also different geological faults in and around the country, as shown in **Map 5.2**. Seismic Zone-1 is the most and Zone-3 is the least vulnerable to seismic risks. For example, the northern part of the country falls under Seismic Zone-1 means the most vulnerable to seismic risks whereas the southern part falls under Seismic Zone-3 means the moderate vulnerable to seismic risks.

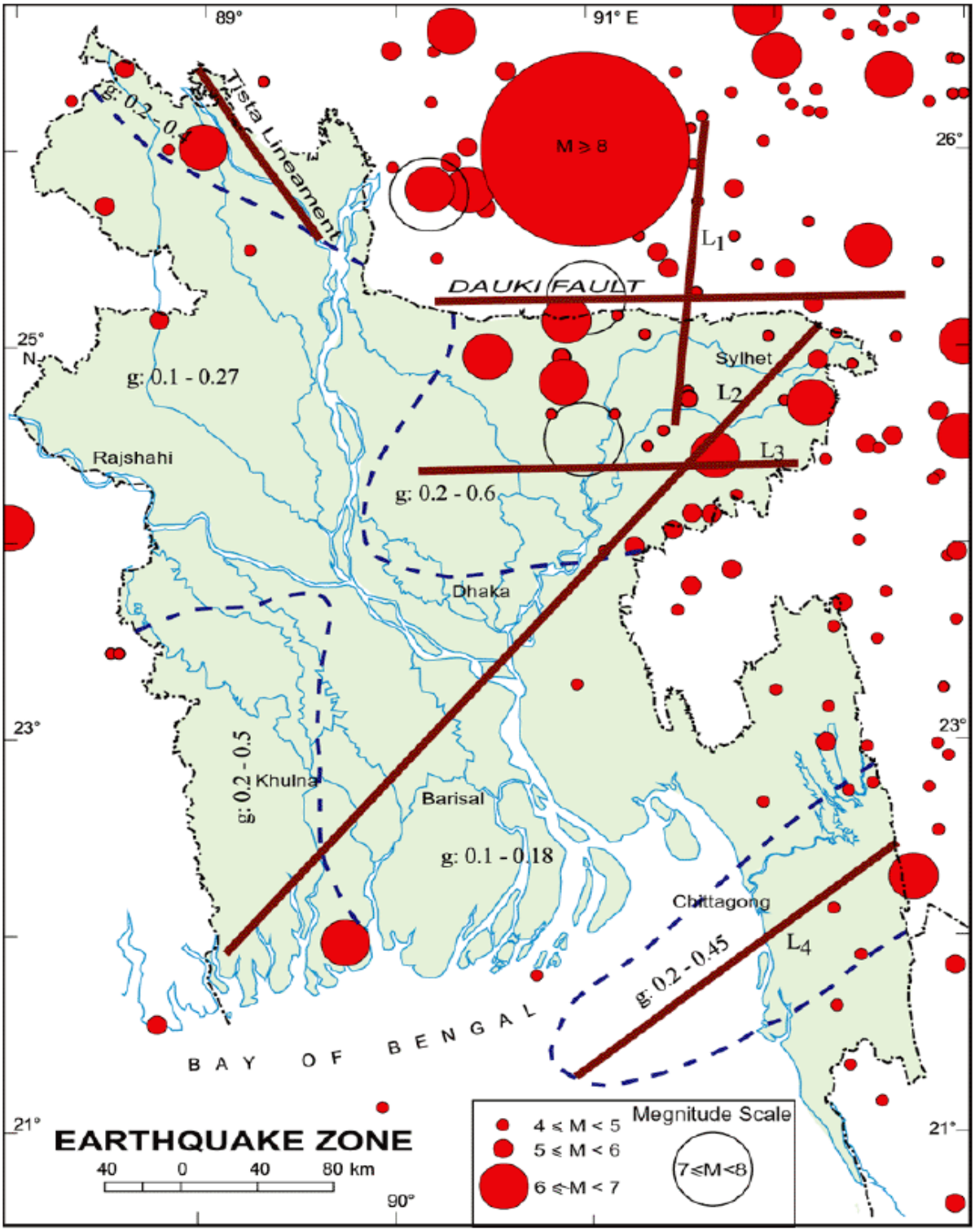
Table 5.2: Seismic zones of Bangladesh

Zoning	Area Mercalli Scale
I	North and eastern regions of Bangladesh (seismically most active)
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla Noakhali and western part of Chittagong Folded belt
III	Khulna division S-W Bangladesh (seismically less active)

The study area falls under Zone-I, which is characterized by high earthquake prone site and has a basic seismic coefficient of 0.08g (**Table 5.2** and **Map 5.2**) and there is also fault line near the study area (**Map 5.3**). According to it, the maximum magnitude of earthquake is within the range of $6 \leq M < 7$ on the Richter scale in and around of the study area. During seismic or earthquake delineation, ground condition has not been taken into account in Bangladesh. Hence special precaution is needed in considering the risk from earthquakes to any water structure in floodplain formations.



Map 5.2: Earthquake zoning map with seismic coefficients



Map 5.3: Fault Lines of Bangladesh (Source: GSB)

5.2.2 Climate Change

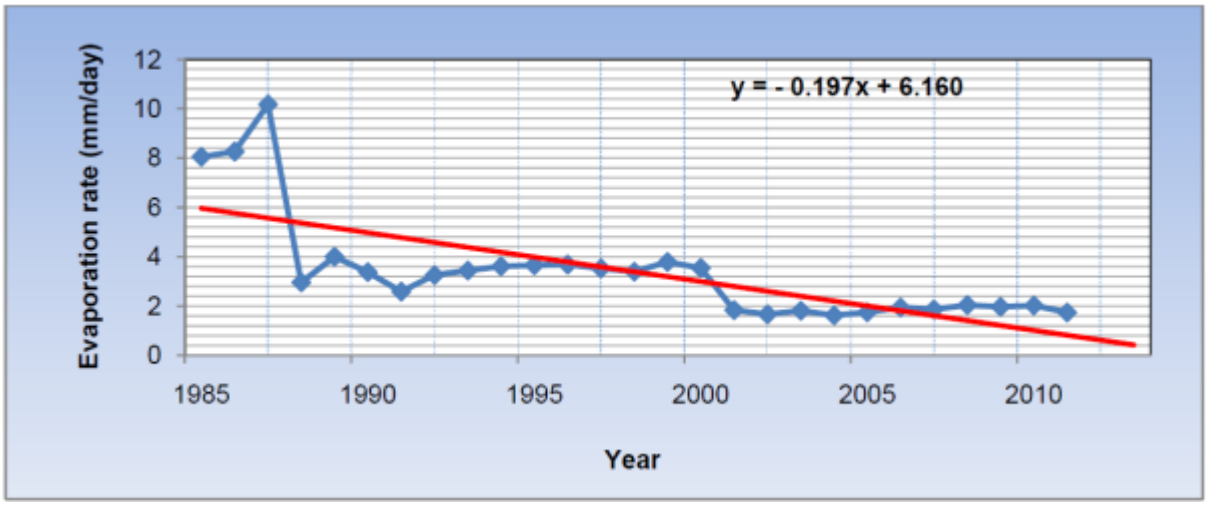
In the northeast region, the climate is sub-tropical monsoonal. The sub-tropical monsoon climate tends to have more sharply defined seasons than the tropical climate. Rainfall is the most distinctive component of climate in the haor region. Climate is dominated by distinctive geographical characteristics of the region which ultimately plays a major role in determining the spatial and temporal distribution of rainfall, evapotranspiration and hydrology of surface and groundwater. In order to assess the change in climatic factors, trend of annual variations of the aforementioned meteorological parameters were analyzed.

Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.9: Annual variation of mean temperature in the study area (1960-2010)

The major impact caused by climate change is the rise in temperature. As per analyses made in the study, the average temperature is found to be gradually increasing in the area. In last 50 years, the mean annual temperature has experienced a rise of about 0.022°C per year (**Figure 5.9**). The variation of mean annual temperature recorded at Sylhet station is shown in **Figure 5.9**.

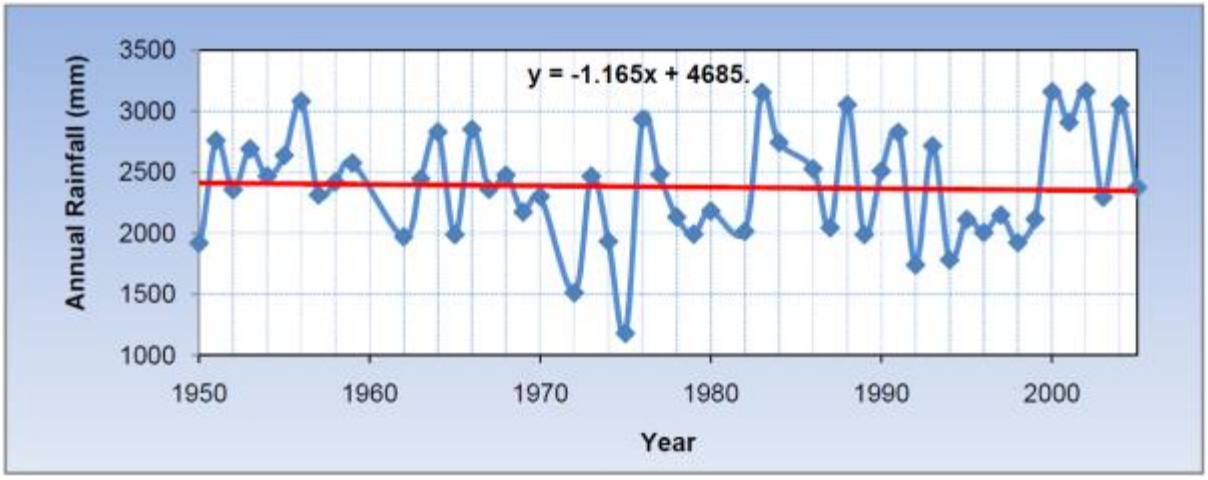
The hot season commences early in April and continues till August. The maximum temperature observed is about 32.0°C to 40.1°C during May to July and the minimum temperature recorded in January is about 6.2°C to 20.6°C. The highest rainfall is observed during monsoon.



Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.10: Annual variation of evaporation rate in the study area (1985-2010)

The increase in mean annual temperature affects the rate of evaporation and thus rainfall intensities. The evaporation rates recorded at Sylhet station shows a decreasing trend (decreasing by 0.197 mm/day each year in last 25 years). The **Figure 5.10** has shown the decreasing trend in Evaporation rate. During this period, spring season has been shortened and monsoon has been shifting towards May. These days, monsoon starts from the month of May and lasts up to mid -October. Due to such timing, water scarcity is often observed in the Boro season. This phenomenon affects the cropping patterns as well as the biodiversity and ecosystem of the study area. Now-a-days, farmers initiated hybrid cropping, which eventually improved their socio-economic status.

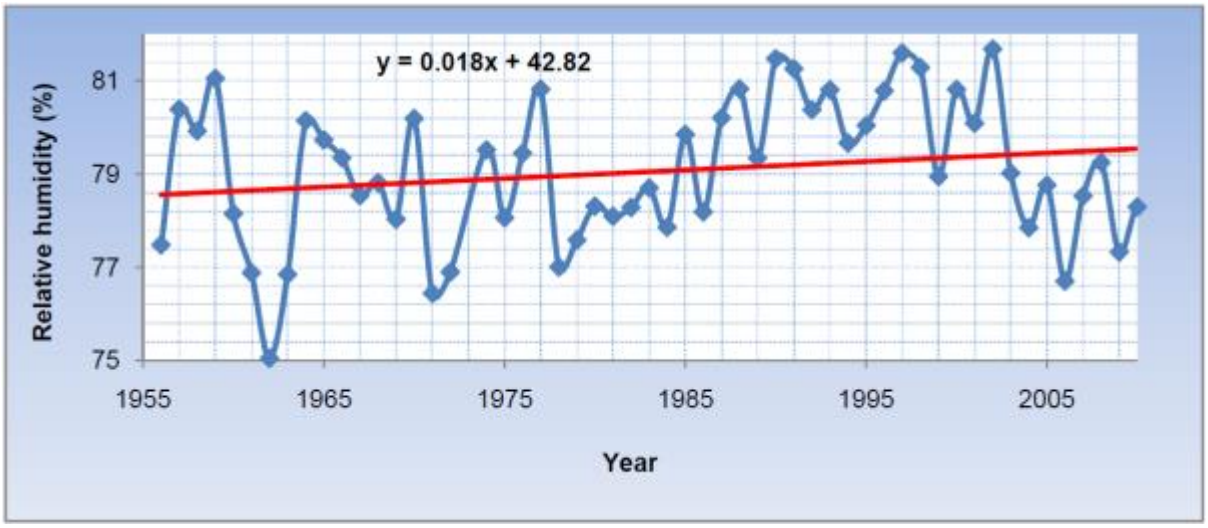


Source: CEGIS report on EIA study of Kalni Bridge, 2014

Figure 5.11: Annual variation of rainfall in the study area (1950-2005)

The rainfall intensities and patterns have also been changed and extreme consequence of it is affecting the study area. In the last 60 years the annual rainfall of the study area decreased by 1.165mm per year at Sylhet. The annual variation of the rainfall in the study area is shown in **Figure 5.11**.

Along with the other factors, average humidity also experienced a slight change. The average annual relative humidity increased 0.018% per year in last 55 years at Sylhet region. The variation of average annual relative humidity of the study area is shown in **Figure 5.12**.



Source: CEGIS report on EIA study of Kalni Bridge, 2014

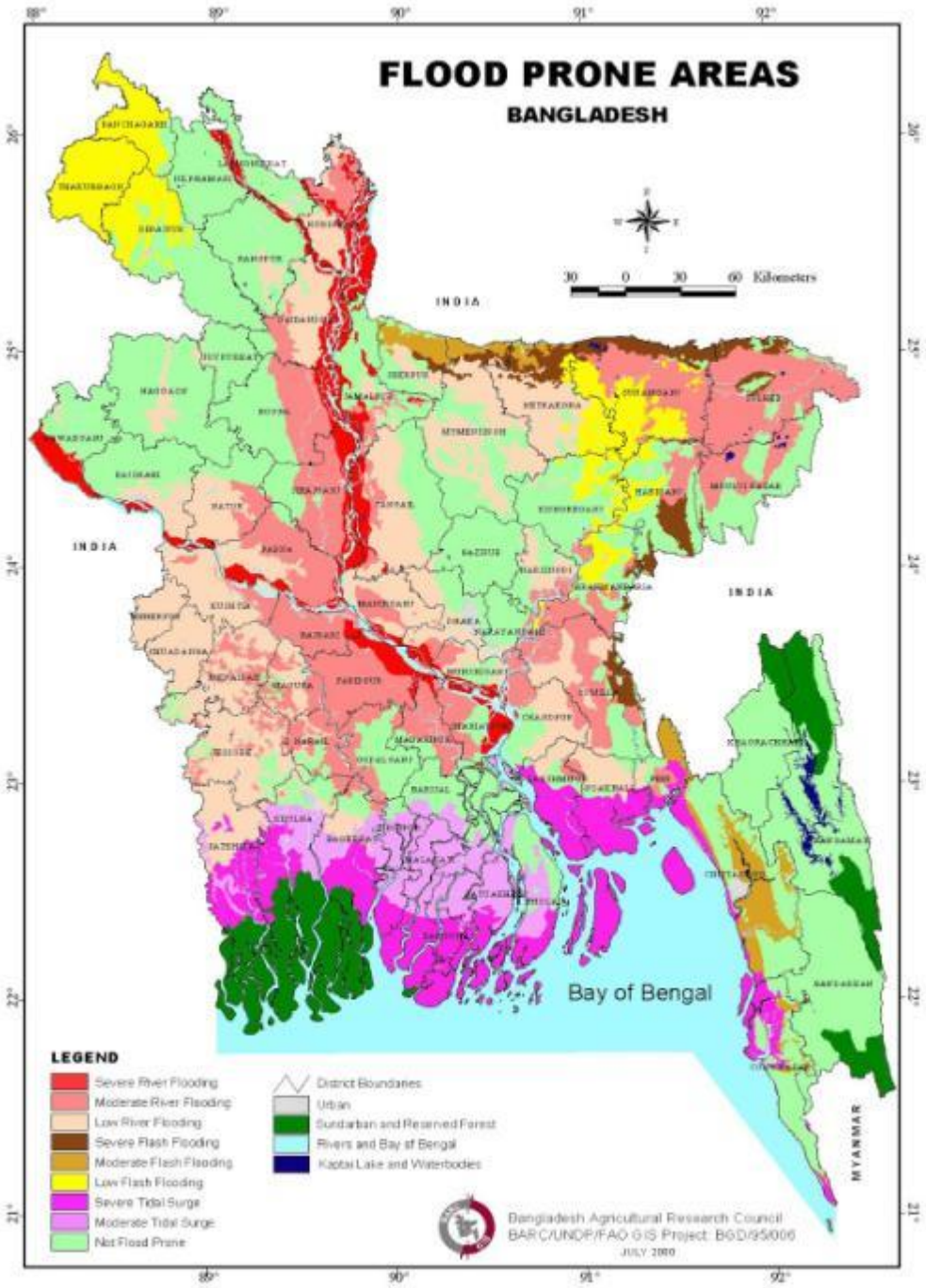
Figure 5.12: Annual variation of relative humidity in the study area (1955-2010)

5.2.3 Flooding

Bangladesh is particularly vulnerable to climate change. Two-thirds of the country is less than 5 meters above sea level, making it one of the most flood prone countries in the world. Severe flooding during a monsoon causes significant damage to crops and property with severe adverse impacts on rural livelihoods. Future climate change seems likely to increase the destructive power of monsoon floods.
The Haor Basin is a particularly vulnerable region of Bangladesh (IFAD 2011, WB 2010). Sunamganj district is situated in haor area consisting of medium lowland, lowland and very lowland. Usually haor areas are flooded for 6 months of the year from May to October. Flash flood in Sunamganj destroys agricultural products of large areas, causing death, damage to property, environmental pollution and destruction to roads and bridges. Pre-monsoon flash floods damage the main crop Boro rice at the time of or just before the time of harvesting. Flood Forecasting and Warning Centre (FFWC) of Bangladesh Water Development Board (BWDB) simulates a flash flood forecast model of the region during the pre-monsoon period to generate the flash flood forecast. Institute of Water Modelling (IWM), Bangladesh also maintains and operates hydrological and hydrodynamic models covering the entire country. However, due to lack of satisfactory rainfall forecast, none of the organizations can produce flash flood forecast in a satisfactory level. ADPC is simulating Weather Research Forecast Model and generates a high resolution 72 hour forecast of rainfall, mean sea level, pressure and wind covering the entire Southeast Asia. The simulation parameters are likely to be useful input for hydrological and hydrodynamic models to be developed for flash flood forecast in the northeast region of Bangladesh.

Most of the rivers in haor areas are originated from nearby hilly area of India. These rivers are extremely flashy that is characterized by sudden and wide variation in flow as a result of excessive rainfall. When heavy rainfall occurred in the hilly region of India, water quickly moves towards the haor area through a

number of rivers and khals generating flush flood. During flush flood, flow of water carries sediments, which are eroded from the hilly catchment area. During heavy rainfall in the hilly region, massive erosion takes place on the exposed surface of the hill. When the high intensity rainfall is continued for certain period, coarser sediment starting to erode and move along the rivers. Finally these sediments are deposited on the river bed, khals, canals and agricultural land.



Map 5.4: Flood Prone Areas of Bangladesh

Flush floods are more likely occur in the project site. The project area faced severe flush flooding in 2004 and 2018. During these flush floods, flood water came into the haor very early in the monsoon and farmers didn't get sufficient time to harvest their standing boro crop. Though some of low lying areas are protected by flood embankments by BWDB, these embankments are submersible and sufficient only to check local early flash floods. The study area is bounded by Surma river system in the north, Surma-Baulai river system in the west and by Kushiyara-Kalni river system in the southest. The Madanpur-Dirai-Sullah road crosses and runs along a few small rivers and khals namely Old Surma, Champti and Darain. Therefore, flush flood is a vital issue for the long-term safety of the the Madanpur-Dirai-Sullah road.

5.3 Environmental Quality

Baseline data for environmental quality monitoring has gathered on noise quality, air quality, water quality and soil quality in the project area. The values of the aforementioned environmental parameters are collected and analysed considering both primary and secondary information from different sources.

5.3.1 Noise

The noise in the environment is a noise caused by unwanted or harmful external sound, made from the human activities, which is imposed by the surroundings and it causes discomfort and disturbance, including the noise emitted from vehicles, road, rail and air transport and from the industrial activity. The existing Dirai-Sullah road is running through low-lying haor area which is thinly populated with lack of development activities. Many haors like Boram haor, Dekher haor, Bera Haor etc. are located in and around the project site. Therefore, usually noise level in the haor area is quite good and within the permissible limits by the DoE. **Table 5.2** shows the standard values for noise in Bangladesh and **Table 5.3** shows day and night time noise levels of the haor area.

Table 5.2: Standards of noise levels for different zones of Bangladesh

Zone Class	Limits in dBA	
	Daytime (6am-9pm)	Nighttime (9pm-6am)
Silent zone	45	35
Residential zone	50	40
Mixed	60	50
Commercial zone	70	60
Industrial zone	75	70

Table 5.3: Daytime and night time noise levels of the haor area

Location	Maximum Noise Level (dBA)	
	Day time	Night time
Dhekher haor	48.5	46.2

Location	Maximum Noise Level (dBA)	
	Day time	Night time
Bero haor	74.5	55.2
Dhaskhiner haor	50.5	44.2
Mokker haor	58.5	48.2
Shanir haor	59.5	54.2
Naogaon haor	50.5	48.2
Chatal haor	66.5	56.2

Source: EIA Report on 'Haor Flood Management and Livelihood Improvement Project', 2016

5.3.2 Air Quality

Air quality of the project site is quite good. The data of air Quality has been collected from the EIA study of the haor management plan, 2016. The ambient air quality of some the haors at and around project site are given below in the following Table.

Table 5.4: Ambient air quality of some the haors at and around project site

Location	Unit	SPM	PM_{10}	CO	O_3	NO	NO_2	NO_X	SO_2
Dhekher haor	$\mu g/m^3$	41.6	23.3	1393	18	107	194	301	3
Bero haor	$\mu g/m^3$	35.3	20.6	1516	19.15	155	302	457	0
Dhaskhiner haor	$\mu g/m^3$	87.3	49.1	2057	14.81	133	259	382	0.133
Mokker haor	$\mu g/m^3$	65.4	35.2	1624	16.0	197	189	386	3
Shanir haor	$\mu g/m^3$	82.3	46.1	2477	25.30	271	196	467	1.2
Naogaon haor	$\mu g/m^3$	88.5	52.1	2166	16.19	90	296	386	0.083
DoE Urban Standards 2005	$\mu g/m^3$	200	150	40000	235	NSY	200	-	365
WHO Guidelines	$\mu g/m^3$	50	25	30000	-	-	40	-	20

Source: EIA Report of 'Haor Flood Management and Livelihood Improvement Project', 2016

5.3.3 Water Quality

Water quality including surface and groundwater of the study area are quite good. The Water quality monitoring is very important in the study area as most of the people of the study depend on the river/haor water for their domestic/irrigation and ground water for drinking purposes.

The water quality parameters were tested in-situ by the study team using portable multi-parameter meter and Colorimeter in four locations namely, Dirai Sadar, Machurkhaira, Anandapur and Sullah Sadar. The in-situ water quality parameters Temperature, pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), Total Dissolve Solid (TDS), Resistivity, Salinity, Phosphate (PO_4^-), Sulphate (SO_4^-) and Nitrate (NO_3^-) are given below along with the DoE standard of water quality. It is observed after analysing **Table 5.5**, and **Table 5.6**, the water quality parameters are within Standard value provided by DoE (ECR, 1997) in the study area.

Table 5.5: In-situ water quality test results using HQ30D portable multi-parameter meter

Location	Easting	Northing	Temp. (°C)	pH	DO (mg/l)	EC (µS/cm)	TDS (mg/l)	Resistivity (kΩ-cm)	Salinity (%)
Dirai Sadar	333161	27420668	29.1		6.75	47.2	22.10	22.10	0.02
Macchrkhaira	330951	2738102	29.4		6.89	46.00	21.58	21.72	0.02
Anandapur	327398	2733935	30.1		7.09	53.30	25.00	18.76	0.02
Sulla Sadar	325129	2730069	30.3		7.63	55.00	25.8	18.17	0.02
DoE Standard (ECR, 1997)	Irrigation		20-30	6.5-8.5	>5.0	-	1000	-	-
	Fishing		20-30	6.5-8.5	>5.0	-	1000	-	-

Source: RRI field Investigation, July, 2018

Table 5.6: In-situ water quality test results using Colorimeter

Location	Easting	Northing	PO_4^- (mg/l)	SO_4^- (mg/l)	Cl^- (mg/l)	Fe (mg/l)	Mn (mg/l)
Dirai Sadar	333161	27420668	1.01	8.0	0.99	0.61	0.60
Macchrkhaira	330951	2738102	0.72	4.0	0.25	0.71	0.30
Anandapur	327398	2733935	0.48	2.0	0.08	0.76	0.30
Sulla Sadar	325129	2730069	1.47	11	0.55	0.70	0.40
DoE Standard (ECR, 1997)	Irrigation		6.0	400	-	0.30-1.0	0.10
	Fishing		6.0	400	-	0.30-1.0	0.10

Source: RRI field Investigation, July, 2018

Figure 5.13: RRI personnel testing water quality in-situ at Macchrkhaira, Dirai (left) and Sullah Sadar (right)

5.3.4 Sources of Pollution in the Project Area

The project area is a thinly populated haor area and very quiet and tranquil. So, pollution might be less likely occurred in this site. One of the sources of pollution is human waste as some of the people of this area uses kancha Toilet. Besides, this area is renowned for rice production. Fertilizer and pesticides are used for crop production which ultimately get washed out and enter into the river and haor during monsoon. From the people's opinion, it is known that the land is very fertile due to heavy siltation and therefore, limiting use of fertilizer and pesticides in this area. So this kind of chemical pollution is not that much threatening. Further, dust generation during rice harvesting is another possible source of air pollution.

Figure 5.14: Water and air pollution from kancha Toilet (left) and dust generation during rice harvesting (right) in the study area

5.4 Water Resources

The water resources system of the study area meets the demand of the surrounding ecosystem and provides livelihood for the people of this region. It is the source of water supply, and plays an indispensable role in assimilating and diluting waste, attenuating and regulating drainage, recharge into the aquifer, and maintaining the environment for aquatic habitats.

5.4.1 Major River Systems

The major river systems of the northeast region are described below:

- Surma-Baulai-Ghorautra river system which starts as the northern branch of the Barak River at Amalshid and collects inflows from the Meghalaya hills and Kangsha system.

