Initial Environmental Examination (draft)

Project Number: 38412-033
March 2018

India: Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program – Project 2

(Dibrugarh Subproject)
(1 of 2)

Prepared by the Flood and River Erosion Management Agency of Assam for the Asian Development Bank. This is an updated version of the initial environmental examination originally posted in March 2018 available on https://www.adb.org/sites/default/files/project-documents/38412/38412-033-iee-en.pdf.

This subproject has been categorized as B for environment in accordance with ADB SPS 2009 for which an Initial Environment Examination (IEE) is required. The report prepared by FREMAA refers to Environment Impact Assessment (EIA), however throughout the report, the terminology EIA is implied as IEE.

Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (RRP IND 38412-02)

Environmental Impact Assessment Report

Update Environmental Impact Assessment
Project Number: 38412
March 2018

INDIA: ASSAM INTEGRATED FLOOD ANDRIVERBANK EROSION RISK MANAGEMENTINVESTMENT PROGRAM - (Tranche 2)

DIBRUGARH SUBPROJECT
DIBRUGARH DISTRICT
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Prepared by FLOOD AND RIVER EROSION MANAGEMENT AGENCY of Assam for the Asian Development Bank

CURRENCY EQUIVALENTS
(As of 1 March 2018)

Currency Unit - rupee (₹)

₹1.00 = $0.01532

$1.00 = ₹65.27

ABBREVIATION

ADB	-	Asian Development Bank
DMO	-	Disaster management organization
EARF	-	environmental assessment and review framework
EIA	-	environmental impact assessment
EIRR	-	economic internal rate of return
EMoP	-	environmental monitoring plan
EMP	-	environmental management plan
FRERM	-	Flood and Riverbank Erosion Risk Management
IUCN	-	International Union for Conservation of Nature
IWAI	-	Inland Water Transport Authority
KNP	-	Kaziranga National Park
MOEF&CC	-	Ministry of Environment, Forest and Climate Change
MFF	-	multitranche financing facility
NGO	-	nongovernment organization
PMU	-	project management unit
PPTA	-	project preparatory technical assistance
SEIA	-	summary environmental impact assessment
SIO	-	subproject implementation office
SPCB	-	State Pollution Control Board
WRD	-	Water Resources Department

WEIGHTS AND MEASURES

dBA	-	decibel
ha	-	hectare
km	-	kilometre
km^2	-	square kilometer
m	-	meter
mm	-	millimetre
m^3/s	-	cubic meters per second

GLOSSARY

porcupine	-	Tetrahedron-shaped concrete frames commonly made of six concrete members, each 3 meters long connected with bolts, which are placed in an arrayed manner in the riverbed to retard river water flow and induce sedimentation.
revetment	-	A riverbank protection structure constructed on the bottom or banks of a river by placing a layer of material, such as rock, stones, concrete blocks, or mattresses including sand-filled geo- textile containers.
spur	-	A river training structure built from the bank of a river in a direction transverse to the current, by placing a large quantity of rocks, stones, or concrete blocks (or earth armoured with these heavy materials).

NOTES

(i) The fiscal year (FY) of the Government of India ends on 31 March. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY 2017 ends on 31 March 2017.

(ii) In this report, "$" refers to US dollars.

Table of Contents

List of Tables

List of Figures

List of Maps

APPENDIX

Executive Summary

1. The Government of India with assistance from the Asian Development Bank (ADB) has implemented MFF Assam Integrated Flood and Riverbank Erosion Risks Management Investment Program. The investment program will enhance the reliability and effectiveness of flood and riverbank erosion risk management (FRERM) in Assam. It will focus on three existing flood embankment systems (Dibrugarh, Kaziranga, and Palasbari) protecting key urban and productive rural areas along the Brahmaputra River. These areas are vulnerable to flooding because of infrastructure deterioration, and riverbank erosion. The investment program and its tranche 1 was approved in October 2010 and became effective in August 2011. The tranche 1 implementation was closed on July 2017.

2. The Dibrugarh subproject activities for tranche 2 are continuation of flood protection works along Brahmaputra River in Dibrugarh areas. The completed tranche 1 works included (i) pro-siltation porcupine screens (8.53 kilometers [km]), (ii) bank protection works with geobags and concrete cube at Mothola bank revetment with total length 2.4 km), and (iii) DTP dyke 8.53 km. The tranche 2 project activities will include: (i) river bank protection works, from downstream end point of Rohmoria protection work up to the beginning point of Mothola bank protection works for a reach of 2,700 m, (ii) rehabilitation of existing Oakland dyke–from 0 km to 9.16 km (iii) pro-siltation measure with porcupine screens from Oakland to Bogibeel area, (iv) construction of pump house including installation of pump at selected location of DTP dyke, and (v) riverbank protection work along the DTP dyke. The above components of Dibrugarh subproject area are being planned to be implemented under the tranche 2 and expected to be approved by ADB in 2018.

3. The environmental impact assessment (EIA) report for all project activities for Dibrugarh subproject was prepared and disclosed in ADB website on June 2009. Therefore, for the continuation work activities for Dibrugarh tranche 2 that will be started in 2018, the EIA report needs to be updated.

4. This updated EIA report was prepared to capture any changes both from environment and project design as the subproject will be implemented under the tranche 2. The most important work during updating the EIA report is public consultations particularly with the affected people aiming to refresh them with information that the project will be implemented and also to provide information with the potential impacts as well as the project implementation schedule. Public consultations were carried out on 14 and 15 February 2015; July 2015 and on 11 November 2015 during tranche 2. Although there was no significant concern raised by the affected people during the public consultation, it has been planned to continue public consultations throughout the period of project implementation. Public consultations will be held to ensure that any unexpected impacts can be prevented and managed timely. The updated EIA is based on most up-to-date subproject details/concept design provided by the design team during the preparation of this report. Information regarding demography, flooding pattern, checking the recent floral and faunal diversity in the area, recent maps based on the feasibility study for tranche 2 and on recent detailed project report (DPR) have been updated.

5. Under tranche 2, provision of pump house, and provision of riverbank protection works are made with the structural works focusing on the sustaining the functions of the existing flood embankment systems through renovation of deteriorated embankments. Due to nature of the activities involved, it is anticipated that the tranche 2 may have impacts on the environmental setting of the area which will include impacts on river hydrology, morphology, and sediment transport. However, the impacts will not be significant as most of the work includes the strengthening of the existing embankment systems to maintain their intended design functions. Proposed components will normalize the flooding behavior that has persisted since these embankments were constructed. Riverbank protection measures—with their focus on revetments

and pro-siltation measures along the naturally developing bank lines in an adaptive manner and will not alter the existing dynamic channel formation pattern of the Brahmaputra morphology. Nevertheless, river hydrology, morphology, and sediment transport will be systematically monitored under the tranche 2. Mitigation measures to minimize these impacts have been incorporated in the environmental management plan (EMP).

6. No significant negative impacts are anticipated. Impacts are not anticipated on endangered species such as the river dolphin and endangered species along the Dibrugarh subproject areas. While the dolphins can be seen in Brahmaputra River, particularly at the tributary confluence and deep channels, impacts can be avoided by ensuring that construction does not occur during the breeding season (between April and August) near the sighting locations. Efforts should also be made to ensure that construction waste does not end up in the water and channels are not obstructed. All works along the river areas are minor and involve mostly earth works by local workers. Construction camps will be located outside village and destruction of the vegetation will be minimum. Furthermore, care will be taken that construction will not obstruct the breeding period (April–August) in the fish breeding sites and that construction waste will not enter the river water there. There is also no impact on aquatic endangered species, such as the river dolphin along the Brahmaputra especially in Dibrugarh subproject areas is expected. Mitigation measures are incorporated in the EMP for management of construction waste and best management practices to be adopted during the construction phase to minimize generation of the waste. Implementation of the prescribed mitigation measures particularly for dolphin sighting location at the Maijan tributary confluence, including the environmental management and monitoring plans will further minimize the adverse and minor impacts on dolphins.

7. During the construction phase, a number of trees along the embankment are likely to be cut. If the compensatory afforestation plan is implemented effectively and survival rates are monitored and sustained, the result will be positive. Program activities are likely to generate other adverse environmental impacts during construction, but these will be temporary. Implementation of the prescribed mitigation measures including the environmental management and monitoring plans will minimize the adverse and minor impacts.

8. The institutional arrangement for EMP implementation has been established, the project management unit (PMU) will take an overall responsibility to implement EMP and to address other environmental problems associated with the project if any. The PMU will be equipped with professional environmental staff, and at the project site level the subproject implementation office (SIO) will take an important role as the first level project team to handle any unexpected environmental problem and monitor the implementation of EMP by the contractor. The monitoring system has also been developed, which contractor will be required to submit report on implementation of EMP in monthly basis, and SIO will also routinely carry out field monitoring. The PMU will be assisted also by PMC consultant team with environmental consultant as member of the team. Semi-annual report on monitoring the implementation of EMP and monitoring environmental quality will be submitted to ADB.

9. The grievance redress mechanism (GRM) has been established to provide opportunity to affected peoples to raise their concerns. The SIO will be the focal point in the field to receive public complaint, and the committee at the SIO level will resolve the public concerns. The committee at FREMAA supported by the PMU team will handle the grievance, if SIO could not resolve the grievance. However, the GRM is not substituting any Court of Law. While complaints files to the GRM of the project, complainant has its freedom to submit the case to the court.

10. In view of the strong and almost enormous support by the local population in the subproject areas, the subproject interventions are recommended for implementation. During construction, a number of trees along the embankment is expected to be cut. Implementation of effective compensatory afforestation plans and monitoring of survival rates will give positive results.

Program activities are likely to generate other adverse environmental impacts during construction, but these will be temporary and are manageable.

1. INTRODUCTION

1.1. AIFRERM Project Background

1. The Government of India with assistance from the Asian Development Bank (ADB) has implemented MFF Assam Integrated Flood and Riverbank Erosion Risks Management Investment Program (AIFRERMIP). The investment program will enhance the reliability and effectiveness of flood and riverbank erosion risk management (FRERM) in Assam. It will focus on three existing flood embankment systems (Dibrugarh, Kaziranga, and Palasbari) protecting key urban and productive rural areas along the Brahmaputra River. These areas are vulnerable to flooding because of infrastructure deterioration, and riverbank erosion. The Investment Program and its tranche 1 was approved in October 2010 and became effective in August 2011. The tranche 1 implementation was closed on July 2017.

2. This updated environmental assessment (EIA) report focuses on the Dibrugarh reach only. The original environmental assessment report for Dibrugarh reach was disclosed in ADB website on June 2009 that covers planned implementation in two tranches of MFF (tranche 1 and tranche 2). This updated report is basically to capture information from public consultations aiming to refresh affected people with the project and cover any change on environmental conditions.

1.2. Rational for AIFRERM Project

3. India is one of the most disaster-prone countries in the world. Flooding is a major recurrent natural disaster, causing damage of average $450 million annually with increasing incidence in the recent years. The country has a flood prone area of 46 million hectares (ha) (accounting for some 14% of the geographical area and 25% of cultivable area). A national level policy framework for flood management is promoting short- to long-term programs for both structural and non-structural measures with a basin wide approach with improved catchment management. More than 18 million ha in flood prone area has so far been protected with flood embankments and other structures, whereas nationwide flood forecasting and warning system has been set up. However, large gaps still exist between the policy framework and operations at the individual state level.

4. Flooding in the Brahmaputra plain in Assam is a complex phenomenon with different factors often changing roles. These factors are: (i) the Brahmaputra River in high spate has the potential to flood major parts of the plain for extended period of time; (ii) tributaries flood their adjacent plains, but for shorter periods being of short term character in steeper hilly parts with longer-term flooding, influenced by Brahmaputra water levels, in their lower floodplains; and (iii) local rainfall can cause flooding (local floods associated with drainage congestion) even when rivers not over spilling, but commonly drain away after hours or days. Overall, the effective FRERM requires a long-term basin wide approach with a sound planning framework integrating short- to longer-term programs including (i) improved catchment management, (ii) multipurpose reservoirs including flood cushion where feasible, and (iii) balanced combination of structural and non-structural measures to cope with immediate annual risks.

5. While Assam has flood embankment systems protecting 50% of its flood prone areas, their effectiveness is limited due to deterioration associated with poor maintenance, riverbed rising, and failure from river erosion. High priority needs to be accorded to improve the existing embankments in particular along high value locations with assured maintenance, with provision of riverbank protection where feasible, exploring more cost-effective and flexible options adaptive to highly dynamic river process following the international and national best practices. Alternative risk management measures need to be pursued in other areas with flood proofing, strategic retirement of embankments, and a range of non-structural measures including risk mapping and advance

warning, and safety nets for the people displaced by flooding and river erosion. These need to be implemented with comprehensive strengthening of the relevant policy, planning, and institutional basis, data and knowledge base, and participatory mechanisms to ensure accountable program delivery and management.

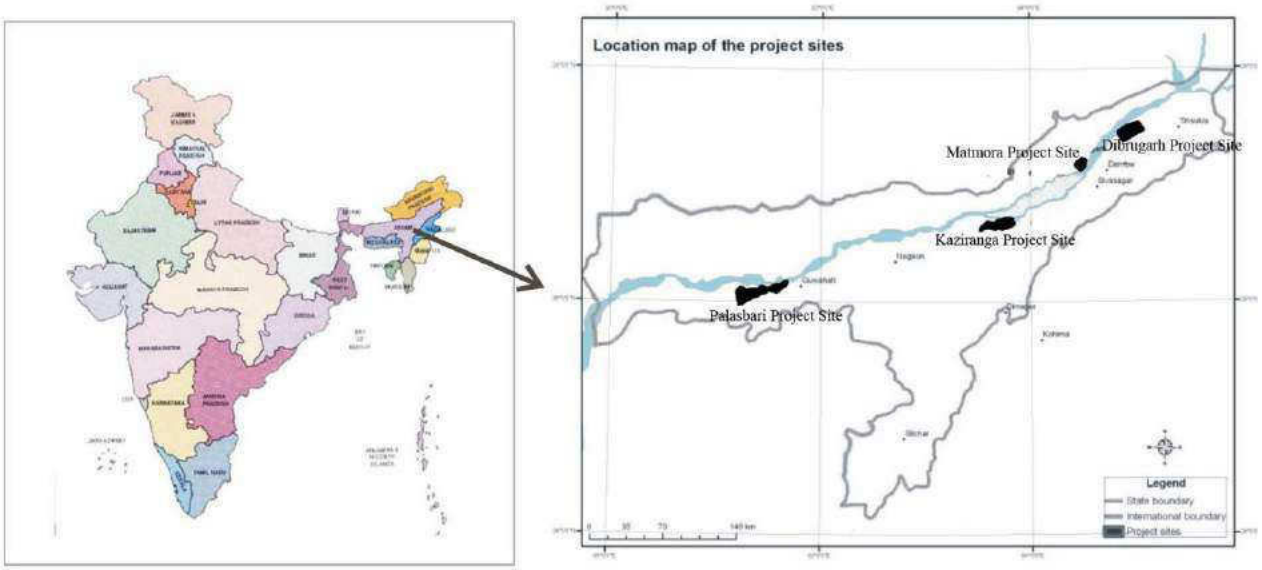
6. The Government of India has continued to put high priority to flood management. This is in line with the paradigm shift of the country's disaster management strategy to focus more on preparedness as opposed to post-disaster responses, as well as a growing concern on the impacts of climate change. Within this framework, the Assam State Government has initiated steps towards establishing sound policy, planning, and institutional framework of water resources management. A draft state water policy has been prepared with a vision to establish institutions for integrated water resources management on the basis of river basins. It also envisages a holistic flood management plan as an essential instrument, along with the reforms and strengthening of key sector organizations such as Water Resources Department and local level participatory disaster management organizations.

7. The investment program has been supported by funding from ADB's loan. Effective structural and non-structural measures in strategic locations of the state are planned under this initiative. Structural measures will focus on proper functioning as per the intended design of the existing embankment systems protecting key urban and productive rural areas and requiring upgrading and protection against river erosion exploring alternative (cost effective and sustainable) designs, whereas non-structural measures will extend to the most vulnerable locations to the impacts of chronic flooding. Significant emphasis will also be placed on establishing sound data and knowledge base to effectively manage or respond to the dynamic natural river processes while not disturbing them as much as possible. Dibrugarh subproject is part of above initiative itself.

1.3. AIFRERM Subproject Locations

8. Under the investment program, three most vulnerable reaches located in the State of Assam along the bank of Brahmaputra River have been selected for two tranches. The locations of the subproject reaches are (i) Majirgaon-Nagarbera (Palasbari reach) in south bank of Kamrup District, (ii) Oakland-Bogibeel (Dibrugarh reach) in Dibrugarh District, and (iii) Bankoal-Moraiholla-Diffalupathar (Kaziranga reach) in Golaghat District are shown in Map 1.

Map 1: Location Map of Subprojects



1.4. Extent of the EIA Study

9. The updated EIA was done in tandem with the preparation of the feasibility report of tranche 2. The updated EIA is based on most up-to-date subproject details/concept design provided by the design team during the preparation of this report. Minor changes may occur in the subprojects structural component, but these changes are expected to be limited to implementation schedule. References have also been made on the pre-feasibility and feasibility reports of tranche 1 and 2.

10. The EIA study covered all activities proposed for the integrated flood and riverbank erosion management in Dibrugarh reach. The impact area covers section of river Brahmaputra (complete reach length, its immediate upstream and downstream sections, area within 100 m either side of the reach,[1] project benefit area, and beels/wetlands/ tributaries connected with the river in the reach area). The study area has been extended to cover a buffer zone of 8 kilometer (km) wide[2] on either side of the embankment to analyze the land use, identify environmentally sensitive locations, if any, and understand the overall drainage pattern of the area. Geographical Information System (GIS) techniques have been used based on recent satellite data of the project area to analyze the baseline physical, ecological and cultural landscapes and to gather the relevant data for EIA purpose. Impact on aquatic life including dolphin, their breeding/spawning areas, migratory route of fishes have also been assessed as there are no major endangered wildlife in the project location. Assessment of vegetation cover, migratory route of animals, and sourcing of construction material particularly borrow earth and aggregate has also been undertaken.

[1] Core zone of the impact was taken as 100 m on either side of the reach based on the expert judgement as most of the project activities related to embankment renovation and/or new construction, bank protection will primarily be limited to this zone.

[2] The study area has been selected based on the following two considerations: The subproject specific benefit area which is varying up to about 8 km from the embankment in case of Dibrugarh reach. The practice adopted by Ministry of Environment and Forests (MoEF&CC), Government of India for delineating environmental assessment of the project, which is 10 km around the project boundary.

1.5. Approach and Methodology

11. The updated EIA study was carried out using reconnaissance survey, review of previous studies, field visits, consultation with stakeholders and nongovernment organizations (NGOs), review of existing data, assessment to identify adverse impacts, and the preparation of environmental management plan (EMP). Under secondary data review, the available published literature, documents and maps (e.g. topographic, geological maps, forest, satellite imagery, Google image maps, etc.) related to the influence area was reviewed. The existing policies, legislations, guidelines and manuals related river bank protection and environment in India and ADB's policies and guidelines were also reviewed. Apart from the above the detailed project report (DPR) were thoroughly reviewed. The assessment also builds on the Brahmaputra morphology study using satellite imagery, risk maps, and studies on the influence of spurs and anti-erosion activities of the Water Resources Department (WRD) in Assam. Discussions were carried out with people living in the neighborhood of Brahmaputra, NGOs and Village Councils, etc. The scope of the EIA extends well beyond the vicinity of the proposed structural measures and covers the entire Brahmaputra River section fronting the existing and proposed measures, and to the extent possible, 8-km radius as the general impact zone. While, the immediate 100-meter corridor centered along the existing and proposed embankment alignments as the primary impact zone where most of the adverse impacts may occur. The decision to expand the environmental assessment impact zone to 8-km radius is based on the following: (i) to ensure that environmental impacts attributable to the project are comprehensively identified and assessed; (ii) allow flexibility in the detailed design of tranche II measures which will adapt to the rapid changes in Brahmaputra River morphology by providing a comprehensive environmental baseline information; and (iii) recognizes that FRERM measures to influence the flow direction and promote siltation in strategic areas may have environmental impacts downstream. As part of alternative analysis, comparisons were made among different alternatives of realignments, as well as comparison of selected option with "without project" option in terms of environmental, social and technical parameters.

12. The updated EIA was prepared based the original EIA (as it was prepared for all component activities for Dibrugarh included activities planned for the tranche 2), as approved EIA document (original EIA) for both tranche 1 and tranche 2 remains valid and serves as the basis for updating. The final design of tranche 2 works is within the investigated areas described in the original EIA studies and there is no major structural change. Therefore, the updated EIA involves only updated some environmental data, impact assessment, mitigation and result from the latest public consultation carried out in February, July, and November 2015.

1.6. Data Collection

13. To provide description of environmental condition of project areas, data need to be collected. The preparation of original EIA starts with scoping exercise, identify the parameters to be considered, and outline the activities for collecting data on identified parameters. Sources of data were identified and relevant existing data on the physical, biological, and socio-economic aspects of the environment from authentic secondary sources were collected.

14. The data gathering for EIA updating started with field visit to verify whether any change on environmental conditions described in the original EIA. Additional information for tranche 2 were collected from the DPR of tranche 2 of Dibrugarh, Water Resource Department, Bokakhat; feasibility report of tranche 2; and economic assessment conducted by Omeo Kumar Das Institute of Social Development. Primary data was also collected for noise, water quality, air quality (2015) and soil. Recent demographic data were collected from the census reports (2011) of the districts. Since dolphin is an endangered species, special efforts were made to identify areas where they are frequently sighted including their breeding grounds Data collected, sources, and application are summarized in the succeeding Table-1.

Table.1 : Information Collected and Sources for Tranche 1 and Tranche 2

Information Collected	Sources	To be Used in
Project location, project objectives, project designs, and sourcing of construction materials	Pre-feasibility report; concept design prepared by TA consultant team and WRD, DPR	Project description and impact assessment
Wildlife, forest areas in project vicinity, flora and fauna details, and possible ecological impacts and mitigative actions	Department of Zoology, Gauhati University; District Forest Office; Department of Environment and Forests, Govt. of Assam	Project description, impact assessment and mitigative actions, alternative analysis, and economic assessment.
Engineering details	TA consultants, DPR, WRD, Tranche 2 documents	Project description, impact assessment, and mitigative actions
Existing quality of the environment, land use, meteorological data, possible impacts because of the project and proposed action plans, identification of ecologically sensitive locations, regulatory compliance	Primary/Secondary data collection; Department of Environment and Forests; Department of Fisheries; District Forest Office; Census Report, Govt. Of Assam; IMD Regional Office, Guwahati; State Pollution Control Board, Assam	Project description, impact assessment and mitigative actions, management plan, and environmental economic assessment
River geomorphology, hydrology, and flood pattern. Demographic data.	Published Research; Govt. Reports; Unpublished Doctoral thesis's, ARSAC reports, Brahmaputra Board, WRD, and GSI Reports, Census reports	Project and environmental descriptions, and impact assessment

1.7. EIA Content

15. This EIA report is presented in accordance to ADB's Safeguard Policy Statement, 2009 (SPS). The content of the report includes Executive Summary, introduction, rules and regulations related to environment, project description, environment description, anticipated environmental impacts and mitigation measures, analysis of alternatives, information disclosure and public consultation, grievance redress mechanism, and environmental management and monitoring plan.

16. The updated EIA report has been prepared by Dr. Jayanta Das, National Environmental Expert, PMC, Tetra Tech Es India Private Limited.

2. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1. Regulatory Requirements

2.1.1. ADB's Environmental Safeguard Policy and Requirement

17. The ADB's SPS covers three important risks to be taken into consideration for ADB funded projects. These three risks are risks associated with environment impact, involuntary resettlement impacts, and indigenous people impacts. The SPS described the objective of adopting environmental requirement is to ensure the environmental soundness and sustainability of ADB funded projects, and to support the integration of environmental consideration into project decision making process. The environmental safeguard requirements are triggered by the likely environmental impacts and environmental risks. Therefore, all ADB activities have to be screened as early as possible to determine the appropriate extent and type of environmental assessment, and appropriate study to be undertaken to enable identifying potential impacts and potential mitigation measures.

18. With regard to the critical habitat, ADB prohibited any activities in the critical habitat, unless (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critical endangered species, and (iii) any lesser impacts are mitigated.

19. As per ADB's SPS, projects are categorized into Category A, B, C and FI. Project with significant impacts affecting the larger area are category A projects; project with lesser significant and site-specific impacts are category B; projects with minimal and no potential impacts are category C projects while projects having funding through FI are FI projects. On the basis of ADB's safeguard policy objective and considering ADB's principle in dealing with riverine habitat, the Dibrugarh subproject has been categorized as a Category B project, because the impact of the work is localized. The overall tranche 2 covering Kaziranga, Palasbari and Gumi, and Dibrugarh is categorized as "A" from environmental safeguard requirement under ADB's SPS because the Kaziranga subproject area is located in border of the Kaziranga National Park.

20. For category A projects, detailed environmental impact assessment study and careful monitoring and management of environmental and social implications to ensure that impacts are manageable and will not become a trigger to generate cumulative and irreversible impacts. On this basis, the Dibrugarh subproject will also become subject of strict environmental monitoring, in which, semi-annual report has to be submitted to be used as a tool to monitor the effectiveness of implementation of environmental management and monitoring plans.

2.1.2. Regulatory Requirements of the Government of India and Assam State

21. The Government of India has framed various laws and regulation for protection and conservation of natural environment. These legislations with applicability to this project are summarized below in Table 2 and approval and monitoring framework is depicted Figure 1.

22. The project, does not require forest land diversion and there are no protected areas (National Parks, Tiger Reserve and Wildlife Sanctuaries) thus no clearance is required from the Forest Department, Assam and from National Wildlife Board, MoEF&CC, Government of India.

Table.2 : Applicable Key Environmental Legislation at a Glance

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Environmental Protection Legislations					
Environment Protection Act-1986 and Rules	To protect and improve overall environment.	Applicable for all the projects which have environmental impacts associated with its development and operation	No permit required. Permit is required as per various laws and rules framed under the act	MoEF&CC	Contractor and PIU
EIA Notification 14th Sep 2006 and amendment till date	Requires prior environmental clearance for new, modernization and expansion projects listed in schedule 1 of EIA Notification, 2006	Considered Not Applicable (EIA Notification 2006 does not classify for embankment construction). Borrowing of earth for embankment and road construction as may be required, will require prior environment clearance under mining category.	Environmental clearance for borrowing of earth	MoEF&CC	Contractor
Air (Prevention and Control of Pollution) Act, 1981, 1987	An act to prevent and control Air pollution	Applicable. The applicability is due to emission from operation of construction equipment like batching plants, DG sets.	Consent to Establish (CTE) & Consent to Operate (CTO)	SPCB	Contractor, should obtain CTE & comply its conditions for setting up each facility, batching plant, DG set as prior to its establishment from SPCB CTO should be taken by contractor for batching plant, prior to operation and it should be renewed

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
					before the expiry of permit.
Water Prevention and Control of Pollution) Act, 1974, 1988	An act to prevent and control water pollution.	Applicable. It is applicable for the projects having potential to generate effluent during any stage of the project. Effluents are expected to be generated during construction stage from construction camps.	Consent to Establish and Consent to Operate	State Pollution Control Boards	CTE should be taken by contractor for disposal of sewage and construction of septic tank/soak pit prior to start of construction from SPCB. Compliance to the conditions mentioned in the CTE should be done by Contractor.
Noise Pollution (Regulation and Control Act) 2000 and amendment till date	Ambient Noise Standards for different areas and zones	Applicable due to generation of noise during construction.	No permits issued under this act	SPCB	Contractor and PMU to ensure compliance to Ambient Noise Level Standards.
Hazardous & Other Wastes (Management and Transboundary Movement) Rules, 2016	Protection to public against improper handling storage and disposal of hazardous waste. The rules prescribe the management requirement of hazardous wastes from its generation to final disposal.	Applicable. Project may generate hazardous waste (Waste Oil) during construction	Authorization for storage and handling of hazardous waste	SPCB	Contractor should obtain authorization for handling, storage and disposal of hazardous waste (Waste Oil) along with CTE/CTO for air and water act. Also, compliance to the conditions mentioned in authorization should be ensured by contractor and PMU

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Manufacture, Storage, and Import of Hazardous Chemicals (MSIHC) Rules, 1989	Usage and storage of hazardous material	Applicable only for storage of highly inflammable liquids like HSD/LPG	No specific permit is required, however precautions defined under the material safety datasheets should be followed for use of hazardous substances listed under the schedules attached to this notification if any proposed to be used. Safety requirements should have to be complied if storage quantity exceeds the regulated threshold limit	Chief Controller of Explosives,	Contractor and PMU. Compliance to the rules should be ensured
Construction and Demolition Waste Management Rules, 2016	To manage the construction and demolition waste	Applicable Applies to all those waste resulting from Construction, repair & demolition of any civil structure of individual or organization who generates construction and demolition waste such as building material, rubble, debris.	Approval required from local authorities, if waste generation is >20 tons in a day or 300 tons per project in month	Local Authorities. Segregation, management and disposal of waste as per rules.	Contractor and PMU. Compliance to the rules should be ensured
Plastic waste Management Rules, 2016	To manage the plastic waste generated	Applicable. Plastic waste is unlikely to be generated in small quantities.	No authorization to be obtained. Waste management and minimization to be done. Fee to be paid to local bodies, if applicable	Local bodies	Not Applicable

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
The Batteries (Management and Handling) Rules 2001	To regulate the disposal and recycling of lead acid batteries	Applicable Applicable for disposal of used lead acid battery if likely to be used in any equipment during construction stage.	No specific registration required. Compulsion to buy and sale through registered vendor only.	MoEF&CC	Contractor
Forest Conservation and Wildlife Protection Legislation					
The Forest (Conservation) Act, 1980 and amendments The Forest (conservation) Rules 1981 and amendments till date	To protect forest by restricting conversion of forested areas into non- forested areas and deforestation	Not Applicable[3]. (No forest land is being diverted. However large no. of tree cutting is envisaged for which NOC from forest department as per applicable rules of the state.)	Forest Clearance / Permission for tree cutting.	Forest Department, MoEF&CC	NOC should be obtained from forest department prior to tree cutting. Compensatory plantation should be carried out as per state forest policy.
Wild Life Protection Act, 1972, 1993	To protect wildlife through notifying National Parks and Sanctuaries and buffer areas around these zones	Not Applicable for this subproject.	Wild life clearance	Chief Conservator Wildlife, Wildlife Wing, Forest Department, MoEF&CC	Not Applicable
Eco Sensitive Zone	The expansion of industrial area, townships, infrastructure facilities and such other activities which	Not Applicable for this subproject.	Permission To be obtained prior to start of construction	MoEF&CC	Not Applicable

[3]The land revenue records need to be verified again to ascertain if any forest land is required to be diverted. If yes then this ACT shall be applicable and necessary clearance for forest land diversion will have to be obtained. Permission for tree cutting in any case would be required from concerned forests/district authorities.

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	could lead to pollution and congestion shall not be allowed within "No Development Zone" except with the prior approval of the Central Government.				
Biological Diversity Act, 2002	Conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto	Applicable		Biological Diversity Act, 2002	Contractor and PMU. Compliance to the rules should be ensured during construction phase
Safety and Other Related Legislations					
Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Requirement of preparation of on-site and off-site Disaster Management Plans for accident-prone areas.	Not Applicable. The project does not involve handling of any hazardous chemical during both construction and operation phase which may lead to continuous, intermittent or repeated exposure to death, or injury.	No permits issued under this act	Central, State & District Crisis Group	Not Applicable

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Public Liability and Insurance Act 1991	Protection from liability arising due to accidents from handling of hazardous chemicals.	Not Applicable. The project does not involve storage of any chemicals (HSD) beyond the threshold limit during construction and	No permits issued under this act. Owner of project should take out insurance policies providing for contracts of insurance so as he is insured against liability to give relief, before handling any such hazardous material	Collector of the Area	Not applicable
Explosive Act 1884 & Explosive Rules, 2008	Safe transportation, storage and use of explosive material	Not Applicable as no explosive (as described in act & rules) should be used in the construction and operation stage of the project.	Permission for storage and usage of explosive	Chief Controller of Explosives	Not applicable
Petroleum Rules, 2002	Use and Storage of Petroleum products	Applicable as storage of HSD/LPG or any other petroleum product may be required for the project purpose	License to store petroleum beyond prescribed quantity.	Chief Controller of Explosives/DC	Contractor
Central Motor Vehicle Act 1988 and amendment Central Motor Vehicle Rules, 1989 and amendments till date	To minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise pollution.	Applicable, for all the vehicles at site during construction & operation phase	No permit issued under this Act	Motor Vehicle Department (Licensing authority, registration authority &State Transport Authorities)	Contractor to follow Rules for all the construction vehicles being used at site during construction purposes
The Gas Cylinder Rules 2004	To regulate the storage of gas / possession of gas cylinder more than	Applicable if contractor store more than the exempted	License to store gas cylinder more than the regulated quantity	Chief Controller of explosives	Contractor. Compliance to the rules should be ensured

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	the exempted quantity	quantity of gas cylinder.			
Ancient Monuments and Archaeological Sites and Remains Act, 1958	Conservation of cultural and historical remains found in India. According to this Act, area within the radii of 100m and 300m from the "protected Property" are designated as "protected area" and "controlled area" respectively. No development activity (including building, mining, excavating, blasting) is permitted in the "protected area" and development activities likely to damage the protected property is not permitted in the "controlled area" without prior permission of the Archaeological Survey of India (ASI).	Applicable only if any intervention is planned within 300 m of archaeological protected sites falling along the ROW	No objection certificate	Archaeological Dept. GoI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	Not applicable yet as no intervention planned within 300m of these sites.

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Guidelines for evaluation of proposals/requests for ground water abstraction for drinking and domestic purposes in Notified areas and Industry/Infrastructure project proposals in Non-notified areas, 2012	To regulate extraction of ground water for drinking and domestic purpose	Applicable if ground water is extracted for meeting drinking/domestic water needs of contractor workers	No objection certificate	Central ground Water Authority/Board & MoEF&CC	Contractor
Other Regulations					
• Workmen's Compensation Act 1923 • Contract Labour (Regulation and Abolition) Act, 1970 • Minimum Wages Act, 1948 • Payment of Wages Act, 1936 • Equal Remuneration Act, 1979 • Child Labour (Prohibition and Regulation) Act, 1986 • Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979 • The Building and Other Construction Workers (Regulation of Employment and Conditions of • Service) Act, 1996 and the Cess Act of 1996 • The Factories Act, 1948 • Hazardous Wastes (Management and Handling) Rules, 1989Chemical Accidents (Emergency • Planning, Preparedness and Response) Rules, 1996					

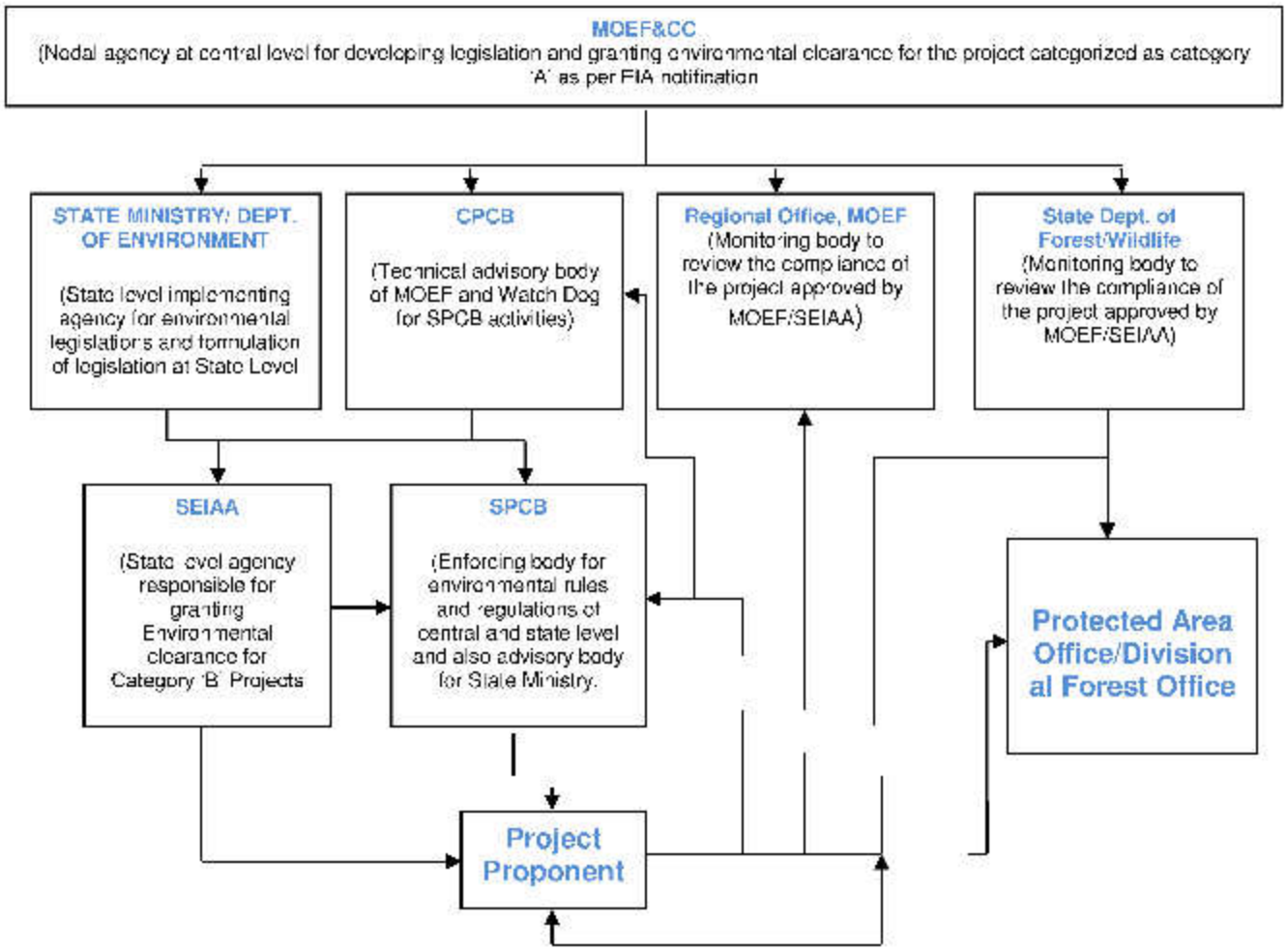


Figure 1: Legislative Interface between various Central and State Authorities

3. DESCRIPTION OF THE PROJECT

3.1. Nature, Size and Location of Dibrugarh Subproject

23. The proposed subproject - the Dibrugarh reach is approximately 40 km long from Oakland to Bogibeel. Location map showing the Dibrugarh reach is given in **Map 2.** Satellite imagery showing the project are and surrounding buffers within 500 m, 5 km and 10 km are given in **Map 3.** The subproject covers about a 25 km reach, including Dibrugarh Town, and extends upstream towards Oakland. Most of the embankments in this reach were built in the mid-1950s. This includes 9.5 km of town protection, which has also been provided with revetment and a series of spurs that have stabilized the bank line over the past 50 years. On the other hand, this reach is undergoing a process of aggradations. A sequence of successive satellite imageries over the Brahmaputra River along the targeted river stretch, over years 2009 through 2014, show also evidences of a constantly retreating southern riverbank, along reaches that had not been protected by respective levels of time (ex. Oakland reach).

24. The DTP dyke has several cross-drainage culverts, which had catered to the need of regulating the drainage flow accumulate - during flood periods - in the Dibrugarh Town areas, in the past.

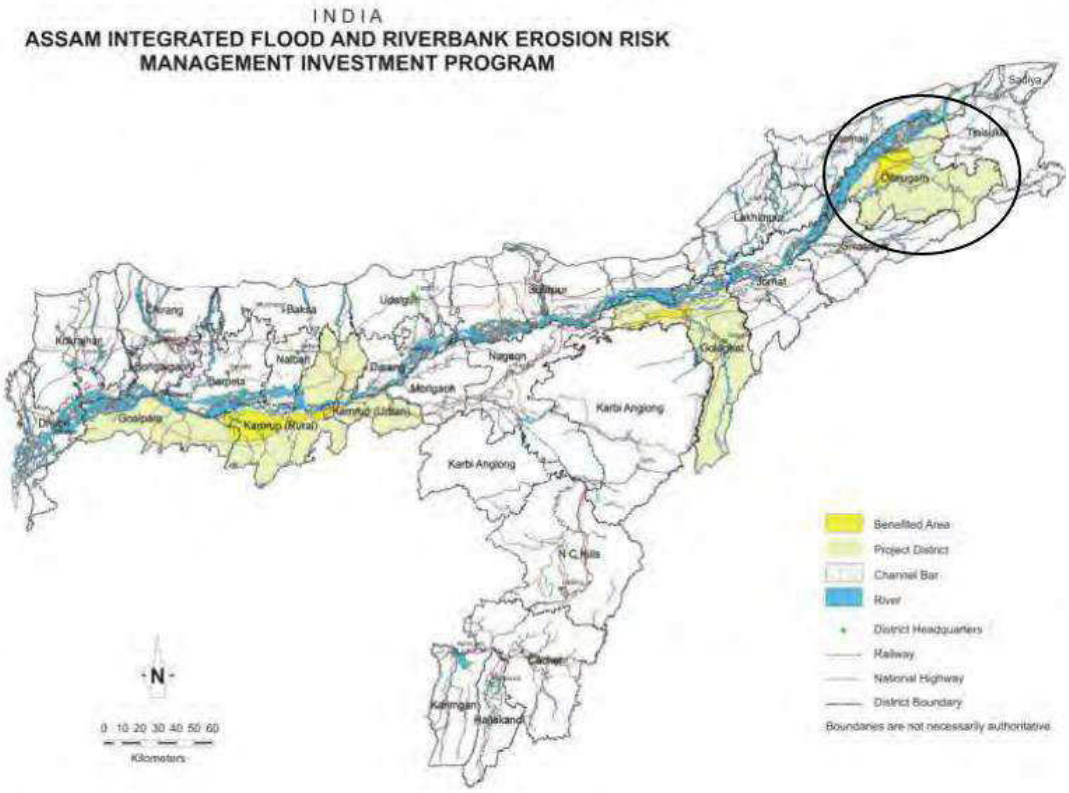
25. Though these sluice culverts provide drainage facilities since their constructions in 1956 onwards, few such sluice culverts have become redundant presently, due to changes occurred of the river conditions, specifically due to systematic rise of river bed and flood level. Therefore, provision of pump house with high discharge pump facilities is proposed in place of the sluice

26. The Dibrugarh subproject was divided into five project components: (i) riverbank protection works, from downstream end point of Rohmoria protection work up to Nagaghuli Spur, upstream of Mothola Reach, for a length of 2,700 m, (ii) pro-siltation measure with Porcupine screens from Oakland to Bogibeel area, (iii) upgradation of Oakland dyke- from 0 km to 9.16 km, (iv) construction of pump house including installation of pump at selected location of DTP dyke, and (v) riverbank protection work along the DTP dyke. All the components of Dibrugarh subproject will be implemented under the tranche 2 and are expected to be approved by ADB in 2018. Location of the proposed works under the subproject is given in **Map 4.**

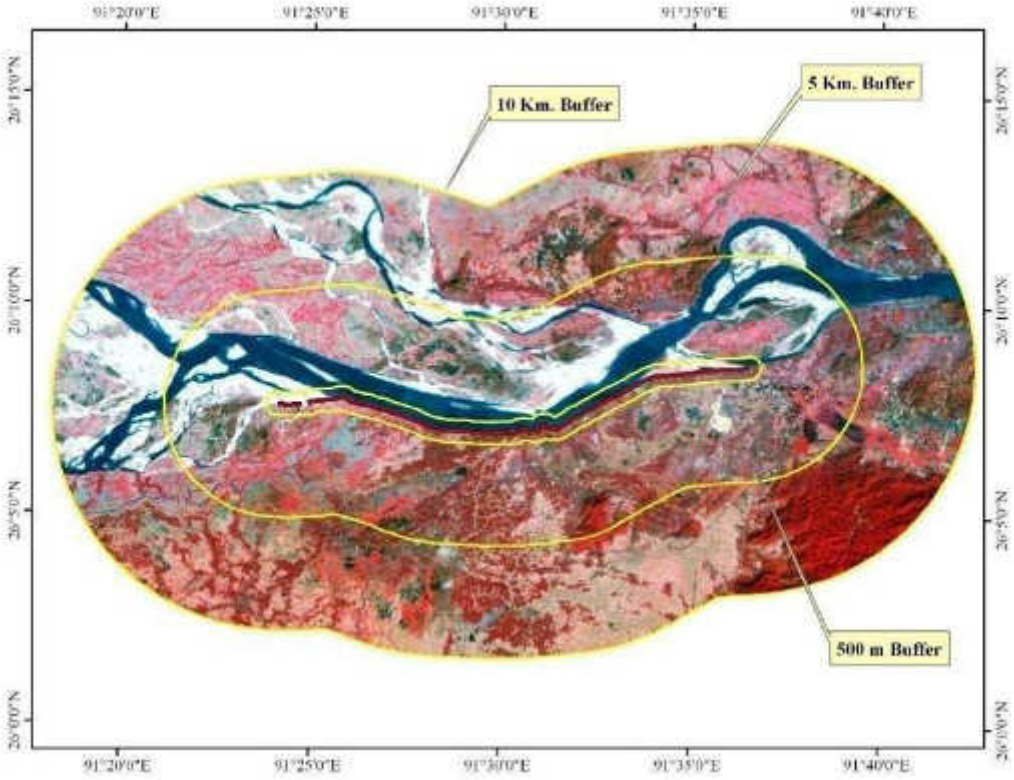
27. The Dibrugarh subproject has been categorized as a B project under ADB's SPS. Since this subproject was originally planned to be implemented under Tranche 1 and 2, the EIA for Dibrugarh subproject covering both tranches was prepared and disclosed in ADB website on June 2009.

28. This updated EIA report was prepared to capture any change both from environment and project design as some of the components of the subproject which will be implemented under the Tranche 2. The initial EIA as well as the updated EIA were prepared to identify any potential impacts and prepare EMP to avoid and minimize the impacts. The updated EIA study was carried out from February 2015 to January 2016 and continued to take inputs till the preparation of the report September 2017.