- Kushiara-Kalni-Dhaleswari river system, which starts as the southern branch of the Barak river at Amalshid and collects inflows from the Tripura Hills, local runoff, and spills from the Surma river.

- Kangsha river system, which includes inflows from the Susang Hills and locally generated runoff from the northwest corner of the region.

- Old Brahmaputra river, which now only carries spills from the Brahmaputra river and local runoff.

- Upper Meghna river, which commences 5 km upstream of Bhairab Bazar at the junction of the Ghorautra and Dhaleswari river systems, to form the outlet of the northeast region;

The Barak River is the main source of inflow of this region. It enters Bangladesh at Amalshid border and bisects to form the Surma and Kushiara rivers. The Surma and Kushiara rivers are two main rivers of the eastern part of the region and these two rivers receive most of the flashy river flows which enter the region from the Meghalaya Plateau and Tripura Hills. The largest of these rivers includes the Sarigowain, Lubhachara, Manu, Kowhai and Sonaibardhal. Inflows from these tributaries cause considerable spilling from the Surma and Kushiara during the monsoon. Spill flows follow a wide flood plain on the Kushiyara right bank, eventually joining the Kalni and Dhaleswari rivers before reaching the upper Meghna.

The Kangsha, Someswari and Mogra rivers drain a large part of the west of the region. These rivers join the Dhanu and Baulai rivers, which in turn capture additional flash flood flows emerging from the hilly catchments across the border before entering the central depression. The floodplain which constitutes the depression carries enormous volumes of water under minimal hydraulic gradient; in the monsoon the longitudinal gradient in the depression is almost horizontal, falling less than 1 cm per km, but conveying flows of more than 5000 m^3/s. The entire region drains through a single outlet at Bhairab Bazar on the upper Meghna.

The project area is located in the low-lying haor area of the north-eastern part of Banhladesh. Many rivers pass through the low lying this area creating a complex network of rivers. The main rivers include the Surma, the Kushiyara, The Kalni and the Baulai. There are many tributaries and distributaries of the main rivers. The network of the rivers at and around the study area is shown in **Figure 5.15**.

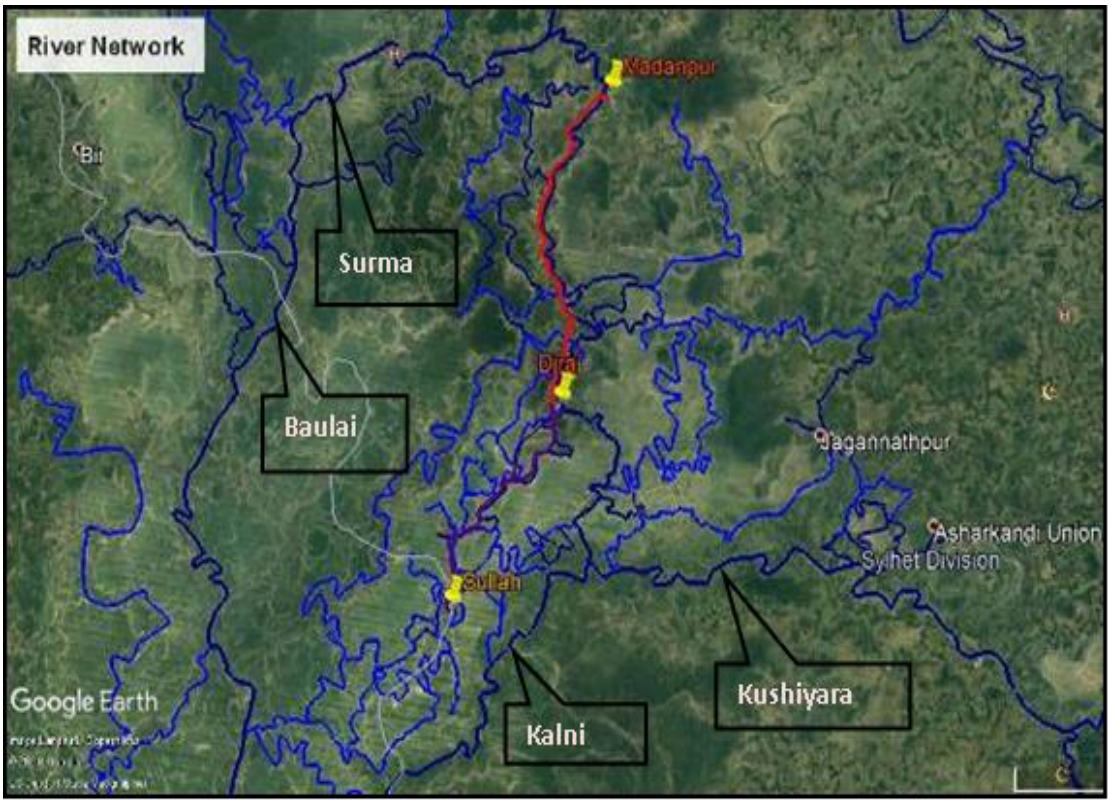


Figure 5.15: Complex River system at and around the project area

Surma-Kushiyara river System

The Kushiyara is one of the trans-boundary rivers in Bangladesh which is a branch of the Barak river of India. It originates from the northern hills of Assam and then it flows further creating the border between Nagaland and Manipur States. The river enters Bangladesh along 24°53/ north latitudes and 92°32/ east longitudes after flowing westward from Milchar in Kachar district of India. At Amalshid in the northeast border of Zakiganj upazila of Sylhet district the Barak river bifurcates into two branches. The southwestern arm is the Kushiyara river and the northwest arm is the Surma river. The Kushiyara rejoins with the Old Surma at Markuli in Ajmiriganj upazila and flow south upto Bhairab Bazar receiving the name Kalni. The Kalni meets with the Dhanu, a branch of the Surma, and then is renamed as the Meghna. In the upstream from Markuli, part of the course of the Kushiyara is known as the Bibiyana.

A large part of the Surma river is dried up at Amalshid, and as a result, about 85 percent flow of the Barak passes through the Kushiyara. The total length of the Kushiara river from Amalshid to Markuli is about 180 km. In its course the Kushiyara meets with two tributaries on its left bank, the Sonai-Bordol river and the Juri river. They arrive from Assam and Tripura States of India. Next the Manu river, a major tributary of the Kushiara river falls at Manumukh of Maulabibazar district. The Kushiara and its tributaries are silt carrying, flashy and eroding rivers. It's important water level measuring stations are at Amalshid, Sheola, Fenchuganj and Markuli. From Amalshid, the Surma flows west and then southwest to Sylhet town. From there it flows northwest and west to Sunamganj town. Flowing north of the Sylhet basin, Surma receives tributaries from Khasia and Jaintia Hills of Shillong plateau and bifurcates at the south of

Mohanganj soon after it receives the Kangsa and further south the Mogra. Then one branch continues to flow southwest and the other flows down to south to Markuli. This southward flowing branch of the Surma river is called Old Surma river. At about 11km (along the river) southwest of the Sunamganj town the Old Surma river (formerly the main branch of the Surma river) turns southwards near Mohanpur union and heads into the low-lying central Sylhet basin, eventually rejoining the Kushiyara river at Markuli. By 1952 the the Old Surma channel was a smaller distributary and the entrance of this river was only about 40m wide and 2m deep in the dry season. It is highly likely that the Old Surma river does not carry much of the flood flow of the Surma. In the downstream of the off-take, the Old Surma river flows through the Central Basin lowlands and experiences backwater from the Meghna river throughout the monsoon. As a result, flow spills out of bank and the channel becomes deeply submerged in the vast lake of the flood basin. During these conditions the channel carries only a fraction (in the order of one third to one half) of the total river discharge and the channel's capacity to transport sediment becomes substantially reduced. Therefore, this lower reach becomes a natural sedimentation zone during the monsoon.

At about 4.3km (straight distance) north of the Dirai upazila headquarter the Old Surma river bifurcates into two channels. The eastern channel flows south to the Dirai town and finally joins the Kushiyara river at Markuli. Along its course, the Old Surma river follows a meandering pattern. There are a few stretches of the river where the sinuosity value is very high (>1.5). There is no bank erosion problem in this river. It is known that the flow volume and width of the river is gradually decreasing. The Old Surma river near the Madanpur-Dirai part of the road is shown in **Figure 5.16**.

Mohashing-Dauka-Kamarkhali River

The Mohasing river originates from the beel area (Ufa Beel) of South Sunamganj. Afterwards it follows a southeastward meandering course upto Chhayhara. It crosses Sunamganj-Sylhet regional highway at Pagla (Debor Point) and Pagla-Jagannathpur-Raniganj regional highway at Chhayhara. There are bridges over this river at these two locations. From its origin to Chhayhara the river is fed by a number of drainage channels and tributary. The Ghanura-Bagala (Bukha) is a tributary that meets with the Mohashing river at about 2.7km (along the river) downstream of the bridge over the same river near Debor Point. From Chhayhara bridge the river flows southwest for about a distance of 5.3km and then flows down to south and east to fall into Kamarkhali river. The total length of the river is about 33km. The discharge and width of the river have not undergone noticeable changes over the time but the depth is decreased. There is also problem of bank erosion. During monsoon, water enters into the flood plain. The width of the river varies along its course with average width being 116 m. It has sinuous pattern with surface water slope o.3 cm/km. The only BWDB water level gauge station is SW 199-Mohasing Ferrighat (NTWL) and there is no discharge gauge station.

The Duaka river takes off from Botor khal at Dular Bazar union of Chatak upazila under Sunamganj district. After traversing a distance of about 33km (along the river) the river falls into the Kamarkhali river of Dhakshin Sunamganj upazila. The river remains almost dry from the month of November to April. However, during monsoon water enters into the floodplain. Navigation is possible only during monsoon. The river crosses the Pagla-Jagannathpur-Raniganj highway at Kalkalia. There is a 47m long

baily bridge (from chainage 12.108km to chainage 12.155km) over the river at this location. The width of the river varies from 29m to 113m. The average width of the river is 60m.

The Kamarkhali river starts from the meeting point of the Mohashing and the Dauka at Telikona. After traversing a distance of about 35km (along the river) from the starting point it joins with the one branch of the Surma river at Taral union of Dirai upazila. The combined flow then follows an 8km (along the river) course to finally discharge into the Kalni river at Markuli. The Kamarkhali is a meandering river and it is very highly sinuous in its downstream part. There are traces of meander scars in this downstream part of the river. The river runs through Dhakshin Sunamganj, Jagannathpur and Dirai upazilas of Sunamganj district. During monsoon, water enters into the flood plain. The river water is used for agriculture. The river is navigable throughout the year.

Source: RRI field investigation, 2018

Figure 5.16: A view of Old Surma river flowing along the Madanpur-Dirai-Sullah road at Dirai (left) and the Champti-Darain river at Sullah upazila sadar (right)

Chamti-Darain River

The Chamti-Darain is originated from the southern branch of the Surma river. From Dirai the Chamti-Darain flows down to the south and fall into the Bera Mohona Beel in Sullah Upazilla which finally drains out to the Kalni at Ajmeriganj. A view of the Champti-Darain river at Sullah upazila headquarter appears in **Figure 5.16**. The total length of the river from its source at the Dirai town to Sullah upazila headquarter is about 27.5km whereas the straight distance between these two points is about 14km. It means the Champti-Darain river exhibits highly meandering pattern. The width of the river varies along the course. Generally higher width is found at bend locations. The Anandapur bazar and the Sulla upazilla headquarter are located on the banks of this river. The river Darain flows as irregularly meandering sand-bed channel and the meandering is extreme at the downstream part. At the downstream channel, the river splits around permanent islands and displays bars and shoals. The river system carries sediment originated from the upstream areas.

5.4.2 Drainage

The Dirai-Sullah portion of the Madanpur-Dirai-Sullah road runs along the Champti-Darain river and crosses the same river at Sullah upazila headquarter. There are a number of floodplain channels that drain water to the nearby rivers during the recession period of flood. The road is an obstruction to smooth drainage. There is no water level and discharge gauge station on the Champti-Darain river or on the Old Surma river. However, there are BWDB water level and discharge measurement stations on the rivers surrounding the project area.

The study area is frequently devastated by early flooding in terms of damage to crops, homesteads and different infrastructures. BWDB constructs low height submersible dams along the river to protect the crop damage by early flooding in the form of flash flood. The cross-drainage works on the Dirai-Sullah road allows for passage of floodplain flow and flood spill of the Champti-Darain river from northeast to southwest and east to west direction during monsoon. Therefore, these structures maintain without project flow regime in the study area to some extent. However, in case of a pre-monsoon flash flood they also allow for entrance of flood water into the adjacent floodplain and damage crops. In order to cope with this situation, local people generally construct closures themselves across the culvert openings to prevent flood water from entering into cropland. There are a number of major connections between the river and its adjacent floodplain to the west. RHD has already closed three such connections (at Islampur, Chandipur and Anandapur) by constructing roads. At two locations (between Nayagaon and Dhanpur and at Kashipur) Bangladesh Water Development Board (BWDB) constructs temporary submersible channel closures every year to prevent early flood water from entering into the cropland. There is no road structure at these two locations. Local people and authorities are of the opinion that total closure of these two gaps will be the permanent solution of the early flooding problem. They are strongly against construction of any bridge at these two locations despite the fact that these channels serve as important connections between the river and floodplain. Therefore, this issue is very important and has to be addressed very carefully.

Drainage pattern throughout the study area follow the land gradient, sloping from north to south and from either side of the study area towards the Surma (Nawa River) Baulai channel. Consequently, distributary channels from the Surma river all behave as spill channels, diverting water out of the Surma system into the central basin lowlands. In the downstream of the study area, Someswari river, Kangsha river and Dhanu river drains in a south and easterly direction into the Baulai river system. The gradient of these tributary streams all flatten out appreciably as they approach the low-lying central basin lands. The streams connect with the Baulai river through a complex maze of distributary channels.

5.4.3 Siltation

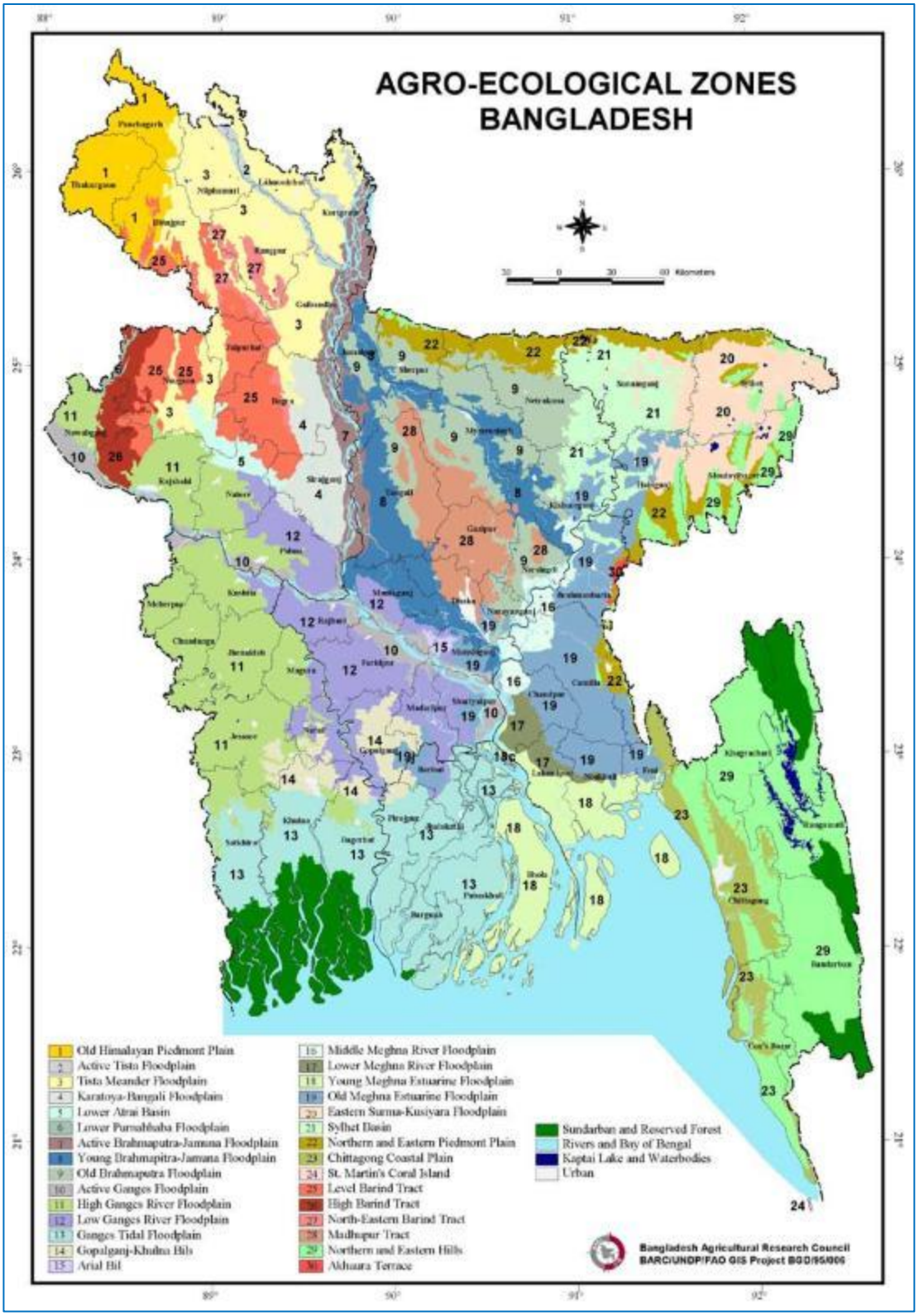
Siltation is a common issue in the haor area. The most of the rivers are very flashy in this region and the origins of the rivers are adjacent to hilly area of India. During heavy rainfall in the hilly region of India, water quickly moves towards the haor area of Bangladesh through a number of rivers and khals. This floodwater not only carries the water but also carry a huge amount of sediment. This sediment gets deposited over time on the river and canal beds and reduces the conveyance capacity more or less all of the water resources system within the haor area. During heavy rainfall in the hilly region, massive erosion

is taken place on the exposed surface of the hill. If the high intensity rainfall is continued for certain period then coarser sediment such as big sized stone, boulders etc. start to erode and move along the rivers. Finally these sediments are deposited on the river bed, khals, canals and agricultural land. During flash flood, sediment transport rates of the rivers increase significantly and hence major flood events make a disproportionate distribution of sediment and changes in channel size, shape and even location. The sediments carried by the rivers are also deposited along the river banks resulting in an increase in the land elevation there compared to the surrounding haor and beel areas. These elevated lands are inhabited by people. Similarly, siltation is more likely a key problem in Dirai-Sullah road link project. The Surma, Baulai River and Kalni are silted up from upstream along with high flow. Sedimentation has been taking place in the river both upstream and downstream over the years and cumulative effect in fact reduces the depth significantly. The conveyance capacity of the river has decreased due to high siltation rate. The level of water is changing with its seasonality. When the river has low flow, sediment is deposited. Thus, depth of the river is decreasing and the carrying capacity is reducing.

5.5 Land Resources and Agricultural Environment

5.5.1 Agro-ecological regions

Agro-ecological region/ zone have unique combination of physiographic, soil, hydrological and agro-climatic characteristics. Bangladesh has been subdivided into 30 agro-ecological regions and 88 sub-regions according to the Land Resources Appraisal of Bangladesh for agricultural development (**Map 5.5**).Thirty agro-ecological regions zones, 88 sub-regions and 535 units have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. These layers are: (i) Physiography (land forms and parent materials); (ii) Soils and their characteristics; (iii) Depth and duration of seasonal flooding; (iv) Length of the rainfed Kharif and Rabi growing periods; (v) Length of the pre-Kharif period of unreliable rainfall; (vi) Length of the cool winter period and frequency of occurrence of extremely low (below 0.4^0C) winter temperature; (vii) Frequency of occurrence of extremely high (> 40^0C) summer temperature (FAO/UNDP, 1988). Agro-ecological regions and sub-regions are very broad units and fertility status of these regions varies considerably (BARC, 2005).



Map 5.5: Agro-ecological zones of Bangladesh

The project area is positioned in the agro-ecological zone of Sylhet Basin (4573 sq. km) (AEZ-21). The region occupies the lower, western side of the Surma-Kushiyara floodplain. The soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. Peat occupies some wet basin centres. The soils have a moderate content of organic matter and soil reaction is mainly acidic. The fertility level is medium to high. About 74% of the top soil texture of the haor region is clay to clay loam, 21% loam and the rest are silty loam, sandy loam and sand.

Table 5.7: Some Physiochemical properties of soils of AEZ-21

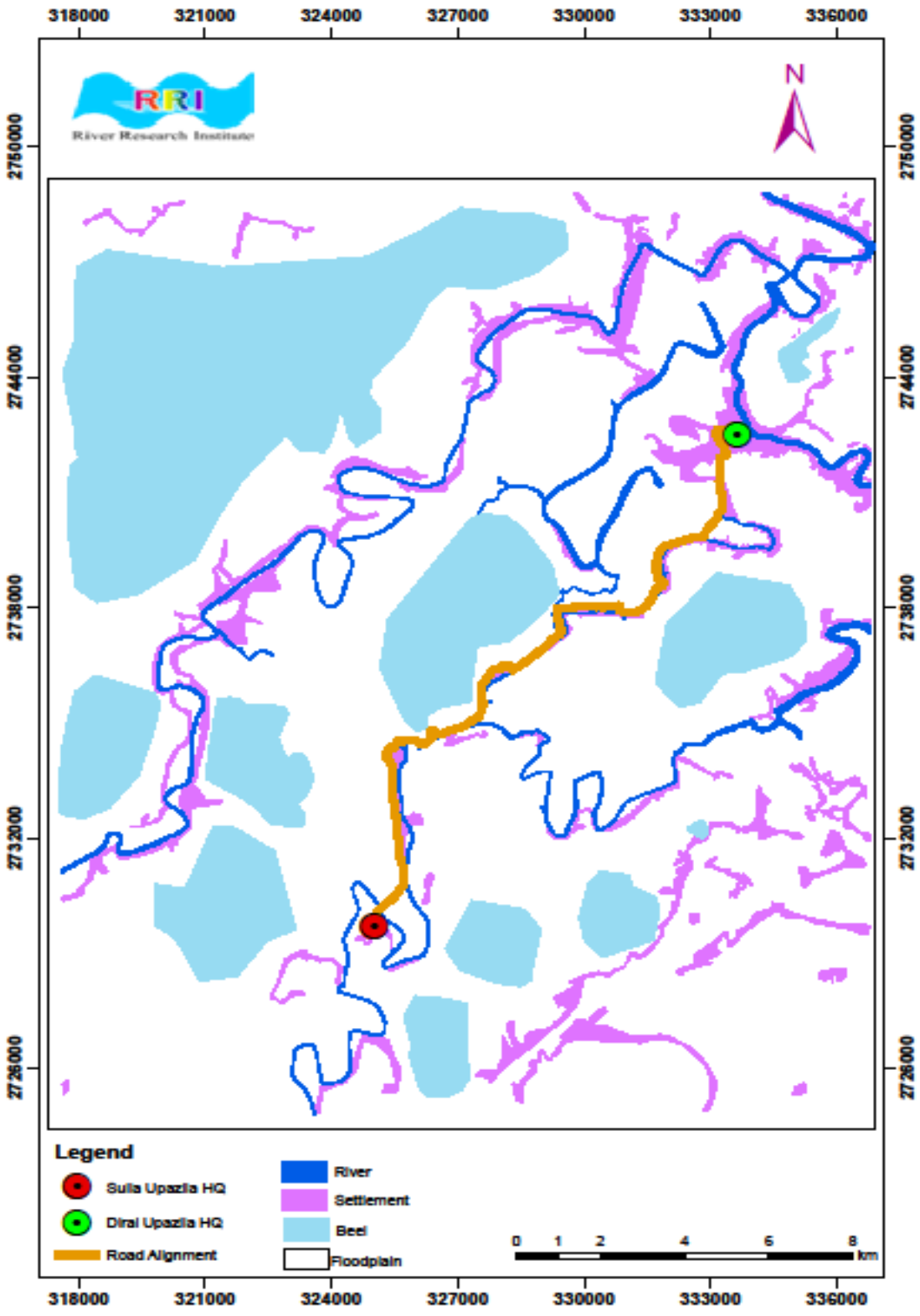
Major Land Type	Soil pH	Soil OM	Nutrients Stats								
			N	P	K	S	Ca	Mg	Zn	B	Mo
Medium Low Land (19%)	4.8-6.0	L-M	L	L-M	L-M	M-Opt	M-Opt	M-Opt	M-Opt	Opt	Opt
Low Land (43%)	4.8-6.0	M	L	L-M	L-M	M-Opt	M-Opt	M-Opt	M-Opt	Opt	Opt
Very Low Land (32%)	4.8-6.0	M	L	L-M	L-M	M-Opt	M-Opt	M-Opt	M-Opt	Opt	Opt

OM=Organic matter; VL=Very low; L-Low; M=Medium; Opt=Optimum; H=High; VH=Very high

Source: Fertilizer Recommendation Guide-2005, BARC.

5.5.2 Land use

The study area lies within low lying haor areas surrounded by cultivable lands, some uncultivable lands and water bodies with a small amount of human settlements etc. Besides, there are hats, bazars and growth centers are also available. There is very small amount of commercial and industrial establishments are available as the study area is in haor area. The study area belongs to deeply flooded area (flood depth>1.8m) and cropping pattern is fallow-fallow-boro. The agricultural land is mainly vegetation type. Agriculture and fishing are the main output of the region. Cropping patterns are determined by the seasonal floods with rice is the major crop in this region. Details of land use status of the study area are presented in the **Table 5.8**.



Map 5.6: Land use pattern in Study area of the Dirai-Sullah Road Project

Source: RRI Field Investigation, 2018

Figure 5.17: Land uses pattern in the study area

Table 5.8: Present land use status of the project area

Land Use	Area (ha)	Percent of total area
Total Area	46060	100
Net Cultivable Area (NCA)	31878	69
Settlements	2368	5
Water bodies (river, beel)	11814	26

Source: RRI estimation from Satellite Image and Upazila Agricultural Offices, 2018

5.5.3 Soil texture and Organic Matter Content

Soil texture is the relative proportions of sand, silt and clay and it is very important for agriculture crop production. On the other hand organic matter is the fraction of the soil that consists of decomposition of plant or animal tissue and it is very important parameter for determining agricultural production. Most of productive agricultural soils contain 3 to 6% organic matter.

The study area is under the Sylhet Basin (4,573 sq. km). The region occupies the lower, western side of the Surma-Kushiyara floodplain. The soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. Peat occupies some wet basin centres. The soils in the study area contain with a range of 4 to 8% organic matter. The fertility level is medium to high. About 74% of the top soil texture of the haor region is clay to clay loam, 21% loam and the rest are silty loam, sandy loam and sand.