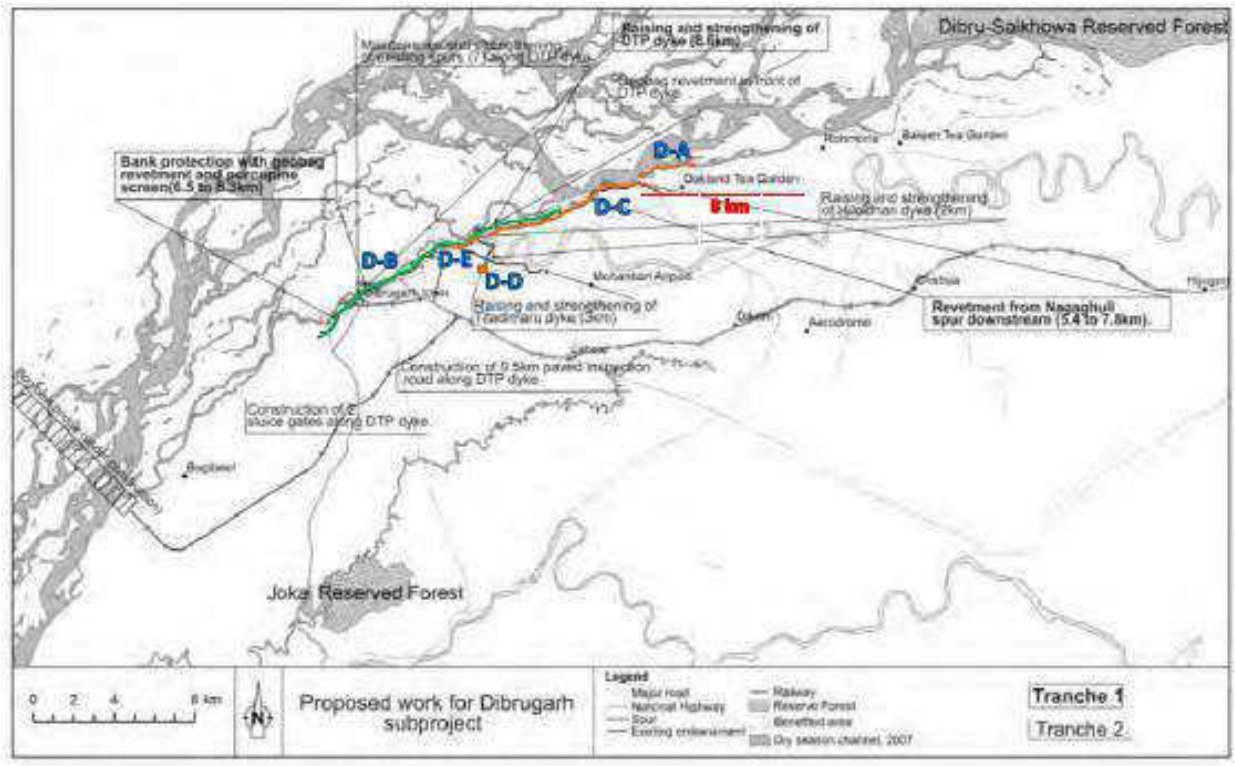
Map 2: Location Map of the Project (Selected Sub-projects)



Map 3: Satellite Imagery of Dibrugarh Sub project area and surrounding area



Map 4: Proposed Flood and Bank erosion Works at Dibrugarh Subproject Area – Tranche 2



D- Dibrugarh, A,B,C,D,E- works

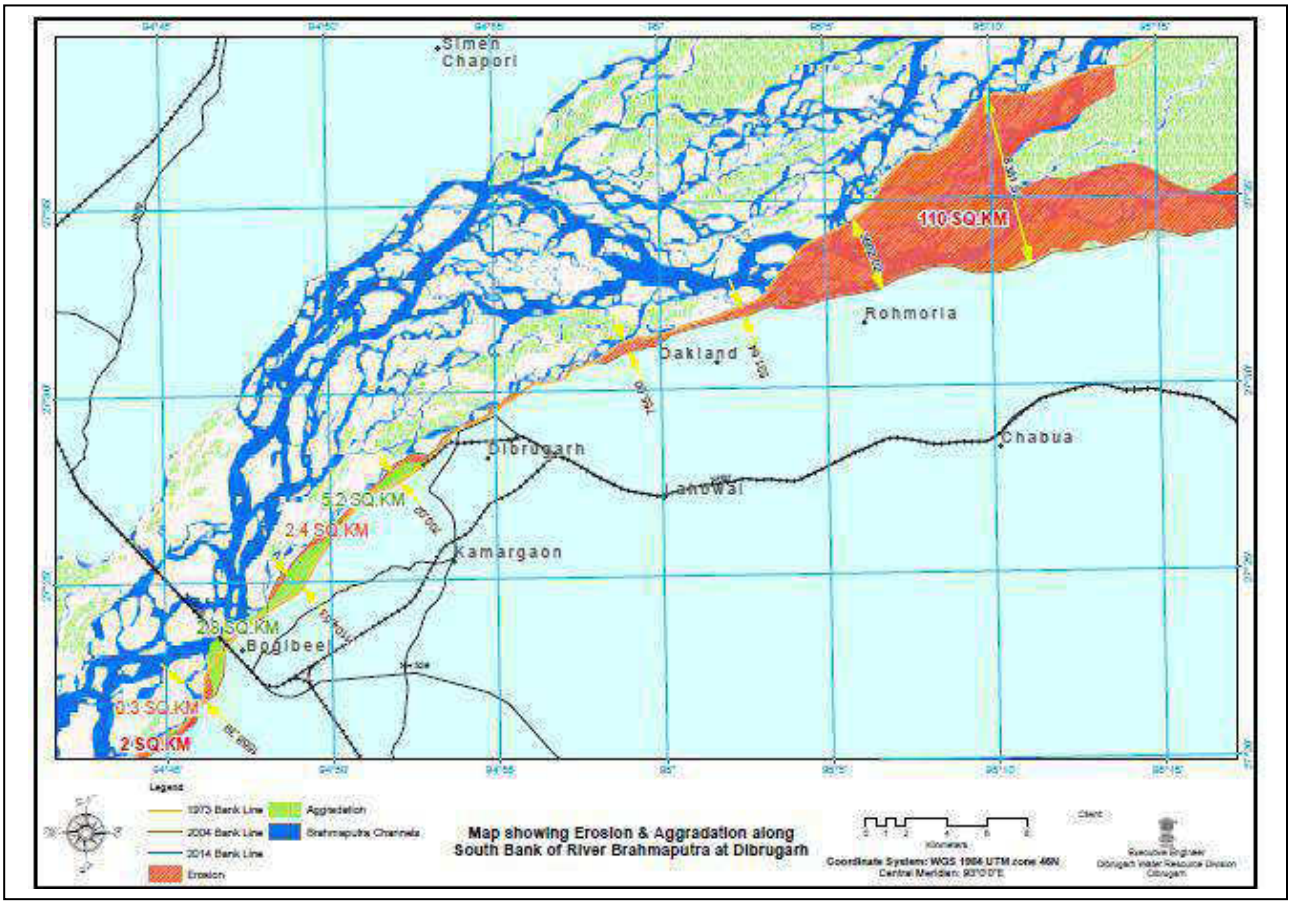
3.2. The Dibrugarh Reach Sub-Project

29. The Dibrugarh reach has considerable significant from the socio-economic, terrestrial ecological as well as hydrological perspectives. Although the protection of Dibrugarh Town from erosion of the Brahmaputra River that started in 1960's is rightly being claimed to be a success story, yet over the years the problem resurfaces itself in new forms as the river configuration vis- à-vis the adjoining riverbank areas have changed considerably and reaches upstream and downstream of the town are being affected by chronic erosion hazards eating away large chunks of productive tea cultivated lands. A dense settlement of permanent nature has come up on the river side of the embankment which has undergone considerable degradation and lowering over the years and often affected by seepage during high flood level. Strengthening of Titadimaru dyke (4.70 km) along south bank of Maijan beel as per highest HFL is equally essential for the protection of vital installations like Airport, Medical College. Therefore, safeguarding the area and protection of tea and oil industries through integrated flood and riverbank erosion management is considered highly essential.

30. The Brahmaputra River in the vicinity of Dibrugarh is undergoing a process of aggradations (Map-5). The related problems are channel widening accompanied by substantial bank erosion upstream of Dibrugarh and an increasing flood risk for the surrounding flood plains. Significant and sudden aggradations occurred immediately following the powerful earthquake of 1950, leading to the loss of approximately half of the town from bank erosion and flooding. Following this disastrous event, substantial money and effort were invested in constructing effective riverbank protection as well as flood protection works. The process of bed aggradations and channel widening is placing the existing flood embankments under increasing threat of erosion as well as the possibility of being overtopped by the upward-trending peak flood heights. Ongoing downstream work at the Bogibeel bridge crossing is encroaching into the river and is likely to

exacerbate the present situation as the bridge backwater will lead to increased deposition rates. The succeeding shows the general geomorphic features of the area.

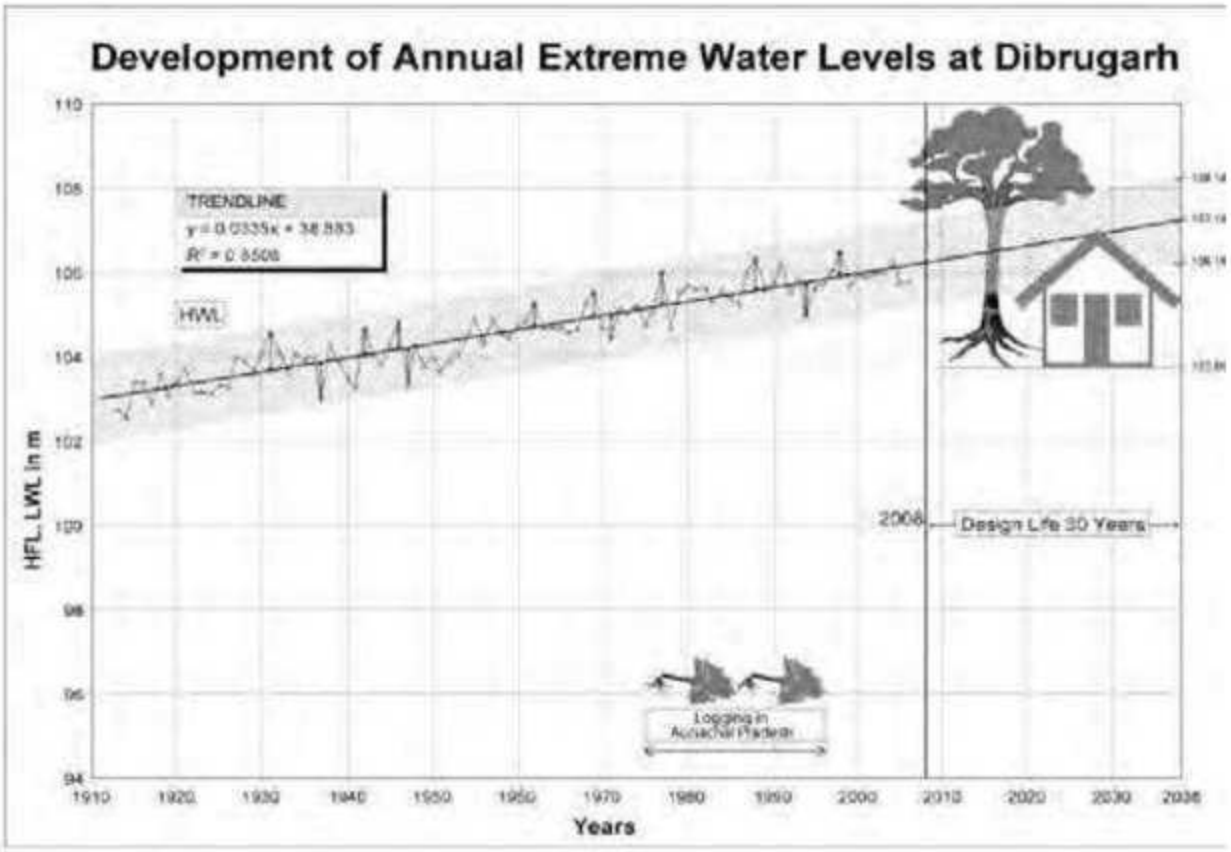
Map 5: Geomorphic features and Past Bank Erosion along Dibrugarh Subproject (1973-2014)



31. Based on the frequency distribution of water levels at Dibrugarh, the 2004 Flood had an average return period of 2–3 years and a flood level of 107 m would have a return period of about 35 years. Both these estimates are for the state of the bed level in 2010. If we are designing for a life span of 30 years (say to 2040), bed levels are projected to rise a further 1 m. Thus 107 m in 2040 corresponds to 106 m in 2010. This reduces the average return period to less than 2 years. The conclusion is that the embankment crest level has to be continually raised into the future to provide the same level of protection.[4]

[4] While this project assumes a crest level sufficient for the next 30 years, future construction space must be created/preserved for further raising and incorporated into land-use zoning.

Figure 2: Water level development at Dibrugarh



3.2.1. Subproject Components and Activities

3.2.1.1 Structural Measures

32. The Dibrugarh dyke was constructed in 1955–1956 on the south bank of the Brahmaputra River in front of Dibrugarh Town. The dyke known as DTP dyke has a length of 9.42 km from Maijan to Mohanaghat. This dyke was extended further up to Oakland on upstream (9.10 km) and Titadimaru along Maijan beel (4.70 km). The total length along Brahmaputra River was 18.52 km (9.42 + 9.10). A marginal bund exists along river near Maijan beel. This reach will cover important Dibrugarh town, vital installation in Dibrugarh Town and tea gardens. The site plan of DTP from Oakland Ghat to Mohanaghat is shown in Map-3.

33. The existing embankment system requires a higher level of water proofing and protection from overtopping. Due to the often-limited space and in order to avoid large scale disturbance of the existing settlements, the project proposes specific technical solutions for the improvement of the existing embankment along the densely-settled areas such as sheet piles, slurry walls, or grouting. In less populated places widening and raising of the embankment is envisaged. The embankment line will be straightened in close discussion with settlers, where feasible.

34. The existing embankment system will be protected from riverbank erosion by installing pro-siltation measures along the bank in order to reduce the flow and provide a buffer between main channel and embankment. Riverbank protection will extend to areas upstream of the town, in order to avoid outflanking of the town.

35. The details of structural measures in tranche 2 in Dibrugarh are presented in the succeeding paragraphs and also shown in maps-4 and 6.

- **Civil works under Dibrugarh Subproject**

A. Riverbank protection works, from downstream end point of Rohmoria protection work up to Nagaghuli Spur, upstream of Mothola reach, for a length of 2,700 m.
The works include:
   (i) Construction of an apron of size 22 m width x 0.75 m thickness (Type-A geo-bag in 5 layer);
   (ii) Slope pitching with C.C. blocks of size 0.3mx0.3mx0.25m, over geotextile filter media, on trimmed bank slope of 1:2;
   (iii) Toe-key of PVC coated wire netting cages of size 1.5mx1.5mx0.5m, in two layers, filled with C.C. blocks of size 0.3mx0.3mx0.25m.

B. Pro-Siltation measure with Porcupine screens from Oakland to Bogibeel area.

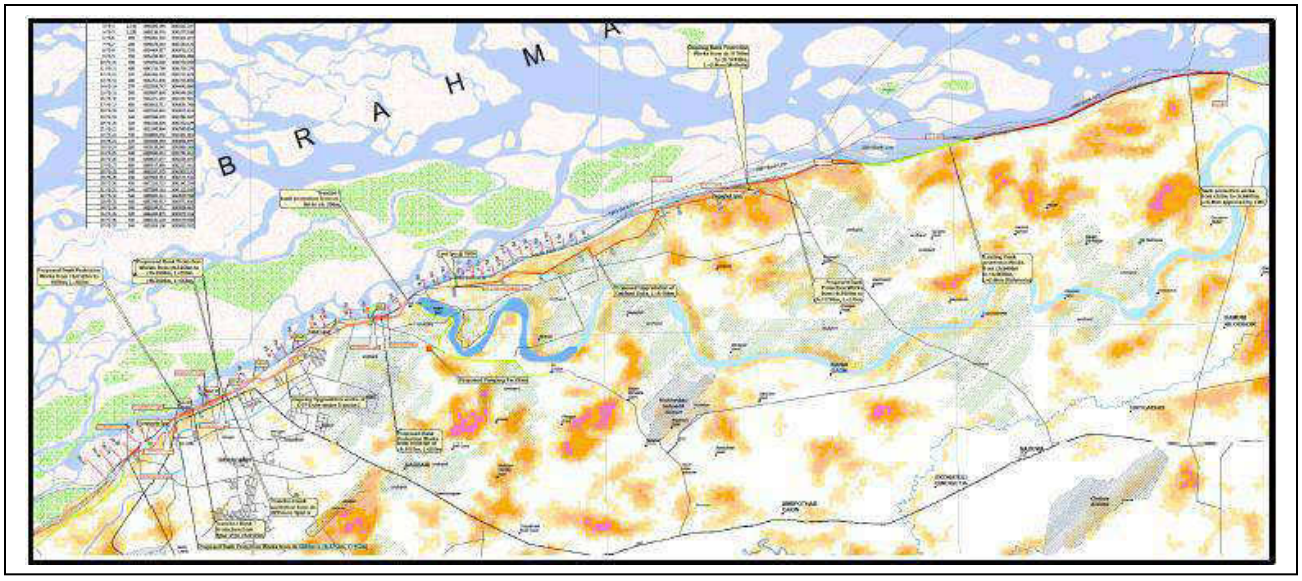
C. Upgradation of Oakland dyke- from 0 km to 9.16 km.

D. Construction of pump house including installation of pump at selected location of DTP dyke.

E) Riverbank Protection work along the DTP dyke (1,950 m in two locations of the DTP dyke)-

(Est. Amt: ₹512 Million)

Map 6: Tranche 2 work sites under Dibrugarh Reach



Structural Measures: **Objective**

(i) Improvements for the deteriorated flood embankment systems protecting key urban, productive rural, and other strategic areas in the four districts,
(ii) Provision of associated flood protection and drainage facilities such as sluice gates and regulators, improvements in local drainage channels etc.
(iii) Provision and support for construction of platforms in areas not protected by embankments or as additional measures to modify the hazard.
(iv) Provision of riverbank protection works along critical reaches with the main purpose of ensuring the embankment stability
(v) Plan all future measures in a participatory manner involving local stakeholders, linked to community disaster risk management activities and making use of latest scientific tools and understanding of the site conditions.

Activities

(i) Embankment works consisting of (a) strengthening existing earthen embankments, including in places wave protection layers, (b) upgrading earthen embankments to higher standards for town protection (Dibrugarh), and (c) closing of gaps in the existing system;
(ii) Building sluice gates in order to provide better drainage in line with the natural conditions and as per demand of the local population;
(iii) Coordinate with local stakeholders and other rural development programs (such as NREGA) construction of platforms near vulnerable communities and along new or strengthened embankments where feasible.
(iv) Riverbank protection work consisting of (a) upgrading of existing works (spurs), and (b) construction of new bank protection in the form of revetments and pro-siltation measures following an adaptive implementation approach;
(v) Use the hydrologic and hydraulic models developed under Knowledge Base activities to (a) undertake a regional assessment of the impacts of existing (road) embankments on flood behavior and to identify the best location and height (and impacts) of new embankments, and (b) assess required improvements to the drainage system. Follow participatory planning principles.

Results/Outputs:

(i) Reliable flood protection;
(ii) Mitigation of local drainage problems
(iii) Reduced flood risk through temporary shelter
(iv) Reduced riverbank erosion supporting reliable embankments and a more predictable river course
(v) All measures planned in a participatory manner, closely linked to community-based disaster risk management measures, designed according to latest state-of-the-art technology applying Assam specific experience, implemented as quality works, and monitored and adapted as needed.

3.2.1.2 Non-structural and CBFRM Measures

36. **Land Use** Guidelines. Land use guidelines are aimed at ensuring that land use across the floodplain is consistent with the likelihood, risk, and hazard of flooding. For this purpose, current and likely future land use in flood-prone areas will be reviewed, especially the expected population growth and its impact on future flood risk and damage in higher-risk areas. In addition, the use of land use zoning to preserve wetlands and protect existing flood storage areas from further development will be assessed.

37. **Building and Development Guidelines.** While building and development controls are also not expected to provide a panacea for reducing flood risk and flood impacts in Assam, the flood proofing of public infrastructure is one area where improvements might be possible (to ensure it is ready and effective to return to service after a flood). The program will assess flood damage to buildings and public infrastructure to identify possible improvements. The United Nations Development Program Disaster Management Project's works have been taken into account on the design and construction of flood-resilient buildings.

38. **Flood Forecasting and Warning.** Flood forecasting is a means to an end—to provide timelier and more accurate flood warnings. It is the warning that is essential, rather than the forecast. While a variety of public agencies participate in the flood forecasting and warning (FFW) process in Assam, most villagers receive no formal flood warnings—they generate their own warning by watching the river during the flood season, taking into account local rainfall. The program will review the elements of FFW process, paying special attention to warning needs of villages and possible improvements in communities and flood emergency management. An important element of an improved FFW system is anticipated to be the provision of local forecasts by the Water Resources Department, i.e., the translation of regional forecasts by Central Water Commission (CWC) into clear and easily understandable warnings to villages. Local communities will be centrally involved in this process.

39. **Flood Emergency Planning and Management**. Flood emergency planning includes prevention, preparation, response, and recovery activities. Flood emergency planning and management (FEPM) is and will remain a central plank of flood risk management in Assam—flooding is a regular recurring natural event that cannot be prevented or entirely eliminated by structural measures. Flood emergency planning will to be reviewed and probably strengthened at the village, district, and state levels (e.g., through the use of the army for evacuation).

40. **Community-Based Flood Risk Management (CBFRM).** CBFRM is one area where considerable opportunity exists to reduce the impacts of floods on village communities. Under the Program, comprehensive community surveys will be undertaken to address community concerns on flood risk management. Based on the responses, a CBFRM plan will be prepared, including raised platforms and associated facilities (e.g., permanent latrines, a raised tube-well for water supply, and permanent public buildings that are needed during flood emergencies, such as the local school and dispensary, and emergency shelter), along with community non-structure programs, such as flood warning and flood education.

41. **Flood Education.** Villagers appear to be very aware of floods and highly flood resilient. The need for further flood education in villages will be assessed in the community surveys. Flood management in Assam is fragmented across many different agencies. The Program will promote cooperation and the exchange of ideas and information between the different agencies through workshops, seminars, etc. (a form of flood education).

42. **Financial Measures.** When in emergency accommodation during floods, flood-prone villagers cannot afford kerosene for cooking purposes. Relief payments—whether in cash or kind—are a financial measure (and a form of insurance) aimed at reducing the impacts of flooding. Under the program, the system of flood relief payments, food, and stock fodder issue and other relief measures will be reviewed and possible improvements will be pursued.

3.2.2. Construction Material for Bank Protection

43. Use of inert or natural material is proposed to be used for the same. Geo-textile bags filled with sand shall be the preferred option. It is very stable material and used worldwide. The engineered bags life is considered to be beyond 30 years. Use of geotextile rather is considered

good even from aquatic fauna aspect. (Refer Appendix 1: which provides the extract of the research carried out by Hannes Zellweger on use of geotextile bags for river erosion control in Bangladesh).

3.2.3. Implementation Schedule and Project Cost

44. The project will be implemented over a period of three years from 2018 to 2020. Some of the remaining works of tranche 1 will continue in tranche 2 simultaneously. The total estimated cost of the subproject for structural works is estimated as ₹51.2 Crores (i.e. $7.88 Million).

45. The subproject will provide improved flood and riverbank erosion risk management to achieve more stable living conditions for the existing population needs to be put into the larger context of land-use zoning to avoid future catastrophes due to overtopping of flood water. The boundary of the benefited area is provided in the succeeding figures taking into account the recommended combination of flood and erosion protection measures. The upstream boundary follows the higher ground and is demarcated by the embankments at Dibrugarh downstream of Maijan Beel, whereas the downstream boundary follows the national highway, providing reasonable protection from flooding from any downstream embankment breaches. Riverbank protection extends beyond the boundaries of the flood protection, especially towards Oakland to provide a certain safety margin. The protected area (in grey) compared with the larger area of the socio-economic survey suggest that project interventions benefit the Dibrugarh area in several ways compared to a “without project” scenario. The erosion in this reach will be reduced and the embankment system will be upgraded to avoid future overtopping causing disaster for the town and the adjacent areas.

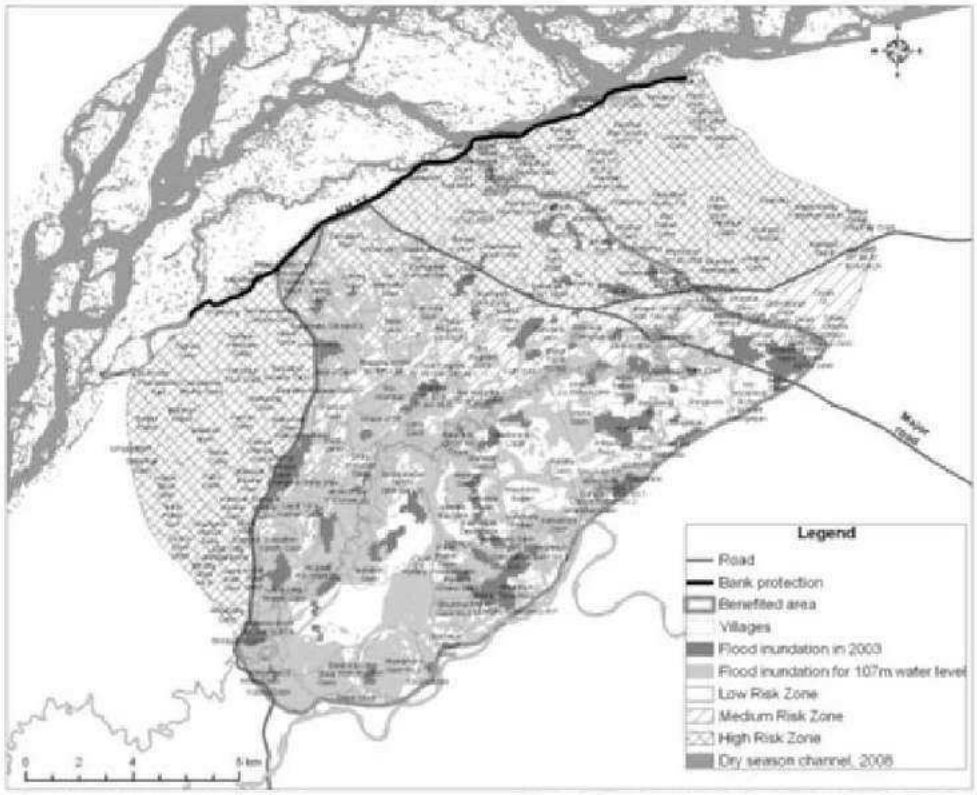
46. Dibrugarh Town which is also part of the flood plain will benefit from more reliable flood protection allowing in places changes in cropping patterns to higher yield varieties. The following considerations guide the selection of the benefits.

(i) Riverbank protection will be provided along eroding parts along a total reach length of around 21 km. The total proposed length of protective works covers the existing seven spurs and adds 9.5 km additional protection during tranche 2 in order to provide a stable bank line. Compared to a “without project” scenario, reliable riverbank protection will avoid future land loss in the area. Future provisions (for adaptation work, which means additional riverbank protection protecting the existing work from outflanking) have been incorporated into the economic feasibility study to respond to additional unpredictable erosion in this area.

(ii) A stable riverbank and strengthening of the existing embankment system will avoid future flood losses in a larger area. This area covers 25,138 ha of the floodplain.

(iii) Associated with bed level rise, there is a substantial difference between the area flooded at high flood level without embankment and with embankment. The succeeding figure shows the areas flooded at different levels. While a projected HFL of 107 m would flood 14,892 ha or 59% of the total protected area, the maximum observed flooding during the 2003 flood inundated 2,144 ha, or 9% of the total protected area. Translating this to the agricultural area shows that out of 7,533 ha flooded without embankment 780 ha were flooded in 2003. This difference shows that the existing embankment system provides a certain safety from flooding at this moment.

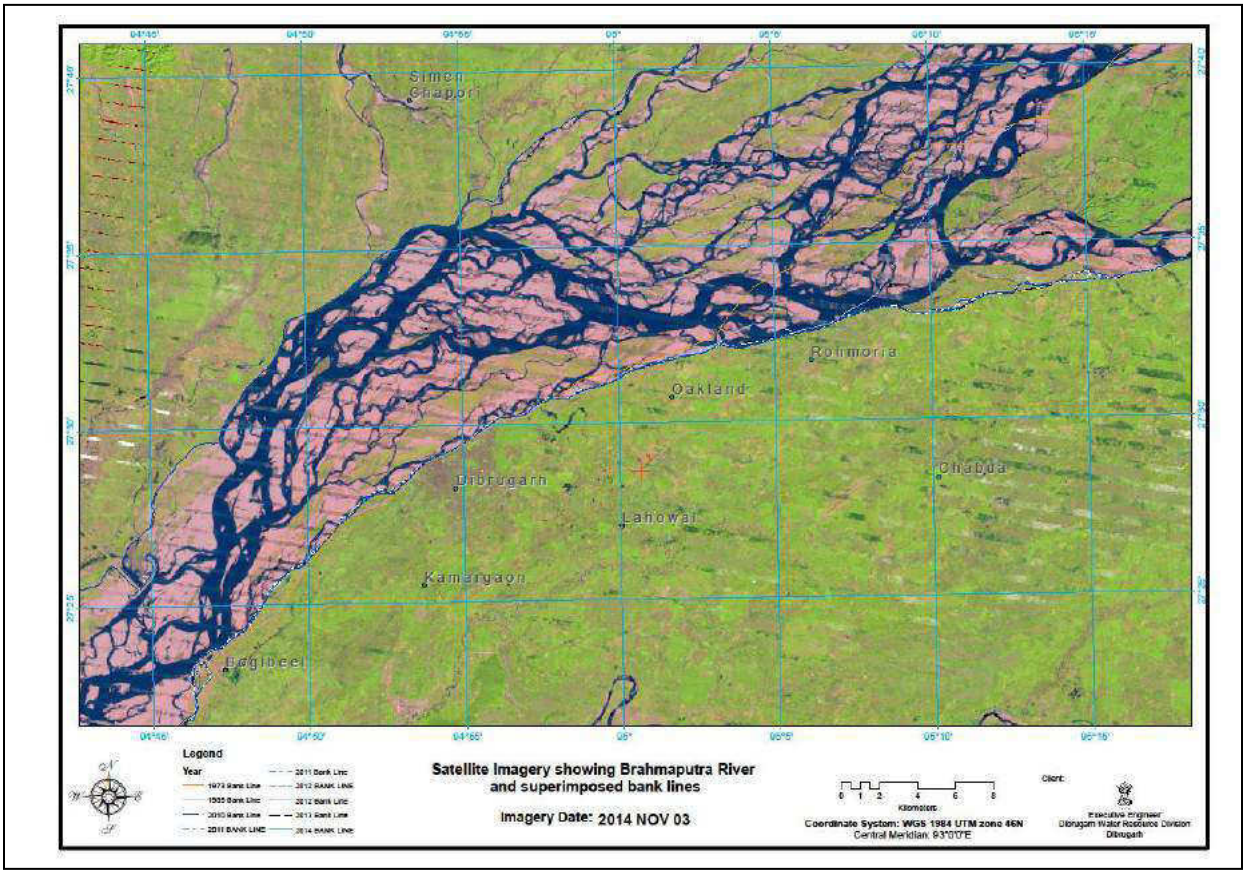
Map 7: Comparison of 2003 Flooded Area with Existing Embankments and No Embankment Solution



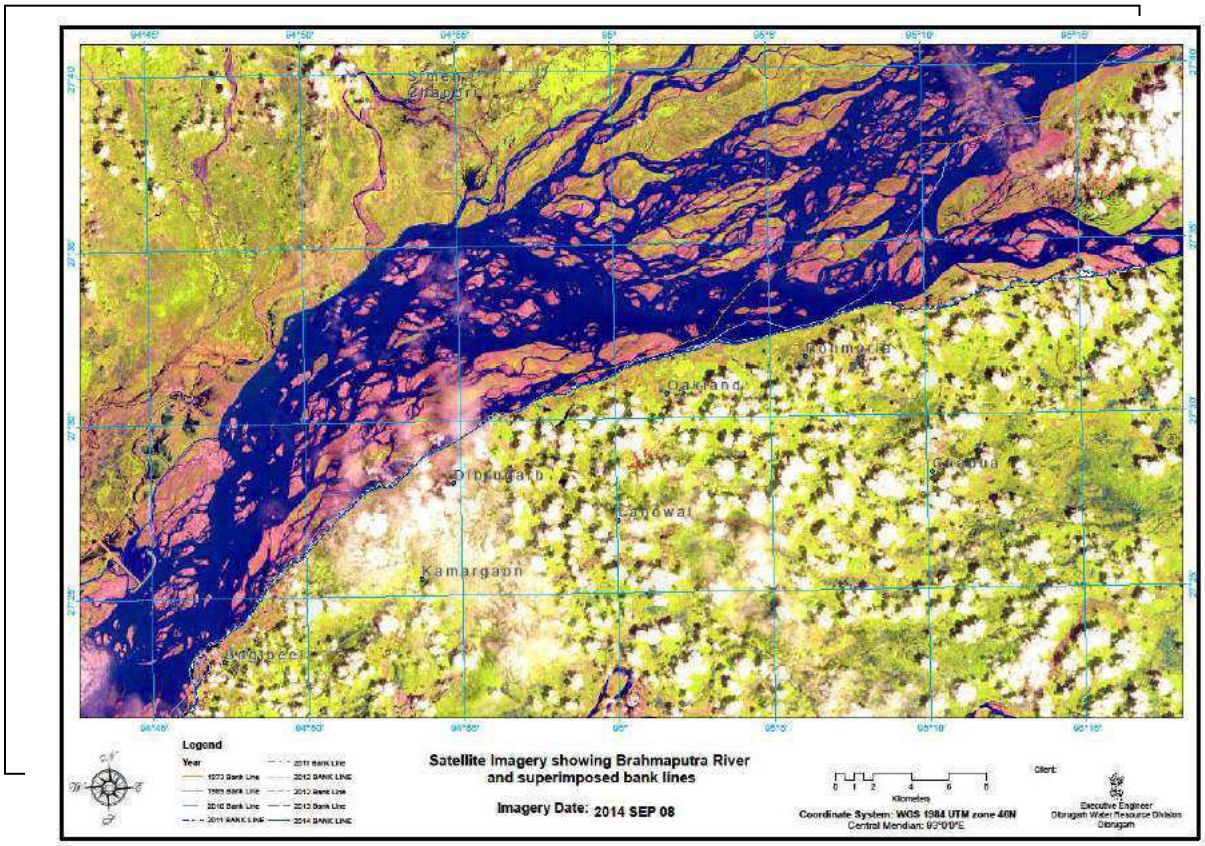
Flood Inundation in Dibrugarh

Flood inundation: 13th July 2004 (as observed in RADARSAT image).

Map 8: Satellite Image of Dibrugarh subproject area (2014)

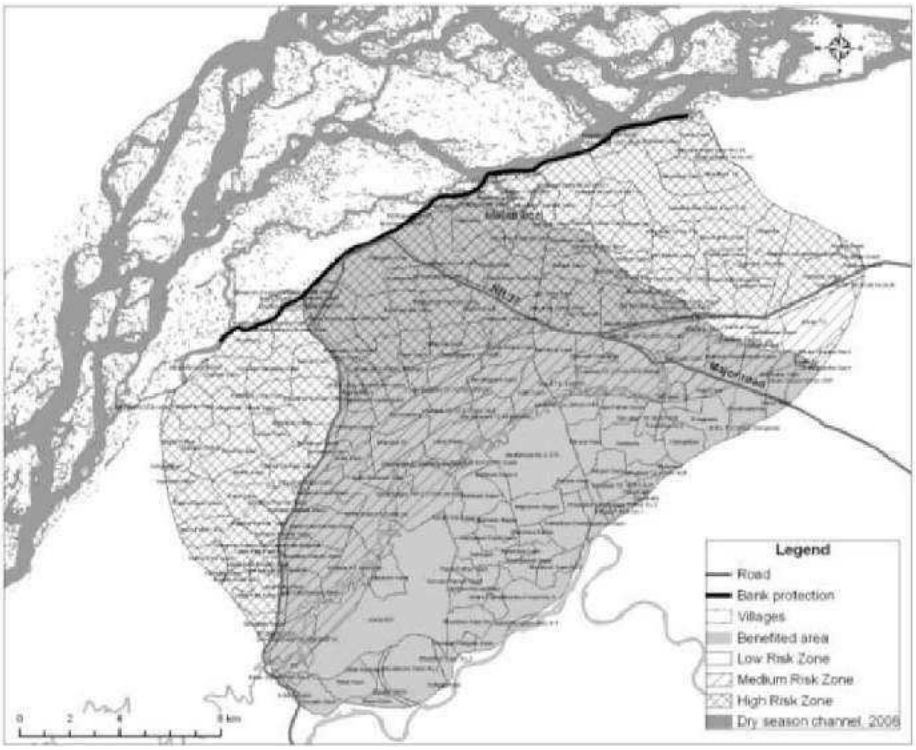


Map 9: Satellite Image of Dibrugarh subproject area: During Flood (2014)



47. To establish the feasibility of flood and riverbank erosion management measures for certain areas, interventions were planned based on the existing river situation. These measures were prioritized based on urgency, implementation costs, and benefits from reduced risk of flooding and riverbank erosion. To cover potential changes in location of future work, this EIA considered a larger area of assessment, beyond the scope of this subproject extending to the full (upstream and downstream) Brahmaputra River section where existing and proposed embankments and pro-siltation works will be installed. The area for which structural interventions are planned together with the benefited area is shown in the succeeding map.

Map 10: Base map of Dibrugarh with Benefited Area



48. The Dibrugarh Reach has considerable significance from the hydrological perspectives but less significant on terrestrial ecology. The Dibrugarh reach along the Brahmaputra River has few sighting records of dolphin in deep channels and in the confluence of the tributaries. Some chelonian (turtle) activities were also reported seasonally in less human dominated riverbank. The reach is severely being affected by continuous bank erosion and flood inundation caused by the Brahmaputra over the last few decades threatening the existence of Dibrugarh Town. The project activity though will not prevent the desired flow of nearby wetlands. The present project will therefore positively contribute towards providing protection to Dibrugarh Town, and the adjoining villages.

3.2.4. Tranche -2 Project Implementation Schedule

49. The tranche 2 will be implemented over a three-year period (2018–2020).

4. DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

4.1. Introduction

50. It is necessary for the environmental assessment studies to establish baseline for valued environmental attributes, which are likely to be affected because of the developmental activities. Hence, it is imperative to study the existing environmental conditions not only to establish the pre-project physical, biological and socio-economic conditions, but also to predict associated environmental impacts caused during the construction and operation phases of the sub project.

51. During the preparation of 2009 EIA, emphasis was given to data collection on the physical environment, biological environment, and socio-economic environment of the study area (i.e. 8 km buffer zone around the embankment). These data are of prime importance considering the nature and location of the proposed subproject focused on the Dibrugarh Reach in Dibrugarh district of Assam.

52. The updated EIA 2017 has been prepared by data and information collected for preparing 2009 EIA which are still relevant such as data on (i) physiography and drainage, (ii) topography, (iii) geology, (iv) soil conditions, (vi) biological information (available species), and (v) hydrology. Biological information were again verified with the recent literature and consulted with the Forest Department for any changes. The updated EIA 2017 has also included some new and update data and information on (i) climate especially data on mean monthly rainfall (2016), (ii) water quality on selected Dibrugarh areas (2011), (iii) environment quality such as ambient air quality (2011, 2012), and (iv) morphology with update data on pattern of erosion and accretion. While data on socio-economic environment has mostly been updated by using census data 2011, and socio-economic survey in 2012–2013, 2014, and 2015.

4.2. Description of Physical Environment

4.2.1. Climate

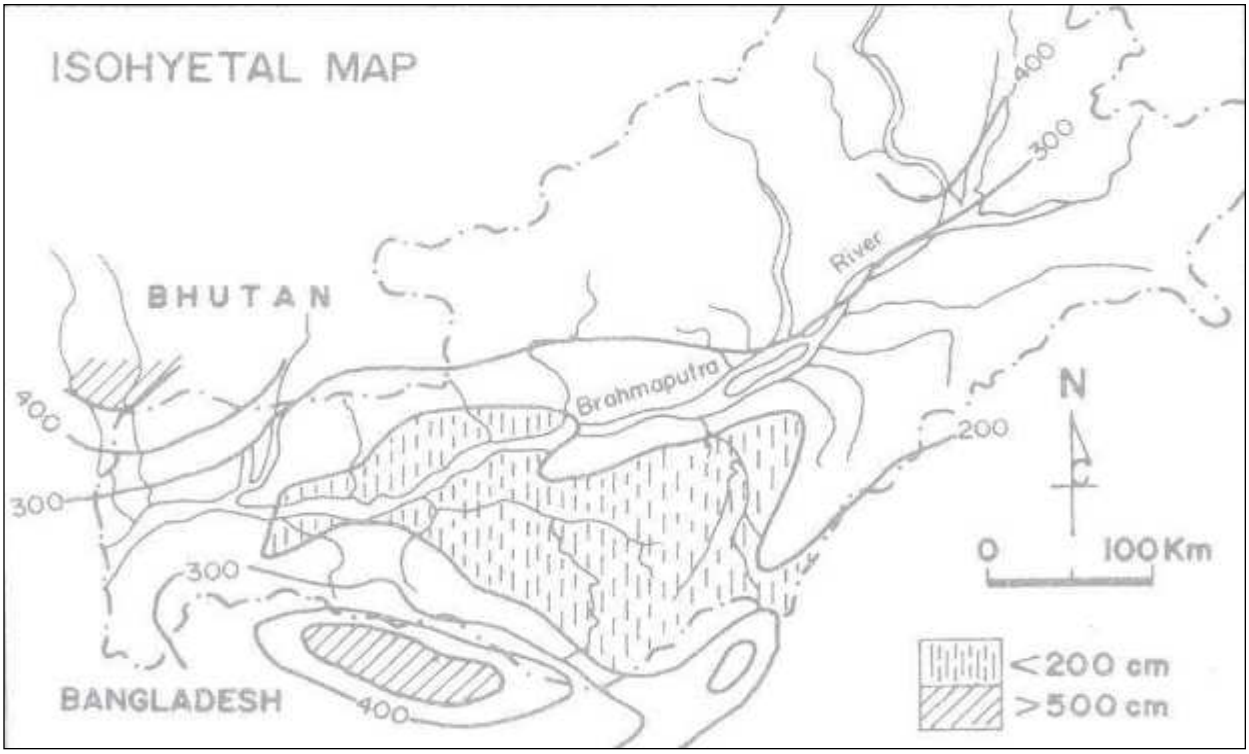
53. The climate of the region is sub-tropical with a hot, humid summer season dominated by the southwest monsoons from early-June to mid-September and a cool, dry winter from late October to the end of February. The pre-monsoon season starts in the early part of March until May marked by occasional thunderstorms and rising temperatures during the day. The post (retreating) monsoon season from last part of September to mid-October generally represents fair weather conditions with declining rainfall as well as temperature.

54. The Brahmaputra Valley in Assam forms an integral part of the subtropical monsoon regime of Eastern Asia receiving a mean annual rainfall of 230 centimeter (cm) with a variability of 15–20%. Distribution of rainfall over river basins in Assam shows marked spatial variations, e.g. from as low as 175 cm in the Kopili basin located in the central part of the valley to as much as 410 cm in Jiadhol basin close to the Matmora reach in upper Assam. The isohytel map of the Brahmaputra Valley and adjoining highlands (based on IMD data) is shown in the Figure 3.

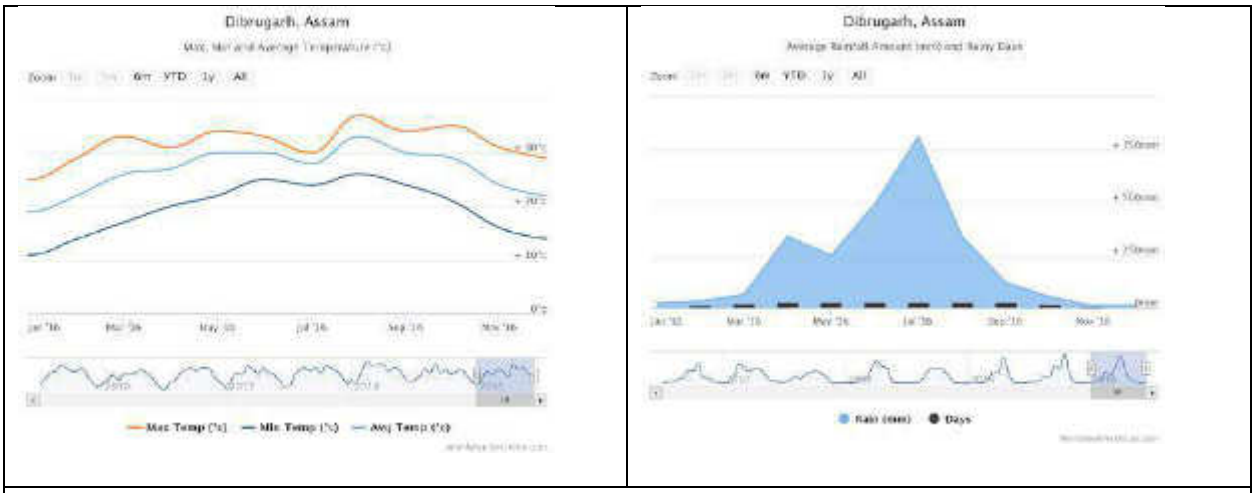
55. The Dibrugarh area enjoys sub-tropical monsoon climate with warm and humid summers and mild winters. Average annual rainfall in Dibrugarh City is 276 cm with a total number of 193 rainy days. With the onset of monsoon in early June heavy rainfall occurs. Occurrence of heavy thunderstorm is common during this period. The maximum temperature recorded in the city ranges from 33°C to 37°C.

Figure 3: Isohytel Map of the Brahmaputra Valley and Adjoinging Highlands[5]

[5] Goswami, D.C. 1998. Fluvial regime and flood hydrology of the Brahmaputra River, Assam. Memoir Geological Society of India, No.41: 53-75



56. The rainfall pattern of distribution of mean monthly rainfall for the year 2016 is presented in Figure 4. It shows that the highest mean rainfall of 800 mm is recorded in the month of July, while the minimum of 10 mm in the month of December. During the monsoon season (i.e. in the months of June, July, August and September) more than 66% of the total annual rainfall occurs.



Source: worldweatheronline.com. Year-2016

Figure 4: Monthly Temperatures and Rainfall in Year 2016 at Dibrugarh

57. Powerful atmospheric systems called cloudbursts that trigger intense rainfall in limited areas causing flash floods of great fury and destruction are being experienced in greater frequency along the foot hill region of and in the immediate downstream areas in the Brahmaputra plains. The situation aggravates further if such extreme climatic events trigger landslide and slope failure in the upper watersheds or temporarily block river courses creating dams that subsequently break sending surging flood waves downstream. During the 1950 Assam earthquake, a massive landslide in Arunachal Himalayas blocked the Subansiri River - a major tributary of the

Brahmaputra for days together creating a dam which was eventually released in a deluging flood that greatly devastated the downstream areas in Dhemaji and Lakhimpur districts of Assam. On 10 June 2000, a massive flood occurred in the upstream parts of the Brahmaputra basin in India reportedly as a result of a sudden failure of a landslide induced dam in the neighboring uplands. Cloudburst and landslide related flash floods occurred in 2004 in the Manas and Beki rivers of Assam due to failure of a landslide dam upstream of Kurichhu hydroelectric project in Bhutan that caused highly destructive flood and channel avulsion. On 7 October 2004, a flash flood in Jinari River of Assam was triggered by a cloudburst over Meghalaya that caused great havoc in the downstream areas in Assam.