It is observed from the field visit that the existing Dirai-Sullah road is constructed of locally available soils collected from surrounding the road and road structures. The road is constructed only a few years ago and borrow pits are still clearly visible. The top soil in the project area consists of an upper alluvial cohesive deposit of very soft to medium stiff silty clay and clayey silt mixed with varying amount of fine sand. At places the soil type is acid basin clays. The texture of the soils is silty clay. The bearing capacity of this type of soil is poor. These types of soil are very good for agricultural production but not suitable for road construction.

5.5.4 Soil Moisture

The available soil moisture is very important for the cultivation of different crops. The soils having capacity of high level of available soil moisture are highly suitable for cultivation of Rabi crops under rain fed condition. According to SRDI (1988), the available soil moisture has been classified into four categories. In the study area three categories of available soil moisture have been identified. About half of the area is covered under high level of available soil moisture (46%) with other half combined of medium level soil moisture (31%) and low soil moisture (23%). Detailed distribution available soil moisture of the study area is presented in Table-5.9.

Table 5.9: Detailed distribution of available soil moisture in the project area

Available Moisture	Characteristics	Area (ha) of NCA	% of NCA
Low	Plant extractable soil moisture remained in the field level less than one month.	7456	23
Medium	Plant extractable soil moisture remained in the field level from one to two months.	9952	31
High	Plant extractable soil moisture remained in the field level more than two months.	14470	46
	Total	**31878**	**100**

Source: RRI estimation from field information, Secondary data from Upazila Agricultural Offices and Satellite Images.

5.5.5 Drainage characteristics

Drainage plays a vital role in the management of soil in the study area. As per the SRDI (1988), the drainage characteristics have been divided into six classes from the agriculture point of view. About half of the area in study area is under very poorly drained (46%) which is followed by poorly drained (31%) and well drained (23%). Detailed drainage characteristics of the study area are presented in Table 5.10.

Table 5.10: Detailed drainage characteristics of the study area

Drainage classes	Drainage Characteristics	Area (ha) of NCA	% of NCA
Well Drained	Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep.	7456	23
Poorly Drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season.	9952	31
Very Poorly Drained	The land remains submerged under water for more than 8 months and remains wet throughout the year.	14470	46
	Total	**31878**	**100**

Source: RRI estimation from field information and Secondary data from Upazila Agricultural Offices, 2018.

5.5.6 Farming practices

Agricultural crops are grown according to cropping seasons. Kharif and Rabi seasons are two distinct cropping seasons in a year. The Kharif season starts from March and ends in October while the Rabi season starts from November and ends in February. Based on crop adaptability and crop culture, the Kharif season has been further sub-divided into Kharif-1 (March-June) and Kharif-II (July-October) season. The Rabi season starts from November and ends in February. During this season, crops are favoured with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield because of very low or evens no rainfall throughout the season. Wide ranges of crops can be grown in this season. Major crops grown in this season of the study area are HYV Boro, Tomato, chili, Mustard and Cucumber. However, there are occasional overlaps such that the Kharif-II season crops (Aman rice) are harvested in the Rabi season and Rabi season crop (HYV Boro) is harvested in the Kharif-I season.

5.5.7 Crop production constraints

The main constraints of the study area are siltation of river and drainage canals, drainage congestion, over rainfall etc. According to local people, the natural calamities such as flash flood, hailstorm, cyclone and drought, pest and disease infestation etc. are also affecting normal crop production to some extent. The main obstacle of agricultural production according to DAE, Sunamganj are as follows:

- Flush Flood
- Heavy Rainfall
- Fallow Land
- Low Ground Water Level and Rock Layer
- Siltation
- River Bank Erosion
- Hailstorm and Thunderstorm
- Lake of Human Resources in Field Level
- Labour Problem in Boro Cutting Season
- Lake of Technological Devices in DAE offices

5.5.8 Cropping pattern by land type

The dominant cropping pattern in medium high land and medium low land is Fallow-B. Aman-Mustard/Cucumber occupies 25% of the NCA. Fallow-Fallow-HYV Boro which is occupied by about 26% of the NCA in medium low land. In the very lowland, Fallow-Fallow-HYV Boro is being practiced about 46% of the NCA in low land. Detailed cropping pattern is presented in **Table 5.11.** Kharif-I season remains fallow. In Kharif-II season, B. Aman is grown in about 25% of the NCA. In Boro /Rabi season, Boro is grown in about 75% of the NCA. Rabi crops such as Mustard and Cucumber are occupied about 25% NCA. Summer and winter vegetables are mainly cultivated in the household area.

Table 5.11: Existing major cropping pattern by land type

Land type	Kharif-I (March-June)	Kharif-II (July-Oct)	Rabi (Nov-Feb)	Area (Ha) of NCA	% of NCA
Medium High Land	Fallow	B. Aman	Mustard	3826	12
	Fallow	B. Aman	Cucumber	2551	08
	Fallow	Fallow	HYV Boro	1079	03
			Sub Total	**7456**	**23**
Medium Low Land	Fallow	B. Aman	Mustard	1594	05
	Fallow	Fallow	HYV Boro	8358	26
			Sub Total	**9952**	**31**
Low Land	Fallow	Fallow	HYV Boro	14470	46
			Sub Total	**14470**	**46**
			Total	**31878**	**100**
			Cropping Intensity (%)	**117**	

Source: Secondary data from Upazila Agricultural Offices and RRI field survey, 2018.

5.5.9 Crop damage

Crop damage/ production loss along with area has been collected from the field in consultation with stakeholders, farmers, and officials of DAE. The main causes of crop damage are flash flood, drainage congestion, heavy rainfall, drought as well as different natural calamities in the haor regions. Flash flood and hail storm are common threat which causes crop damage in the study area. The siltation of the river and khals is caused rise of bed which directly influence for drainage congestion. The infestation of pest and diseases are also responsible for crop damage.

Crop damage is a common phenomenon in the study area. The Dirai-Sullah road crosses the Old Kalni river and paralally run through Champti-Darain river. The BWDB constructs low height submersible dams along the river to protect the crop damage by early flooding in the form of flash flood. The cross-drainage works on the Dirai-Sullah road allows for passage of floodplain flow and flood spill of the Champti-Darain river from northeast to southwest and east to west direction during monsoon. Therefore, these structures maintain without project flow regime in the study area to some extent. However, in case of a pre-monsoon flash flood they also allow for entrance of flood water into the adjacent floodplain and damage crops. In order to cope with this situation, local people generally construct closures themselves across the culvert openings to prevent flood water from entering into cropland. There are a number of major connections between the river and its adjacent floodplain to the west. RHD has already closed three such connections (at Islampur, Chandipur and Anandapur) by constructing roads. BWDB constructs temporary submersible channel closures every year to prevent early flood water from entering the cropland.

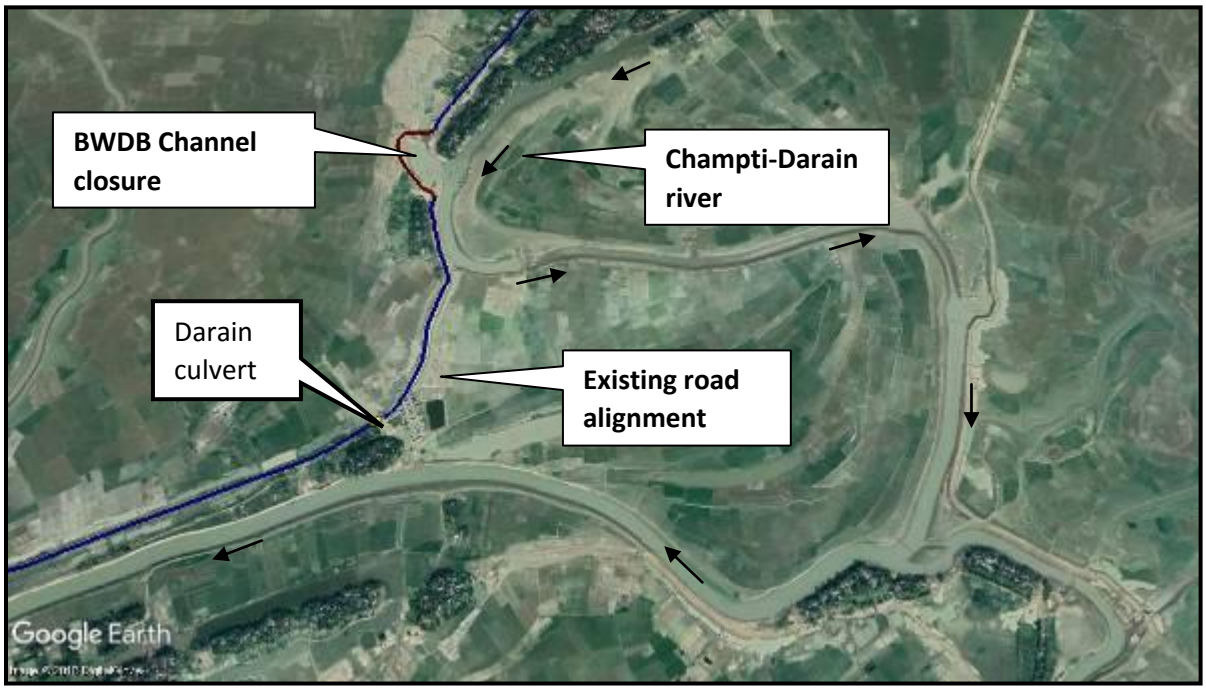


Figure 5.18: BWDB channel closure for preventing crop damage at Kashipur

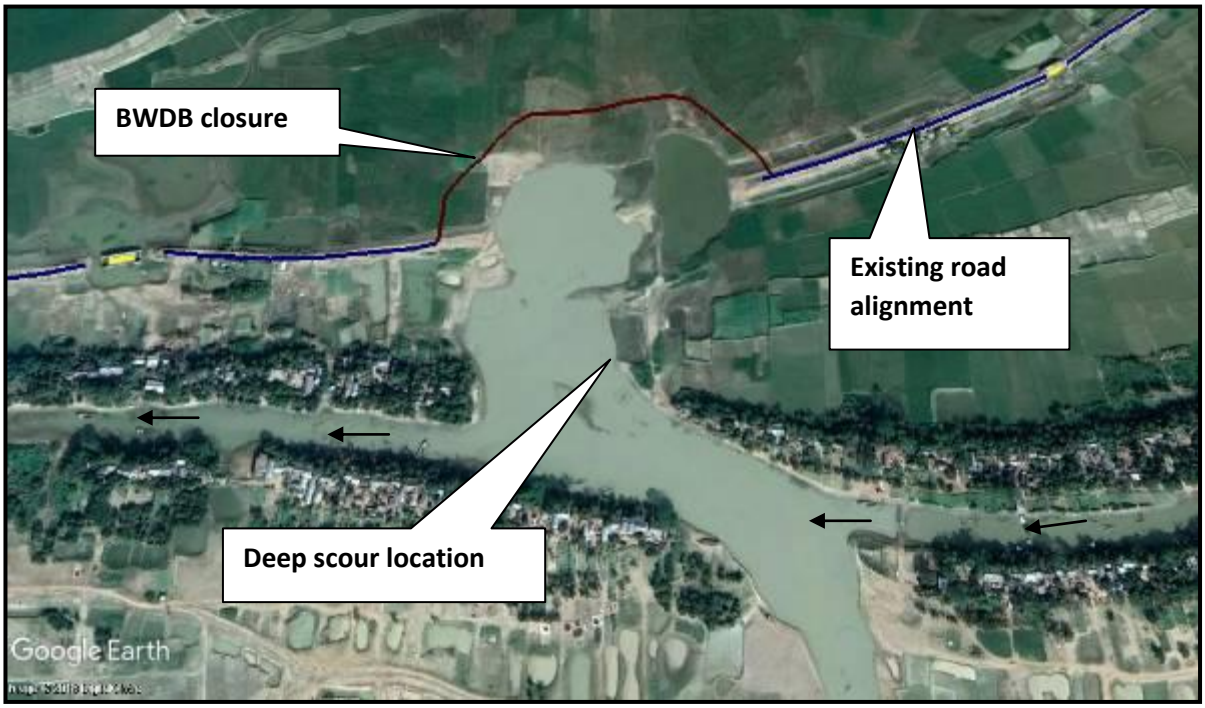


Figure 5.19: BWDB channel closure for preventing crop damage at Dhanpur

Annual crop damage in the project area has been evaluated. Crop production loss has been calculated using the formula: Crop production loss = Total cropped area ×damage free yield - (damaged area ×damaged yield+ damaged free area × damage free yield). Total 3958 metric tons of rice has been lost in 31878 ha land of the project area.

In 2018, HYV Boro and B. Aman were damaged about 10% and 20% respectively. The area of Dirai and Shulla were affected by heavy rainfall and drainage congestion during broadcasting period of Aman. Detailed crop damage is presented in **Table 5.12.**

Table 5.12: Crop wise damage in the study area

Crop name	Location	% of damage area	Timing	Causes of damage
HYV Boro	Dirai - Shulla	10	March-April	Flash Flood, Hail storm & pest infestation
B. Aman	Dirai - Shulla	20	July-August	Flash Flood, Heavy rainfall & drainage congestion

Source: Secondary data from Upazila Agricultural Office, Dirai and Sullah and RRI field survey, 2018

5.5.10 Seeds

Seeds are very important input to get a good agricultural production. A mature fertilized plant ovule, consisting of an embryo and its food store surrounded by a protective seed coat is termed as seed. It means, a ripened plant ovule containing an embryo. A propagation part of a plant, as a tuber or spore is also considered as seed. The role of seeds is very important for growing crops. Selection of seeds has to be made carefully. More than 85% germination rate, free from disease infestation and high yield potential need to be considered. The seed rate (kg/ha) varies crop to crop. The rice seeds are usually supplied by BADC, but hybrid vegetables are mostly supplied by private companies in the study area.

Table 5.13: Seed and Labor used in the study area

Crop Name	Seed Used (Kg/ha)	Labor (Number/ha)
HYV Boro	48	190
B. Aman	50	160
Mustard	8	100
Cucumber	0.5	90

Source: CEGIS report on EIA study of Kalni Bridge, 2014

5.5. 11 Labourers

Mostly manual labourer is used for cultivation in the study area as mechanized cultivation is very rare in the Haor region. So, agricultural labor is considered as one of the essential inputs for crop production in the study area. The labor requirement is vary throughout the year. There is some labourer problem during rice cutting season as people from other places comes in this place in a laser amount. The number of labor requirement varies from crop to crop.

Figure 5.20: Rice harvesting by manual labourer in the study area

5.5.12 Fertilizer and Pesticide

Fertilizer application rate is lower in the study area compared to the other part of the country because of the heavy siltation in rainy season and the extensive presence of organic matter in soil in this haor region. The rate of use of fertilizer per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in the project area are Urea, TSP and MP. Major insects as reported by the farmers are Stem borer, Ear cutting Caterpillar, Gall midge, pulse beetle and Aphids. Local farmer reported that they are using different types of pesticides such as Basudin, Furadan, Bavistin, Theovit, Know in WP and Virtako etc. to prevent pest infestation in rice and Rabi crops cultivation. Detailed fertilizer and pesticides used is presented in **Table 5.14.**

Table 5.14: Fertilizer and pesticides application of the study area

Crop Name	Fertilizer (Kg/Ha)				Pesticides		
	Urea	TSP	MP	Gypsum	No. of Application	Liq. (ml/ha)	Gran. (Kg/ha)
HYV Boro	180	10	60	-	2	700	8
B. Aman	100	30	20	-	1	700	-
Mustard	120	60	40	-	-	-	-
Cucumber	100	-	-	-	2-3	800	10

Source: CEGIS report on EIA study of Kalni Bridge, 2014

5.5.13 Irrigated area by crop

Irrigation is used in dry season to grow rice and vegetables. Irrigation coverage of the project area is about 85% of the total NCA during the dry season. Irrigation is mainly provided to HYV Boro crops. The source of irrigation water is surface water (Surma River). Irrigation water is lifted with the help of Low Lift Pumps (LLPs) to grow vegetables and rice. Detailed irrigated area is presented in **Table 5.15**.

Table 5.15: Irrigation area by crop

Crop name	Irrigation (Surface water)		
	Irrigated area	% of area	Charge (Tk./ha)
HYV Boro	19404*	85	6500/-
B. Aman	9050	100	5500/-
Mustard	5420	30	3500/-
Cucumber	2551	100	3500/-

Source: RRI estimation from field information

* Supplementary irrigation.

5.5.14 Yield level (Normal and damaged)

The crop yield rate was estimated from the information collected from DAE offices and consultation with the beneficiaries/ farmers at field level. The yield of rice is estimated as cleaned rice. The average yield value of different crops of the project area is presented in the following Table.

Table 5.16: Crop Yield level by different crops

Crop Name	Yield (ton/ha)	
	Normal	Damaged
HYV Boro	3.8*	2.5*
B. Aman	1.8*	1
Mustard	1.0	-
Cucumber	12.0	-

Sources: RRI estimation from field information and CEGIS report on EIA study of Kalni Bridge, 2014

**Indicates cleaned rice*

5.5.15 Crop production

The major agricultural production comes from the rice crop. In the study area, the annual total rice production is about 94512 metric tons after loss of 3958 metric tons. The total production of non-rice crops (such as Mustard and Cucumber) is about 36032 metric tons. Detailed crop production and crop production loss is presented in the following Table.

Table 5.17: Existing crop production of the study area

Crop name	Crop area (ha)	Damage free area		Damaged area		Total production (ton)	Production lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
HYV Boro	22828	20545	3.6	2283	2.5	79670	2510
B. Aman	9050	7240	1.8	1810	1	14842	1448
Total Rice	**31878**	**27785**	**-**	**4093**	**-**	**94512**	**3958**
Mustard	5420	5420	1	-	-	5420	-
Cucumber	2551	2551	12	-	-	30612	-
Total Non Rice	**7971**	**7971**	**-**	**229**	**-**	**36032**	**-**
Total	**39849**	**14472**	**-**	**1843**	**-**	**130544**	**3958**
Cropping Intensity (%)						**117**	

Source: RRI estimation from field information and DAE office, Dirai and Sullah upzilla.

Farmers receive about Tk 4,054,664,000 as annual return from different crops. Among the agricultural crops grown in the study areas, highest annual return of about 82% is coming from Rice. About 9% annual returns come from Mustard and 9% come from Cucumber of the total annual income. Detail of annual incomes of the agricultural crops of the study areas is shown in the following Table.

Table 5.18: Annual gross return from agricultural crop

Crop Name	Production (ton)	Rate (tk/ton)	Return (tk)	% of return
Rice	94512	35,000	3,307,920,000	82
Mustard	5420	70,000	379,400,000	09
Cucumber	30612	12,000	367,344,000	09
		Total	**4,054,664,000**	**100**

Source: RRI estimation from field information.

5.5.16 Livestock Resources

A large number of populations of the study area earn their livelihood through work associated with raising cattle and poultry. The use of cow dung as manure and fuel, and animal power for transportation, a ready source of capital and meat, milk and eggs for human consumption make up the demand of the local area. Livestock resources also play an important role in the sustenance of landless people. Most of the people are rearing cows/ bullocks, goats, chickens and ducks in their household.

Figure 5.21: Livestock resources in the study area

5.5.17 Feed and fodder

The owners of the livestock population are facing problems in respect of availability of fodder and feeds during rainy season due to standing crop and non-availability of grazing land. Rice straw is the main fodder. Oil cake, rice husk etc. are the other common fodders in this project area. Shortage of grazing land due to water logged is barrier to grazing cow in the land throughout the year aggravates the feed and fodder problem to the animal population. Poultry population at family level survives by scavenging and generally no feed supplements are provided. All feeds and fodder are insufficient of poor paddy cultivation due to waterlogged and drainage congestion. However, at times kitchen waste becomes feed to the poultry.

5.5.18 Livestock and poultry diseases

Productions of livestock and poultry are mainly constrained due to diseases and death of the population. Outbreak of disease is causing a considerable economic loss in livestock farming. Every year livestock population is affected by different diseases like Fever, Foot and Mouth Disease (FMD), Anthrax, Diarrhea, Black leg and Pest Des Petits Ruminants (PPR). Major poultry diseases are Rani khet (Newcastle), Paralysis, Fowl Pox and Fowl cholera. During monsoon season, the soggy condition of the animal shelter promotes various kinds of diseases to the bullock and cows. Moreover the unhygienic condition of the courtyard during this season increases the diseases of poultry birds. More of there is vulnerable period in between July to October (rainy season) months for spreading diseases to livestock and poultry population. However, some diseases are found round the year.

5.5.19 Fisheries resources

The study area of Madanpur-Dirai-Sullah Road project is an important source of fisheries. Old Surma River, Kalni River and Chamti-Darain River, Boram haor, Dhalar Haor, chhayar haor, Bera Dohor haor etc. and inundated paddy fields are the open water fish habitat of the project area. This diversity of wetland habitats, seasonal inundation and fluctuation of water regime and connectivity of the haor with the Rivers, canal, khals, and beels system make the haor suitable for capture fisheries production of this area. The Haors/beel of the project area provide the winter shelter for the mother fishery, and in the early monsoon these mother fisheries produce millions of fries for the entire downstream fishing communities. Free flow of water at the early monsoon from River to the haor facilitates migration of fish from the river to the haor. Varied depth classes of the haor basin provide habitats for young fish grow larger, adults to grow maturity and the brood fish to spawn at various suitable habitats. During wet season, inundated floodplains are highly suitable for nurturing riverine and Beel fish.

5.5.20 Constraints and Issues

There is a gradual decline in the production trend of capture fisheries over decade due to indiscriminate fishing, shrinkage of fish habitat, reducing depth of river etc. Most of the riverine and beel habitat fishes use floodplain as feeding and breeding ground. During full flood monsoon season the most of the study area goes under water and form a suitable water system for fish habitation and subsistence fishing.

Silting up of beels and canals reduces the depth as well as water volume negatively impacting fish production. The exploitation pressure is very high in the haor areas. No care is taken as to the future of fish stock. Fishermen use sometimes nets with too small mesh gear to catch as much fish as possible gradual bringing many species to extinction. There is no effective enforcement of the fish conservation act. There is also decline in the natural production of fry and fingerlings in open waters during the decades due to indiscriminate fishing of brood stocks and spawn. Heavy drought also creates a major problem for fisheries. Floodplain / beel area are being reduced, ultimately reduce the shelter, feeding and rearing grounds of fish and hampered their life cycle for migration. As a result, some species are threatened or endangered. Ultimately the productions are being decreased. Further, in the study area,

water is found in lower parts of the haor where can only save the mother fish/ brood fish but some ill motive peoples are being harvesting the brood fish.

Source: RRI field survey, April 2018

Figure 5.22: Indiscriminate fishing by dewatering beel and over exploitation of fishes at Badalpur, Dirai

Major fisheries problems and issues so far identified during baseline survey are as follows-

- Indiscriminate fishing by dewatering beel and over exploitation of fishes by using huge number of small mesh sized fishing gear
- Lack of communication systems for trading fish
- Siltation of internal khals are causing loss of year round river khal connectivity;
- lack of quality fish seed and feed for the improved aquaculture practices;
- insufficient trained fish farmer, etc.
- Decreasing trend of fish production due to habitat loss, improper fisheries management;
- Morphological changes of rivers caused loss of the year round river-beel connectivity;
- Reduction of beel fish habitat area due to conversion of beel into crop fields

5.5.21 Fish habitat and diversity

Fish habitat is primarily classified under two categories such as capture fishery and culture fishery. River, beel and floodplain are considered under capture fish habitat. In the study area the most of the fish production is coming from capture fisheries whereas culture fisheries are limited.

Source: RRI field survey, April 2018

Figure 5.23: Capturing of fish from Boram haor at Daudpur, Dirai

Fish habitat of the study area is classified into river, floodplain and beel. Different types of fish habitat in the study area are shown in **Figure 5.25**. A wide range of fishes are captured in the study area round the year.

Table 5.19: Fish habitat status in Dirai Upazila

Sl. No.	Fisheries Category	Habitat Types	Area (Ha)
1	Capture	River	885.38
		Beel	2461.30
		Floodplain	12225.00
		Haor	1273.00
		Sub-total	16844.68
2	Culture	Fish Pond	169.87
		Seasonal Cultured water body	356.80
		Sub-total	526.67
		Grand total	17371.35

The major source of fish is haor/beels followed by rivers and a little portion comes from ponds. According to the World Fish Centre (2016), the major species from these three different sources has shown the following **Table 5.20.** The Fish species diversity in the study area is shown in Appendix-3.

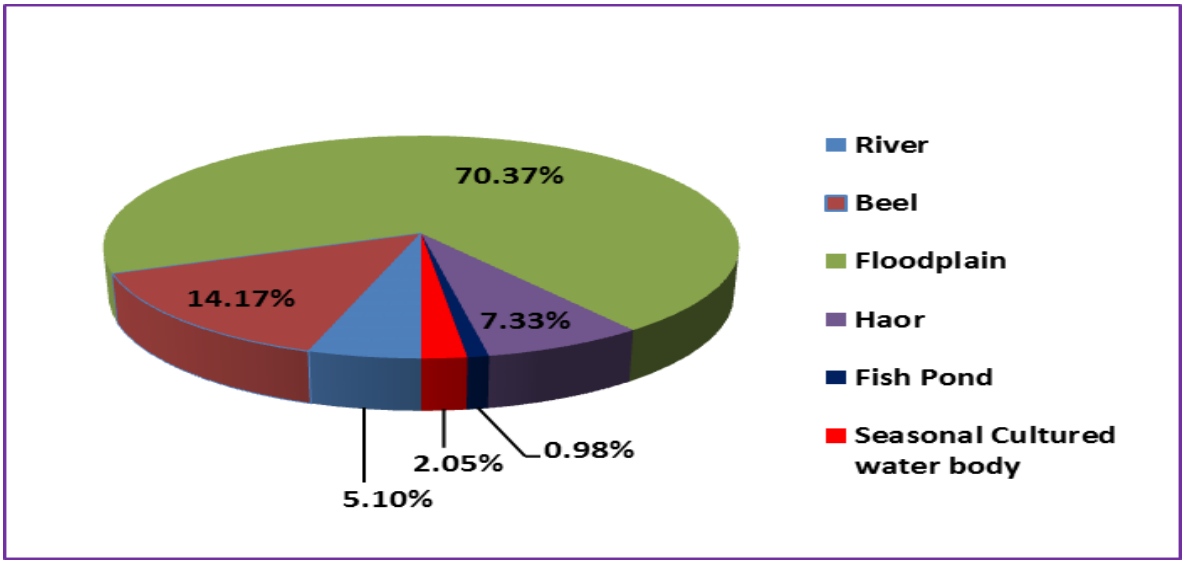


Figure 5.24: Fish production as percentage of area of different habitats in the Dirai upazila

Table 5.20: Major fish species from different sources

Type of source	Species		High demand
	Small fish	Big fish	
River	*Ghulsha* (small *Tengra*), *Kajoli, Ritha, Ghaura*	*Ruhi, Boal, Shol, Mohashol, Bacha, Kalibaush, Bata*	*Ruhi, Kajoli, Bacha*
Haor/*beel*	*Tangra, Meni, Puti, Icha* (small prawn), *Taki, Bujuri*	*Shing, Magur, Shol, Gojar, Boal*	*Pabda, Koi, Meni, Tangra, Shing, Magur*
Pond	Tilapia	*Pangas, Ruhi*, Mrigel, Bighead	*Pangas*

Source: The World Fish Center, Bangladesh and South Asia Office, 2016

Source: RRI field survey, April 2018

Figure 5.25: Seasonal cultured waterbody along the existing Dirai-Sullah road (left)

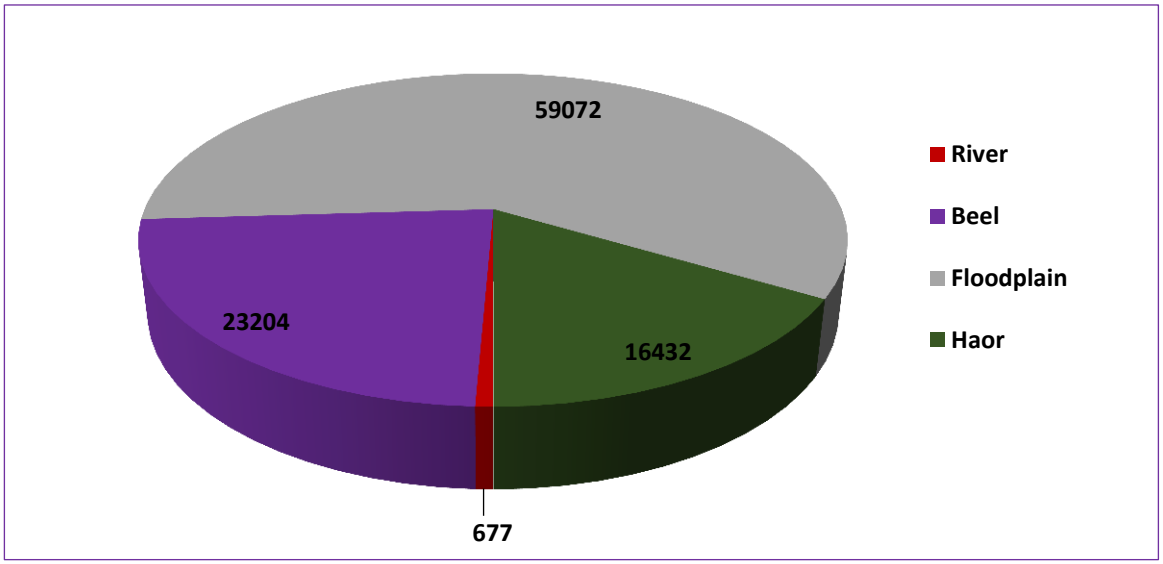
5.5.22 Fish Production

Sunamganj is in surplus in overall fish production. However, the total fish traded comprises both local production and outside fish coming from other districts. In one hand, it exports fish captured from haor, beel and river to few major areas of the country and on the other hand, it imports culture fishes from outside. Fish is captured round the year from rivers and *haors*/beels in the district. A large number of active populations are involved in fishery making it a dynamic sector and a lot of fishes goes outside from Sunamganj to other districts including Dhaka and also abroad through processing companies. The overall scenario of Fish production is shown in **Table 5.21**.

Table 5.21: Overall scenario of Fish production in Sunamganj district

Sl. No.	Fisheries Category	Habitat Types	Total production (MTon)
1	Capture	River	677
		Beel	23204
		Floodplain	59072
		Haor	16432
		Sub-total	99385
2	Culture	Fish Pond	7500
		Seasonal Cultured water body	1124
		Sub-total	8624
		Grand total	108009

Source: RRI estimation according to Year Book of Fisheries Statistics, of Bangladesh (2015-16), DoF.



Source: RRI estimation according to Year Book of Fisheries Statistics, of Bangladesh (2015-16), DoF.

Figure 5.26: Fish production estimation in MTon of different habitats in Sunamganj District

Fish production of the study area is mainly derived from capture habitat which includes river, beel and floodplain. Estimated total annual fish production in Dirai upazilla is about 7035.02 Mtons. The bulk of the inland fish production is coming from capture fisheries.

Table 5.22: Fish production from different habitats in Dirai Upazilla

Sl. No.	Fisheries Category	Habitat Types	Total production (MTon)
1	Capture	River	505.57
		Beel	2310.5
		Floodplain	2070.35
		Haor	1040
		Sub-total	5926.42
2	Culture	Fish Pond	864.3
		Seasonal Cultured water body	244.3
		Sub-total	1108.60
		Grand total	7035.02

Source: RRI estimation according to Upazila Fisheries Office, Sunamganj.

5.5.23 Fishing effort

Seasons

In the project area fish are catching all the year round in the Surma River. However, organized Catch and Open Catch two distinct seasons are identified in the haor/beel. Organized Catch usually starts in Mid-November when the water starts drying up and the dykes surrounding the water bodies appear and continues till end of March of the following year. The Open Catch season starts when the new water of monsoon comes in May-June and continues rest of the year until the Organized Catch starts.

Fishing Gears

A large number of fishing net/gears are used in fishing in the study area. Some common fishing gears are (a) Current jal, which is used to Boal, Baim, Goinna, Tengra, Punti, etc., (b) Ber jal which is used to catchBoal, Goinna, Rui, Catla, Punti, Chanda, Gura Chingri, etc.; (c) Urainna jal which is used to catch tengra, gulsha, baila, bata, chingri, etc., (d). Tana jal which is used to catch baila, tengra, gura chingri, etc.(e) Thela jal which is used to catch Gura Chingri, Punti, Tengra, Baila etc. About 10% of fishers have fishing boat and 90% have fishing net. Traditional fishing gears of the study area are Urainna jal, Thela Jal, Lining (Borshi) etc.

5.5.24 Fish migration

The project area covers rivers, seasonal floodplain, and haor/beel. The Old Surma, Kalni and Champty-Darain rivers are main route as longitudinal fish migration in the study area. The Haors/beel of the project area provide the winter shelter for the mother fishery, and in the early monsoon these mother fisheries produce millions of fries for the entire downstream fishing communities. Connectivity of the haor with the Rivers, canal, khals, and beels system are the way to fish migration of this area. Many fish species migrate horizontally to the rivers, and other water bodies of the area as part of their life cycle. Overall fish

migration situation is moderate in the study area. Feeding and sheltering migration of riverine fishes occur through different connected *khals* of the study area.

5.5.25 Fish marketing and post-harvest facilities

Due to lack of the communication systems in the study area, fish marketing and postharvest facilities are poor. Local fishermen sell bulk of their catch either directly to the local fish markets such as Dirai, Taral bazar, Anandapur, Sullah etc. or to fish traders or buyers (Bapari) coming from Sunamganj. There is no specific fish markets (arats) present in study area. No structured fish landing centres are found in the area. No ice factories are observed in the scheme area. Fishermen sell their catch fish as early as possible to nearby fish markets or to the fish traders. No good fish storage facility is available. Fish seeds for culture fishery are collected from the fish hatcheries and nurseries which are situated apart from the study area. Fish feeds are also collected from the fish feed dealers of Sunamganj.

5.6 Ecological Resources

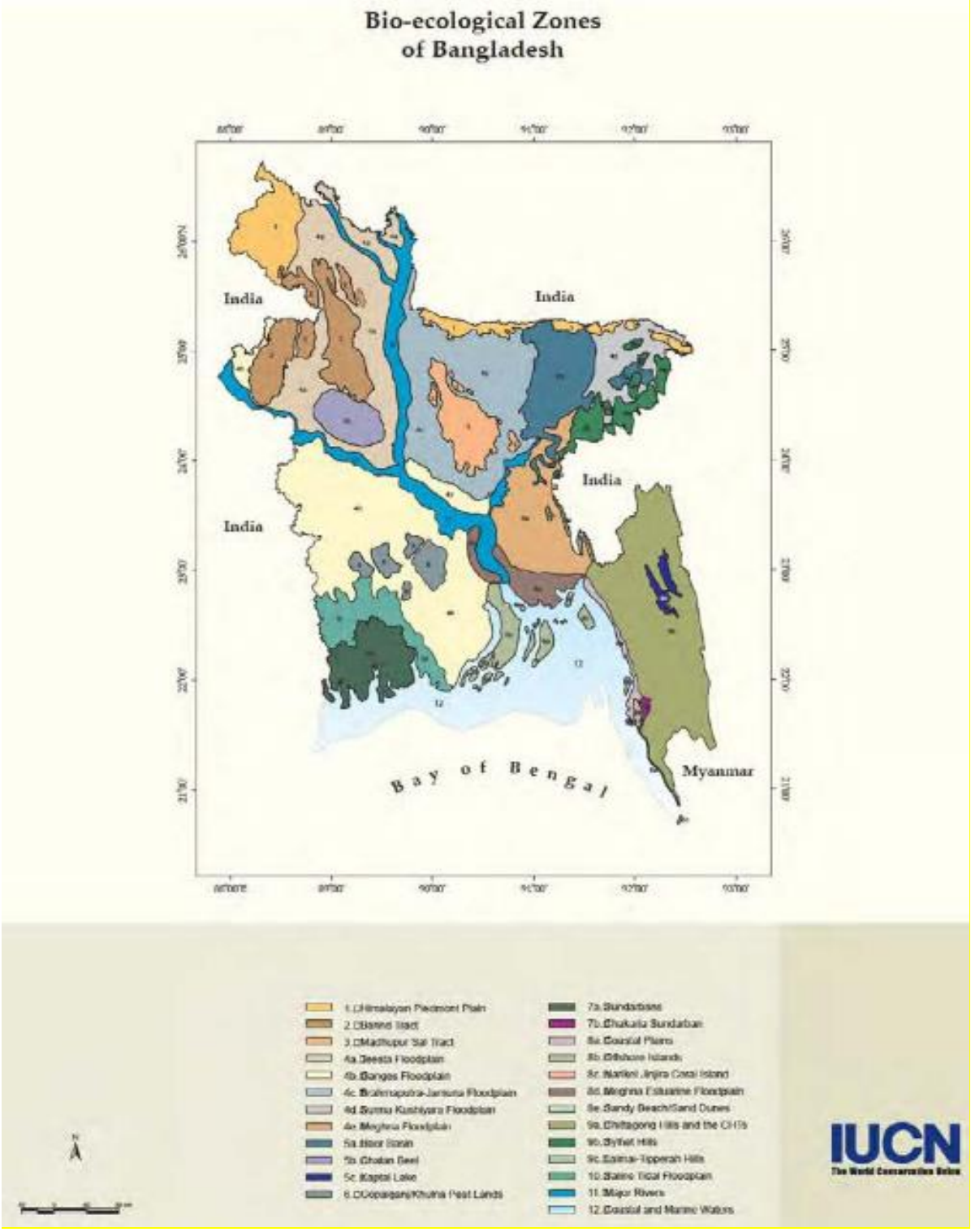
The study area is situated in the northeast part of the country which has unique hydro-ecologically characteristics. The study area consists of human settlement, haors, beels and river systems. Haor refers to a large natural depression where there are perennial water bodies (i.e., beels) that become part of a contiguous wetland during monsoon and remain disconnected by vast crop lands during the dry season. Due to its alternative wet and dry nature, the ecosystem offers two major livelihood options: fishing in the wet season (June-October) and cropping in the dry season (December-April). The haor is fed by small rivers draining the adjacent land and also by the rivers during flood season. During the subsequent dry season, the water evaporates or drains away through the southern outflow to leave a diverse system of dry season water bodies. This seasonal variability of flow and water level in the haor area helps support a unique wetland eco-system. Both rivers and haors are made up of a complex of habitats whose diversity supports exceptionally rich fish faunas. Haors and beels are connected to the rivers and natural river functioning depends on the diversity in form of these various habitats and the inter-connectivity between them, with uninterrupted flows along the main channels and the seasonal invasion of the haor and its water bodies. Brief ecological description is presented below:

5.6.1 Bio-ecological zones

IUCN Bangladesh identified 25 Bioecological Zones in Bangladesh according to the ecosystem features, species diversity (Nishat *at el*, 2002). They are Himalayan Piedmont Plain, Barind Tract, Madhupur Sal Tract, Teesta floodplain, Ganges Flood plain, Brahmaputra-Jamuna floodplain, Surma-Kushiara floodplain, Meghna floodplain, Haor basin, Chalan Beel, Kaptai Lake, Gopalganj-Khulna Peat Land, Sundarbans, Chakaria Sundarbans, The coastal plains, Offshore islands, Narikel Jinjira coral island, Narikel Jinjira coral island, Sandy beach/Sand dunes, Chittagong Hills and the CHT, Sylhet hills, The LalmaiTipperah hills, The saline tidal floodplain, Major Rivers, Coastal Marine Water. These bio-ecological zones can be classified as major ecosystems of the country. According to the bio-ecological map, the study area encompasses one of these bio-ecological zones, namely the Haor basin (**Map 5.5**). A brief description of the Haor basin (5a) is presented below:

Haor Basin

The Haor basin is an internationally important wetland ecosystem, which is situated in Sunamganj, Habiganj, Sylhet, Kishoreganj, Moulvibazar and Netrokona districts. It is a mosaic of wetland habitats, including numerous rivers, streams and irrigation canals, large areas of seasonally flooded cultivated plains, and hundreds of *haors* and *beels.* This zone contains about 400 *haors* and beels, varying in size from a few hectares to several thousand hectares. Some of the most important *haors* and *beels* are: the Meda beel, Tanguar haor, Aila beel, Dekhar haor, Kuri beel, Erali beel, Dubriar haor, Hakaluki haor, Kawadighi haor and Hail haor. These *haors* and *beels* support major subsistence and commercial fisheries while the seasonally flooded lake margins support major rice-growing activities, and the abundant aquatic vegetation provides rich grazing for domestic livestock and an alternative source of fuel and ferti1izers for the local people. The wetlands are also home to a wide variety of resident and migratory waterfowl, including perhaps as many as 100,000 to 150,000 ducks, and provide a refuge to many other species of wildlife, which are becoming increasingly rare elsewhere in Bangladesh. Keeping in mind all these ecological benefits, the Tanguar haor, which is located in this zone, has been declared a Ramsar site. The Bangladesh Government has also declared this *haor* an Ecologically Critical Area (ECA) (GoB-IUCN, 1992).



Map 5.7: Bio-Ecological zones of Bangladesh

The Haor basin is the only region in Bangladesh where remnant patches of freshwater swamp and reed lands still exist. The Hijal *(Barringtonia acutangula)*, Koroj *(Pongamia pin nata)*, Bhui dumur *(Ficus heterophyllus)*, Nol *(Arundo donax)*, Khagra *(Phragmites karka)*,

Ban golap *(Rosa involucrata)* and Barun *(Crataeva nurvala)* are the main plant species found in the swamp forests. All of them are flood-tolerant species and can survive in submerged conditions for extended periods of time. However, among these, hijal, tamal and koroj trees are of the greatest value to the people and the environment (GoB-IUCN, 1992). About 150 species of waterfowl have been recorded in this zone; but over 70 of these are now rare and several have not been reported for many years. However, the most common species include: the little grebe *(Tachybaptus ruficollis),* Little cormorant *(Phalpcrocorax niger),* a variety of herons and egrets, Asian openbill *(Anastomus oscitans),* Lesser adjutant *(Leptoptilos javanicus),* Black-headed ibis *(Threskiornis mclanocephalus),* several ducks notably the Lesser whistling-duck *(Dendrocygna javanica),* Cotton pygmy-goose *(Nettapus coromandelianus)* and Northern pintail *(Anas acuta),* White-breasted waterhen *(Amaurornis phoenicurus),* Water cock *(Gallicrex cinerea),* Purple swamp hen *(Porphyria porphyria),* Common coot *(Fulica atra),* Pheasant-tailed jacana *(Hydrophasianus chirurgus),* Bronzedwinged jacana *(Metopidius indicus)* and a wide variety of shorebirds, gulls and terns. Besides, mammalian species associated with these wetlands include the Ganges river dolphin *(Platanista gangetica),* which is still common in the large rivers, the Fishing cat *(Prionailurus viverrinus)* and three species of otter: the Common otter *(Lutra lutra),* Smoothcoated otter *(L. perspicillata)* and Clawless otter *(Aonyx cinerea)* (GoB-IUCN, 1992).

5.6.2 Terrestrial fauna (Wildlife)

There is endangered species are not available at and around the project site. Common mongoose (Herpestes edwardsi), Jackle (Canis aureus), Jungle cat (Felis chaus), common house rat (Rattus rattus), house mouse (Mus musculus) are the major mammals. Indian flying bat (Pteropus giganteus) colonize in some dense homestead forest. Among the reptiles, Bengal Grey Lizard (Veranus bengalensis), Garden Lizard (Calotes versicolor), dark bellied marsh snake (Xenocrophis cerasogaster) are known to occur in the area. The common lizards found within the scheme area include garden lizard (Calotes versicolor) and house lizard (Hemidactylus frenatus). Among other species that once were common but now are only occasionally seen in are the Asiatic soft-shell Turtle (Chitra indica). Amphibian species favor wetland areas and the marginal dried areas. Some species like Common toad (Bufo melenostictus), Jerdon's bull frog (Hoplobatrachus crassus), Maculated tree frog (Polypedates maculatus), Ornate microhylid (Microhyla ornata), Balloon frog (Uperodon globulosus) prefer the cool, damp habitat of the bamboo grooves.

Birds can be divided into two major groups in the study area. One types of birds are observed in floodplains and wetland, where as other types of birds are detected in dry land habitat such as homestead, open woodland, scrub and grass land. Birds of prey survive well in the area. The Major birds are found in the project area are Duck, Crow, Dove, Kingfisher, Wagtail, Egret, Stork, Titra, Crane, Cheer, sparrow etc.

5.6.3 Terrestrial Flora (Vegetation)

In the study area there are cultivable lands, human settlements, some uncultivable lands and water bodies are available. There is no significant urban or industrial development. Few numbers of small commercial

centers are situated there. The agricultural land is mainly vegetation type. Agriculture is the main output of the region. Cropping patterns are determined by the seasonal floods with rice as the most important crop. Major terrestrial flora of this area can be divided according to following categories:

- Crop fields vegetation
- The upland settlement vegetation
- Settlement Ridges vegetation
- The undulating Kanda vegetation

Figure 5.27: Crop field vegetation in the study area

Cropland is major land type in all over the haor area including the study area. This land is mainly used for boro cultivation. Cropland supports various avifauna and reptiles. Human settlements with dense vegetation along with some well grown trees are exists in the study area. The tree species are common species characteristic of the district and include eucalyptus, plum, rain tree, koroi, neem, akasmoni, debdaru, acacia, mango, jackfruit etc. Homestead platform is only host land of big trees like Bamboo, Rain Tree *(Albizia lebbeck),* Narikel *(Cocos nucifera),* Kola *(Musa sp.),* Neem *(Azadirachta indica),* Mera *(Trewia nudiflora)* koroi, akasmoni, debdaru, acacia, mango, jackfruit etc. Besides, Kanda is a land that forms undulation and a slightly higher than agricultural land. This type of land remains fallow or use as cattle grazing or crop thrashing in dry season. Kandas are abounded by mixed grass species. Kanda is good habitat for insects and as well as some birds. Dholkolmi *(Ipomoea fistulosa)* is another dominant species grown on some kandas.


Figure 5.28: Vegetation along the existing Dirai-Sullah road

5.7 Socio-Economic Environment

The development of infrastructures including roads in any region is likely to create high impacts on the socio-economic aspects of the local people. The Dirai-Sulla road link project might also have high impacts on the socio-economic aspects of the people of this region. As a part of the EIA, a rapid socio-economic study was carried out to assess the current socioeconomic condition of the areas surrounding the proposed project site. A sample socio-economic baseline study was carried out at randomly selected places in Dirai and Sullah upazillas. The specific objectives of the baseline study were to gather information on the existing socio-economic environment of the areas in and around the project site; to gather and assess peoples' perception on different aspects of the proposed project. Efforts were made to identify the socio-economic attributes that may be impacted due to the proposed project activities. The main objectives of the socio-economic study were:

1. To understand people's socio-economic condition
2. To understand extent of people's access to basic services
3. To understand people's perception regarding possible impacts of proposed project
4. To get feedback from people regarding preferred and possible mitigation measures

In order to assess the impacts of the proposed Project on people living in the vicinity of the proposed Dirai-Sulla road link project area, detailed survey was conducted and existing socio-economic conditions and salient features of the area were duly observed. During the detailed site visit, relevant government agencies/departments were also consulted for the collection of the relevant data. Information on socio-cultural resources and economic development were collected through field survey and secondary sources.

5.7.1 Location

The study area mainly consists of Dirai and Sullah upazilla under Sunamganj district in the low lying haor region. The existing Dirai-Sullah road link connected between Dirai and Sullah upazila. The Dirai-Sullah road links starts at Dirai (Esting -333102.00 m, Northing- 2742656.00 m) and ends at Sullah upazila headquarter (Esting-325060.24 m, Northing- 2729762.20 m). Eighty percent of the study area consists of Dirai and Sullah upazilla and rest of (only 15%) covers Habiganj and Netrokona. Dirai Upazila covers 420.93 sq. km area, located in between 24°39' and 24°53' north latitudes and in between 91°10' and 91°28' east longitudes. It is bounded by Dakshin Sunamganj and Jamalganj upazilas on the north, Sullah, Baniachang and Nabiganj upazilas on the south, Jagannathpur upazila on the east, Sullah, Khaliajuri and Jamalganj upazilas on the west. Whereas Sulla is an Upazila consistists of 260.74 sq. km area, located in between 24°34' and 24°49' north latitudes and in between 91°08' and 91°23' east longitudes. It is bounded by Dirai upazila on the north, Itna and Ajmiriganj upazilas on the south, Baniachang and Ajmiriganj upazilas on the east, Khaliajuri and Itna upazilas on the west. The following figure shows the map of Dirai and Sullah Upazila.

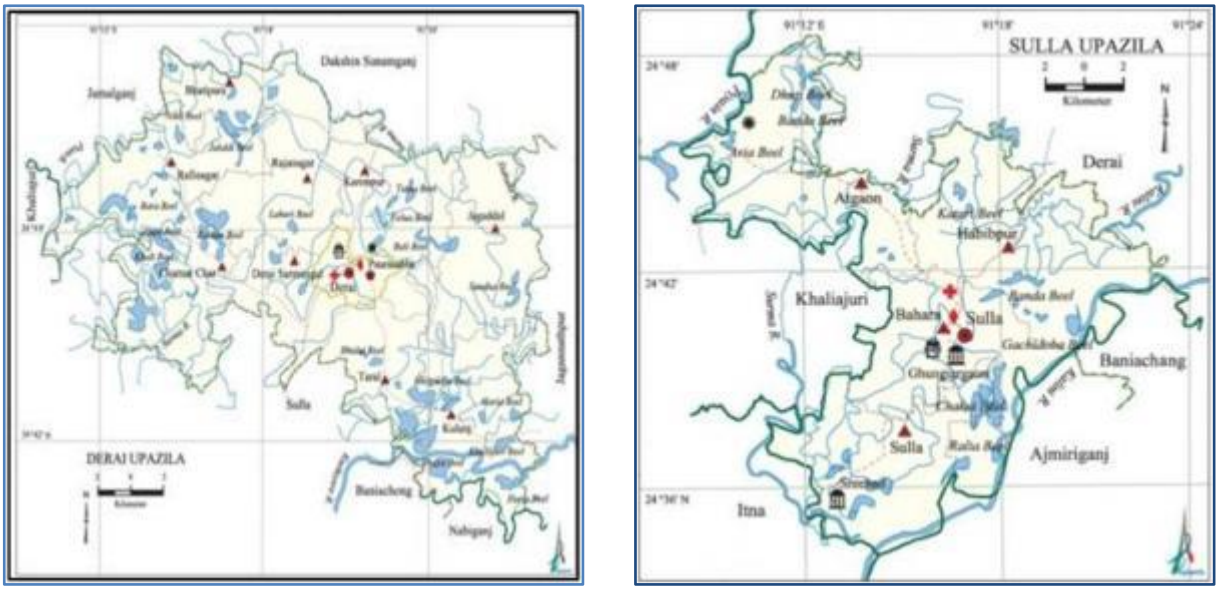


Figure 5.29: Map showing Dirai (left) and Sullah (left) Upazila

The study area comprises of seven unions of Dirai, four unions of Sullah, four unions of Habiganj and two unions of Netrokona district. The following table shows proportional distribution of study area in percentile in terms of per union.

Table 5.23: Location of the study area including upazilla, union, area and % of union within project site

SL.	District	Upazila	Union	Area (Ha)	Union in Percentage of Total Area
1	Sunamganj	Dirai	Karimpur	2934.60	6.37
2			Rajanagar	3693.50	8.02
3			Rafinagar	3257.50	7.07
4			Dirai Sarmangal	4339.60	9.42
5			Charnachar	4375.70	9.50
6			Taral	2626.50	5.70
7			Kulanj	117.10	0.25
8		Sulla	Atgaon	3040.30	6.60
9			Habibpur	7745.90	16.82
10			Bahara	5231.90	11.36
11			Sulla	1628.90	3.54
12	Habiganj	Baniachong	Daulatpur	2424.50	5.26
13		Nabiganj	Paschim Bara Bhakhair	385.90	0.84
14		Ajmeriganj	Badalpur	1431.50	3.11
15	Netrokona	Khaliajuri	Krishnapur	1893.90	4.11
16			Khaliajuri	932.80	2.03
				46060.00	100.00

5.7.2 Demography and household

Seven unions of Dirai, four unions of Sullah, four unions of Habiganj and two unions of Netrokona district are included as a project impacted zone. Union wise demographic scenario including total area, household, population and density of the project area are presented in the following **Table 5.24**.

Table 5.24: The demographic scenario including total area is presented in in the study area.