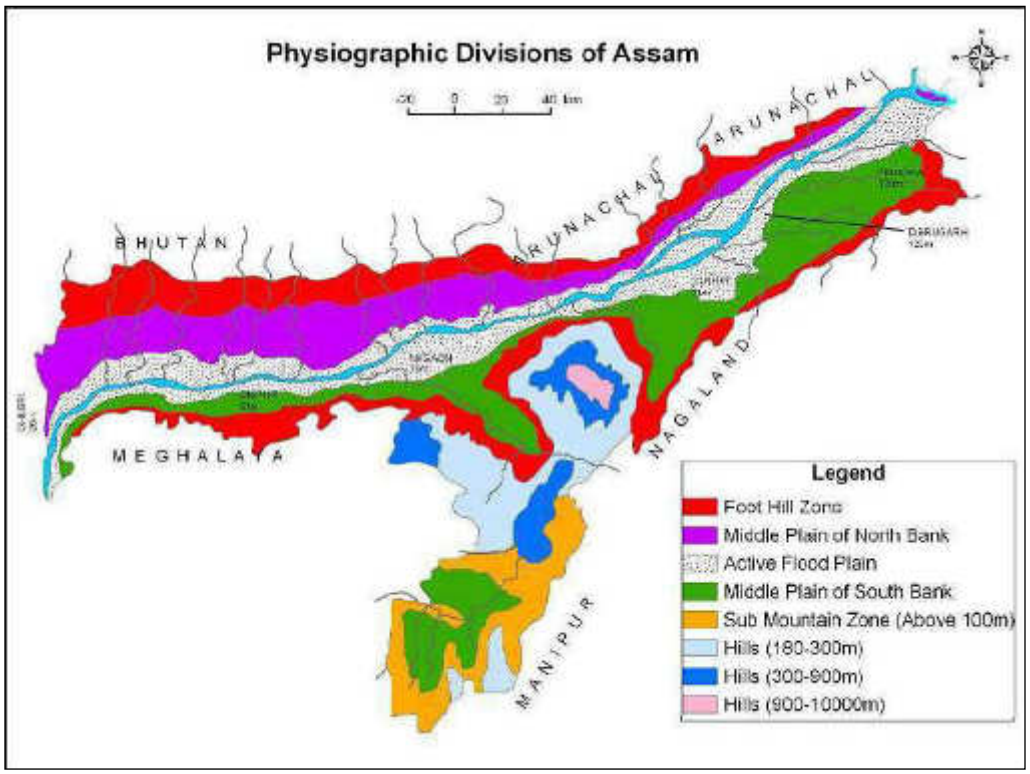
4.2.2. Physiography and Topography

58. The physiography of the Dibrugarh reach of the Brahmaputra along the south bank comprises of flood plain, beels, swamps, sandbars (chars) and occasional highlands. The physiography of Assam consists of (i) Foothill Zone; (ii) Middle Plain of North Bank; (iii) Active Flood Plain; (iv) Middle Plain of South Bank; (v) Sub-mountain Zone; and (vi) Hills. The physiographic divisions of Assam are shown in Map 11.

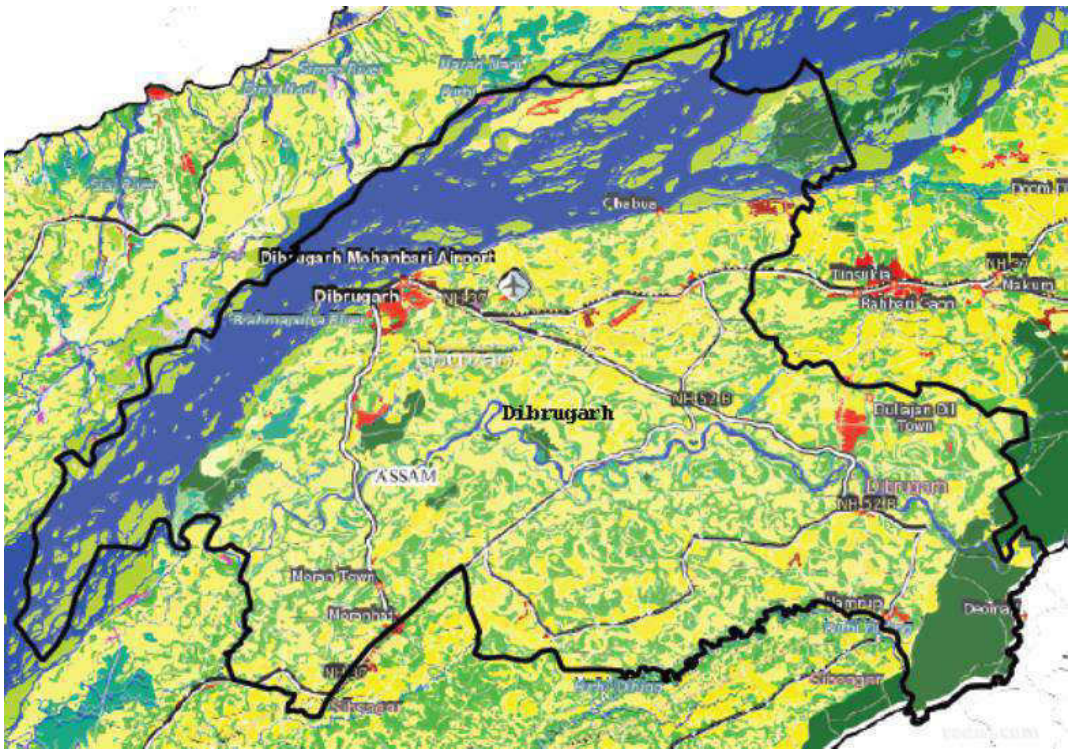
59. The Dibrugarh Reach extends some 40 km along the southern embankment of the Brahmaputra River between the new road and rail bridge at Bogibeel (Latitude 94°37' E), which marks the downstream limit of the reach, and the Oaklands Tea Garden (Latitude 95°04' E), which marks the upstream end of the reach. The District of Dibrugarh comprises three major physiographic zones: (i) a Southern Foothills Zone, which consists of the Naga foothills; (ii) an Active Floodplain Zone, which lies adjacent to the Brahmaputra and contains many ‘Charland'; and (iii) a Middle Plain, which covers the intermediate area and contains innumerable beels and swampy areas. Topographically, the District of Dibrugarh slopes gently from east to west, from an elevation of around 200 m in south-eastern corner of the district to some 99 m at the mouth of the Burhi-Dihing River. The Dibrugarh Reach, which consists of a mix of active floodplain and middle plain zones, follows this topography, with elevations falling from about 115 m across the Oaklands Tea Estate to about 100 m around the Bogibeel Bridge site (Map 12).

60. The immediate hinterland of the Dibrugarh Reach consists largely middle plain zone and is characterized by beels, wetlands and poor drainage. The Maijan Beel to the immediate west of Oaklands Tea Garden is part of a residual flood runner of the Dibru River. Various anabranches, distributaries and flood runners of the Burhi-Dihing River crisscross the area behind and to the southwest of Dibrugarh Town. One of these channels, the Buridehingmukh River, enters the Brahmaputra just to the west of the western end of the DTP dyke.

Map 11: Physiographic Divisions in Assam



Map 12: Dibrugarh District - Topography and land use



4.2.3. Flooding Behaviour

61. Flooding behavior at the subproject site is relatively straightforward. The site is exposed to mainstream flooding from the Brahmaputra River, tributary flooding from both Maijan Beel (to the north of Dibrugarh Town) and the Buridehingmukh River (to the south of Dibrugarh), and local flooding from heavy rains. These three types of flooding behavior, which can occur separately or in conjunction, can interact to exacerbate flooding impacts. Obviously, high water levels in the Brahmaputra serve to increase the level and duration of tributary flooding in Maijan Beel and the Buridehingmukh River. It is noted that the outlet sluice on Maijan Beel is of small capacity, which raises the level and extends the duration of tributary flooding along this waterway. It is also noted that local flooding is an issue at Dibrugarh Town: the town drainage is poor, and a major south-westerly flowing drain was constructed. This drain, which runs behind and parallel to the Brahmaputra River, delivers runoff to the Buridehingmukh River.

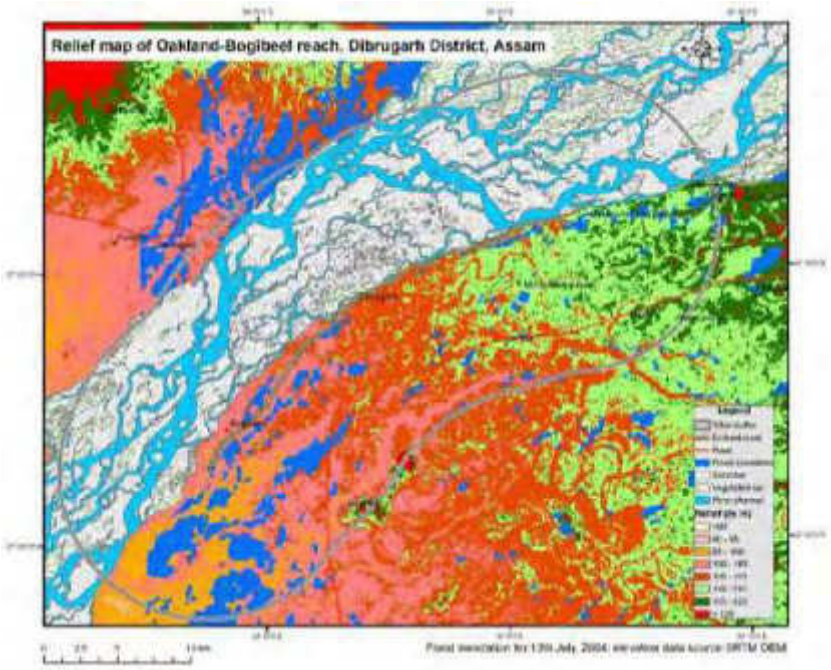
62. The town flooding was presumably exacerbated by poor drainage and the inadequate sluice outlet on Maijan Beel. Major flooding occurred down the Brahmaputra in 2008 after 2004 disastrous flood. In early September, the Brahmaputra at Dibrugarh was flowing some 1.5 m above danger level and was approaching its highest previous flood level. The Dibrugarh embankments are in poor repair other than DTP dyke which was strengthened in tranche 1, as evidenced by many leaks (attributed to rodent burrows) that were successfully plugged with bags of silt. It is apparent that ensuring the Dibrugarh embankments (and indeed embankments in general across Assam) can provide the expected levels of protection are a year-by-year challenge.

63. The flood inundation Map 13, shows the area affected during the flood of year 2008. The area covered by inundation was 8,698 ha, which accounts for 9.2% of the geographical area in 10 km buffer around the embankment.

Table.3 : Pattern of Flooding in 10 km Buffer Zone of Dibrugarh Reach

Particular	Area (ha)	Area (%)
Total Flooded Area	8,698	9.2
Total Area in 10 km Buffer	94,900	100.0

Map 13: Flood Inundation Map



4.2.4. Water Environment

64. The Dibrugarh Reach represents one of the most dynamic reaches of the Brahmaputra River, especially in the aftermath of the great Assam Earthquake of 1950. However, due to timely and appropriate remedial measures taken up by the then Government and initiative taken by Prime Minister Jawaharlal Nehru the urban center was saved from totally being wiped out although it had already lost a considerable part to the river's erosion.

4.2.4.1 *Surface Water*

65. In Dibrugarh reach, till the great earthquake of 1950, the northeastern corner of the reach was drained by the Dibru River, a tributary of the Brahmaputra with its confluence about 18 km east of the Dibrugarh City. However, due to the raising of the river bed through aggradations as a result of the earthquake, the Dibru River got merged with the Brahmaputra River. At present Maijan channel, a tributary of the former Dibru River, meets the Brahmaputra through a small opening and becomes a great cause of concern.

66. The Burhi Dihing is a major tributary of the Brahmaputra that joins this stretch at its extreme western end about 16 km. downstream from the Bogibeel Bridge. The course of the river shows intense meandering in the valley. It carries an average annual discharge of 141,539 cubic meters /second, and a sediment yield of 1,129 tons/km^2/year. The location of wetlands and other water bodies along with land use of the Dibrugarh Reach in a 10 km buffer zone around the embankment is shown in Map-22.

67. Water quality monitoring and analysis in regard to physico-chemical as well as biological parameters was carried out on samples collected from two locations in the project area in 2015. The locations of the sampling points are shown in Map-14. The analysis results are presented in Table 4 and these are compared with the water quality criteria of designated best use given by Central Pollution Control Board (CPCB). (Refer Appendix 2).

Map 14: Sampling Locations of Water, Soil, Air and Noise

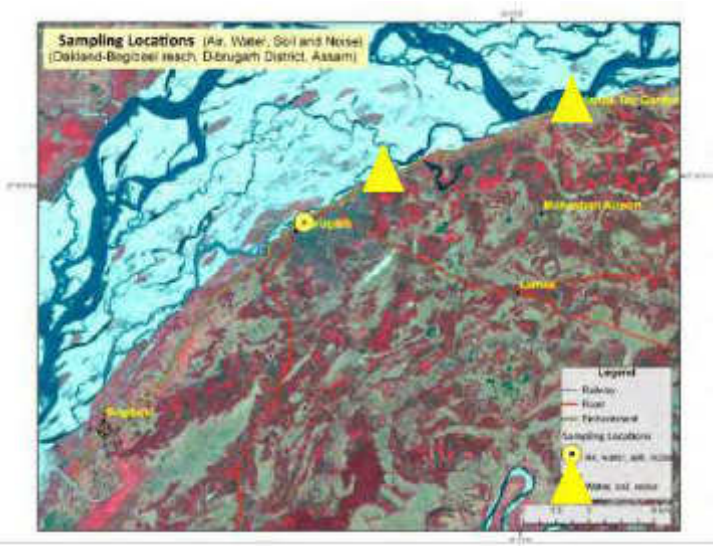


Table.4 : Water Quality at Selected Locations in Dibrugarh Reach

Parameter	Unit	Oakland (March 2015)	Maijan, DTP dyke site (March 2015)
Colour	Hazen	Colorless	Colorless
Odour	-	Nil	Nil
Temperature	(ºC)	20	
pH	-	7.5	6.7
Electrical Conductivity	(mS/cm)	3.4	
TSS	mg/L	172	47
TDS	mg/L	13.6	
Total Hardness	mg/L	64	55
DO	mg/L	6.5	4.1
BOD	mg/L	4.2	4.3
COD	mg/L	3.1	3.2
Chloride	mg/L	34	30
Sulphate	mg/L	7.4	--
Nitrate	mg/L	3.9	--
Calcium	mg/L	12	--
Magnesium	mg/L	52	--
Ammonical Nitrogen	mg/L	3.8	--
Total nitrogen	mg/L	5.9	--
Arsenic	Ppb	0.002	--
Iron	Ppm	0.87	--
Manganese	mg/L	BDL	BDL
Lead	mg/L	BDL	BDL
Fluoride	mg/L	1.4	--
Total Coliform	Coliform/100mL	9	50
Fecal Coliform	Coliform/100mL	1	Nil
Oil & Grease	mg/L	--	<0.05

(Note: BDL – Below Detection Limit) (Source: Analysis done by Labs, approved by *Pollution Control Board, Assam during Tranche - 1, results are from the work sites and from Trance 2 sites)

68. The comparison of the surface water samples analyzed against the water quality criteria for designated best use shows that the water quality of the project area meets the criteria of Class C —Drinking Water Source after Conventional Treatment.

4.2.4.2 Ground water quality

69. Understanding the water quality of the project area is an integral part of EIA to identify critical issues with a view to suggest appropriate mitigation measures for implementation. Water samples were collected from the project area to represent the baseline condition. Even though impact on groundwater is not envisaged in the construction work, three groundwater samples were collected from tube wells from schools and analyzed for its chemical parameters. The following Table 5 furnishes the various physico-chemical property of the groundwater. The water qualities with respect to almost all the essential parameters were observed to be good and of acceptable quality.

Table.5 : Groundwater Quality

Sl.no	Parameter	Test Method	Dibrugarh	Units
1	pH Value	IS 3025 P-11	7.1	--
2	Appearance		Clear	
3	Temperature	IS 3025 P-9	18	°C
4	T. Hardness ($CaCO_3$)	IS 3025 P-21	176	mg/l
5	Chlorides (as Cl)	IS 3025 P-32	10	mg/l
6	Turbidity	IS 3025 P-10	5	mg/l
7	Total Iron (as Fe)	IS 3025 P-53	0.4	mg/l
8	Total Alkalinity		180	
9	Calcium		90	
10	Magnesium		86	
11	Arsenic (as As)	IS 3025 P-37	BDL	mg/l
12	Nitrate NO_3		14	
13	Cadmium		BDL	
14	Fluoride		0.8	mg/l
15	Sulfate as So_4	IS 3025 P-24	82	mg/l
16	Total Coliform	IS 1622	Absent	MPN/100ml
17	F. Coliform	IS 1622	Absent	--
18	Lead (as Pb)	IS 3025 P-47	BDL	mg/l
19	BOD		1.6	mg/l

Source: Primary Analysis. Test carried out on 7.12.2015 by Greenviron

4.2.4.3 Hydrological and Morphological Aspects

70. The hydrologic and morphological regime of the Brahmaputra in the Dibrugarh section is examined on the basis of satellite imageries and recorded river observations. It is focused primarily on the recent years extending for the last twenty years that explains the present configurations better and indicates trends for the future.

Table.6 : Water and Sediment Yields of Selected Tributaries of the River Brahmaputra, Assam

River	Drainage area (km^2)	Water yield ($m^3 s^{-1} km^{-2}$)	Sediment yield (tons $km^{-2} yr^{-1}$)
Brahmputra at			
⊏ Tsela d' Zang (china)	191222	0.0105	100
⊏ Pasighat (India)	244700	0.0231	340
⊏ Pandu (India)	500000	0.0306	804
⊏ Bahadurabad (Bangladesh)	580000	0.0331	1128
Dibang	12120	0.1066	3765
Lohit	22077	0.0709	1960
Subansiri	27400	0.0756	959
Jia Bharali	11300	0.0858	4721
Puthimmari	1787	0.0403	2887
Pagladia	383	0.1087	1883
Manas	36300	0.0232	1581
Kulsi	750	0.0797	135
Buridhing	4923	0.0788	1129
Desang	3950	0.0382	622
Dhansiri	10240	0.0184	379
Kopili	13556	0.0182	230

Source Goswami, 1985[6]

71. The morphology of the Brahmaputra River is characterized by intense braiding and bar formation and extremely dynamic bank line and bed configuration. The morphology and behavior of the river undergoes drastic changes in response to variation in the flow regime and pattern of sediment transport and deposition in the river following the seasonal rhythm of the monsoon.

72. The Brahmaputra is a classic example of a braided river - a river in which the channel exhibits successive bifurcation and rejoining of flow around sand bars and islands. In case of the Brahmaputra in its Assam reach, a combination of multiple factors, such as excessive sediment load, large and variable flow, easily erodible bank materials, aggradations of the channel have been identified has the possible underlying factors. Further, the braiding mechanism is related to the presence of narrow sections (nodes) where the banks are stable due to the existence of resistant rocks, like the one near Guwahati, in the immediate downstream of which the channel fans out developing an intricately braided channel. In the case of Dibrugarh reach, no such structural node points are present.

73. Another striking feature of the river's morphology is the continuous shift of the thalweg (deep channel) from one location to another within the bank lines of the river. Bank materials of the Brahmaputra consist mainly of varying proportions of fine sand and silt with only occasional presence of clay. There is a relatively fine grained top statum and a coarser substratum. Bank failures are rampant in numerous locations like the upstream part of Dibrugarh reach. These failures largely seem to be a function of hydraulic character of the flow and engineering properties of bank materials. Shear failures in the upper bank materials appear to be by far the most widespread mode of bank failure in the river. These are caused either by undercutting of the upper bank materials by channels during the high floods producing an overhanging cantilevered block that eventually fails or by over steepening of bank materials due to migration of the thalweg closer to the bank during the falling stages.

74. The bed regime of the Brahmaputra is characterized by drastic changes in bottom configuration and occurrence of bed forms of greatly varying sizes ranging from small size ripples of few centimeters wavelength to giant size dunes and waves of dozens of meters. The dynamic

[6] Goswami, D.C. 1998. Fluvial regime and flood hydrology of Brahmaputra River, Assam. Memoir Geological Society of India, No. 41: 53-75.

pattern of the channel configuration and movement of the Brahmaputra in the Dibrugarh reach is demonstrated for different years based on the IRS satellite images for 1973, 1990, 2000, 2007 and 2008 (Map-13). The movement of the thalweg (deep channel) towards the south bank and its present position hugging the backline where existing embankments and spurs are under serious threat is well evidenced in the successive images. Map-15 & Figure 5 shows the pattern of erosion and accretion of the bank during the period 1967 to 2008 based on analysis of satellite as well as conventional data using GIS. The rates of erosion and accretion estimated from this analysis between 1967–2008 are 3616.42 ha, and 802.87 ha, respectively, giving a net loss of around 2813.55 ha of land. Pattern of erosion and accretion of the Brahmaputra Bank in the Dibrugarh reach (1973–2014) is shown in Table- 7.