Administrative Unit	Area in Acres	Total Households	Total Population	Population Density [sq.km]
Charnar char Union	**12430**	**4988**	**26364**	**524**
Dirai Sarmangal Union	10897	2942	15160	344
Karimpur Union	10159	4579	26255	639
Kulanj Union	13293	5343	29101	541
Rafinagar Union	12764	4594	24018	465

Administrative Unit	Area in Acres	Total Households	Total Population	Population Density [sq.km]
Charnar char Union	**12430**	**4988**	**26364**	**524**
Raja Nagar Union	10571	4811	24476	572
Taral Union	9833	3888	20653	519
Atgaon Union	16288	5485	31466	477
Bahara Union	14426	5084	27515	471
Habibpur Union	18597	5379	29534	392
Sullah Union	13957	4351	25228	447
Badalpur Union	17461	3986	22340	316
Daulatpur Union	6816	5129	30204	1095
Paschim Barabhakhair Union	6746	3341	17309	634
Khaliajuri Union	11621	2905	14839	316
Krishnapur Union	7053	2612	14448	506

Figure 5.30: Housing in the study area

5.7.3 Housing Tenancy

Almost all of the people are dwelling in their own household in the project site. The higher rented housing tenancies are found in Bahara and Khaliajuri Union representing greater urban area than other areas. The maximum rent free housing tenancy are found in Jagaddal, Karimpur and Kulanj Union indicating heights Socioeconomic environmental vulnerability in the study area.

Table 5.25: Tenancy status of residence in the project area

Administrative Unit	Percentage of Tenancy of House		
	Owned	Rented	Rent free
Charnar char Union	96.8	1.1	2.1
Dirai Sarmangal Union	97.7	0.0	2.3
Jagaddal Union	91.3	0.3	8.4
Karimpur Union	93.3	0.7	6.0
Kulanj Union	91.5	1.9	6.6
Rafinagar Union	93.0	1.7	5.2
Raja Nagar Union	94.3	0.5	5.2
Taral Union	94.5	0.2	5.4
Atgaon Union	94.6	0.5	4.8
Bahara Union	91.7	5.0	3.3
Habibpur Union	97.7	0.2	2.1
Sullah Union	95.7	0.1	4.3
Badalpur Union	95.6	1.2	3.2
Daulatpur Union	92.4	2.1	5.6
Paschim Barabhakhair Union	96.8	0.6	2.6
Khaliajuri Union	91.0	4.0	5.0
Krishnapur Union	93.0	2.0	5.1

Source: Population and Housing Census, BBS, 2011

5.7.4 Household Size

People are considered as munificent if most of the household members are able to contribute to household income. Generally big household size is considered as curse with small number of earning member. According to the household and population census 2011 by BBS about 13.3% to 22.5% households comprise of 8 more than members. Findings reveal that the average size of the household in the study area ranges from 5.0 to 5.9 members. It is found that the highest concentration is in Daulatpur Union (5.9) and the lowest concentration is in Khaliajuri Union (5.0). **Table 5.26** has showed the distribution of household members by Upazila and Unions.

Table 5.26: Distribution of household members by Upazila and Unions

Administrative Unit	Percentage of households comprising of								Average Size of Household
	1 Person	2 Persons	3 Persons	4 Persons	5 Persons	6 Persons	7 Persons	8+ Persons	
Charnar char Union	2.4	7.4	12.3	18.5	18.4	15.7	10.0	15.4	5.3
Dirai Sarmangal Union	2.1	6.6	15.4	17.4	19.0	14.9	10.8	13.7	5.2
Karimpur Union	2.3	6.4	11.2	15.6	17.6	15.3	11.4	20.2	5.7
Kulanj Union	2.8	7.8	12.5	15.0	16.8	15.3	10.8	19.0	5.5
Rafinagar Union	2.2	8.7	12.9	18.5	17.0	14.9	10.5	15.2	5.2
Raja Nagar Union	3.1	9.2	13.1	18.5	18.2	14.6	10.1	13.3	5.1
Taral Union	2.1	7.5	12.9	16.3	18.2	15.1	12.2	15.7	5.3
Atgaon Union	1.7	6.2	10.8	15.7	16.2	16.5	11.4	21.5	5.7
Bahara Union	3.1	6.9	11.3	17.6	18.9	15.6	10.7	15.9	5.4
Habibpur Union	2.1	6.2	11.8	16.4	19.2	16.1	11.1	17.2	5.5
Sullah Union	1.6	5.6	10.6	14.8	18.1	16.5	12.8	19.9	5.8
Badalpur Union	2.9	5.7	11.2	15.4	18.7	15.9	10.8	19.4	5.7
Daulatpur Union	2.2	5.7	9.3	13.7	17.7	16.8	12.2	22.5	5.9
Paschim Bara Bhakhair Union	2.7	7.5	12.4	18.7	19.5	15.4	10.0	13.9	5.2
Khaliajuri Union	3.0	8.8	12.8	18.8	19.7	14.6	10.4	11.8	5.0
Krishnapur Union	1.9	6.7	10.6	16.6	18.8	17.4	11.4	16.6	5.5

Source: Population and Housing Census, BBS, 2011

5.7.5 Age Structure

People of all ranges are more or less equally distributed across the study area according to Population and Housing Census, BBS, 2011. The following **Table 5.27** describes the Percentage of population in age group in the study area by Upazila & Unions.

Table 5.27: Percentage of population in age group in the study area by Upazila & Unions

Administrative Unit	Percentage of population in the age group									
	0-4	5-9	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Charnar char Union	15.4	15.0	10.1	6.9	8.1	8.1	22.0	5.9	3.3	5.0
Dirai Sarmangal Union	15.7	14.5	9.9	7.7	7.3	8.0	22.5	5.9	3.4	5.1
Jagaddal Union	14.7	14.6	11.8	8.8	7.8	7.5	20.3	5.9	2.9	5.6
Karimpur Union	13.7	14.8	12.0	8.5	8.1	20.1	5.6	3.1	5.6	5.6
Kulanj Union	14.0	15.1	12.0	8.7	7.9	7.4	20.9	5.6	3.1	5.3
Rafinagar Union	16.1	14.7	9.5	6.7	8.6	8.4	21.7	5.9	3.0	5.4
Raja Nagar Union	15.0	15.1	10.9	7.9	8.3	7.8	20.9	6.0	2.9	5.2
Taral Union	14.2	15.3	11.8	8.2	7.6	7.6	21.2	5.8	2.9	5.6
Atgaon Union	16.8	15.8	10.2	7.2	7.5	8.2	20.9	5.7	2.8	4.8
Bahara Union	12.4	13.0	11.1	8.6	8.4	8.1	22.4	6.7	3.5	5.7
Habibpur Union	14.3	13.9	10.6	8.3	7.9	7.9	21.9	6.6	3.3	5.4
Sullah Union	15.3	14.9	10.5	7.9	8.3	8.0	20.8	6.1	3.0	5.3
Badalpur Union	13.7	14.0	11.1	8.9	8.6	7.9	20.6	6.4	3.0	5.8
Daulatpur Union	14.4	14.6	12.0	8.9	7.9	7.8	20.7	6.0	2.7	5.0
Paschim Bara Bhakhair Union	12.5	14.1	10.7	8.8	7.8	7.9	22.6	6.6	3.3	5.7
Khaliajuri Union	14.0	14.6	10.3	6.8	8.1	8.8	23.0	6.3	3.1	4.8
Krishnapur Union	14.5	14.5	11.3	7.7	8.0	8.5	21.4	6.1	2.9	5.1

Source: Population and Housing Census, BBS, 2011

5.7.6 Gender Ratio

According to Population and Housing Census, BBS, 2011, it is found that the number of male and female population is almost equal. The gender ratio ranges from 93 to 109. The following table shows the detail of gender ratio in the study area.

Table 5.28: Gender ratio in the study area

Administrative Unit	Population		Gender Ratio
	Male	Female	
Dirai Upazila	122636	121054	101
Charnar Char Union	13489	12875	105
Dirai Sarmangal Union	7638	7522	102
Karimpur Union	13283	12972	102
Kulanj Union	14409	14692	98
Rafinagar Union	12309	11709	105
Rajanagar Union	12226	12250	100

Taral Union	10410	10243	102
Sullah Upazila	57316	56427	102
Atgaon Union	15962	15504	103
Bahara Union	13739	13776	100
Habibpur Union	14795	14739	100
Sullah Union	12820	12408	103
Badalpur Union	11197	11143	100
Daulatpur Union	14976	15228	98
Paschim Bara Bhakhair Union	8336	8973	93
Khaliajuri Union	7755	7084	109
Krishnapur Union	7391	7057	105

Source: Population and Housing Census, BBS, 2011

5.7.7 Community structure

The following table illustrates the number of Muslim person ranges from 21.23% to 94.4% of total population and about 5.57% to 78.76% are the range of Hindu person of total population in the study area. Other religions are negligible in the most of the Union. **Table 5.29** has shown the detail.

Table 5.29: Distribution of Population by Religion, Residence and Community in the study area by Union

Administrative Unit	Total	Muslim	Hindu	Christian	Buddhist	Others
Charnar char Union	26364	15066	11287	6	0	5
Dirai Sarmangal Union	15160	8111	6990	9	0	50
Karimpur Union	26255	18873	7375	1	0	6
Kulanj Union	29101	23889	5202	7	3	0
Rafinagar Union	24018	13993	10012	11	0	2
Raja Nagar Union	24476	18618	5821	7	0	30
Taral Union	20653	15799	4850	4	0	0
Atgaon Union	31466	25173	6293	0	0	0
Bahara Union	27515	5842	21670	2	1	0
Habibpur Union	29534	9356	20177	1	0	0
Sullah Union	25228	19906	5315	0	0	7
Badalpur Union	22340	5691	16643	6	0	0
Daulatpur Union	30204	16707	13488	8	1	0
Paschim Bara Bhakhair Union	17309	4385	12742	14	156	12
Khaliajuri Union	14839	8556	6282	1	0	0
Krishnapur Union	14448	10331	4107	10	0	0

Source: Population and Housing Census, BBS, 2011

5.7.8 Literacy and Education

Education is an important indicator of socio-economic development. It is well established that the distribution of personal incomes in society is trongly related to the amount of education people have had. Generally speaking more schooling means higher lifetime incomes. Information on Literacy and Education based on Population and Housing Census, BBS, 2011 of the study area are describing below:

5.7.9 Literacy rate in Dirai and Sullah Upazila

Literacy denotes to the ability of writing a letter in any language. Literacy rates in Dirai and Sullah Upazila by gender of three consecutive censuses are shown in the following two tables. There show that the literacy rate of female always less than male. The literacy rate was decresed in 2011 for both male and female in both Upazila.

Table 5.30: Literacy rate in Dirai Upazila by gender in three consecutive censuses

Item	1991	2001	2011
Both Gender	25.3	35.4	37.1
Male	30.1	38.4	38.5
Female	20.2	32.2	35.8

Source: Population and Housing Census, BBS, 2011

Table 5.31: Literacy rate in Sullah Upazila by gender in three consecutive censuses

Item	1991	2001	2011
Both Gender	21.8	36.0	34.3
Male	26.8	38.8	36.4
Female	16.5	33.2	32.1

Source: Population and Housing Census, BBS, 2011

5.7.10 Education in Dirai and Sullah Upazila

School attendance of boys and girls aged between 3-29 years is presented in the Table **5.32** for Dirai Upazilla and in the Table **5.33** for Sullah Upazilla.

Table 5.32: School Attendance rate in Dirai Upazila by gender

Item	3-5 Years	6-10 Years	11-14 Years	15-19 Years	20-24 Years	25-29 Years
Both Gender	6.59	67.20	60.24	23.41	3.77	0.53
Male	4.06	65.38	57.01	22.67	4.26	0.78
Female	6.92	69.14	63.69	24.17	3.34	0.31

Source: Population and Housing Census, BBS, 2011

There is gender difference in school attendance rates in various age groups which can be observed from both **Table 5.32 and Table 5.33.** The female attendance rate in the age groups 3-5, 6-10, 11-14 and 15-19 year is higher than their male counterparts. On the other hand, male attendance rate in the age groups 20-24 and 25-29 years is higher than female. The highest school attendance rate is 61.34% which is found for female in the age group 6-10 years in Sullah Upazila.

Table 5.33: School Attendance rate in Sullah Upazila by gender

Item	3-5 Years	6-10 Years	11-14 Years	15-19 Years	20-24 Years	25-29 Years
Both Gender	4.36	59.88	52.31	20.22	3.66	0.71
Male	3.71	58.49	50.29	19.35	4.63	0.84
Female	5.02	61.34	56.93	21.15	2.55	0.59

Source: Population and Housing Census, BBS, 2011

The following two tables show the detail education scenario in the study area.

Table 5.34: School attending scenario of population aged 3-14 in the study area

Administrative Unit	Population Aged 3-5 Years				Population Aged 6-10 Years				Population Aged 11-14 Years			
	Attending School		Not Attending School		Attending School		Not Attending School		Attending School		Not Attending School	
Union	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Charnarchar	117	151	1450	1207	1211	1221	704	633	510	528	476	348
Dirai Sarmangal	38	46	825	769	575	525	542	462	244	265	323	245
Jagaddal	60	76	1476	1401	1623	1596	601	509	876	914	437	329
Karimpur	71	60	1249	1200	1445	1462	512	416	729	749	446	381
Kulanj	134	123	1403	1295	1546	1547	720	589	778	844	500	408
Rafinagar	77	80	1272	1191	923	869	842	722	358	302	520	433
Raja Nagar	84	84	1192	1188	1291	1341	603	439	531	569	430	341
Taral	61	63	1079	968	904	911	703	591	465	471	435	346
Atgaon	79	112	1745	1617	1251	1220	1201	1129	515	500	681	574
Bahara	35	42	1080	1104	1298	1345	553	447	735	744	410	368
Habibpur	77	92	1392	1369	1246	1256	808	753	559	622	599	497
Sullah	24	38	1360	1281	1066	1003	888	711	428	533	521	376
Badalpur	64	56	979	926	1018	1073	519	439	551	565	450	326
Daulatpur	96	78	1358	1365	1635	1446	718	633	829	917	548	379
Paschim Bara Bhakhair	31	57	780	698	847	888	385	341	329	405	306	287
Khaliajuri	9	8	695	710	652	587	546	386	250	231	319	24
Krishnapur	47	49	656	688	633	596	461	394	310	339	305	228

Source: Population and Housing Census, BBS, 2011

Table 5.35: School attending scenario of population aged 15-29 in the study area

Administrative Unit	Population Aged 15-19 Years				Population Aged 20-24 Years				Population Aged 25-29 Years			
	Attending School		Not Attending School		Attending School		Not Attending School		Attending School		Not Attending School	
Union	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Charnar char	200	161	793	667	40	28	908	1168	10	6	994	1137
Dirai Sarmangal	109	83	491	479	14	15	457	614	3	3	507	703
Jagaddal	340	364	940	970	46	36	1019	1200	9	2	950	1263
Karimpur	231	274	885	833	51	37	1010	1125	9	2	1038	1085
Kulanj Union	298	318	960	965	33	25	1067	1161	3	2	985	1163
Rafinagar	119	94	736	660	27	15	953	1071	5	2	970	1043
Raja Nagar	156	168	827	784	36	17	950	1022	3	2	843	1066
Taral	184	210	669	625	26	30	701	807	3	0	715	845
Atgaon	160	158	1077	873	27	17	1015	1308	9	4	1211	1356
Bahara	354	345	839	835	86	60	1040	1112	12	10	1012	1206
Habibpur	231	251	1035	936	49	24	1065	1190	6	10	1056	1247
Sullah	170	167	862	789	36	22	962	1084	9	5	953	1050
Badalpur	207	232	828	727	39	30	870	993	7	1	851	902
Daulatpur	278	381	1021	1017	62	25	998	1304	9	2	1049	1301
Paschim Bara Bhakhair Union	170	208	532	607	25	29	629	670	8	3	570	784
Khaliajuri	97	82	474	363	10	4	560	622	2	0	650	657
Krishnapur	152	142	457	356	18	11	540	591	4	3	576	649

Source: Population and Housing Census, BBS, 2011

5.7.11 Employment and labor market

According to BBS population and housing census 2011 in the study area the number of employed person ranges from 11% to 21%, of total population, about 10% to 18% are engaged in household work (mostly women), about 5% to 9% of total population are not working (it includes children and physically handicapped population) and about 0.05% to 0.52% of total population are looking for work.

Table 5.36: Distribution of population aged 7 years and above not attending school by activity study in the study area.

Administrative Unit	Activity Status							
	Employed Work		Looking for Job		Household		Do not work	
	Male	Female	Male	Female	Male	Female	Male	Female
Dirai Upazila	32254	2391	344	143	850	32072	7987	9468
Charnar Char Union	3991	260	24	17	78	3828	812	985
Dirai Sarmangal Union	2441	369	53	26	25	2049	609	767
Karimpur Union	3319	214	37	9	80	3028	1023	1089
Kulanj Union	3538	248	30	16	48	3687	927	1172
Rafinagar Union	3973	416	33	24	247	3859	752	942
Rajanagar Union	3549	136	23	11	36	3711	796	774
Taral Union	2991	163	27	13	107	2985	926	894
Sullah Upazila	16084	1418	142	56	726	15698	3805	4640
Atgaon Union	5608	392	39	16	388	5382	1207	1496
Bahara Union	2703	253	28	23	39	2713	799	1043
Habibpur Union	3702	581	18	9	199	3607	818	937
Sullah Union	4071	192	57	8	100	3996	981	1164
Badalpur Union	2513	92	12	1	15	2789	598	866
Daulatpur Union	3254	210	46	20	234	3439	644	894
Paschim Barabhakhair Union	1966	109	11	11	41	2186	431	535
Khaliajuri Upazila	17832	1732	175	71	442	15890	3406	4002
Khaliajuri Union	2922	251	10	1	34	2528	551	632
Krishnapur Union	2692	186	5	4	28	2527	433	494

Agriculture was reported by the local people is the mainstay of their mode of livelihood. About 9% to 19% of the total population in the study area engaged in agriculture. The engagement in industrial sector is negligible (0.02% to 0.47%) in the study area. However, no industries are found in the study area. A small section of total population is engaged in the field of service (0.25% to 4.5%) in harnessing their livelihood.

Table 5.37: Population aged 7 Years and above not attending school but employed

Administrative Unit	Population Aged 7 Years and Above Not Attending School but Employed			Field of Employment					
				Agriculture		Industry		Service	
	Both Sex	Male	Female	Male	Female	Male	Female	Male	Female
Dirai Upazila	34645	32254	2391	27880	1089	503	58	3871	1244
Charnar Char Union	4251	3991	260	3795	188	112	11	84	61

Administrative Unit	Population Aged 7 Years and Above Not Attending School but Employed			Field of Employment					
				Agriculture		Industry		Service	
	Both Sex	Male	Female	Male	Female	Male	Female	Male	Female
Dirai Sarmangal Union	2810	2441	369	2366	252	26	2	49	115
Jagaddal Union	3577	3439	138	2741	52	49	1	649	85
Karimpur Union	3533	3319	214	2253	39	41	8	1025	167
Kulanj Union	3786	3538	248	3237	101	54	5	247	142
Rafinagar Union	4389	3973	416	3887	209	16	15	70	192
Rajanagar Union	3685	3549	136	3256	75	22	4	271	57
Taral Union	3154	2991	163	2626	79	31	2	334	82
Sullah Upazila	17502	16084	1418	15755	1256	154	38	175	124
Atgaon Union	6000	5608	392	5503	362	50	7	55	23
Bahara Union	2956	2703	253	2595	213	59	8	49	32
Habibpur Union	4283	3702	581	3629	534	39	23	34	24
Sullah Union	4263	4071	192	4028	147	6	0	37	45
Badalpur Union	2605	2513	92	2389	63	20	6	104	23
Daulatpur Union	3464	3254	210	2961	145	10	7	283	58
Paschim Bara Bhakhair Union	2075	1966	109	1904	58	40	2	22	49
Khaliajuri Union	3173	2922	251	2699	124	19	2	204	125
Krishnapur Union	2878	2692	186	2657	93	5	2	30	91

Source: Population and Housing Census, BBS, 2011

Field findings showed that there is no shortage of agricultural or non-agricultural labor in the study area but now young are tending to go to foreign countries in search of better opportunities. About 10 years ago there was sufficient temporary labourer coming to the study area. Now a days it become decreasing because less temporary labourers are coming. The wage rate varies between 300 tk. to 350 tk. /day. A few migrated laborers are tending to stay here round the year and finally return to their household at the end of the year with all their income. Women's participation in agricultural sector is negligible

5.7.12 Public Utilities

5.7.12.1 Water Supply

Most of the households in the haor area are using tube-well water (groundwater) for drinking purpose. About 50% of the households are dependent on surrounding river/pond water for domestic use. As a result, in spite of having good safe water access, the haor people are affected by many water borne diseases. In the study area, above 90% of general household get the facility of drinking water from tube-well and the remaining below 10% of household get water from tap or other sources exception Badalpur Union and Paschim Bara Bhakhair Union. **Table 5.38** has shown the detail.

Table 5.38: Distribution of general household by source of drinking water in the study area

Administrative Unit	Percentage of Source of Drinking Water		
	Tap	**Tube well**	**Others**
Dirai Upazila	0.2	93.4	6.5
Charnar Char Union	0.0	99.6	0.4
Dirai Sarmangal Union	0.0	99.8	0.2
Karimpur Union	0.1	95.1	4.8
Kulanj Union	0.0	81.6	18.4
Rafinagar Union	0.0	94.3	5.7
Rajanagar Union	0.0	92.5	7.5
Taral Union	0.1	93.3	6.7
Sullah Upazila	0.0	98.7	1.3
Atgaon Union	0.0	98.9	1.1
Bahara Union	0.0	99.6	0.4
Habibpur Union	0.0	99.0	1.0
Sullah Union	0.0	96.9	3.1
Badalpur Union	0.0	41.5	58.5
Daulatpur Union	0.6	86.6	12.8
Paschim Bara Bhakhair Union	91.2	8.8	24.5
Khaliajuri Union	0.1	95.8	4.2
Krishnapur Union	0.0	94.5	5.5

Source: Population and Housing Census, BBS, 2011

5.7.12.2 Sanitation

In the Rajanagar union, 52.3% of general household have sanitary latrine which is the highest rate in the study area, where 70.1% non-sanitary latrine have in the Sullah Union and 31.3% have no toilet facility in the Rafinagar Union (BBS population and housing census 2011). **Table 5.39** has shown the detail.

Table 5.39: Types of toilet structure and toilet facility

Administrative Unit	Type of toilet Structure (%)				Toilet Facility (%)			
	Pucca	**Semi-Pucca**	**Kancha**	**Jhupri**	**Sanitary (WithWater Seal)**	**Sanitary (NoWater Seal)**	**Non-Sanitary**	**None**
Dirai Upazila	4.3	11.4	81.7	2.5	6.4	30.0	51.9	11.7
Charnar Char Union	0.7	5.5	93.1	0.6	0.6	33.8	56.4	9.2
Dirai Sarmangal Union	0.9 l	6.5	92.4	0.2	0.0	8.7	80.4	10.9
Karimpur Union	3.2	11.9	79.6	5.3	7.4	27.8	53.9	10.9
Kulanj Union	5.2	16.3	75.6	2.8	1.9	23.7	61.9	12.4
Rafinagar Union	0.7	5.7	91.0	2.5	2.6	13.1	53.0	31.3
Rajanagar Union	1.8	8.8	88.7	0.6	4.9	52.3	33.5	9.3
Taral Union	2.2	7.4	86.7	3.7	3.5	28.7	60.5	7.3
Sullah Upazila	1.3	3.7	92.6	2.4	1.8	14.9	66.9	16.4
Atgaon Union	0.6	2.2	94.6	2.6	1.7	11.8	73.7	12.8
Bahara Union	2.6	5.8	90.8	0.8	1.7	12.7	62.8	22.8
Habibpur Union	0.7	3.3	91.5	4.5	1.7	23.8	61.2	13.3
Sullah Union	1.4	3.4	93.8	1.4	2.2	10.3	70.1	17.4
Badalpur Union	1.3	4.2	93.4	1.1	1.9	18.9	58.3	20.8
Daulatpur Union	4.1	10.5	82.6	2.8	7.4	29.9	56.6	6.1
Paschim Bara Bhakhair Union	2.1	9.4	80.6	7.9	10.7	22.5	56.3	10.5
Khaliajuri Union	1	4.9	90.5	3.7	4.4	29.2	50.7	15.7
Krishnapur Union	2.3	5.3	89.2	3.1	3.6	20.7	67.1	8.6

Source: Population and Housing Census, BBS, 2011

5.7.12.3 Access to Electricity

According to BBS population and housing census 2011, 96.8% of electricity connection exists in Paschim Bara Bhakhair Union. On the other hand, less then 50% of electricity connection exists in the most of the Union of the study area exception Atgaon Union. The following **Table 5.40** describes the picture of electricity connection in the study area.

Table 5.40: Percentage of access to electricity in the study area

Administrative Unit	Percentage of Electricity Connection
Dirai Upazila	35.4
Charnar Char Union	42.6
Dirai Sarmangal Union	34.0
Karimpur Union	25.3
Kulanj Union	29.4
Rafinagar Union	18.0

Administrative Unit	Percentage of Electricity Connection
Rajanagar Union	27.7
Taral Union	21.7
Sullah Upazila	37.0
Atgaon Union	57.7
Bahara Union	33.9
Habibpur Union	28.4
Sullah Union	25.4
Badalpur Union	28.6
Daulatpur Union	43.9
Paschim Bara Bhakhair Union	96.8
Khaliajuri Union	40.3
Krishnapur Union	42.4

Source: Population and Housing Census, BBS, 2011

5.7.12.4 Health Disabilities

The following **Table 5.41** provides information on the percentage of health disabilities in the study area. According to BBS population and housing census 2011, the highest rate of health disabilities is 2.8% in Jagaddal Union and the lowest rate of health disabilities is 1% in Dirai Sarmangal Union.

Table 5.41: Type and percentage of health disabilities in the study area

Administrative Unit	**Total Population**	**Percentage of Type of Disability**						
		All	Speech	Vision	Hearing	Physical	Mental	Autistic
Dirai Upazila	243690	1.8	0.2	0.5	0.2	0.6	0.2	0.1
Charnar Char Union	26364	2.0	0.2	0.9	0.3	0.5	0.1	0.0
Dirai Sarmangal Union	15160	1.0	0.2	0.1	0.2	0.3	0.1	0.1
Karimpur Union	26255	1.2	0.2	0.4	0.1	0.4	0.1	0.1
Kulanj Union	29101	2.0	0.2	0.6	0.2	0.7	0.2	0.1
Rafinagar Union	24018	1.6	0.1	0.4	0.2	0.6	0.1	0.1
Rajanagar Union	24476	2.1	0.2	0.6	0.2	0.6	0.2	0.1
Taral Union	20653	1.6	0.3	0.5	0.2	0.4	0.2	0.2
Sullah Upazila	113743	1.7	0.2	0.5	0.2	0.5	0.1	0.1

Administrative Unit	Total Population	Percentage of Type of Disability						
Atgaon Union	31466	2.6	0.3	0.9	0.3	0.9	0.2	0.1
Bahara Union	27515	1.6	0.2	0.5	0.2	0.5	0.1	0.1
Habibpur Union	29534	1.1	0.2	0.3	0.1	0.3	0.1	0.1
Sullah Union	25228	1.3	0.2	0.4	0.1	0.4	0.1	0.1
Daulatpur Union	30204	1.1	0.2	0.3	0.1	0.3	0.2	0.1
Paschim Bara Bhakhair Union	17309	2.4	0.2	0.6	0.3	1.0	0.2	0.1
Khaliajuri Union	14839	1.7	0.2	0.4	0.3	0.7	0.1	0.0
Krishnapur Union	14448	2.3	0.3	0.6	0.3	1.0	0.2	0.0

Source: Population and Housing Census, BBS, 2011

The above table and field investigation revealed that the health disability of the population is not noticeable in the study area.

6 Public Consultations

6.1 Introduction

This chapter deals with the information disclosure to the public and consultation with the different stakeholders that are likely to be affected adversely and/or beneficially due to the implementation of the Madanpur-Dirai-Sullah road Z 2807 (Dirai-Sullah portion), Sunamganj. The purpose of public participation and consultation was to gather opinions and suggestions on any environmental issues considered relevant by the people living in the area of the Project impact zone. The public consultation is an essential part of the environmental assessment process according to the EIA Guidelines of the DoE. For this ESIA, the public consultation meetings has been undertaken both formally and informally throughout the study to ensure that the knowledge, experience and views of stakeholders and the general public are taken into account during the ESIA. During field reconnaissance, the public consultation meeting was carried in order to generate qualitative and quantitative data on baseline and to identify important environmental component (IEC). During the consultation process the proposed Dirai-Sullah road project were discussed and the stakeholders got involved with the study in reforming/developing the project interventions considering the local needs and aspirations in line with the problems and solutions.

6.2 Objective

The main objective of the public consultation was to explore the prospect of the reconstruction of existing Madanpur-Dirai-Sullah road (Z 2807, Dirai-Sullah portion) under Sunamganj road division, Sunamganj. For better understanding, this public consultation aimed to familiarize the stakeholders/government agencies in terms of technical, environmental, social, and economic issues of the project. The specific objectives are the following:

Specific objectives

- To share information with stakeholders on proposed improvement works and expected impacts on the physical, biological and socio-economic environment of the project area;
- To identify the environmental issues relating to the project components;
- To investigate the causes of failure/ breakdown of the existing Dirai-Sullah portion of the Madanpur-Dirai-Sullah road (Z 2807);
- To observe the present status of the existing alignments of the Dirai-Sullah road and existing road network systems of the project area;
- To examine the condition of the existing culverts and bridges on the Dirai-Sullah road and the necessity for reconstruction/replacement/modification in the existing culverts and bridges, and or construction of new road structures;
- To explore the problems that are currently faced by the local people due to lack of smooth road route from Dirai to Sullah;
- To understand the extent of people's access to basic services;
- To understand people's perception regarding possible impacts of proposed project;
- To get feedback from people regarding preferred and possible mitigation measures (positive and negative);
- To understand the present status of the water resources including rivers, haors/beels and

ground water;

- To collect inputs from affected communities/individuals for crucial decisions regarding mitigation of the identified environmental and social issues;
- To promote collaboration among officers, communities, and the stakeholders to achieve a friendly working relationship for smoothing the Dirai-Sullah road project implementation;

6.3 Approach and methodology

Participatory approach has been followed for identifying the important environmental component (IEC) and conducting public consultation meetings. A multi-disciplinary team has been formed having specializations in respective disciplines pertinent to conduct public consultations. The team equipped with GPS, digital cameras and in-situ testing apparatuses for facilitating the collection of primary data and related project information. Baseline condition including physical, biological and socio-economic environment of the project area have been identified by the study team during field visits. Different Participatory rural appraisal (PRA) techniques has been followed during field visit such as transect walk, tea-stall meeting, key Informant Interview (KII), Focus Group Discussion (FGD) etc. During field reconnaissance survey i) consultation with Government and non-Government officials and elected representatives, ii) Questionnaire survey, and iii) samples collection for lab analysis also done.

Significant efforts have been made to identify the possible categories of stakeholders and their stakes during the field survey. Key stakeholders have been identified through consultation with local people and local government officials. During the field survey, the villagers/local residents, government officials, farmers, fishermen, businessmen, shop keepers, elected representatives, and NGO workers have been identified as different stakeholders. All those stakeholders had different types of stakes according to their professions and livelihood characteristics. Therefore, during the consultation process inputs has been obtained from a range of stakeholders, including government officials, experts, and researchers, including elected representatives, residents at the project locations, and project affected persons who may be impacted after the reconstruction of the road. Initially, the consultants talked with the RHD, LGED, DAE, DLO, DFO, BWDB and other related authorities of the respective areas in order to obtaining their views and suggestions on the project. The consultant used necessary checklists for facilitating the public consultation and disclosure meetings to maintain uniformity and relevance in discussion and recording the opinions and views of the participants properly.

Checklist and Questionnaires were prepared covering the issues like overall briefing of the project including problem of the area with the potential solutions, existing and proposed interventions, probable impacts of selected interventions etc. During the consultation meeting (PCM), all relevant issues within socio-economic, agricultural, hydrological, fisheries and ecological aspects were discussed in detail. Principal investigator of the multi-disciplinary consultant team facilitated the consultation meeting where the other members of the team were attended and assisted as necessary. The principal investigator displayed maps and other relevant documents of the study area and explained the initial baseline condition and proposed interventions. The other team members explained all relevant points and issues in order to enable the participants to comprehend the proposed interventions/activities properly and to respond, accordingly. The stakeholders' perceived views over the impacts on important environmental and social components (IESCs) along with perceived benefits, risks, threats and demand from the project

were identified. The consultants paid the utmost care in recording opinions and views of the participants relevant to the EIA Report.

6.4 Public Consultations

During the PCM and FGD, the participants expressed their opinions and suggestions about the Dirai-Sullah road project. They informed that the project will add a new dimension to their lives by smoothing roadway communication facilities in this area. They also opined that livelihoods as well as socio economic status of the people will greatly progress due to improved road communication and service related activities.

The Dirai-Sullah road is very essential for the people of this area. The people of Dirai and Sullah upzilas are in desperate need of Dirai-Sullah road as there is no smooth roadway communication facility between Dirai and Sullah upazilas. Especially people of Sullah upazila feel them isolated due to lack of good roadway communication. They trust that the complete construction of the Dirai-Sullah road will bring great fortune to them. This road will play vital role in improving communication in that region and it will enhance the overall socio-economic condition of the region. The road will help them get economic justice. Because of improved roadway communication system farmers could sell their products with fair price. Besides, accessibility of daily commodities not produced in theses upazilas will be increased after the full completion of construction work of the road. Emergency medical service is a basic need. However, they could not avail this service due to lack of road communication system.

Figure 6.1: A stakeholder at Taral union showing the existing condition of the road

The local people expressed their negative perception towards the quality of the construction work of the Dirai-Sullah Road project. They imparted that the construction work of Dirai-Sullah Road had been started in 2011 and finished/stopped in 2016 due to various causes. However, the road is not yet suitable for vehicular movement as construction of road and road structures is not complete. People around this region suggested that well constructed slope protection works may guarantee the sustainability of the

road. Some people adjacent to the road area opined that no bridge or culvert is needed, because they allow early flood water (monsoon flood or flash flood) to enter into the low-lying area that causes damage to their crops. Moreover, some people told that sufficient road opening is required for free flow of water. They also said that the existing Dirai-Sullah Road alignment is in right position. In respect of negative environmental impact, no change will be observed after construction of the existing road the local people deemed. So in the public insight the implementation of this road would not cause any detrimental effect to the environment. Some photos of Public consultation have been shown in **Figure 5.1.**

PC at Badalpur, Dirai

FGD at Tol Baishe (Maccharkhaira), Dirai

FGD at Khaya Ghat, Dirai

PC at Daudpur, Dirai

PC at Tol Baishe (Maccharkhaira), Dirai

PC at Bholanagar, Sullah

FGD at Sullah Sadar, Sullah

PC at Telephone Bazar, Dirai

Figure 6.2: Public Consultation (PC) and Focus Group Discussion (FGD) at different Places during field investigation

6.4.1 Participants list

Table 6.1: A list of the participants take part in different meetings is mentioned in the following Table with their addresses.

Sl. No.	Name	Age (Years)	Religion	Address	Date
1	Abdul Jalil	38	Islam	Badalpur, Karimpur	23.04.2018
2	Abdul Ali	55	"	"	"
3	Md. Muzibur Rahman	50	"	"	"
4	Soyeb Miah	32	"	"	"
5	Shirjil Miah	47	"	"	"
6	Nasima Khatun	14	"	Daudpur, Dirai	"

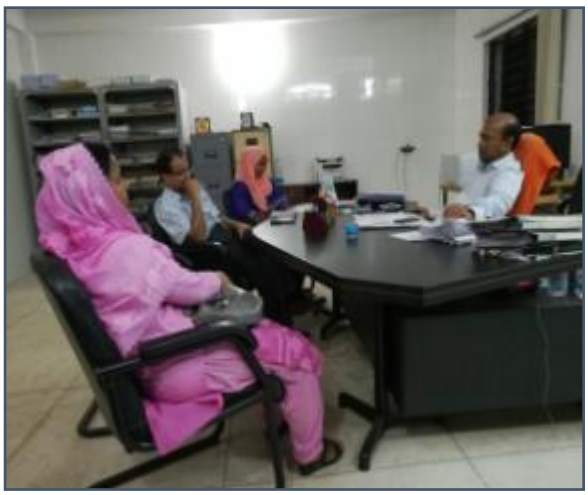
Sl. No.	Name	Age (Years)	Religion	Address	Date
7	Shirina Begum	25	"	"	"
8	Fatema	26	"	"	"
9	Tamim Hossain	16	"	"	"
10	Aontu Deb	38	Hinduism	"	"
11	Md. Sumon	31	Islam	"	"
12	Firoza Begum	48	"	"	"
13	Shahanara Begum	35	"	"	"
14	Md. Rashidul islam	28	"	"	"
15	Md. Afjal	39	"	"	"
16	Mahmud Ali	58	"	"	"
17	Selina Khatun	36	"	"	"
18	Nurul Haque	42	"	"	"
19	Suzat Miah	39	"	Telephone bazaar, Tarol	"
20	Muhibur Rahamn	56	"	"	"
21	Noor Mohamad	36	"	"	"
22	Hafsa Begum	34	"	"	"
23	Rabiul Islam	38	"	"	"
24	Abdul Khaleque	55	"	"	"
25	Fazor Ali	63	"	"	"
26	Md. Motibor Rahman	47	"	"	"
27	Md. Mintu	19	"	"	"
28	Noor-un-Nabi	21	"	"	"
29	Md. Afzal Hossain	23	"	"	"
30	Abul Hasan	33	"	"	"
31	Sabiha	31	"	Tol Baisah, Tarol	24.04.2018
32	Hadesa	42	"	"	"
33	Kausar	45	"	"	"
34	Jakir Hosain	50	"	"	"
35	Jilani	26	"	"	"
36	Mehedi Hasan	40	"	"	"
37	Jobeda	54	Islam	Tol Baisah, Tarol	24.04.2018
38	Rina	38	"	"	"
39	Ayna Mati	33	"	"	"
40	Lal Mamun	41	"	"	"
41	Amena Begum	48	"	"	"
42	Md. Monsur Ali	68	"	"	"
43	Lavlu	38	"	"	"
44	Kulsum	33	"	"	"
45	Suronjit Das	37	Hinduism	Volanagar, Anandapur	25.04.2018

Sl. No.	Name	Age (Years)	Religion	Address	Date
46	Dilip Chandra Das	28	"	"	"
47	Sipon Kumar Das	37	"	"	"
48	Abdul Halim	42	Islam	"	"
49	Rasel	25	"	"	"
50	Mithu Miah	27	"	"	"
51	Mokkaram	33	"	"	"
52	Md. Akkul Ali	58	"	"	"
53	Md. Mizanur Rahman	62	"	"	"
54	Md. Sagar	43	"	"	"
55	Md. Atiar Rahman	45	"	"	"
56	Abu Lais Chowdhury	56	"	Sullah Sadar	"
57	Md. Siraj Miah	60	"	"	"
58	Abdul Goni	43	"	"	"
59	Kajol Das	46	Hinduism	"	"
60	Suvash Sarkar	36	"	"	"
61	Muktar Hossain	41	Islam	"	"
62	Bakul Das	26	Hinduism	"	"
63	Pran Krishno Sarkar	49	"	"	"
64	Kul Mia	54	Islam	"	"
65	Ekramul Hossain	28	"	"	"

6.5 Organization concern

During the ESIA study, consultations have been made with officials from different government organizations and elected representatives of the local government. The study team consulted about the proposed Dirai-Sullah road project with Roads and Highways Department (RHD), Bangladesh water Development Board (BWDB), Agriculture Extension Department (DAE), Dirai Upazilla Fisheries Office, Dirai Upazilla Agriculture Office and Sullah Upazilla Agriculture office. The consultants have also talked about the project to elected representatives such as Chairman of Dirai Upazilla, Vice –Chairman of Dirai Upazilla and Chairman of Taral Union etc.

The study team consulted in detail about the existing Dirai-Sullah road project with Executive Engineer, RHD, Sunamganj. He informed that the proposed road construction was initiated in 2011 and the construction was finished in 2016. However, the road is not fully functional yet. He requested to keep the road alignment in its existing position as much as possible with changing other design parameters, if necessary, as the road has already been constructed and a lot of money has already been invested. For example, most of the road structures have been constructed and for some of them the approaches are yet to be constructed. Therefore, the study should focus on the adequacy of the already constructed structures as well as on the need for new structures and their location, type, dimension and hydraulic design variables.



Study team consulting with Executive Engineer, RHD.

Study team consulting with Sub-divisional Engineer, RHD

Sub-Divisional Engineer, RHD informed that the implementation of the Dirai-Sullah road is very high demanding to the local people. However, he expressed his deep concern about the road as the road is still non-functional. He informed that the road is an all weather road and it connects the Sullah upazila with the national road network. Moreover, he added that the alignment and design of the road might be standard including design height/level of road is perfect for protection from flood water. He also added that the location of the project site is very remote with lack of communication facilities be it either roadway communication or waterway communication and therefore, it is very hard to supervise construction works. In response to a question about land acquisition for the road project, he replied that land acquisition has not been done from DC office yet.

The study team exchanged views with the personnel of BWDB about the existing Dirai-Sullah road. According to Mr. Omitav Chowdhury, SDE, BWDB, the likely causes for damage of the road are inadequate road openings such as bridges and culverts, poor design or construction of the slope protection works and mismanagement of construction works. He proposed that at the location of the Machuarkhara of Dirai Upazila, there should be a sluice gate/other structure to control the flow of water for the protection of land and crops of the local people from flood water. He also added that there is connectivity between Champty-Darain river and Boram haor. He also mentioned that the road project will not be in conflict with BWDB undertakings nearby.

The study team also discussed details about the Dirai-Sullah road project with District and Upazilla Fisheries Officer, Dirai and Sullah Upazilla Sub-Assistant Agricultural Officer.

Study team consulting with Sub-divisional Engineer, BWDB, Sunamganj.

Study team consulting with Upazilla Fisheries Officer, Dirai.

Dirai upazilla fisheries officer expressed his opinion about the project. He told that construction of road in the haor area needs sufficient water passages to allow water to flow from haor to haor or from haor to river so that fishes can avail their migration passages for feeding and breeding. He said that even though there are sufficient numbers of culverts/bridges, the Dirai-Sullah road has been damaged. There might be other reasons for damage of the road, he added. He mentioned that the road project didn't have adverse impact on fish population. However, fish production is now declining due to overfishing, the officer mentioned.

Upazilla Sub-Assistant Agricultural Officer
Sullah Upazilla

Upazilla Sub-Assistant Agricultural Officer
Dirai Upazilla

Md. Hafijiur Rahman Talukdar, incumbent Chairman of Dirai Upazila deemed that the Dirai-Sullah road link is very essential for the people of this region. He noted that the existing Dirai-Sullah mud road imposes a huge risk for the emergency patients to reach Sadar Hospital in Sunamganj. This situation is very critical specially for the people of Sulla upazilla. The risk will be significantly minimized and travel time will be considerably reduced after the construction of proposed road completely. He expects that the

easy movement due to road improvement has a positive impact on tourism, flourishing tourism at local as well as international level. However, the incumbent Vice Chairman of Dirai Upazila, expressed his negative attitude towards the Dirai-Sullah road project. In his view, any kind of road/bridge/culvert is not suitable for hoar region. The reason behind that is any road running through the hoar area may destruct the natural resources of the area. He proposed that only submersible road would be suitable for the hoar region.

Figure 6.3: Md. Hafijur Rahman Talukdar, Incumbent Upazila Chairman of Dirai Upazila, exchange views about the proposed road interventions with the study team

Md. Abdul Kuddus, Chairman Taral Union Parishad, Dirai Upazila showed his very positive feelings towards the Dirai-Sullah road project. He asserted that the construction of Dirai-Sullah road will improve the socio-economic condition of the people of this region by enhancing roadway communication facilities. After reconstruction of the road, people will get benefit due to reduced travel time and cost to transport goods such as rice, fish and other agricultural products. He also mentioned that the proposed road will promote industrial activities. He pointed out that the implementation of the road doesn't have harmful effect on fish, livestock and agriculture resources rather the road could be helpful for fish breeding during monsoon. When fishes are moving through the haor, the brood fish could push down to the side of the road which will accelerate fish hatching. Besides, Hafsa Begum, women member, Taral Union Parishod, Dirai, also expressed her optimistic views about the road interventions.

Md. Abdul Kuddus, Incumbent Chairman, Taral Union Parishad, Dirai

Hafsa Begum, women member, Taral Union Parishod, Dirai

Figure 6.4: Md. Abdul Kuddus, Incumbent Chairman and Hafsa Begum, women member, Taral Union Parishad, Dirai exchange their views about the road interventions with the study team.

Table 6.2: Name of the official personnel consulted during field visit with addresses

SI No	Consulted People	Address
1	Md. Shafiqul Islam	Executive Engineer Roads and Highways Division (RHD) Sunamganj.
2	Md. Nazmul Woahed Chowdhury	Sub Divisional Engineer Roads and Highways Division (RHD) Sunamganj.
3	Mr. Ranjan Kumer Das	Sub Divisional Engineer Bangladesh Water Development Board (BWBD) Sunamganj.
4	Mr. Omitav Chowdhury	Sub Divisional Engineer Bangladesh Water Development Board (BWBD) Sunamganj.
5	Mr. Shamsul Alam	Upazila Fisheries officer Dirai Upazila, Sunamganj.
6	Md. Hafijur Rahman Talukdar	Incumbent Upazila Chairman Dirai Upazila.
7	Mohammad Golap	Incumbent Upazila Vice Chairman Dirai Upazila
8	Md. Abdul Kuddus	Incumbent Chairman Taral Union Parishad.

SI No	Consulted People	Address
9	Mrs. Hafsa Begum	Women member, Taral Union Parishod, Dirai.
10	Mrs. Joba Rani Das Mr. Bibhutosh Chowdhury	Upazilla Sub-Assistant Agricultural Officer Sullah Upazilla

6.6 Overall findings of consultations with community and organization

The overall findings of consultations with community and organization are given as follows:

- Local people have shown very positive attitude towards the implementation of Dirai-Sullah road project.
- The existing Dirai-Sullah road is constructed only a few years ago but still most part of the road and a good number of road structures are non-functional or damaged.
- The construction of the existing Dirai-Sullah Road had been started in 2011 and finished/stopped in 2016 due to various reasons.
- There are 20 road structures along the road including Dirai-and Sullah bridges. Among them 4 are bridges and 16 are culverts.
- The likely causes of the road and road structure damages are the poor quality of construction works and natural phenomenon in haor such as connectivity between rivers and haor, flooding, drainage congestion etc.
- At some stretches of the road, there is very low distance between the road and river bank margin.
- The road gaps at Macharkhaira, Nayagaon and Kashipur are important for maintaining river and floodplain connectivity. There is strong public opinion for closing these gaps by constructing road in order to prevent the potential of crop damage by early flooding.
- Currently, BWDB and local people construct temporary low height closures every year to protect the crop land from early flooding at different places.
- Education rate, Health care facilities, emergency medical service etc., will be increased after the implementation of the road which eventually would be improved quality of life.
- Accessibility of daily commodities which are not produced in theses upazillas will be increased after the implementation of the road.
- Children will get better education as some parents do not send their children to school due to high risk of life during flood.
- Currently, the people of this region work only 6 months in a year. However, after the implementation of the road they can go to other places to find jobs easily in the rainy season too and therefore, job opportunities will be increased.
- There will be possibility of industrialization/urbanization in Dirai and Sullah upazillas that will help decrease the poverty line through creation of job market.
- The upgradation or improvement of the road will significantly improve the road communication system which will ultimately enhance socioeconomic condition of the people of this area.
- Present dependence on waterway communication will be decreased, which in turn will decrease the travel time from one place to another place with reduced travel cost.
- Fish production, migration and diversity will not be affected if the road is constructed with proper engineering design.

- It is very urgent to repair and improve the existing Dirai-Sullah road in order to establish all weather road communication facilities in the deeply flooded project area that is essential to improve the quality of life of people in this region.
- The existing road alignment is acceptable to the people of the project area. Some minor local modifications in this alignment may be needed to ensure safety of the road as well as smooth movement of vehicles.
- Approaches of the road structures should be well constructed and protected against potential damages.
- Involvement of local community during construction works may bring about positive results.

7 Anticipated Environmental Impacts and Mitigation Measures

The implementation of any project interventions will have either positive or negative impacts on some environmental and socio-economic components or may have no impact on some other environmental components. On the other hand, mitigation refers to the measures that are designed to cope with adverse consequences and to enhance the positive impacts on the environment as a result of the project implementation. Mitigation measures are recommended actions that reduce, avoid or offset the potential adverse environmental consequences of the project activities.

The Madanpur-Dirai-Sullah road (Dirai-Sullah portion) project has both positive and negative impacts including direct and indirect impact on the environmental and socio-economic components. Rapid Environmental Assessment Checklist for this project was prepared to screen the project for environmental impacts and categorization of the project (Appendix B).

The sustainability of any road project in the low-lying haor area involves a number of issues. The construction of a new road is likely to change the existing environmental condition of the area. Road structures like bridge and culvert over the river and khal can cause changes in river hydraulics and morphology in the vicinity of the structure and may result in local river instability. Besides, modification of land for road construction is likely to change wetland ecosystem and biodiversity of the area. The Dirai-Sullah road link (Z 2807) has already been established. However, the fact is that the road is not fully serviceable for vehicular movement. It is still unpaved at many parts and approaches of most of the road structures have been damaged fully or partially or have not yet been constructed. It is clear that the road is already in place. RHD suggested that the alignment of the road may be kept almost as it is now and redesign other related parameters for establishing a smooth and uninterrupted road link between Dirai and Sullah upazilas. Therefore, the likely impacts of the proposed project intervention on each of the important environmental component (IEC) have been assessed under present condition (existing Dirai-Sullah road condition), during reconstruction condition and after project implementation condition. The difference between the present condition and after the project implementation condition has been taken as the impact of the proposed intervention of the IEC. Qualitative and quantitative field assessment has been converted to values indicating magnitude of environmental changes using the scale from 0 to 5 (+5 for maximum positive and -5 for maximum negative).

Table 7.1: Environmental Impacts and Mitigation Measures during present condition (existing road condition) of the Dirai-Sullah road project

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
Land acquisition and resettlement impacts	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	• The road construction is mostly completed but land acquisition hasn't been completed. • The road occupied land is low lying floodplain mainly used for the rice and fish production. .	• Land has been already modified for construction of the road. • It has negatively impacted as the land owners haven't gotten compansation yet.	Permanent	-3	• Appropriate compensation should be provided for land acquisition and displaced people should be resettled. • Expedite the process of land acquisition to pay the compensation to the land owners. • These impacts will be addressed through the EMP.
Air quality	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar	• Air quality is quite satisfactory. • Dust generation during rice harvesting in the project site in dry season	• Dust generation during vehicle movement and construction material transportation by heavy vehicles.	Temporary	-2	• Construction materials (sand/soil) to be covered with thick polythene while transporting • Water to be

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Tol Baisha (Machuarkhara) Dhonpur Chandipur Kashipur Darain Bholanathpur Gridhar Anondopur Sakline Angaruabari Sullah sador	• No severe air pollution has been found or reported by the local people.	• Dust generation during rice harvesting • This impact will be low as the vast expanse of land is low lying haor or beel area that is very thinly populated.			sprinkled as and where needed
Noise	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur	• Sound is within tolerable limit • No significant source of noise is found.	• Noise may be generated during mobilization of vehicles and construction materials.	Temporary	-1	• Noise levels from vehicles, equipment and machinery to comply with national noise standards.

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Sakline Angaruabari Sullah sadar					
Seismic considerations in design of structures	Sunamganj Dirai Sullah	• The project site is characterized by High earthquake prone under Zone-I. • The basic seismic coefficient is 0.08g and there is also fault line near the project site.	• Earthquake may cause damage to the road.	Permanent	-4	• The designs of the project components will conform to Bangladesh National Building Code, 2006.
Identification of sources of materials	Sunamganj Dirai Dhal Bazar Sullah Ajmeriganj Sylhet Dhaka	• The project site lies in a remote area and there is unavailability of construction materials	• Difficulty of Construction	Temporary	-1	• The contractor, at the detailed design stage, shall (i) identify all potential material sources (ii) propose quarry sites and sources permitted by government and (iii) verify suitability of all material sources.
Social conflict between owners	Daudpur Radhanagar	• haor or beel area/ Crop land	• Damage of crop land/ catch fish	Temporary	-1	• Compensate the land owner as per

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
of land and contractor	Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Bholanagar Sullah sadar					the current value
Drinking water availability and water arrangement	Daudpur Radhanagar Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Bholanagar Sullah Sadar	• Insufficient Tube-well water for drinking purposes.	• Reduced drinking water availability at work place • Water-borne disease may spread out	Temporary	-2	• Prior to the initiation of construction activities, the contractor will be responsible for arrangement of water in every workplace at suitable and easily accessible places for the whole construction period.
Sanitation	Daudpur Radhanagar Telephone bazar Tol Baisha (Maccharkhaira) Dhonpur Bholanagar	• No sanitation facilities near the work place	• Environmental degradation and health hazards	Temporary	-1	• Required sanitation facilities should be established.