Map 15: Channel Configuration of River Brahmaputra in Dibrugarh Reach

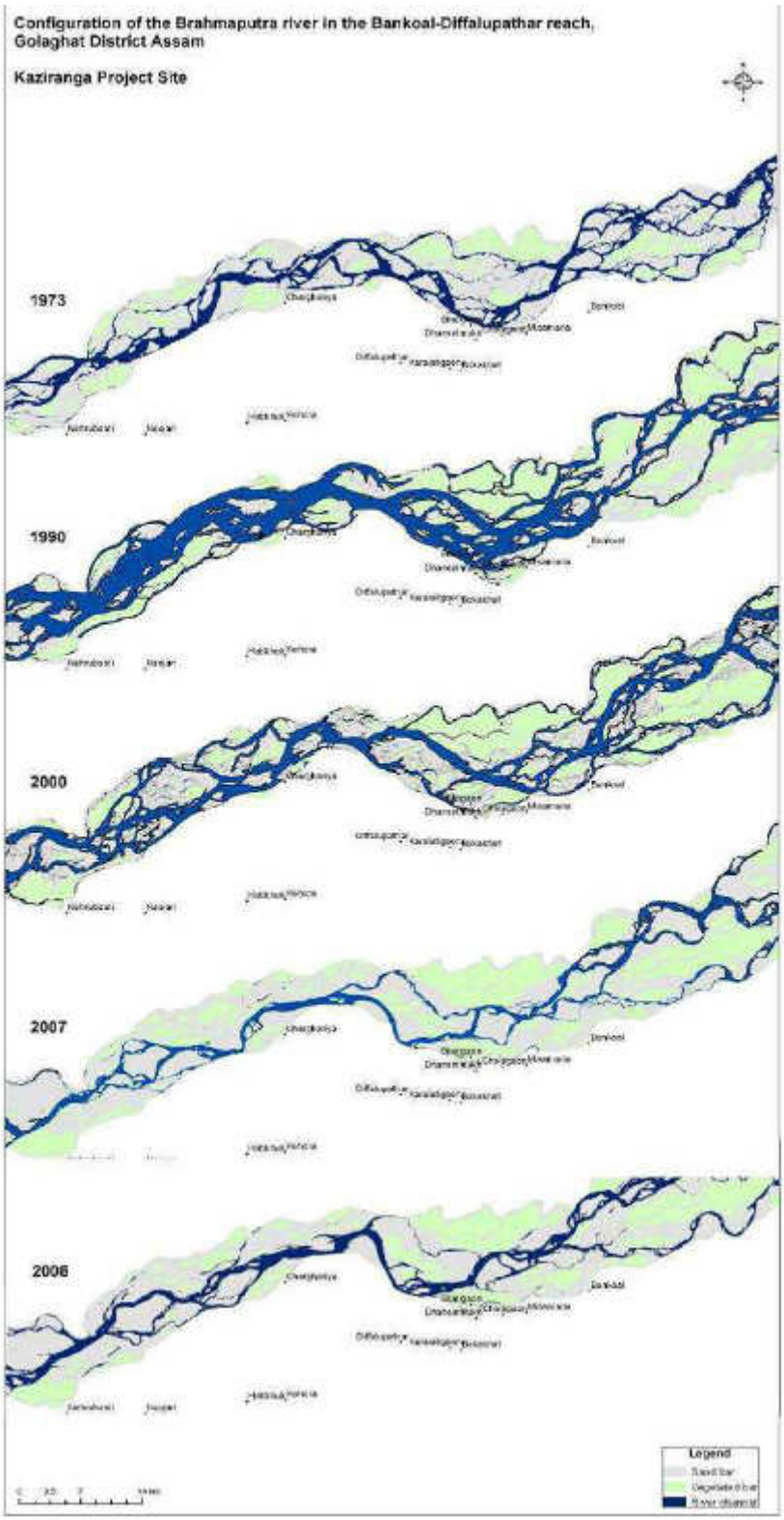
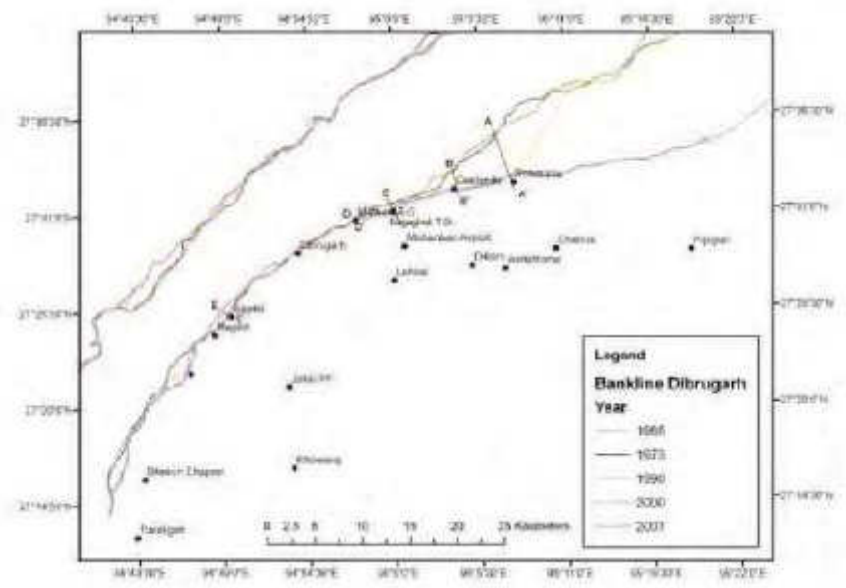
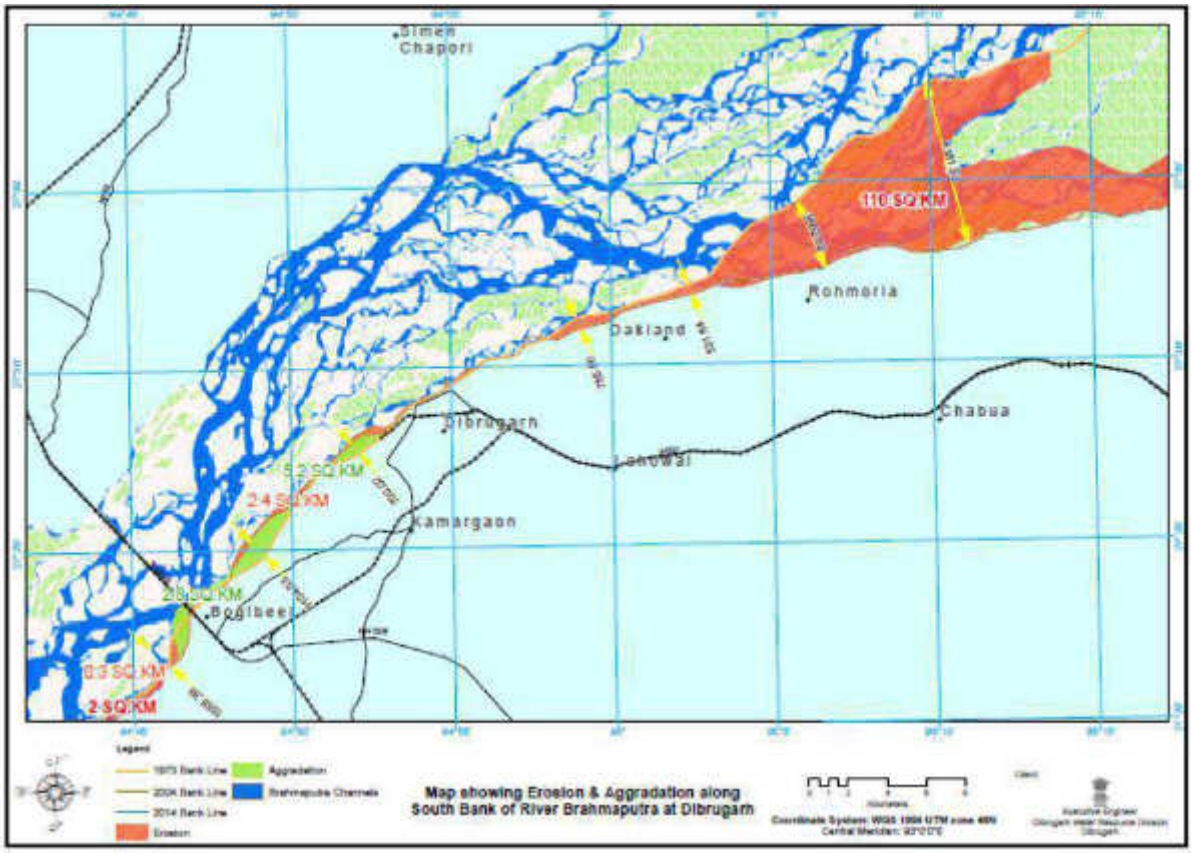


Figure 5: Bankline Migration (in m) of the Brahmaputra River in the Dibrugarh reach at Selected Cross-sections during different Time Periods



Map 16: Pattern of Erosion and Accretion of the Brahmaputra Bank in the Dibrugarh Reach (1973 - 2014)



75. The pattern of bank line migration in the reach during different time periods is shown in Map 16. There has been persistent regression of the backline in most of the locations where cross sections are taken although at varying rates (Table- 7. The pattern of shifting of the bank line during the present decade as depicted on the map between 2000- 2007 shows regression in all

the sections except a major amount of progression (forward shifting) in one cross-section. Maximum bank line shift of about 7 km was observed during the period of 1973 to 1990.

Map 17: Bankline Migration (in m) of the Brahmaputra River in the Dibrugarh Reach at Selected Cross-sections during Different Time Periods

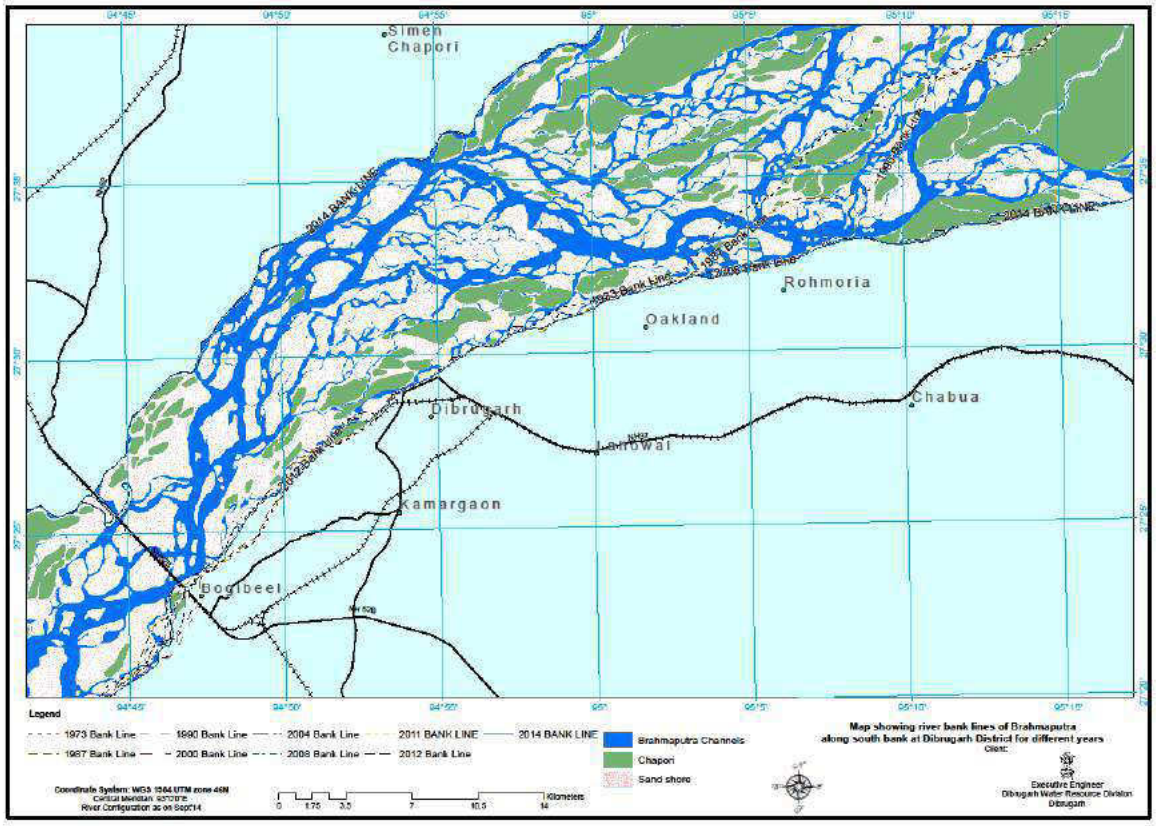


Table.7 : Rates of Bankline Migration (in m) at Selected Cross-sections in the Dibrugarh Reach during Different Time Periods

Cross-Section	Period			
	1965 - 1973	1973 – 1990	1990 – 2000	2000 - 2007
AA'	-100	-4516	-60	-120
BB'	213	-1612	-266	-392
CC'	-25	-706	73	-12
DD'	-33	-157	163	-176
EE'	-36	-17	-40	898
Total	**19**	**-7008**	**-130**	**198**

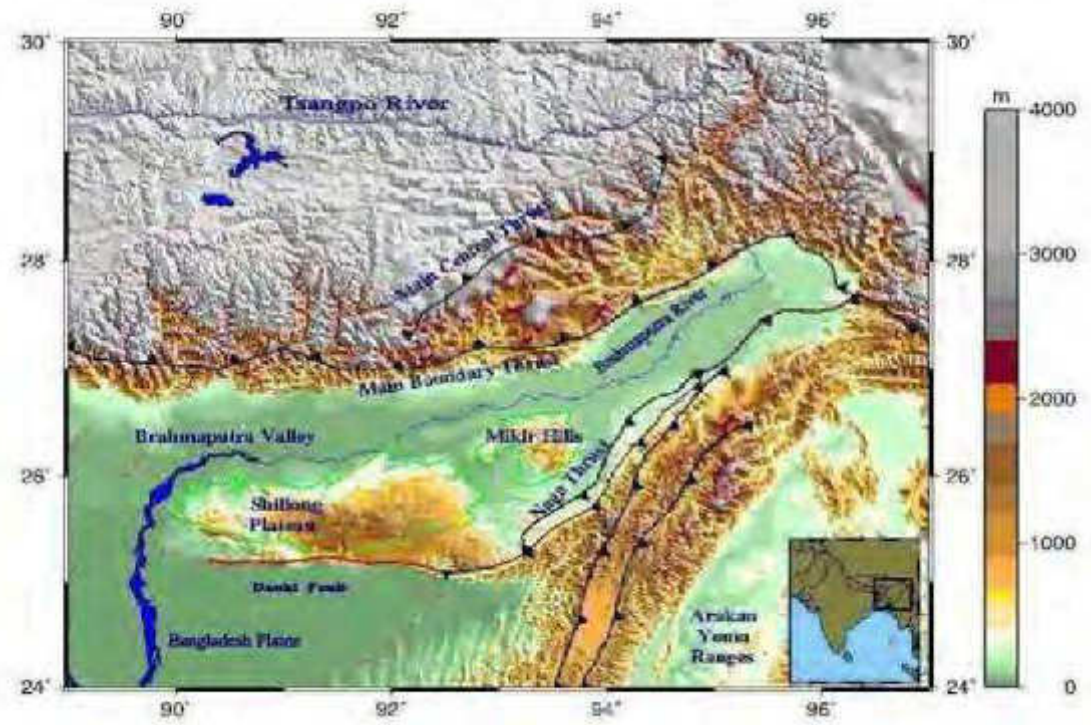
4.2.5. Geology

76. The geology of the area adjacent to the Dibrugarh Reach is almost entirely made up of recent alluvial deposits called new alluvium comprising clay, sand, silt and shingle. The alluvial soils forming the floodplain extend down to a depth of 200 to 300 m.

77. The Brahmaputra Valley is formed during the Pleistocene and recent times dating back to approximately 2 million years from sediments derived from the Himalayas in the north and the Assam plateau in the south and brought down by the Brahmaputra River and its tributaries. It is

considered to be a tectono-sedimentary basin, 720 km long and 80–90 km wide, underlain by recent alluvium approximately 200–300 m thick consisting of clay, sand and pebble.[7] The basin is underlain for the most part by very young and unweathered sedimentary formations with the result that the river carries mainly fine sand and silt with very little clay. A dominant feature of the riverine landscape of the Brahmaputra is the large number of sandbars of varying shapes and sizes locally known as Chars that develop on the sandy bed of the braided channel. Although mostly transitory in nature, some of these chars are more or less permanent with a veneer of fertile soil on the top that support vegetation, crops and settlements.

Map 18: Geotectonic Map of Brahmaputra River Valley and its adjoining Highlands



4.2.6. Seismology

78. Due to their strategic location in regard to colliding Eurasia (Chinese), Indian and Burmese tectonic plate boundaries, the Brahmaputra Valley and its adjoining hill ranges are seismically very unstable. The earthquakes have caused extensive landslips and rockfalls on the hill slopes, subsidence and fissuring of ground in the valley, and changes in the course and configuration of several tributary rivers as well as the mainstream. The geo-tectonic map of the Brahmaputra Valley and its adjoining highlands is presented in Map 18.

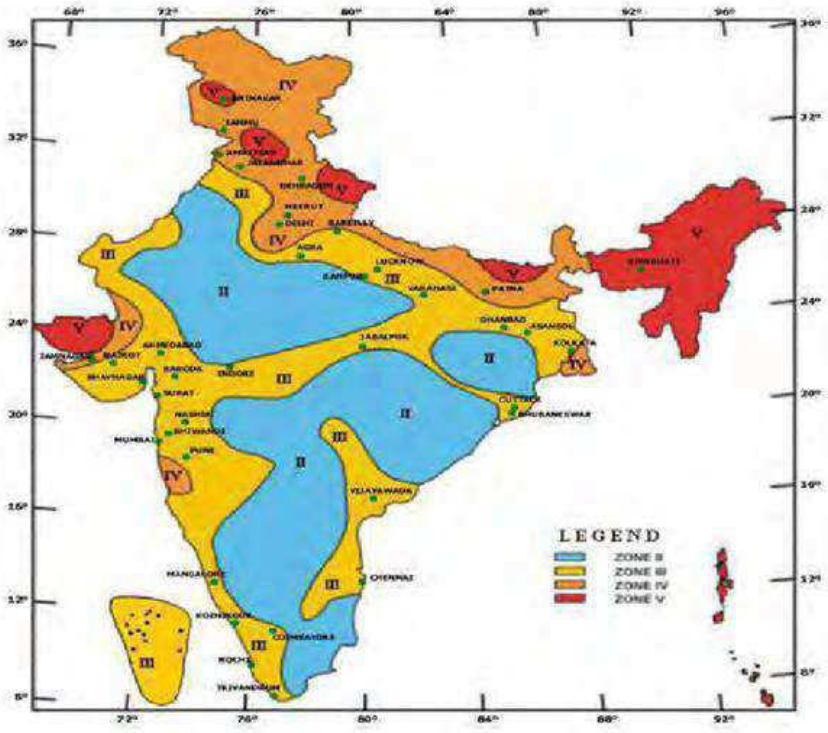
79. There appears to be phases of rapid aggradations of the Brahmaputra River associated with earthquakes, mainly as a result of deposition of sediments received from landslides, followed by relatively slower removal of accumulated debris over longer time periods. Active seismicity of the NE region has a very significant impact on the hydrologic regime and morphology of the Brahmaputra River including its host of tributaries and other water bodies (e.g. wetlands) strewn over the floodplains. Occurrence of these episodic events led to intensification of flood hazards, especially in the aftermath of the two great earthquakes of 1897 and 1950[8]

[7] GSI. 1977. Contributions of geomorphology and geohydrology of the Brahmaputra Valley. Miscellaneous Pub.

[8] Goswami, D. C. and Das, P. J., 2002: Hydrological Impact of the Earthquakes on the Brahmaputra River Regime in of Assam: A case study in exploring some evidences, Proc. 18 National Convention of Civil Engineers, Nov. 9-10, 2002, pp. 40 -48

80. As per the seismic zoning map of India, the entire project area falls in Zone V (very severe seismic intensity zone). The seismicity map of Northeast India with respect to the magnitude of earthquakes is shown in Map-19. The distribution of major earthquakes (above Richter magnitude 7.0) in the NE region since the 1897 is summarized in Table-8. Shillong earthquake is shown in Map-20. The Dibrugarh reach is in the upper course of the Brahmaputra River closer to the eastern Himalayan Region of high seismic vulnerability, and has been significantly affected by the earthquakes of 1950, which had its epicenter in Rimoron, the tri-junction of India, Myanmar and the People's Republic of China. Besides the large amounts of sediments generated by the landslides in the lower Himalayan slopes, the earthquake was also reported to have caused choking of the river channel with sediments released from squeezing of the soft level areas.

Map 19: Seismic Zoning Map of India



Map 20: Seismicity Map of Northeast India (1912 - 2009)

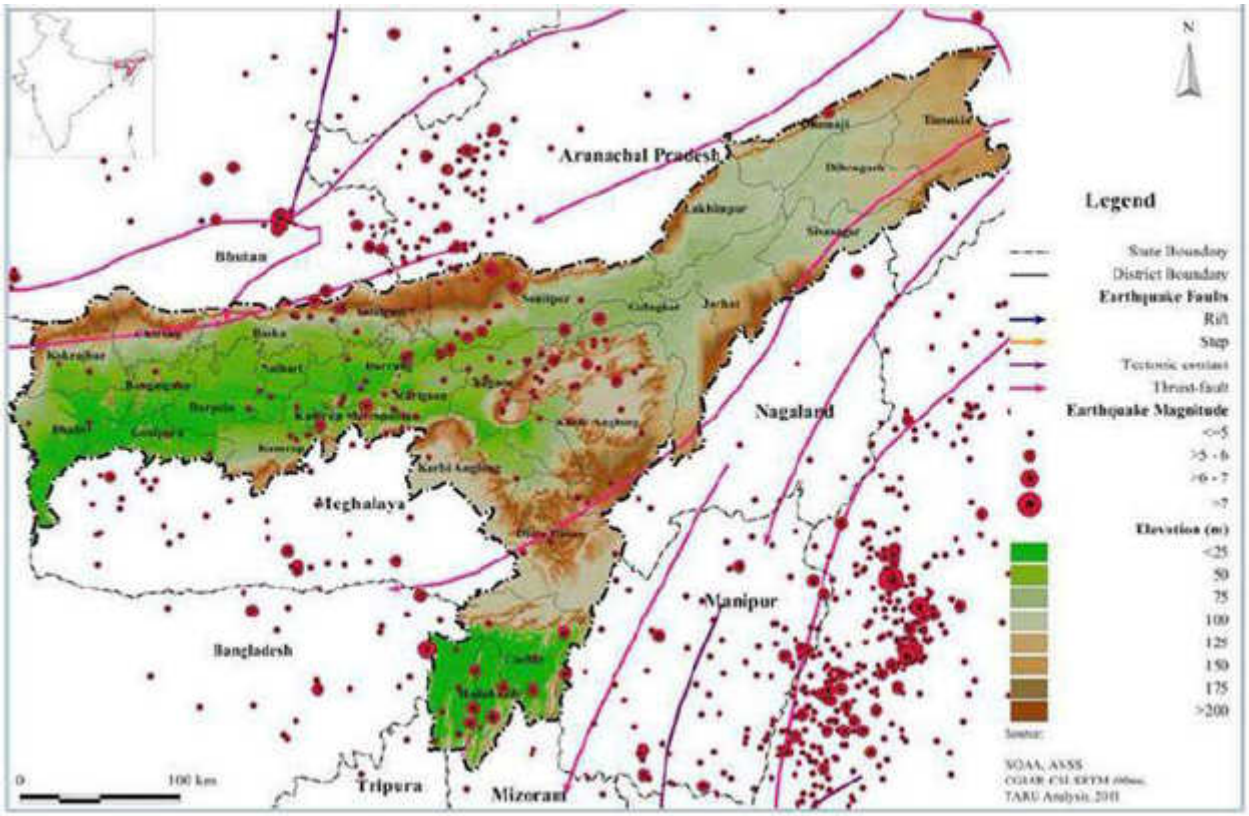
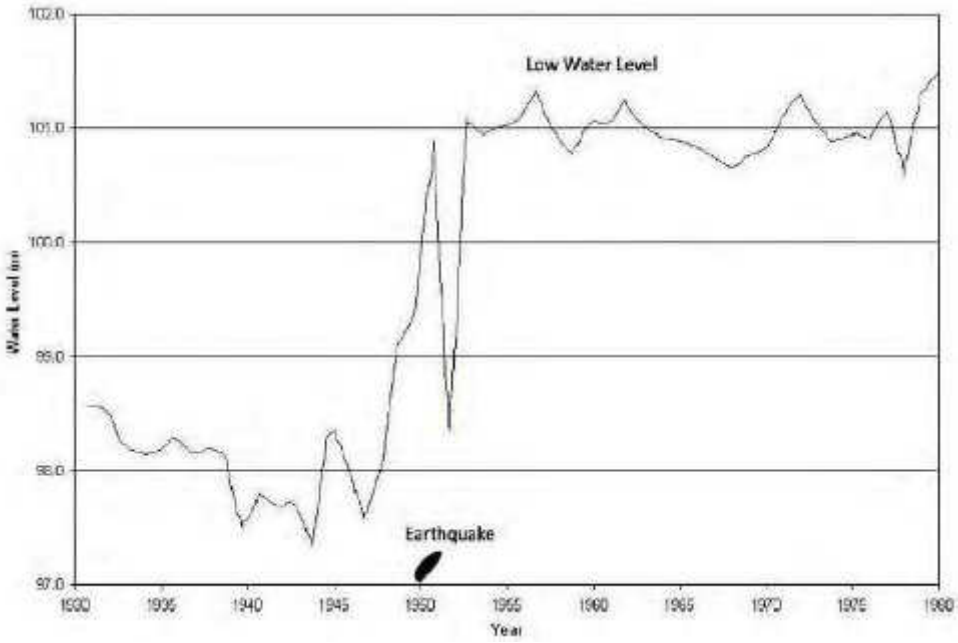


Table.8 : Major Earthquakes in North-Eastern India and Adjoining Regions since 1897[9]

Date	Epicenteral Area	Lat (°N)	Long. (°E)	Magnitude
12-06-1897	Shilong, Meghalaya	26°00'	91°00'	8.7
31-08-1906	India-Burma Border	27°00'	97°00'	7.0
12-12-1908	Kachim,Burma	26 30'	97 00'	7.0
09-09-1923	Jankaria,Meghalaya	25 12'	91 00'	7.1
02-07-1930	Dhubri,Assam	25 30'	90 00'	7.1
27-01-1931	Kachin,Burma	25 36	96 48'	7.6
04-08-1932	India-Burma Border	26 00'	95 30'	7.0
23-10-1943	Hojai,Assam	26 00'	93 00'	7.2
29-07-1947	Tammu,Arunachal Pradesh	28°30'	94°00'	7.8
15-08-1950	India-Burma-China Border	28°50'	96°30'	8.7
06-08-1988	Manipur-Burma-Border	25 14'	95 12'	7.2

[9] Oldham, D. 1899. The Great Earthquake of 1897. Geological Survey of India Memoire 29.