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Sullah upazilla					
Electricity facility	Daudpur Radhanagar Telephone bazar Tol Baisha (Machuarkhara) Dhonpur Bholanagar Sullah upazilla	• Electricity facility is available at the project site.	• Laborers cannot avail modern amenities of life	Temporary	+1	• Electricity connection should be established near the labour shed.
Environmental clearance (EC)	N/A	N/A	N/A	N/A	N/A	• EIA document have to be submitted to DoE as part of environmental clearance requirement. • The EC is to be obtained prior to commencement of civil works.
Strengthening and improving the existing road	Dirai sadar to Sullah sadar	• The existing road is not in good condition everywhere.	• Roadway communication problems between Dirai to Sullah.	Temporary	-4	• Upgradation of existing road as per study outcomes

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
Existing road openings for safe passage of flood water	From Dirai sadar to Sullah sadar	• 19 numbers of bridges and culverts are exists throughout the road. These are: Rajapur Culvert-1 Rajapur Culvert-2 Islampur Culvert Nayagaon Culvet-1 Nayagaon Culvet-2 Nayagaon Culvet-3 Dhanpur Culvet-1 Dhanpur Culvet-2 Chandipur Culvert Kashipur-Culvet-1 Kashipur-Culvet-2 Darain Culvert Bholanathpur Bridge Gridhar Culvert-1 Gridhar Culvert-2 Anondopur Bridge Sakline Culvert Angaruabari Culvert Sullah Bridge	• Hindrance to free passage of flood water over the floodplain. • Occurrence of flood water flow through restricted area resulting in relatively high flow velocity • Afflux caused by the road	Permanent Permanent Permanent	-1	Increase in the total length of road opening
Connectivity between rivers and haors	Daudpur Radhanagar Rajapur Islampur	• There is distinct connection between rivers and floodplain in the project site. The	• Direct connectivity between rivers and haors will be lost • Natural flow regime	permanent	-2	Keeping adequate openings in the road at appropriate locations with

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	existing connectivity is important for maintaining river and floodplain ecosystem • Old Surma, Kalni, Chamty, Piyain Darail, Godi and Kazua river are flowing at and around Dirai and Sulla upazilla • Chaptir haor, Boram haor, Kaliakota haor Dhalar haor, Chhayar haor, Kaligotar haor, Gachher dohor haor, Bera dohor haor, and Baguar Haor are existing at and around Dirai and Sulla upazilla	will be changed as a whole • Fish habitat and fish migration will be negatively affected			appropriate type and dimension of the road structures.
Flood level	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar	• Monsoon flooding inundates the study area regularly • The formation level of the road at some stretches of the	• Flood level would be negatively impacted.	permanent	-1	Keeping provision for adequate road openings

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	existing road are not adequate.				

Table 7.2: Environmental Impacts and Mitigation Measures during reconstruction Phase of the Dirai-Sullah road project

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
Air Quality	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	• Air quality is quite good. • Dust generation during rice harvesting season	• Fugitive dust generation during reconstruction work. • The impact will be low as the project site is very thinly populated.	Temporary	-2	• Water to be sprinkled as and where needed
Noise and vibration	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar	• Noise and vibration level are quite good • No significant source of noise has found.	• Noise generation due to construction work • The impact will be low as the project site is very thinly populated.	Temporary	-2	• Noise levels from vehicles, equipment and machinery to comply with national noise standards.

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Tol Baisha (Maccharkhaira) Dhonpur Chandipur Kashipur Darain Bholanathpur Gridhar Anondopur Sakline Angaruabari Sullah sador					
Connectivity between rivers and haors	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline	• There is distinct connection between rivers and floodplain in the project site. The existing connectivity is important for maintaining river and floodplain ecosystem • Nayagaon, Maccharkhaira, Dhanpur, Kashipur, Bholanathpur and Anondopur are important places for maintaining river and floodplain connectivity	• Nayagaon, Machuarkhara, Dhanpur, Kashipur, Bholanathpur and Anandapur are important for maintaining river and floodplain connectivity • Natural flow regime will be changed at Maccharkhaira and Bholanagar • Fish habitat and fish migration will be	Permanent	-4	• Provide appropriate road openings for flow of water between river and haor • Bridge/sluice gate should require at Maccharkhaira and Bholanagar to maintain natural flow regime. • The bridge approach roads should be properly aligned and provided with slope protection works

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Angaruabari Sullah sadar	as there are river gaps. • There are some BWDB/RHD closures for saving crops from early flooding. • There is strong public opinion that at these places closing these gaps by constructing road in order to prevent the potential of crop damage by early flooding. • If close these gaps, natural flow regime will be changed significantly. • Fish habitat and fish migration will be negatively affected	negatively affected			• Proper monitoring should be done by RHD during construction works. • Quality works should be followed by the contractors during construction work.

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
Road opening for safe passage of flood water.	Daudpur Rajapur Islampur Nayagaon Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	• 20 numbers of bridges and culverts are exists throughout the road. These are: Dirai Bridge Rajapur Culvert-1 Rajapur Culvert-2 Islampur Culvert Nayagaon Culvet-1 Nayagaon Culvet-2 Nayagaon Culvet-3 Dhanpur Culvet-1 Dhanpur Culvet-2 Chandipur Culvert Kashipur-Culvet-1 Kashipur-Culvet-2 Darain Culvert Bholanathpur Bridge Gridhar Culvert-1 Gridhar Culvert-2 Anondopur Bridge Sakline Culvert Angaruabari Culvert Sullah Bridge • Most of these constructed bridges and culverts have lost connection with the	• Monsoon flooding inundates the study area regularly • During rising period of flood water enters into floodplains and during recession period rivers drain the floodplains. This flow system has been hampered as these bridges and culverts are not functioning well. • The road and road structures would be damaged. • Early flooding damage crops.	Permanent	-5	• Adequate number of road openings should be provided at appropriate locations with proper engineering design for safe passage of flood water • The bridges and culverts should have adequate opening for free passage of flood flow • The bridge approach roads should be properly aligned and provided with slope protection works • Proper monitoring should be done by RHD during improvement of the road bridges/culverts. • Quality control of

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
		road due to full or partial damage of approaches. • Most of these constructed bridges and culverts have no adequate opening. • During the construction work of the road pavement, quality control of work didn't maintained.				works should be followed by RHD during construction work.
Strengthening and improving of the existing road	Sunamganj Madanpur Goniganj Dirai	• The existing road and road structure are not in good condition everywhere between Sunamganj to Dirai.	• Communication problems between Sunamganj and Dirai upazilla.	Temporary	-2	• Repair and maintenance of the road and road structures may be required.
Bank/slope protection activities	Daudpur Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain	• Bank/slope protection Work not at good condition everywhere.	• Creates non-hazardous solid waste	Permanent	-1	• Some generated waste like concrete wastes, sand, bricks, and cement during construction would be collected and dumped on a preselected temporary dumping yard • No dumping of

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar					such waste nearby water bodies • These wastes can be used to raise the level of the construction site or connecting roads.
Water quality	Dirai Rajapur Islampur Nayagaon Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	• River, Haor and Tube-well water quality are satisfactory	• Construction work of the proposed road will deteriorate the water quality of the river and haor	Temporary	-1	• Control solid waste from construction site • Compliance with DoE standards during and after construction • Manage wastewater discharge and solid waste from establishment after construction
Clearance of terrestrial vegetation	Dirai Rajapur Islampur Nayagaon Dhanpur Kashipur Darain	• Clearance of vegetation already done at project location.	• Damage to trees and clearance of vegetation at project location • This impact is low as the project site is in low-lying haor area.	Temporary	-1	• Minimize vegetation loss as much as possible • Implement plantation along the Dirai –Sullah road sides after the road

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
	Bholanathpur Gridhar Anandapur Sullah sadar					reconstruction.
Aquatic habitat quality	Daudpur Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Darain Anandapur Sullah sadar	-	• Deteriorate aquatic habitat quality for incautious spillage of concrete materials into river and haor	Temporary	-1	• Care should be taken to minimize spillage of concrete materials into the river water
Material handling at site	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	-	• Workers may be injured during material handling at project site	Temporary	-1	• All workers employed for mixing asphaltic material, cement, concrete, etc. will be provided with protective foot wear and goggles.
Safety measures During	Daudpur Rajapur	-	• During construction safety measures will	Temporary	-1	• All relevant provisions of the

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
construction	Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar		be required to protect the workers.			Bangladesh Labor Act, 2006 and Bangladesh National Building Code, 2006 will be adhered to, with regards to provision of adequate safety measures during construction.
First aid	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	-	• Workers may be injured at project site	Temporary	-1	• At every workplace, a readily available first aid unit, including an adequate supply of sterilized dressing material and appliances, will be provided as per the factory rules. • Suitable transport will be provided to facilitate transfer of injured or ill persons to the nearest hospital.
Hygiene in the	Daudpur	• Hygiene at the project	• Negative impact on	Temporary	-2	• All temporary

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
construction camps and site	Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	site is quite satisfactory	health of workers in the project			accommodations will be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking, and washing. Safe drinking water in sufficient quantity for the work force will be provided at the construction site as well as at the construction camps. • Adequate toilets, separate for women and men, shall be provided at the construction sites, with septic tanks. Garbage bins will be provided in the camps and regularly emptied, and the garbage disposed of in a hygienic

IEC	Location	Baseline condition	Impacts	Duration/ Extent	Magnitude of impact	Mitigation Measures
						manner. • Adequate health care will be provided for the work force.
Employment generation	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	• Normal employment situation at the project area	• Additional employment will be generated during construction work	Temporary	+2	• Recommend the contractor to employ local people by giving priority to women and vulnerable groups • Ensure equal wages to male and female for equal amount and type of work • Promote use of local materials, particularly consumables items.

Table 7.3: Environmental Impacts and Mitigation Measures after Implementation of the Dirai-Sullah road project

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
Regional hydrology and Flooding	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• The project area gets inundated every year during monsoon flood. • At some places the distance between the road and the right bank of the Champty-Darain River that flow almost parallel to the road is very less. • The velocity of flow over the floodplain is generally low. • Occurrence of a flash flood from the Meghalaya Hills causes increase in the flow velocity at the outfalls and rivers. •	• The proposed Dirai-Sullah road alignment has been constructed parallel to the old Surma River and Chamty-Darain river that causes obstruction to natural flow of water. • The road across the floodplain causes blockage of floodplain flow and flow velocity through the road structures is much higher	Will remain in Same condition like baseline scenario that is seen existing road in place.	• The study area gets flooded during monsoon and causes damage to crops and properties • During flash-flood flow occurs over the road at some locations and destroy crops and properties • During flash flood, even the proposed road may	-5	• Adequate number of road openings should be provided at appropriate locations with proper engineering design for safe passage of flood water. • The bridges and culverts should have adequate opening for free passage of flood flow. • Proper monitoring should be done by RHD during construction works. • Quality works

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
			than that over the floodplain.		get damaged if this issue is not properly addressed.		should be followed by the contractors during construction work. • Provide sufficient number of bridges as recommended by RRI mathematical model study to reduce impediment to drainage flow. • Road alignment and formation level of the road should be as per suggestions given from RRI model study • During extreme event proper monitoring

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
							should be done by RHD and local community. • Close monitoring of the developments in the river where there is bank erosion potential or setback distance is not adequate. • Approach of the existing and proposed road structures where it is not constructed yet has to be aligned properly.
Drainage congestion	Tol Baisha (Maccharkhaira) Kashipur Darain Bholanathpur	• Drainage congestion exists in the project areas and is mainly due to monsoon flooding.	• Monsoon flooding will inundate these areas regularly. The proposed	Will remain in Same condition alike baseline scenario.	• Monsoon flooding inundates these areas regularly.	-3	• Use the recommended locations, number and size of the bridge/culverts

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
	Anondopur	• During flash flood, the capacity of the rivers not enough to convey all flood water to the Surma, Kushiara, Baulai and Chamty Darain river. As a result, substantial flood water enters into the nearby low-lying area in the form of floodplain flow.	road may aggravate drainage congestion.		Proposed road may create more drainage congestion.		recommended by RRI Numerical model study
Erosion	Tol Baisha (Maccharkhaira) Kashipur Darain Bholanathpur Anondopur	• Erosion usually takes places at the bend locations of the rivers.	• At some locations river erosion may pose threat to the safety of the proposed road.	• Same as baseline condition.	Erosion may cause damaged to road and lands.	-1	• Erosion protection measures may be under taken where necessary with close monitoring of the morphological developments.
Sedimentation		• Sedimentation has been taking place in the rivers and	• Sedimentation occurs from upstream with	• Will remain in Same condition alike baseline	Implementation of the proposed	-2	Dredging at the silted up location of

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
		floodplains.	water in the floodplain during monsoon.	scenario.	work may have adverse impact on sedimentation at the side of the road.		the project site.
Fish habitat	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• The fish habitat is quite good. • Land filling for construction of the road has already reduced seasonal floodplain. • Seasonal cultured fish habitat has been established along the existing road side.	• After road construction people may fill up floodplains near the road to build houses Markets etc.	Will remain in Same condition alike baseline scenario.	• Occupation of floodplains for road construction and development purposes will reduce floodplain fish habitat	-4	• Adequate opening for free flow of water and fish migration. • Use the recommended locations, number and size of the bridges • Limiting floodplain development • Seasonal cultured fish habitat would be increased along the existing road side.
Fish migration,	Dirai Rajapur	• Fish migration, fish species and fish	• The proposed road	• Will remain in same condition	The proposed road	-4	• Adequate opening for fish migration.

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
Fish species Fish diversity	Tol Baisha Kashipur Darain Bholanathpur	diversity condition is quite good.	construction would be interruption for fish migration or movement of larger and small fish species.	like baseline scenario.	construction would be interruption of fish migration or movement for larger and small fish species.		• Use the recommended locations, number and size of the bridge • Provision of fish paths
Land use pattern	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union	• Mainly for human settlement, agriculture and aquaculture	• Land use pattern will be changed. • Industrial and commercial use of land may be increased. • Number of human settlements may increase and land use for agriculture may decrease.	If the project is not implemented, there would be no change of land use practices.		+3	Proper land use planning and management

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
	Krishnapur Union Khaliajuri Union						
Loss of fish production		• Land has been modified for construction of the road. • This land is low lying floodplain mainly involved with the agricultural practices along with fishing	• The floodplain fish production would be declined due to modification of land for construction of the road	• If the project is not implemented, there would be possibility to loss of fish production due to constraint of fisheries resources management.	• Expected decrease in fish production.	-2	These impacts will be addressed through the EMP.
Loss of crop production		• Land has already modified for construction of the Dirai-Sullah road. • This land is low lying floodplain mainly involved with the agricultural practices along with fishing	• The production of crops mainly rice that declined due to modification of land for construction of the road.	If the project is not implemented, there would be no change of land use practices.	• Expected decrease in crop production.	-2	• Tree plantation along the both sides of the Dirai-Sullah road. • Vegetables plantation at homestead and where possible
Service Accessibility	Karimpur Union Rajanagar Union	• Health care facility is very poor.	• New healthcare facilities will be	Will remain in Same condition		+3	• Improve rural/local roads

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
to Health	Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sullah Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union		established • Expected to increase accessibility to Health due improvement of the communication system	like baseline scenario.			for better access to improve healthcare services and better movement ambulance.
Service accessibility to Tourist/ Recreation	Dirai Upazilla Sulla Upazilla Baniachong Upazilla Ajmeriganj Upazilla Khaliajuri Upazilla	• Tourism facility is unavailable.	• Expected to increase accessibility to tourism due improvement of the communication system.	Will remain in Same condition alike baseline scenario.	• Provide better accessibility to the tourist spots in the haor region through road sign and tourist	+2	• Improvement of rural and regional roads for better traffic movement • Provide tourist facilities.

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
					facilities.		
Education/ literacy	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sullah Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• Literacy rate is low.	• Literacy rate will be increased.	• Will remain in Same condition alike baseline scenario.	• Literacy rate will be increased.	+4	• Provide better and safer walking / travel routes for the students.
Transport and road communication	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union	• Overall poor roadway and waterway communication. • In dry season, very bad quality road and vehicle mainly	• Roadway communication facilities will be increased significantly and dependence on waterway	Will remain in Same condition alike baseline scenario.	• Facilitate direct roadway communication between Sunamganj	+4	• Improvement of rural and regional roads for better traffic movement • Repair and widening of existing narrow

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
	Kulanj Union Atgaon Union Habibpur Union Bahara Union Sullah Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	Motorcycle use from Dirai to Sullah • Waterway communication is the only mode of communication during monsoon with locally available vehicle such as boat or troller.	communication will be reduced. .		to Sullah. • Smooth communication between Dirai and Sullah headquarters and different important locations and growth centers. • Smoothen communication within villages for Hat, bazar etc.		road.
Employment opportunity	Dirai Upazilla Sullah Upazilla Baniachong Upazilla Ajmeriganj Upazilla	• Employment opportunity is least due to lack of industrial development and communication	• Create new employment.	Will remain in Same condition alike baseline scenario.	• Employment opportunity will be increased.	+4	• Employment in new industries and business in the project site • Employment in city or adjacent

IEC	Location	Baseline condition	Future condition with project Implementation	Future condition without project Implementation	Impacts	Magnitude of impact	Mitigation Measure
	Khaliajuri Upazilla	facilities.					areas such as Sunamganj, Hobiganj, Netrokona, Kishorganj, Sylhet, Dhaka etc. due to smooth communication and higher wages.

8 Environmental Management Plan

Environmental Management Plan (EMP) for the Madanpur-Dirai-Sullah road (Dirai-Sullah portion) project under Sunamganj Road Division, Sunamganj comprises of enhancement plan for increasing the benefits of the positive impacts and mitigation plan for minimizing the effect of the negative impacts. All the measures under the EMP have been described in this chapter considering three phases. Dirai-Sullah road link almost has implemented and therefore, there is no scope to consider the pre-construction phase. So, existing Dirai-Sullah road situation has assessed under present condition, during reconstruction condition and after project implementation condition. The difference between the present condition and after the project implementation condition has taken as the impact of the proposed intervention of the IEC. The EMP also includes an environmental monitoring plan for keeping track of changes taking place in the environmental and social components to check if the intended benefits are derived from the project. There is also EMP Implementation Monitoring Plan for project implementation Phase.

The EMP includes negative impacts of the proposed interventions which have been assessed in the environmental and social impact assessment stages as furnished in the previous chapter. Measures to minimize and/ or avoid the negative impacts are suggested, and enhancement and compensation measures also include in the following tables (**Table 8.1** to **Table 8.3**). The EMP is developed for present condition, during reconstruction condition and project implementation stages together with a monitoring plan.

Table 8.1: Environmental Management Plan (EMP) with Monitoring at present condition (existing Dirai-Sullah road condition) phase

IEC	Location	Impacts	Magnitude of impacts	Mitigation/ Enhancement/ Compensation Measures	Magnitude with EMP	Monitoring	Responsible Agency
Air quality	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Maccharkhaira) Dhonpur Chandipur Kashipur Darain Bholanathpur Gridhar	• Dust generation during vehicle movement and from rotation of construction materials movement by vehicles. • This impact will be low as the project area is thinly populated.	-2	• Covering construction material (sand/soil) with thick polythene while preserve/ transporting. • Water sprinkling where needed. • Use low cost environment friendly rice harvesting machine instead of manual harvesting.	0	RHD/ Contractor	Contractors
Land acquisition and resettlement impacts	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur	• Land has already been modified for construction of the road. • It has negatively impacted as the land owners haven't gotten compensation yet.	-3	• Appropriate compensation should be provided for land acquisition • Expedite the process of land acquisition to pay the compensation to the land owners.	0	RHD	RHD/DC office, Sunamganj

IEC	Location	Impacts	Magnitude of impacts	Mitigation/ Enhancement/ Compensation Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Gridhar Anandapur Sakline Angaruabari Sullah sadar						
Noise and vibration	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar	• Noise may be generated during mobilization of vehicles and construction materials. This impact will be low as the project area is thinly populated.	-2	• Noise levels from vehicles, equipment and machinery to comply with national noise standards	0	RHD	Contractors
Impacts on fisheries	-	• There would be no impact on fisheries at this phase.	0	• There would be no mitigation measure in this phase.	-	-	-
Seismic considerations in design of structures	Sunamganj Dirai Sullah	• The project area is high earthquake prone site (zone) and has a basis seismic coefficient of 0.08g.	-4	• The designs of the project components will conform to Bangladesh National Building Code, 2006.	0	RHD	RHD, Contractor

IEC	Location	Impacts	Magnitude of impacts	Mitigation/ Enhancement/ Compensation Measures	Magnitude with EMP	Monitoring	Responsible Agency
Identification of sources of materials	Sunamganj Dirai Dhal Bazar Sullah Ajmeriganj Sylhet Dhaka	• Lack of easily accessible sources of materials	-2	• The contractor, at the detailed design stage, shall identify all potential material sources, propose quarry sites and sources permitted by government and verify suitability of all material sources.	0	RHD	Contractor/ RHD
Drinking water availability and water arrangement	Daudpur Radhanagar Telephone bazar Tol Baisha (Maccharkhaira) Dhonpur Bholanagar Sullah Sador	• Drinking water shortage may occur • Water-borne disease may spread out	-2	• Prior to the initiation of construction activities, the contractor will be responsible for arrangement of water in every workplace at suitable and easily accessible places for the whole construction period. • Sufficient supply of cold potable water will be provided and maintained at the construction camps.	+1	RHD	Contractor
Design and layout - Construction	Daudpur Radhanagar Telephone bazar	• Pollution from construction materials	-1	• The construction camps, hot mix plants, storage areas, disposal	+1	RHD	Contractor and RHD

IEC	Location	Impacts	Magnitude of impacts	Mitigation/ Enhancement/ Compensation Measures	Magnitude with EMP	Monitoring	Responsible Agency
camps and/or hot mix plants, storage areas, and disposal areas	Tol Baisha (Maccharkhaira) Dhonpur Bholanagar Sullah Sador			areas will be located away from river/ beels and other water bodies. At these locations, the contractor will work out layouts adhering to the air and water standards prescribed by DoE.			

Table 8.2: Environmental Management Plan (EMP) with monitoring during reconstruction Phase

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
Air Quality	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Maccharkhaira) Dhonpur Chandipur Kashipur Darain Bholanathpur Gridhar	• Fugitive dust generation during reconstruction work. • The impact will be low as the project site is very thinly populated.	-2	• Water to be sprinkled as and where needed. • Construction materials (sand/soil) to be covered with thick polythene while transporting • Use low environment friendly cost rice harvesting machines instead of manual harvesting.	-1	Monitor air quality	RHD and Contractor
Noise and vibration	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur	• Noise and vibration level are quite good • No significant source of noise has found.	-1	• Noise levels from vehicles, equipment and machinery to comply with national noise standards.	0	RHD	Contractor

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Gridhar Anandapur Sakline Angaruabari Sullah sadar						
Land acquisition and resettlement impacts	Daudpur Radhanagar Rajapur Islampur Nayagaon Telephone bazar Tol Baisha (Machuarkhara) Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	• Land acquisition and resettlement impacts required due to the project components • Resettlement impact will be low as the vast expanse of land of project site is low lying haor or beel that is very thinly populated.	-3	• Minimize land acquisition and resettlement • Appropriate compensation should be provided for Land acquisition and resettlement	+1	Monitor proper compensation and resettlement	RHD/DC office
Connectivity between rivers and haors	Daudpur Radhanagar Rajapur Islampur Nayagaon	• Nayagaon, Machuarkhara, Dhanpur, Kashipur, Bholanathpur and	-4	• Nayagaon and Kashipur are important place for maintaining connectivity between Champty-Darain river and the Boram haor.	-1	RHD and local people	RHD/ BWDB/ local people and

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Telephone bazar Tol Baisha (Machuarkhara) Dhonpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	Anandapur are important for maintaining river and floodplain connectivity as there are river gaps. • There are some BWDB/RHD closures for saving crops from early flooding. • There is strong public opinion that at these places closing these gaps by constructing road in order to prevent the potential of crop damage by early flooding. • If close these gaps, natural flow regime will be changed significantly. • Fish habitat and		• Provide appropriate bridges for flow of water between river and haor according to RRI numerical model study. • Temporary low height closures might be constructed near the bridges every year for saving crop damage. • Bridge/sluice gate might be required at Maccharkhaira, Bholanagar, Nayagaon and Kashipur to maintain natural flow regime. • The bridge approach roads should be properly aligned and provided with slope protection works • Proper monitoring should be done by RHD during construction works. • Quality works should be followed by the contractors during construction work.			Contractor

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
		fish migration will be negatively affected					
Road opening for safe passage of flood water.	Dirai Rajapur Islampur Nayagaon Dhanpur Chandipur Kashipur Darain Bholanathpur Gridhar Anandapur Sakline Angaruabari Sullah sadar	• During rising period of flood water enters into floodplains and during recession period rivers drain the floodplains. This flow system may be hampered. • Road and structure structures may be damaged	-5	• The existing 19 bridges and culverts may be kept as they all allow passage of flood flow in different degrees. • Seven newly proposed road structures (two bridges and five culverts) recommended by RRI model study should be constructed with proper engineering design for safe passage of flood flow from an extreme event. • Construction of sufficient number of bridges/ culverts as recommended by RRI model study that reduce impediment to drainage. • Road structure should be constructed taking into account their hydrologic and hydrologic design	-1	RHD	RHD

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
				parameters.			
Fish habitat	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• Occupation of floodplains for road construction and development purposes will reduce floodplain fish habitat	-2	• Adequate opening for free flow of water and fish migration. • Use the recommended locations, number and size of the bridges • Limiting floodplain development	+1	RHD and DoF	RHD
Employment opportunity	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union	• Facilitate new employment during construction	+2	• Recommend the contractor to employ local people by giving priority to women and vulnerable groups • Ensure equal wages to male and female for equal amount and type	+3		

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union			of work • Promote use of local materials, particularly consumables items.			
Bank/slope protection activities	Dirai Sarmangal Union Habibpur Union Taral Union Bahara Union	• Creating non-hazardous solid waste	-2	• Some generated waste like concrete wastes, sand, bricks, and cement during construction would be collected and dumped on a preselected temporary dumping yard • No dumping of such waste nearby water bodies • These wastes can be used to raise the level of the construction site or connecting roads.	+1	RHD	RHD and contractor
Water quality	Daudpur Rajapur Islampur Nayagaon	• Construction works will deteriorate the water quality of	-1	• Control solid waste from construction site • Compliance with DoE standards during and after	+1	Monitor and control waste water discharge	RHD and Contractor

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	the rivers and haor/beel.		construction • Manage wastewater discharge and solid waste from establishment after construction			
Reduce terrestrial vegetation	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	• Damage to trees and clearance of vegetation at project location • This impact will be low as the project site is in low -lying haor area.	-1	• Minimize vegetation loss as much as possible • Implement tree plantation along the both sides of Dirai–Sullah road sides after the road construction.	+1	RHD	RHD and Contractor
Aquatic habitat quality	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhonpur Chandipur Darain Anandapur Sullah sadar	• Deteriorate aquatic habitat quality for incautious spillage of concrete materials into river water	-1	• Care should be taken to minimize spillage of concrete materials into the river water	0	RHD	RHD and Contractor
Destruction	Daudpur	• During	-1	• Construction workers	0	RHD	Contractor