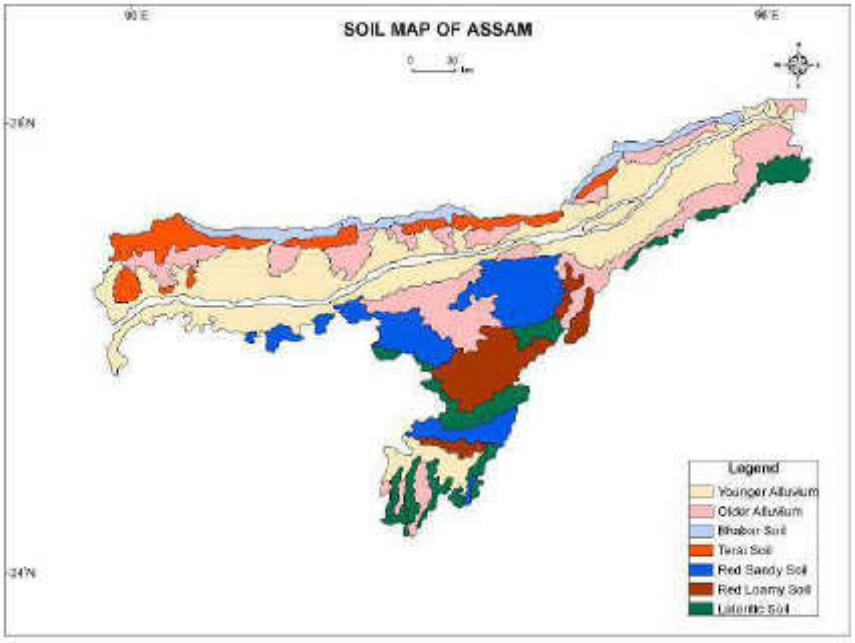
Figure 6: Effect of 1950 Earthquake on the Bed-level of the Brahmaputra at Dibrugarh



4.2.7. Soil

81. The Dibrugarh reach is made up of new alluvium that varies from clay to sandy loam in texture and less acidic in reaction with pH varying from 5.5 to 9.0. In the relatively higher parts of the valley, older alluvium soils are found as low terrace deposits. These soils have alternating beds of pebbles, gravels or boulders with loose sand and clays. The old alluvium soils are relatively more acidic with pH ranging from 4.2 to 5.5. The distribution of soil types in Assam is shown in Map 21.

Map 21: Soil Types in Assam



82. To examine the soil quality of the area adjacent to the river banks sampling and analysis of soil was carried out in two locations as shown in Map-14. The results of the analysis of 2013 are presented in Table 9. The soil quality in the Dibrugarh reach shows medium organic carbon, low available nitrogen, low available phosphorous, and medium available potassium.

Table.9 : Analysis Results of Soil Samples in Dibrugarh Reach

Parameters	Unit	Pach Ali	Kahai Spur
Organic Carbon	ppm	0.52	0.50
Organic Matter	ppm	2.74	1.67
Available Nitrogen	ppm	23.64	22.27
Available Phosphorus	ppm	0.02	0.002
Iron	ppm	0.062	0.029
Copper	ppm	0.009	0.004
Manganese	ppm	BDL	BDL
Lead	ppm	BDL	BDL
Chromium	ppm	BDL	BDL
Zinc	ppm	0.004	0.025
Mercury	ppm	BDL	BDL
Arsenic	ppm	0.001	0.001
Potassium	ppm	49	73
CEC		0.78	0.75
Textural Classes		Sandy	Clay 43
Clay	%	10	2928
Silt	%	15	4.135
Sand	%	74	32.56
Bulk Density	g/cc	4.0950	
Water Holding Capacity	%	29.72	
Pore Space	%	38.72	37.64
Specific Gravity	%	1.14	1.3
Electrical Conductivity	(dS/m)	2	3.4

(Source: Sampling and Analysis done by the Dept. of Environmental Science, Gauhati University, 2013)

4.2.8. Land Use

83. The current land use pattern in the area is examined in three different scale and space dimensions keeping in view the nature and intensity of the potential impact of the different project elements. On a broader scale, a 10 km buffer around the embankment is chosen and the land use pattern within the zone is delineated from satellite images using GIS. Image date 2011–2012. The land use map of the 10 km buffer zone is presented in Map 22 and the area covered by different categories of land use are given in Table 10.

Map 22: Land use map of the 10 km Buffer Zone on either side of the Dibrugarh Reach along the South Bank of the River Brahmaputra (Feb, 2016)

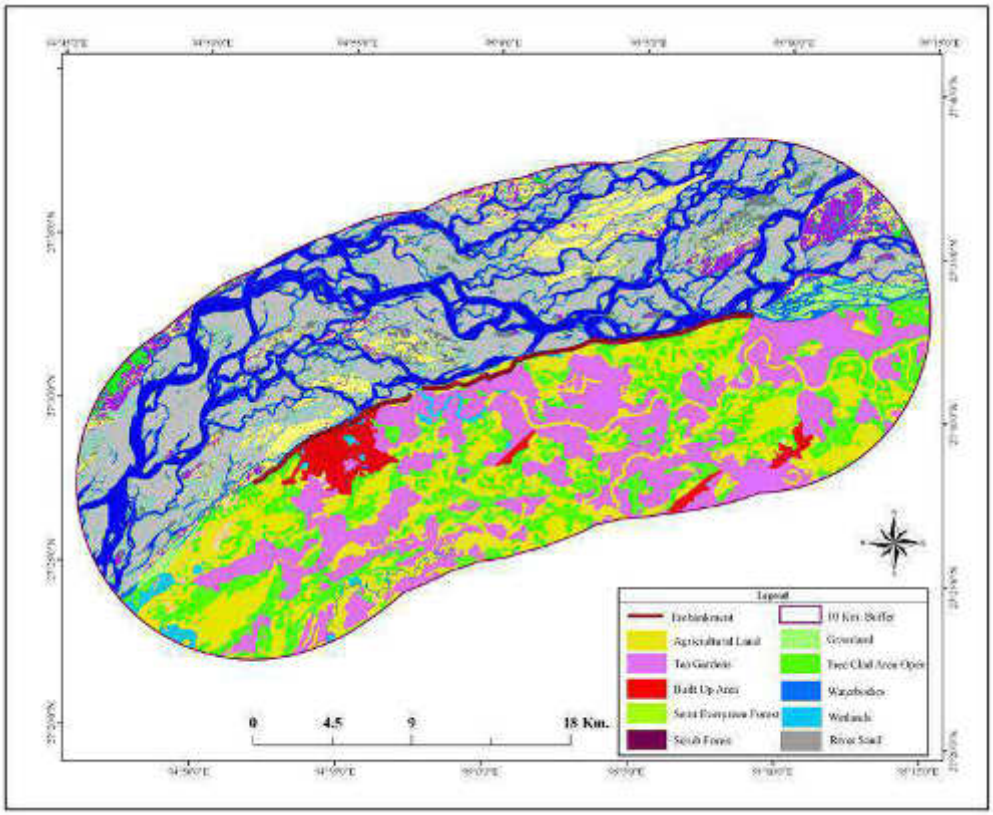


Table.10 : Land use in the Study Area (buffer around embankment)

Land Use Class	Area in sq. km	%
Agricultural Land	129.00	13.93
Tea Gardens	107.00	11.55
Builtup Area	52.10	5.62
Semi Evergreen Forest	124.10	13.40
Scrub Forest	65.34	7.05
Grassland	72.56	7.83
Tree Clade Area Open	95.45	10.30
Waterbodies	104.45	11.28
Wetlands	78.12	8.43
River Sand	98.17	10.60
Total Area	926.29	100.00

84. Out of the total study area of 926.29 km^2, Agricultural land 129 km^2 (13.93 %), Semi evergreen forest 124.10 km^2 (13.40 %) followed by Tea garden 107 km^2 (11.55 %), water bodies 104.45 km^2 (11.28 %) sand bars occupy 98.17 km^2 accounting for 10.6%, and other areas around the embankment.

85. Land use pattern is also examined in a 500 m direct impact zone on either side of the embankment using satellite remote sensing and GIS. The dimension of the direct impact zone is decided based on field observations as well as discussions with technical and administrative officials of the Government. The 500 m direct impact zone for the entire reach is shown in Map

23. The land use data for the direct impact zone is presented in Table 11. It indicates that the built-up land (23.08%) occupy highest portion of the area followed by tea garden (20.51%) followed agricultural land (12.82%) and forest (10.26%), etc.

86. The land use pattern in the zone lying between the bank and the embankment was also mapped using satellite data and GIS. The result of this analysis is shown in Map 24. It shows that agricultural land dominates the land use accounting for more than 38.5% of the total area followed by homestead plantations (27.1%) and built-up land (22.8%). These areas are mostly found in the western part of the reach.

Map 23: Land use Map of the 500 m Buffer Zone on either side of the Dibrugarh Reach along the South Bank of the River Brahmaputra

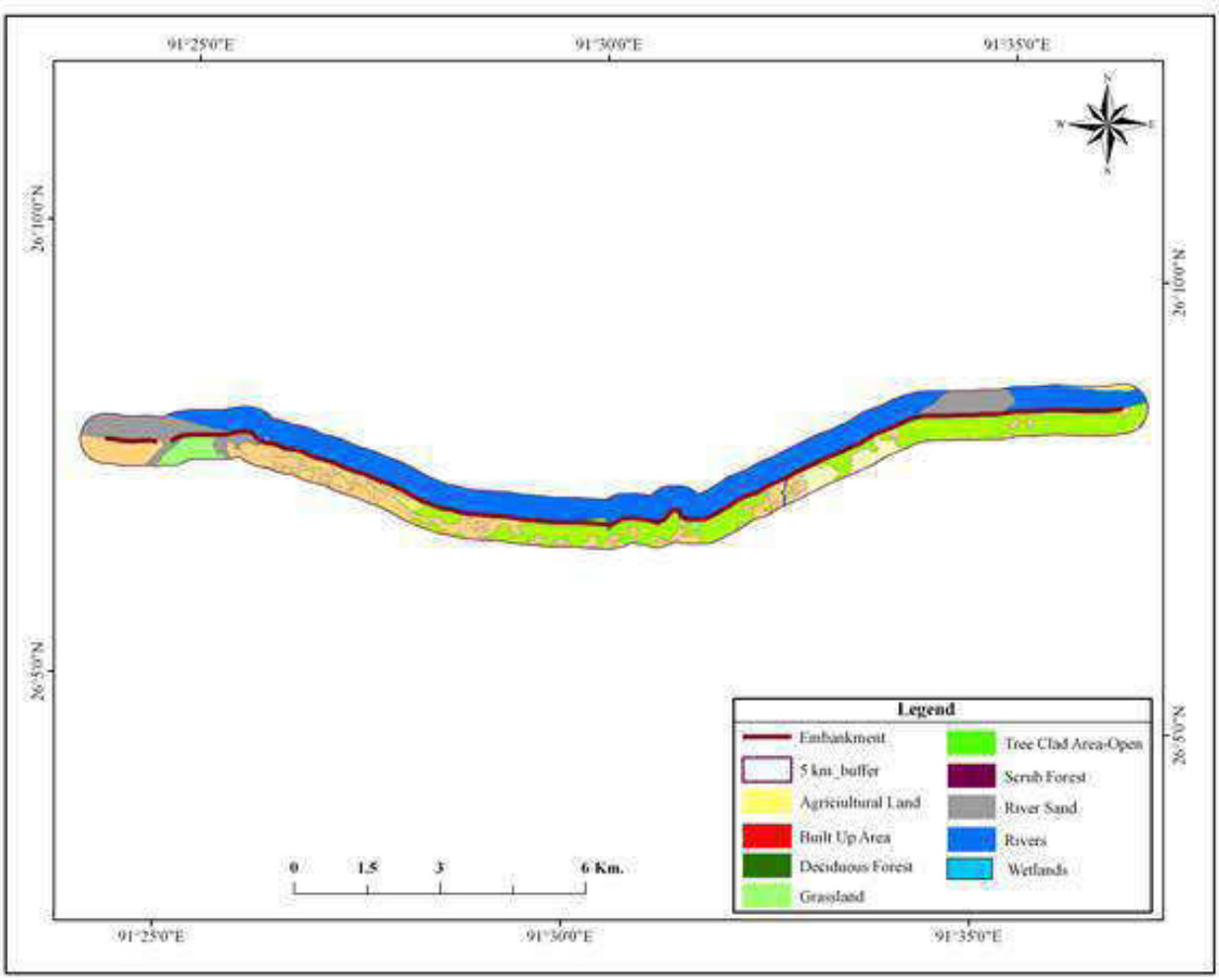


Image - February 2017

Table.11 : Land use of Dibrugarh Reach (500 m buffer around embankment)

Land Use Class	Area in sq. km	%
Agricultural Land	5	12.82
Tea Gardens	8	20.51
Builtup Area	9	23.08
Semi Evergreen Forest	4	10.26
Scrub Forest	1	2.56
Grassland	2	5.13
Tree Clade Area Open	3	7.69
Waterbodies	3	7.69
Wetlands	1	2.56
River Sand	3	7.69
Total Area	39	100.00

Map 24: Land use Map of Dibrugarh Reach (bank to embankment)

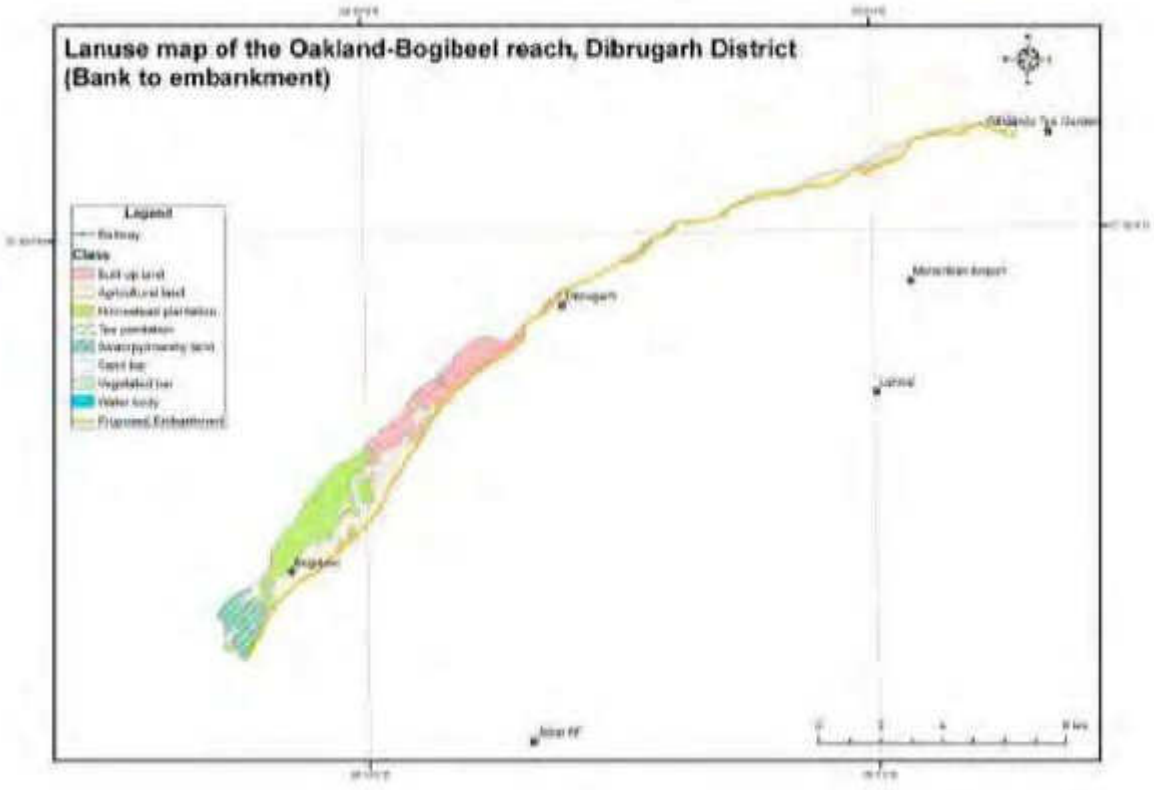


Table.12 : Land use of Dibrugarh Reach (Bank to Embankment)

Category	Area (ha)	Area (%)
Agricultural land	756.5	38.5
Built up land	447.3	22.8
Homestead plantation	532.2	27.1
Swampy/marshy land	184.9	9.4
Tea plantation	43.9	2.2
Total	**1964.8**	**100**

4.2.9. Air Environment

87. Except the stretch falling within the Dibrugarh Town area, the rest of the Dibrugarh Reach comes under rural setting or tea plantations. Air quality was monitored at a location very close to the high activity zone of the urban center (primary data, 2015). The results of ambient air quality monitoring in the reach are presented in Table 13. The ambient air quality results have also been compared with the National Ambient Air Quality Standards (NAAQS) for Residential and Rural Areas in India.

Table.13 : Air Quality in Dibrugarh Reach

S. No.	Parameter	Unit	NAAQS for Residential and Rural Areas	Maijan, DTP dyke site (March 2015)	Nagaghuli, Mothola Oakland site (February 2015)
1.	Suspended Particulate Matter (SPM)	µg/m^3	200	94	74
2.	Respirable Suspended Particulate Matter (RSPM)	µg/m^3	100	81.7	55
3.	Oxides of Nitrogen (NOx)	µg/m^3	80	25	22.4
4.	Sulphur Dioxide (SO_2)	µg/m^3	80	4	3.9
5.	Lead (Pb)	µg/m^3	1.0	0.06	0.06
6.	Carbon Monoxide (CO)	µg/m^3	2000	200	175

(Source: Monitoring done by SIA, contractors in tranche 1, test carried out by Pollution Control Board approved lab)

88. It is evident from the comparison that all the air quality parameters are found well within the permissible limits as per the NAAQS for residential and rural areas. The National Ambient Air Quality Standards in India are shown as Appendix 3.

4.2.10. Noise Environment

89. Noise quality was monitored at the project site close to the high activity zones of the urban center. The ambient noise levels during day and nighttime have been presented in Table 14. Tests carried out in 2015. The ambient noise levels have also been compared with Ambient Air Quality Standards in respect of Noise for residential areas. The National Ambient Air Quality Standards in respect of noise are shown as Appendix 4.

Table.14 : Noise Quality in Dibrugarh Reach

Location	AAQS in respect of Noise for Residential Area		Day Time [dB(A)]			Night Time [dB(A)]		
	$L_{eq(day)}$	$L_{eq(night)}$	L_{max}	L_{min}	$L_{eq(day)}$	L_{max}	L_{min}	$L_{eq(night)}$
Pach Ali	55	45	75	51	57	67	38	45
Kahai Spur			63	47	52	58	37	42
800 m upstream of Maijanghat (March 2015)			59.8	55.2	57	55	52.7	54

(Source: Monitoring done by Dept. of Env. Science, Gauhati University, *Pollution Control Board, Assam during Tranche -1, results are from the work sites of tranche 1 and from Trance 2 sites)

4.3. Terrestrial Ecology

90. Assam is one of the most important biodiversity hotspots in northeastern region of India. The area harbors great varieties of wildlife species in its diverse and mosaic natural habitats. The wilderness habitat of Assam supports 689 species of bird,[10] 194 species of mammals,[11] 185 species of fish,[12] 115 species of reptiles, 54 species of amphibians,[13] more than 900 species of butterflies[14] and immense varieties of moths. In floral diversity, Assam has documented 6,027 species of plants, of which 3,010 are flowering plants along.[15] The area sustained 33 endangered mammalian, fauna above 20 endangered avian fauna under Wildlife Protection Act, 1972 and 45 globally threatened avian fauna and 17 endemic birds. Apart from that the state supports above 15 endangered reptilian and amphibian fauna each, 43 endangered insets fauna.[16] However, there is no biodiversity hotspot in the project areas of Dibrugarh subproject.

4.3.1. Methodology of Baseline Data Collection

91. To collect the baseline data from Brahmaputra Dyke in Dibrugarh, the area from Mohona Ghat to Oakland area was surveyed (total length of 40 km). The tree species available inside and outside the embankment has been counted. The identification of tree species was made based on available Books Plant Taxonomy. Five samplings were taken after each Ch. 1.0 km and the data has been gathered within 100 m width of either side of the embankment. If the DBH of the tree species ranges between 0.45 meters, then it was categorized as tree, whereas, it was categorized as sapling if 0.45 meters. Saplings were not recorded for analysis. Animal species data were collected in study sites through direct sighting methods, indirect evidences and as well as the information of local inhabitants (through displaying the animal's color plates). Identification of Mammalian and Reptilian species were made as per the available Books and published materials. Analysis was done following standard methods.[17]

[10] 5 Kanjilal, U. N. and Bor, N. L. (1940). Flora of Assam Volume I-V, Government of Assam, Shillong.
[11] Menon, B. (2003). A Field Guide to Indian Mammals, D. K. Publication, Delhi, pp. 201
[12] Ali, S. and Riplley, S. D. (1987). Handbook of Birds of India and Pakistan, 2nd edition, Delhi: Oxford University Press, Oxford, pp. 700.
[13] Whitaker, R. and Captain, A. (2004). Snakes of India, The Field Guide. Draco Bookds, P.O. Box - 21, Chengalpattu 603001, Tamil Nadu, India, pp. 480.
[14] Chaudhary, A. U. (1997). Checklist of Mammals of Assam, 2nd revised edition, Gibbon Books, Guwahati, pp. 102
[15] Magurran, A. E. (1988). Ecological Diversity and its Measurement, London: Chapman and Hall, pp. 179
[16] Dytham, C. (1999). Choosing and Using Statistics, A Biologist's Guide, Blackwell Science Ltd. Osney Mead, Oxford OX2 OEL, pp. 218
[17] Choudhury, A. U. (1998). Mammals, Birds, and Reptiles of Dibru-Saikhowa Sanctuary, Assam, India. Oryx 32(3) pp. 192-200

4.3.2. Identification of Terrestrial Flora

92. It is significant to note that the land area inside the embankment that frequently interact with Brahmaputra flood water leads to tremendous harmful impacts on the ecosystem. However, outside the embankment, there has been comparatively less impact of floodwater on land surface since long time.