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
of birds, animals etc.	Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	construction hunting reduces birds, as different types of birds are available in the project site (hoar/ beel area).		should be advised to protect natural resources and wild animals. • Hunting is strictly prohibited in the project site.			
Material handling at site	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	• Workers may be injured during material handling at project site	-2	• All workers employed for mixing asphaltic material, cement, concrete, etc. will be provided with protective foot wear and goggles.	+1	Contractor	RHD and Contractor
First aid	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur	• Workers may be injured at project site	-1	• At every workplace, a readily available first aid unit, including an adequate supply of sterilized dressing material and appliances, will be provided as per the factory rules. Suitable transport will be	0	RHD and contractor	RHD and contractor

IEC	Location	Impacts	Magnitude of Impact	Mitigation/ Enhancement Compensation/ Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Sullah sadar			provided to facilitate transfer of injured or ill persons to the nearest hospital.			
Hygiene in the construction camps and site	Daudpur Rajapur Islampur Nayagaon Telephone bazar Dhanpur Chandipur Darain Anandapur Sullah sadar	• Reduce hygienic condition at project site	-2	• All temporary accommodations will be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking, and washing. • Safe drinking water in sufficient quantity for the work force will be provided at the construction site. • Adequate toilets, separate for women and men, shall be provided at the construction sites, with septic tanks. • Garbage bins will be provided in the camps and regularly emptied, and the garbage disposed of in a hygienic manner.	+2	RHD	Contractor

Table 8.3: Environmental Management Plan (EMP) after reconstruction and during implementation of the Dirai-Sullah road project phase

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
Regional hydrology and Flooding	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	The study area flooded regularly during monsoon and causes damage to crops and properties	-4	• Adequate opening for free flow of flood water. • Provide sufficient number of bridges as recommended by RRI THM model study to reduce impediment to drainage flow.	+1	Safety of road bridge and culvert will be monitored during extreme flood	RHD and Local community
Drainage congestion	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union	Monsoon flooding inundated these areas regularly. Proposed road would create more drainage congestion.	-3	• Use the recommended locations, number and size of the bridges recommended by RRI Numerical model study.	-1	-	RHD and Contractor

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union						
Erosion	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	Erosion is a common phenomenon. Implementation of the proposed work impact erosion slightly.	-1	• Erosion protection measures may be under taken where necessary through close monitoring of the developments.	0	Safety of road and bridges will be monitored during extreme flood to reduce erosion	RHD and local people.
Sedimentation	Karimpur Union Rajanagar Union Rafinagar Union	Implementation of the proposed work	-2	Dredging at the silted up location of the project site.	-1	RHD	RHD

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	may have adverse impact on sedimentation at the side of the road.					
Fish habitat	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union	Occupation of floodplains for road construction and development purposes will reduce floodplain fish habitat	-2	• Adequate opening for free flow of water and fish migration. • Use the recommended locations, number and size of the bridges • Limiting floodplain development	-1	RHD, DOF	RHD, DOF

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Krishnapur Union Khaliajuri Union						
Fish migration, Fish species Fish diversity	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	The proposed road construction, would reduce seasonal floodplain which would reduce fish migration, species and diversity	-2	• Adequate opening for fish migration. • Use the recommended locations, number and size of the bridge • Limiting floodplain development	0	RHD, DoF	RHD, DoF
Service Accessibility to Health	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union	• Expected to increase accessibility to Health due improvement of the communication system	+3	• Improve rural/local roads for better access to improve healthcare services and better movement ambulance.	+4	RHD LGED	RHD

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union						
Service accessibility to Tourist/ Recreation	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• Provide better accessibility to the tourist spots in the region.	+1	• Improvement of rural and regional roads for better traffic movement • Repair and widen existing narrow road • Provide tourist facilities	+3	RHD BPC	RHD BPC
Education/ literacy	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union	• Literacy rate will be increased	+4	• Provide better and safer walking / travel routes for the students.	+5	RHD	RHD

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union						
Transport and road communication	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• Facilitate direct roadway communication between Dirai and Sullah, and • Smoothen communication within villages for Hat, bazar etc.	+4	• Improvement of rural and regional roads for better traffic movement • Repair and widen existing narrow road	+5	RHD	RHD, LGED and Contractor

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
Employment opportunity	Karimpur Union Rajanagar Union Rafinagar Union Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union	• Create new employment	+4	• Employment in new industries and business in the project site • Employment in city or adjacent areas such as Sunamganj, Hobiganj, Sylhet Kishorganj etc. due to smooth communication and higher wages	+5	-	-
Industrial activities	Dirai Sarmangal Union Taral Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Bhakhair Badalpur Union	• Generate new agro-based industries	+2	• Ensuring compliance with the DoE • Proper road /river/ haor connectivity • Industries should be discourage within haor areas	+3	RHD	RHD and Contractor
Travel Safety	Karimpur Union Rajanagar Union Rafinagar Union	• Reduce travel safety	-1	• Facilitate travel safety	+2	Compliance of contractor with	RHD and Contractor

IEC	Location	Impact	Magnitude of impact	Mitigation/ Enhancement Measures	Magnitude with EMP	Monitoring	Responsible Agency
	Dirai Sarmangal Union Charnachar Union Taral Union Kulanj Union Atgaon Union Habibpur Union Bahara Union Sulla Union Daulatpur Union Paschim Bara Union Bhakhair Badalpur Union Krishnapur Union Khaliajuri Union			• Proper traffic safety measures and regulations especially near bazar sides such as Taral, Habibpur, Bhara Bazar.		agreement regarding road safety measures	

Table 8.4: EMP Implementation Monitoring Plan at project implementation Phase

IEC	Indicator	Method	Location	Frequency	Monitoring Cost (Lac Tk)*	Responsible Agency
Water Resources	Physical condition of the road and bridges	Check safety of road and road structures (bridges and culverts).	Suggested locations by RRI numerical model study	Twice in a year. One in extreme flood and another in dry season	5 lac per year	RHD and local people
	Erosion	Check whether any structure of the road is under threat of river bank erosion or damage of road side slope by parallel current or wave action	Suggested locations by RRI numerical model study	During monsoon	4 lac per year	RHD, BWDB and local people
	Siltation	Rate of siltation of river and haor should be measured by measuring the amount of bed level rise	Suggested locations by RRI numerical model study	Twice in a year	2 lac per year	RHD and BWDB
Agricultural Resources	Crop production	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	All unions of the project area	At harvest time of each cropping Season.	2lac per year	DAE and RHD
	Crop damage	Crop damage due to early flooding should be taken into account	Recommended locations by RRI numerical model study and this EIA study	Once a year (before Flood)	5 lac per year	RHD, BWDB and local people
	Fish species diversity	Through surveying the species diversity and composition of the active gear	All unions of the project area	Three times per year	5 lac per year	Consultant and RHD

- **Cost might be changed depending on market price**

8.1 Institutional Arrangements

Roads and Highways Department (RHD) is the leading agency for road development under the Ministry of Road Transport and Bridge (MRTB). It is responsible for translating government policies for the road sub-sector into the provision of services. The services it provides include planning, design, construction and maintenance of the Strategic Road Network, and provisions to ensure a reasonable level of service for all road users. The RHD has appointed River Research Institute (RRI) to conduct the mathematical model study and EIA study of the Project 'Topographical, Hydrological and Morphological Study using Mathematical Model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division, Sunamganj'.

The primary institution for environmental management is the Department of Environment (DoE) under the Ministry of Environment and Forest (MoEF). The DoE is the authority with the mandate to regulate and enforce environmental management, including control of pollution of water resources and ensuring adequate EIAs.

The agencies involved in the implementation of the Project and clearance of environmental assessment document are following:

- Ministry of Road Transport and Bridge (MRTB)
- Ministry of Environment, Forest and Climate Change (MoEF)
- Roads and Highways Department (RHD)
- Department of Environment (DoE)

9 Conclusions and Recommendations

9.1 Conclusions

The existing Madanpur-Dirai-Sullah (Dirai-Sullah portion) road project is located in Sunamganj with complex hydro-ecologically wetland settings. Road embankment along the haors/beel will create obstacle to natural flow of water and the road embankment will be in danger because of wave actions. Besides, Road structures like bridges and culverts are constructed on the road across the natural drainage routes or any other appropriate locations to allow for free passage of flood water. This is required for sustainability of the road as well as the migration and diversity of aquatic life to maintain wetland ecosystem. Moreover, loss of bio-diversity and environmental quality degradation are likely to occur after construction of any road in the haors/beel region.

The Dirai-Sullah road link connects two upazillas between the Dirai upazila headquarter and the Sullah upazila headquarter. A Total of 20 bridges and culverts (including Dirai and Sullah Bridge) have already been constructed across different important drainage route on this road. However, this Dirai-Sullah road link is not yet suitable for vehicular movement. The road is severely damaged and approaches of the road structures are washed away at different locations. There are both paved and unpaved stretches throughout the road. Road top level is not identical all over the road. Construction of approaches of a number of bridges and culverts is not yet complete. Besides, poor quality of construction work including locally available fill material (silt/clay soil), inadequate compaction, lack of supervision, poor quality slope protection works along with long standing high depth of floodwater on both sides of the road, parallel current and wave action are the undesirable reasons for damaging the road. Therefore, it is urgent to repair and improvements of the Dirai-Sullah road link in relation to appropriate alignment, formation level, road embankment slope protection works and construction of road structures at appropriate locations. Since the road is constructed in environment profound marshland, there is also need to assess environmental impact and appropriate mitigation/enhancement measure for ensuring sustainability of the road and surrounding environment. As the road is already be present in place therefore, the location and alignment of the road will be kept as much as possible as it is now to minimize the budget of the road. The road is redesigned considering other related issues.

The ESIA study shows that the re-establishment of the Madanpur-Dirai-Sullah (Dirai-Sullah portion) link has both positive and negative impacts. The major positive impacts after reconstruction of the proposed Dirai-Sullah road link are summarized below:

- The re-establishment of the road would be facilitated uninterrupted road communication systems between Dirai and Sullah upazilla and it would avail to connect national road network systems. So, implementation of this road would ultimately enhance the communication systems in this region.
- People of this region will get benefit in terms of reduced travel time and cost after the improvement of the Dirai-Sullah road.
- The people of this area would benefit to access all weather road after re-establishment of the road. Currently the people of Dirai and Sullah are connected to each other and with nearby bazars by very bad quality roads using only motor cycle in dry season. During monsoon the village roads go under water more than 6 months and village people have to depend solely on boat to maintain communication. After implementation of the road people would be get

advantage to use the road in the monsoon and in dry season too which ensure all weather communication.

- Implementation of the road would be increased trade and commerce in this region. The agricultural products especially rice and fish are grown very well in the project site. The people have no easy access to markets beyond their localities. They completely depend on boats and other modes of locally available vehicles to transport and market their agricultural products in local markets. After completing of this road, it would be easier to transport agricultural products from Dirai and Sullah to other parts of the country. Small agro-industries would be introduced due to improvement of the road.
- With the improvement of the road communication system, employment opportunity will be increased significantly.
- Poverty alleviation would be increased through trade and commerce, employment opportunities, saving crop damage and so on.
- Accessibility in health services would be enhanced with the improvement of the Dirai-Sullah road. The people of the project area have been suffering severe health threat due to lack of communication accessibilities. Especially, Sullah is completely detached from Dirai or Sunamganj sadar and therefore, any adverse situation patient even die. Improvement of the road would also enhance the availability of doctors, nurses and related equipment's in hospitals/health centres.
- Improvement of the Dirai-Sullah road would be increased student's accessibility in schools & colleges.
- Uninterrupted road communication systems would be enhanced tourism industries. The natural beauty of the haor is marvellous. Due to alternative wet and dry nature in haor, two distinct natural scenarios are being apparent over the year in the project site. During monsoon, the area receive surface runoff from rivers and canals to become vast stretches of turbulent water and in the dry season remain disconnected by vast crop lands which creates wonderful natural beauty that would attract tourist.
- Overall the socio-economic condition would be increased after upgradation of the existing Dirai-Sullah road which eventually improves the quality of life in the project surrounding areas.

The ESIA study shows that there might be some adverse impacts for the proposed Dirai-Sullah road. The major negative impacts of the proposed Dirai-Sullah road link project are outlined below:

- The Dirai-Sullah road (Z 2807) is constructed in the low-lying haor/beel area and therefore, the most negative impacts on environmental components are related to water resources. Water resources problems in haor area such as flush flood, wave action, flood level, siltation and bank erosion would be negatively impacted on the proposed road.
- The other major negative impact on the environmental component is land acquisition. The land has been occupied for construction of the existing road which mostly belongs to private owners. However, the land acquisition hasn't completed yet.
- The land use pattern in the study area has already undertaken considerable changes due to human interventions into the rivers such as submersible roads, submersible embankments, homesteads and other infrastructure which would be negatively impacted in the project area.
- For constructing the existing road, the land has been modified from low land to high land that is increase loss of biodiversity.

- Due to construction work and movement of heavy vehicle, air and water contamination and noise generation would be deteriorated at the construction site.
- Land use pattern in this area will be changed temporary during the construction of labor sheds, contractor's office and material stockyard.
- Traffic, excavation and filling operations may create some safety hazards for the local population as well as for the construction workers.
- Fish habitat and fish production are likely to be declined during the construction work.
- Fish migration and fish diversity would be impacted as there is connectivity between rivers and haors as well as adequate road opening for free passage of water is required.

The resultant potential impacts can be offset through proven mitigation measures during the design and adoption of good engineering practices in construction and operation. The ESIA shows that the adverse environmental impacts can be addressed through proper planning, location and design of the components, control of construction activity, and mitigation/enhancement measures. The EMP provides for mitigation of all identified impacts. Moreover, the proposed project components have been discussed with the stakeholders, and no significant issues requiring redress in terms of environmental safeguards have been identified. The ESIA study shows that the most of the beneficial impacts are in high significance, regional and long term in nature. Proposed project has been categorized as Category 'Red' based on Environment Conservation Rules 1997 and an EIA is required to get EC from DoE before project implementation.

9.2 Recommendations

The following recommendation has been made for improving the Madanpur-Dirai-Sullah (Dirai-Sullah portion) Road link to minimize the adverse impact.

- Even though the Dirai-Sullah road has already been constructed the land acquisition didn't complete yet. Acquisition of land should be done in proper way and exact compensation rate should be provided as early as possible.
- The location and existing Dirai-Sullah road alignment may be kept as it is now for minimizing cost of the road.
- The existing bridges and culverts over the road might be kept as they are now because all of them are allow passage of flood water.
- For safe passage of flood flow from an extreme event, RRI Model study recommended constructon of seven road structures (two bridges and five culverts) in addition to existing structures for sustainability of the road and as a whole for maintaining wetland ecosystem. However, there is strong public opinion for closing the gap at Kashipur by constructing road in order to prevent the potential of crop damage by early flooding. Thefore, the road gap at Kashipur may be blocked in order to meet the public demand and construct only a new bridge at Nayagaon with increasing the length.
- BWDB closer/submersible embankments may be required at other places to prevent cropland from early flood flow/flush flood.
- The compaction of the soil should be done appropriately during reconstruction of the road as the soil texture in the project site is clay to loam.
- Road embankment slope failure at unprotected locations and full or partial damage of slope protection works should be done in appropriate engineering consideration.

- Proper traffic safety measures and regulations may be followed especially near bazar sides such as Dirai Bazar, telephone Bazar and Sullah Bazar.
- Construction works will be deteriorated the water quality of the Champty-Darain river and the adjacent boram haor and chhayar haor. Solid waste from construction site should be control. Compliance with DoE standards during and after construction. Manage wastewater discharge and solid waste from establishment after construction.
- During reconstruction of the road, appropriate measures should be taken by contractor to protect fish habitat.
- There is tree plantation along the some part of the Dirai–Sullah road. However, after the reconstruction of the road, there would be required implementation of plantation along the whole part of the road which will recompense the vegetation lost.
- The road embankment slope protection works should be undertaken at the identified vulnerable locations recommended by the RRI numerical model study.
- Construction workers should be advised to protect natural resources and wild animals.
- Residues from construction materials and exudes from construction machineries into the water and soil should be reduced as much as possible by careful handling.
- To reduce human pressure on remaining biodiversity resources, an extensive awareness campaign for biodiversity conservation aimed at local communities within and around the project area should be implemented.
- To minimize the loss of terrestrial habitats within the project area, homestead vegetation and roadside vegetation should be retained or replanted wherever possible.
- Recommend the contractor to employ local people by giving priority to women and vulnerable groups. Ensure equal wages to male and female for equal amount and type of work.

APPENDIX

Appendix A: List of red category project types identified in the ECR, 1997, DoE

1. Tannery
2. Formaldehyde
3. Urea fertilizer
4. T.S.P. fertilizer
5. Chemical dyes, polish, varnish, enamel
6. Power plant
7. All mining projects (coal, limestone, hard rock, natural gas, mineral oil, etc.)
8. Cement
9. Fuel oil refinery
10. Artificial rubber
11. Paper and pulp
12. Sugar
13. Distillery
14. Fabric dyeing and chemical processing
15. Caustic soda, potash
16. Other alkalis
17. Production of iron and steel
18. Raw materials of medicines and basic drugs
19. Electroplating
20. Photo films, photo papers, and photo chemicals
21. Various products made from petroleum and coal
22. Explosives
23. Acids and their salts (organic or inorganic)
24. Nitrogen compounds (cyanide, cyanamid, etc.)
25. Production of plastic raw materials (PVC, PP/Iron, polyesterin, etc.)
26. Asbestos
27. Fiberglass
28. Pesticides, fungicides and herbicides
29. Phosphorus and its compounds/derivatives
30. Chlorine, fluorine, bromine, iodine, and their compounds/derivatives
31. Industry (excluding nitrogen, oxygen and carbon dioxide)
32. Waste incinerator
33. Other chemicals
34. Ordnance
35. Nuclear power
36. Wine
37. Non-metallic chemicals not listed elsewhere
38. Non-metals not listed elsewhere
39. Industrial estate
40. Basic industrial chemicals
41. Non-iron basic metals
42. Detergent
43. Land-filling by industrial, household, and commercial wastes

44. Sewage treatment plant
45. Life-saving drugs
46. Animal glue
47. Rodenticide
48. Refractories
49. Industrial gas (oxygen, nitrogen, and carbon dioxide)
50. Battery
51. Hospital
52. Ship manufacturing
53. Tobacco (processing/cigarette/*biri*-making)
54. Metallic boat manufacturing
55. Wooden boat manufacturing
56. Refrigerator/air-conditioner/air-cooler manufacturing
57. Tire and tube
58. Board mills, E.C.R. ’97 203
59. Carpets
60. Engineering works: capital above Tk 10,000
61. Repairing of motor vehicles: capital above Tk 10,000
62. Water treatment plant
63. Sewerage pipeline laying/relaying/extension
64. Water, power, and gas distribution line laying/relaying/extension
65. Exploration/extraction/distribution of mineral resources
66. Construction/reconstruction/expansion of flood control embankment, polder, dike, etc.
67. Construction/reconstruction/expansion of road (regional, national, and international)
68. Construction/reconstruction/expansion of bridge (length of 100 m and above)
69. Murate of potash (manufacturing)

Appendix B: Rapid Environmental Assessment (REA) checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is
to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES) for endorsement.

(ii) This checklist focuses on environmental issues and concerns.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Screening questions	Yes	No	Remarks
A. PROJECT SITING **IS THE PROJECT AREA……..**			
○ **Densely populated?**		√	
○ **Heavy with development activities?**		√	
○ **ADJACENT TO OR WITHIN ANY OF THE FOLLOWING ENVIRONMENTALLY SENSITIVE AREAS?**			
○ **Cultural Heritage Site**		√	There are no sensitive ecological and cultural sites in the project area.
○ **Protected Area**		√	
○ **Wetland**	√		
○ **Buffer Zone of Protected Area**		√	
○ **Special Area for Protecting Biodiversity**		√	
B. POTENTIAL ENVIRONMENTAL IMPACTS **WILL THE PROJECT CAUSE…**			
○ **Encroachment on precious ecology resulting in loss or damage to terrestrial or aquatic habitats (e.g., wetlands or sensitive or protected areas)?**		√	

Screening questions	Yes	No	Remarks
○ **Encroachment on historical/cultural monuments or areas?**		√	
○ **Decrease in value of land in the area due to noise and other nuisances such as traffic congestion and degradation of environmental aesthetics?**		√	
○ **Dislocation or involuntary resettlement of people?**		√	
○ **Disproportionate impacts on the poor, women and children, IPs or other vulnerable groups?**		√	
○ **Noise and vibration disturbances?**		√	
○ **Short-term ecological disturbances such as soil erosion, water quality deterioration (surface and groundwater), air pollution, noise and vibrations from construction equipment?**	√		
○ **Creation of slum communities?**		√	
○ **Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?**	√		
○ **Accidental disruption of utilities?**		√	
○ **Short-term air quality degradation due to construction-related operations?**	√		

Screening questions	Yes	No	Remarks
○ **Social conflicts if workers from other regions or countries are hired?**		√	
○ **Large population influx of construction causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?**		√	
○ **Risks to community health and safety due to the transport, storage, and use and/or disposal of materials likely to create physical, chemical and biological hazards during construction and operation?**	√		

Screening questions	Yes	No	Remarks
Climate Change and Disaster Risk Questions **The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.**			
○ **Is the Project area subject to hazards such as earthquakes, floods, landslides, bank erosion, cyclone winds, climate changes?**	√		The project area is located in seismic zone I, referred to as a high risk zone for earthquakes. To address potential risks, provisions of the national building code, BNBC 2006, and seismic vulnerability should be considered in the specifications for design and construction of project components. The area has experienced to receive flush flood from upstream Meghalaya and bank erosion. Suggested mitigation measures should be considered during reconstruction of the road.
○ **Could changes in precipitation, temperature,**		√	There is no current record or data to suggest that there is salinity intrusion in

Screening questions	Yes	No	Remarks
salinity, or extreme events over the Project lifespan affect its sustainability or cost?			the project site.
○ **Are there any demographic or socioeconomic Aspects of the Project area that are already vulnerable (e.g. high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?**		√	
○ **Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., increasing traffic or housing in areas that will be more prone to flooding, by encouraging settlement in earthquake zones)?**		√	

Appendix C: Fish species diversity in the study area

Sl. No.	Order	Family	Species	English Name	Local Name
1	*Rajiformes*	*Dasyatidae*	*Himantura Bleekeri*	Bleeker's Whipray	Shapla Pata
2	*Pleuronectiformes*	*Bothidae*	*Pseudorhombus Arsius*	Large Tooth Flounder	Kathal Pata
3	*Syngnathiformes*	*Syngnathidae*	*Microphis Deocata*	Deocata Pipefish	Kota Kumirer Khil
4	*Anguilliformes*	*Anguillidae*	*Anguilla Bengalensis*	Indian Mottled Eel	Bamos
5		*Ophichthidae*	*Pisodonophil Boro*	Rice-Paddy Eel	Hizra
6	*Synbranchiformes*	*Sybranchidae*	*Monopterus Cuchia*	Cuchia	Kuche
7	*Tetraodontiformes*	*Tetraodontidae*	*Tetraodon Cutcutia*	Ocellated Pufferfish	Potka
8	*Cyprinodontiformes*	*Beloniidae*	*Xenentodon Cancila*	Fresh Water Garfish	Kakila
9		*Hemiramphidae*	*Hyporamphus Limbatus*	Congaturi Halfbeak	Ekthota
10		*Aplocheilidae*	*Aplocheilus Panchax*	Blue Panchax	Teen Chokha
11		*Oryziidae*	*Oryzias Melastigma*	Ricefish	Teen Chokha/ Kanpona
12	*Cypriniformes*	*Cyprinidae*	*Securicula Gora*	Gora Chela	Ghora Chela
13			*Salmostoma Phulo*	Finescaled Razorbelly Minnow	Fulchela
14			*Salmostoma Bacalia*	Large Razorbelly Minnow	Narkali Chela
15			*Esomus Danricus*	Flying Barb	Darkina
16			*Parluciosoma Daniconius*	Slender Rasbora	Darkina
17			*Adpidoparia Morar*	Aspidoparia	Morari
18			*Barilius Tileo*	Tileo Baril	Pathor Chata
19			*Barilius Bendelisis*	Hamilton's Barila	Koksa
20			*Danio Devario*	Sind Danio	Chap Chela
21			*Brachydanio Rerio*	Zebra Danio	Anju
22			*Amblypharyngodon Mola*	Mola Carplet	Mola
23			*Osteobrama*	Cotio	Dhela

			Cotio		
24			*Labeo Gonius*	Kuria Labeo	Ghonia
25			*Labeo Calbasu*	Kalbasu	Kalibaush
26			*Labeo Rohita*	Rohu	Rui
27			*Labeo Angra*	Angra Labeo	Agun Chokha
28			*Labeo Pangusia*	Pangusia Labeo	Ghora Mukh
29			*Labeo Dyocheilus*	Brahmaputra Labeo	Ghora Mach
30			*Labeo Bata*	Bata Labeo	Bata
31			*Labeo Boggut*	Boggut Labeo	Ghoria
32			*Cirrhinus Cirrhosus*	Mrigal Carp	Mrigal
33			*Cirrhinus Reba*	Reba Carp	Raik
34			*Puntius Sarana*	Olive Barb	Deshi Sarpunti
35			*Barbonymus Gonionotus*	Silver Barb	Thai Sarpunti
36			*Puntius Guganio*	Glass Barb	Mola Punti
37			*Puntius Phutunio*	Dwarf Barb	Phutani Punti
38			*Puntius Conchonius*	Rosy Barb	Bagha Punti
39			*Puntius Ticto*	Ticto Barb	Tit Punti
40			*Puntius Gelius*	Golden Barb	Gili Punti
41			*Puntius Sophore*	Pool Barb	Jat Punti
42			*Puntius Terio*	One Spot Barb	Teri Punti
43			*Oreichthys Cosuatis*	Cosuatis Barb	Kosua Punti
44			*Tor Tor*	Tor Mahseer	Mohashol
45			*Catla Catla*	Catla	Katla
46			*Crossocheilus Latius*	Gangetic Latia	Kalabata
47			*Garra Gotyla*	Goytala	Ghar Poia
48			*Hypophthalmic hthys Molitrix*	Silver Carp	Silver Carp
49			*Hypophthalmic hthys Nobilis*	Bighead Carp	Bighead Carp
50			*Ctenopharyngo don Idella*	Grass Carp	Grass Carp
51			*Cyprinus Carpio Var. Communis*	Common Carp	Carpu
52			*Cyprinus Carpio*	Common Carp	Carpu
53			*Cyprinus Carpio Var. Specularis*	Mirror Carp	Mirror Carp

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