93. The vegetation compositions of the terrestrial zones comprise of Pakori-Ficus rumphii, Acacia-Acacia auriculiformes, Sagina-Moringa oleifera, Amlakhi-Phylanthus ambilica, Bhimkol-Musa balbasiana, Atlas-Annona squatamosa, Owtenga-Dillenia indica, Jatibanh-Bambusa tulda, Aam-Mengifera indica, Kadam-Anthrocephalus cadamba, Ahot-Ficus religiosa, Bot Goch-F. bengalensis, Indian Rubber-Ficus elastica, Simul-Bombax ceiba, Gamari-Gmelina arboria, Narikol-Cocos nucifera, Jolphai-Elaeocarpus fleribundus, Segun-Tectona grandis, Ghoranim-Melia azedarach, Deodaru-*Polialthia longifolia*, Satiana-*Alstnia scolaris*, Amita-*Carica papaya*, Kathal-Artocarpus heterophyllus, Bogori-*Zizyphus jujuba*, Siris-*Albizia lebek*, Ranga Kanchan-*Bauhinia purpurea*, Krishnasura-*Delonix regia*, Karash-*Pungamia pinnata*, Bijuli Banh-*Bambusa pallida* and Tambul- *Areca catechu* etc. The other important terrestrial plants included viz., Jati bet- Calamus erectus, Dubari Ban- *Cynodon dactylon*, Locosa Ghanh-*Hemarthia compressa*, Birina-*Vetiveria zizanoides*, Khagori- *Phragmites karka*, Ulukher-*Imperata cylindrica*, Hankher-*Pollinia ciliata*, Kahua-*Saccharum sponteneum* and Borota Kher-Saccharum elephantinus, etc.

94. The main climbers comprise the species of Stephania harnondifolia (Tubuki Lata), Zanthoxylum hamiltonianum (Tej-muri), Illegeria khasiana (Kerkeri Lata), Dioscorea hamilttoni (Bonoria Alu), Smilax macrophylla (Tikoni Boral), C. gracilis (Wahing Bet), C. latifolius (Motha bet), Pinaga gracitis (Raidang Bet), Pothos cathcartii (Hati-poita) and P. scandens (Kawri Lata) etc. The tree species identified along the embankment. The community dominance index of tree species in various study zones of Dibrugarh reach have been presented in Appendix 5, Biodiversity Index- Appendix-6.

4.3.3. Ecology of Terrestrial Zones

95. Inside and outside of the Brahmaputra dyke in Dibrugarh reach has been occupied by secondary vegetation and characterized by *Bombax ceiba, Trtramelos nudiflora, Cordia dichotoma, Erythrina indica, Ficus rumphii* and *Zizyphus jujuba* etc. The area was gradually colonized by these plants owing to frequent interactions with Brahmaputra floodwater, sand deposition, and frequent construction/repairing of the embankment during flood season. As a result of regular flooding, once fertile land has been converted into barren land along the stretches of embankment. The area within Maijan site near Tea Estate (coordination: 27°30’ 58 N - 94° 59’ 20 E), Naga Ghuli area (coordination: 27° 31’ 16 N - 95° 00’ 18 E), near Last Spur (coordination: 27° 31’ 50 N - 95° 02’ 14 E), and near earth spur has been eroded heavily and critically threatened of being washed-out in the immediate future. Most of the land area inside the embankment has been sand casted.

96. All tea gardens were situated along the dyke, covering almost half-length of the existing embankment. Along the dyke are also majority of settlers - mostly tea laborers. The only natural wetland found near the embankment site is the Maijan beel, which is the lifeline of the local fishermen. This beel is located about 500 m apart from the existing embankment site, but no feeding channel was observed from Brahmaputra to this beel.

97. According the local elderly people, both the sides of the embankment used to have full of vegetation with valuable trees and fertile agricultural land, but due to regular floods of River Brahmaputra, the area have been either engulfed or washed out along with vegetation therein. Now the entire area has turned into wasteland.

4.3.4. Identification of Terrestrial and Aquatic Wildlife Fauna

4.3.4.1 Birds

98. Altogether 156 species of avian fauna belonging to 36 families were recorded in Dibrugarh Reach, of which 114 species were residential and 42 were migratory birds (Appendix 7). Among migratory birds, nearly all were ducks, geese, and waders were recorded at the river Brahmaputra. More species were not found here owing to seasonality of most of them, but the species have similarities with neighboring Dibru-Saikhowa WLS.

4.3.4.2 Mammals

99. There were altogether 16 mammalian species recorded in Dibrugarh reach that belongs to 9 families and 16 genera, of which two species (Leopard and River Dolphin) were categorized as Schedule-I under Wildlife Protection Act 1972. The comprehensive list of mammals in Dibrugarh Reach is presented in Appendix 8. Most of the species were recorded in the habitat near tea garden and residential campus. The species River Dolphin was recorded in the deep channels of river Brahmaputra and Otter was recorded in adjacent habitat of Maijan beel.

4.3.4.3 Amphibian Fauna

100. There were altogether 8 amphibian species recorded in Dibrugarh reach that belongs to 5 genura, but no Schedule - I species under Indian Wild Life Protection Act, 1972 was found. The comprehensive list of amphibian fauna in Dibrugarh reach is presented in Appendix 9.

4.3.4.4 Reptiles

101. Altogether 24 reptilian species were recorded belongs to 8 families in Dibrugarh reach during the survey. The comprehensive list of reptilian fauna in Dibrugarh reach is presented in Appendix 10.

4.3.5. Faunal Behaviour Pattern

102. The river Dolphins come close to the dyke during monsoon flood when water depth increase, but during survey period, very less sightings were made beyond Mohanaghat and Oakland Ch. 0.0 point. According to local inhabitants, the Dolphins were frequently seen along the dyke and Dhansirimukh during monsoon flood. The Chelonian species (turtles) has been noted to reach the sandbar to lay eggs sometimes coming close to the dyke in Nagaghuli, Maijan and Kohi Spurs, Maijan beel, Maijan Borsaikia, and the last spur.

4.3.6. Land River Interface

103. There were two land-river interfaces found along the dyke, the Maijan Beel and Burhi Dihing mouth. No other connection of wetland was observed with the River Brahmaputra along the dyke. These two interfaces are very important for the entire area for annual biodiversity re-colonization and feeding channels.

4.3.7. Migratory Route of Terrestrial Fauna

104. There was no migratory route of terrestrial faunas reported throughout the embankment in Dibrugarh Reach possibly due to the absence of nearby forest reserve. What was noted during the study was the sightings of amphibian and reptilian fauna to and from river Brahmaputra, however no map was prepared due to lack of detailed information.

4.3.8. Dolphin and Its Behaviour Pattern

105. Dolphins generally feed on fish at deep-water channels, where density is very high, sometimes coming very near the dyke particularly during monsoon season. Dolphins are very accustomed to machine boats because they can easily capture the prey species near moving boats. When water depth recedes, they move to the deeper channels. There is no specific sitting location but mostly seen near confluence of Maijan beel feeder.

4.3.9. Areas of Eco-sensitivity/ Protected Area

106. No eco-sensitive and protected areas were found in the Dibrugarh reach and in the buffer zone of embankment. Also, no wildlife habitat/ reserve forest areas/ sanctuaries were found in this reach. Only tea gardens were found near the dyke.

4.3.10. Vegetation Profile

107. From the vegetation point of view, the area is not very productive, except for the tea gardens. Most of the vegetation indicated secondary growth. The horticultural plants are mostly available in residential compounds and riverside. The survey of vegetation profile revealed that area harbors 33 species of plants were in the dyke area, of which, the Satiana-Alstnia scolaris and Bogori-Zizyphus jujube, Artocarpus heterophyllus, Albizia lebek, Anthocephalus kadamba, Mangifera indica, Cocos nucifera, Gmelina arborea, Elaeocarpus fleribundus, Banbusa pallidaspecies are the dominant plant (Tea species were not included in the survey). (See Appendix 11).

108. Analysis of Community Dominance Index in the dyke area suggested that it is very high in Kaliaghat/ Phulbagan inside, Mohanaghat area, Tinikunia, and Oakland Tea Estate area indicating very limited species diversity (when species diversity is high community dominance index is reduced). In Maijan Thakurbari (inside the embankment) only Bombax ceiba, Alstonia scolaris are found and in contrast there was no tree species in Maijan Thakurbari (also inside the embankment). In the Oakland Tea Estate (inside the embankment) only Alstonia scolaris plant was found.

4.3.11. Economically Important Plants

109. Apart from tea plants, there were 1,439 trees, out of which 399 were fruit bearing trees and 1,073 were timber trees recorded in Dibrugarh Reach. The comprehensive list of economically important plant species is presented in Table 15.

Table.15 : Trees to be affected in Tranche 2 site under Dibrugarh

No.	Village/ Town/ Ward	Trees	No of Timber/Furniture bearing Trees	No of fruit bearing Trees
1.	Kosuwoni Pather	1,439	1,073	366
2.	Oakland			
Total:		**1,439**	**1,073**	**366**

4.3.12. Identification of Endemic/ Threatened and Endangered Species

110. There was no endemic wildlife species found in the study area, but few species of endangered species were recorded during survey. Study recorded 2 endangered mammalian fauna (Table 16), 5 reptilian species (Table 17) and 10 endangered avian faunas (Table 18) in Dibrugarh reach.

Table.16 : Endangered Mammalian Fauna in Dibrugarh Embankment Site

S. No.	English Name	Order/Family/Scientific Name	Status of IWPA
1	Leopard	***Order: Carnivora: Family: Canidae:*** *Panthera pardus*	Schedule-I
2	River dolphin	***Order: Primate: Family:*** *Planista gengeticus*	Schedule-I

Table.17 : Endangered Reptilian Fauna in Dibrugarh Reach

S. No.	Common Name	Scientific Name	Status of IWPA
1	Indian Roofed Terrapin	*Kachuga tecta* (Gray)	Schedule-I
2	Spotted Black Terrapin	*Geoclemys hamiltoni* (Gray)	Schedule-I
3	Indian Mud Turtle	*Lissemys punctata* Lacepede	Schedule-I
4	Peacock Soft-shell	*Trionix hurum* (Gray)	Schedule-I
5	Ganges Soft-shell Turtle	*Trionix gangeticus*	Schedule-I

Table.18 : Endangered/ Globally Threatened Avian Fauna in Dibrugarh Reach

S. No.	English Name	Family/Scientific Name	Status	Status of IWPA/GS
1	Spot-billed Pelican	*Pelecanus philippensis*	R	Schedule-I/GT
2	Lesser Adjutant Stork	*Leptoptilos javanicus*	*R*	GT
3	Greater Adjutant	L. dubius	*R*	Schedule-I/GT
4	Bar-Headed Goose	*Anatidae Anser indicus*	*M*	Schedule-I/GT
5	Grey-Lag geese	*Anser anser*	*M*	GT
6	Osprey	*Accipitridae Pandion haliatus*	*R*	Schedule-I/GT
7	Red-headed Vulture	*Sarcogyps calvus*	*R*	GT
8	Shikra	*Accipiter badius*	*M*	Schedule-I/GT
9	Lesser Kestrel	*Falco naumanni*	*M*	Schedule-I/GT
10	Blossom-headed Parakeet	*Psittacula roseate*	*R*	GT

4.3.13. Wetlands

111. There are only two wetlands found near project site namely, Maijan perennial beel and Nagaghuli temporary wetland. According to local fishermen, the Maijan beel has tremendous potential to support various aquatic fauna including indigenous fish species. The Nagaghuli temporary wetland is also important for various fish fauna, because during monsoon season, the fish species colonized here and the people catch it, when water level comes down at a suitable depth. No other wetlands were found nearby project site except natural rivers.

4.3.14. Peoples Dependence on Flora and Fauna

112. The people who reside near Brahmaputra dyke in Dibrugarh are tea laborer, fishermen, cultivator, and businessmen. They are economically very poor. So, most of them primarily depend on the harvesting natural resources. Majority of the people rely on fishing at river Brahmaputra and Maijan beel for their livelihood. The Maijan beel is the lifeline of fisherfolks in Dibrugarh Dyke where most of the catches are registered to be sold in the daily market. Limited number of people depend their livelihood on selling fuel woods from neighboring tea gardens or naturally growing tree species along the dyke.

4.4. Aquatic Biology

113. Dibrugarh Reach is very rich in aquatic fauna starting from the macro-invertebrates to the higher vertebrates including mammals. All the aquatic fauna were collected from 12 different study zones. The variability and number of each species in the study zones are found to vary. There is tremendous scope of diversity of aquatic fauna as these areas are flood prone. The major fisheries of these areas are Barilius spp, Tor sp, Labeo sp, etc. Migratory fish like hilsa and *Anguilla bengalensis*, an endangered species are also encountered in that projected site.

114. A lean channel of Brahmaputra in Koilaghat area is filled with water during the flood seasons and during that period, channels are covered with benthos and minnows. Burrowing fishes, crabs, turtle like *Kachuga sylhetensis, Aspideretes gangeticus* were also seen in the area.

4.4.1. Aquatic and Macro-Invertebrates Ecology

115. The aquatic fauna gives a rich diversity in the project area. Under macro-invertebrates such as crabs, mollusks, snails, lizards, amphibians and other aquatic mammals are seen. Zooplanktons are also recorded which are listed in Appendix 12.

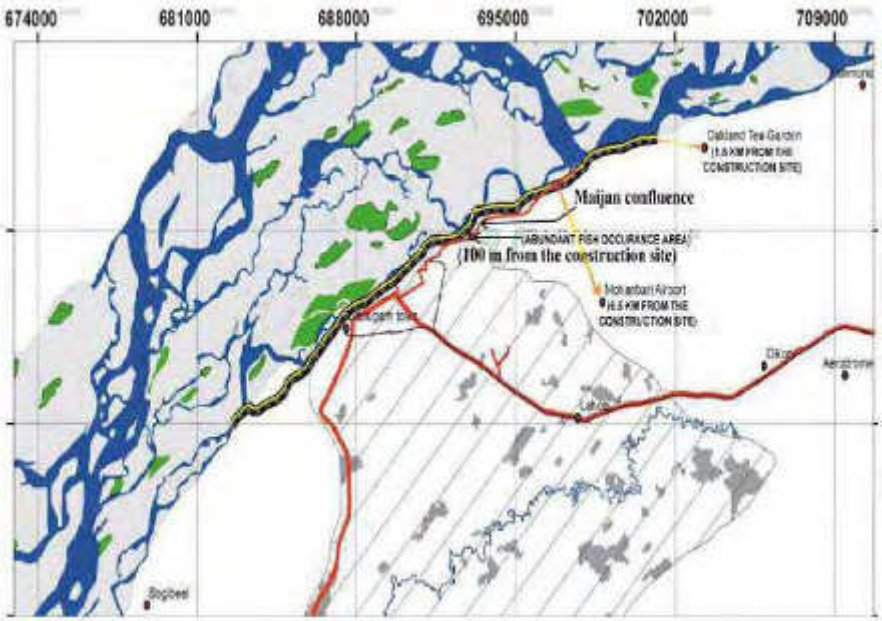
116. Presence of Dolphin was also recorded at Dibrugarh site. The high abundance is reported at the confluence of Maijan beel to feed. At Maijan Thakur area (Stone Spur No. - 1) the abundance of fish is high. This is because of a sub channel of river Brahmaputra which forms a suitable breeding ground for the fish. Many fish prefer to breed in the riparian zone of the river.

117. Although the fish species available are almost similar in both sites, their abundance varies. Ompok species, Baralius sp. and Salmostoma sp. are abundantly found at Dibrugarh area.

4.4.2. Fish Species Diversity

118. Altogether 55 species of fish belonging to 20 families has been identified in the study area. Diversity of fishes in different sites gives different results. Salmostoma, Garra, Gudusia etc. species are predominant in all project sites. Tor and Mahaseer are found to be more dominant in the flood seasons because it migrates through main channel of the Brahmaputra River. In winter season Tor is found to migrate in lesser number. Other fish species like minnows are found to be less diverse at some points. Some species like Channa, Clarius, Heteropneustes, and Anabas etc. are predominant in adjoining wetland area in the Maijan Beel. The fish abundance area is shown at Map 25.

Map 25: Distance of Eco-Sensitive and Fish Abundance area from the Embankment



4.4.3. Faunal behaviour pattern

119. The existing channel of wetland at Tinikonia, Kolaigaon area which is directly connected with the river Brahmaputra has given a rich commercial fishery, supporting large number of fish and amphibian species which breed during pre-monsoon and monsoon season. The river Dolphins also breed and play in the river water adjacent to all sites. Dolphins come to the connecting channels to feed. Other species like turtles and tortoises prefer to breed only in sandy ground near bank of the river having land-river interface. In Mahanaghat, there are good habitat for the amphibians and the lizards. They prefer to live in the river bank and destruction of the bank will create negative impacts on the species. Some fishes as well as other benthos and turtles are very sensitive to the river erosion, sedimentation and abrupt changes of river ecology.

4.4.4. Migratory Route of Aquatic Fauna

120. The migratory fish species like Hilsa and Anguilla which have been encountered show anadromous and catadromous migratory behavior respectively. They migrate through the main channel of the river i.e. through the deeper zones of the river. So migratory route will not have any negative effect owing to the construction of the dyke.

4.4.5. Area of Eco-sensitivity/ Protected Area/ Restricted Area/ Legislative and Others

121. No such eco-sensitivity areas, protected area, restricted area, legislative, and others were found in the project sites. A large number of fish enter through the channel connected with the Brahmaputra. Diversity of fish fauna is high in Maijan Beel. No feeder channel is currently maintained. The north portion of the beel is suitable breeding ground for Indian major carps, minor carps, live fishes, and minnows and is most essential for breeding ground requiring the channel that connects the beel and Brahmaputra should be maintained.

4.4.6. Identification of Endemic/ Threatened and Endangered Species

122. Only three fish species of fish are found under endangered category. Besides fishes, turtles, some amphibians and dolphins are also under Schedule-I endangered species (Appendix-13).

4.4.7. Peoples dependence on aquatic fauna

123. Fishery community people are seen in the adjoining areas of Koilaghat, Maijan Borsaikia Gaon, and Nagaghuli Ghat areas. These people are totally dependent on the adjoining areas of Brahmaputra River and Maijan Beel. Intensive fishing activities were seen in the Maijan Beel which is directly connected with the Brahmaputra River.

4.5. Project sites

124. The area near the confluence of the Maijan River is the most sited location of Dolphins. The initial work packages includes, River bank protection works, from downstream end point of Rohmoria protection work up to Nagaghuli Spur, upstream of Mothola reach, for a length of 2,700 m; pro-siltation measure with porcupine screens from Oakland to Bogibeel area; upgradation of Oakland dyke- from 0km to 9.16 km; construction of pump house including installation of pump at selected location of DTP dyke; riverbank protection work along the DTP Dyke (1,950 m in two locations of the DTP dyke). However, no impact to local wildlife and aquatic life is expected, because no construction camps will be located near the river bank.

125. There is also no impact on aquatic endangered species, such as the river dolphin along the Brahmaputra especially in Dibrugarh subproject areas is expected. The dolphins can be seen in the Brahmaputra River, particularly at the tributary confluence and deep channels, impacts can be avoided by ensuring that construction does not occur during the breeding season (between April and August) near the identified sighting areas. Mitigation measures to ensure that construction waste does not end up in the water and channels to avoid any obstruction have been included in the EMP.

4.6. Socio-Economic Environment

4.6.1. Social Conflict

126. As of the 2011 India census, Dibrugarh City had a population of 154,019. Males constituted 54% of the population and females 46%. The sex ratio of Dibrugarh City was 925 per 1,000 males. Population density 392 person per km^2. Decadal growth rate is 11.92 %. The Dibrugarh district has a single subdivision and seven circles. The revenue circles are Dibrugarh East, Dibrugarh West, Chabua, Tengakhat, Naharkatia, Tingkhong, and Moran. There are 9towns which includes 3 Statutory towns and 6 census towns. The district has seven Community Development Blocks comprising a total of 1,348 villages spread over all the Revenue circles. Dibrugarh district has an area of 3,381 km^2. (Rural: 3,335.52 km^2 and Urban: 45.48 km^2). The Dibrugarh subproject reach falls under 5 development blocks and 134 villages based on land records, namely, Barbarua, Lahowal, Panitola, Tengakhat, and Khowang. These blocks consist of a total of 134 villages along the reach in the core and buffer zones. The general details of demography of the Dibrugarh reach are given in Table 19.

Table.19 : Dibrugarh Reach: General Details

Block	Total / Urban / Rural	Area in km^2	Number of household	Total Person	Male	Female
Barbarua	Total	306.30	34,334	166,835	84,851	81,984
	Rural	301.87	31,766	154,988	78,936	76,052
	Urban	4.43	2,668	11,847	5,915	5,932
Lahowal	Total	277.57	30,765	149,306	75,742	73,564
	Rural	276.94	30,139	146,422	74,284	72,138
	Urban	0.63	625	2,884	1,458	1,426
Panitola	Total	205.51	25,470	124,723	64,461	60,262
	Rural	205.51	25,470	124,723	64,461	60,262
	Urban	0.00	-	-	-	-
Tengakhat	Total	351.70	46,801	220,478	112,046	108,432
	Rural	344.69	37,916	183,100	92,601	90,499
	Urban	7.01	8,885	37,378	19,445	17,933
Khowang	Total	365.68	35,160	169,759	86,247	83,512
	Rural	364.54	33,281	161,325	81,884	79,441
	Urban	1.14	1,879	8,434	4,363	4,071

Source: Census Report, 2011

127. The population profile of the blocks along the Dibrugarh reach with respect to male, female, schedule castes (male and female), scheduled tribe (male and female) have been given in Table 20.

Table.20 : Dibrugarh Reach: Population Profile

Name of the block	Total / Urban / Rural	Total Population	Schedule cast	Schedule Tribe	% of schedule cast	% of schedule tribe
Barbarua	Total	166,835	10,939	27,223	6.56	16.32
	Rural	154,988	10,124	25,230	6.53	16.28
	Urban	11,847	815	1,993	6.88	16.82
Lahowal	Total	149,306	7,575	2,450	5.07	1.64
	Rural	146,422	7,283	2,324	4.97	1.59

Name of the block	Total / Urban / Rural	Total Population	Schedule cast	Schedule Tribe	% of schedule cast	% of schedule tribe
	Urban	2,884	292	126	10.12	4.37
Panitola	Total	124,723	6,944	5,505	5.57	4.41
	Rural	124,723	6,944	5,505	5.57	4.41
	Urban	-	-	-	-	-
Tengakhat	Total	220,478	10,959	15,854	4.97	7.19
	Rural	183,100	8,520	14,783	4.65	8.07
	Urban	37,378	2,439	1,071	6.53	2.87
Khowang	Total	169,759	2,507	21,482	1.48	12.65
	Rural	161,325	2,428	21,171	1.51	13.12
	Urban	8,434	79	311	0.94	3.69

Source: Census of India 2011

128. The economy of Dibrugarh District relies mainly on tea gardens, rice cultivation, and service sector. In the subproject area of ,3013.52 ha, total population was 1,662,202 with 4.63%, and 8.72% population belonging to scheduled caste and scheduled tribe social categories, respectively. The tribal population comprised of several local tribal communities and Mishing community migrated from Dhemaji and Lakhimpur districts. Flooding and riverbank erosion affect severely the tea gardens that generate employment for the two third of the working population in the sub project area. Similarly, the livelihood is based on agriculture for the one third of the population, affect severely due to the flooding and erosion. Though erosion was found to be under control, the flooding every year stalls the economy for at least three to four months.

4.6.2. Education

129. Based on census data 2011, the average literacy rate of Dibrugarh is 76.05%, male literacy rate is 82.82 % and female literacy rate is 68.99 %. The higher proportion of literate population is found in Dibrugarh subproject area due to high proportion of population spread in urban settlements with having educational facilities. The education facilities in the project area are distributed mainly in the form of Primary, Middle, Secondary and Senior Secondary schools mainly. Out of 187 villages, 179 villages have any form of educational facility within their boundary. Only one college is available in the region for higher education. The details of education facilities in the revenue circles have been presented in Table 21.

Table.21 : Education Facilities in the Dibrugarh Reach

Development Block	Total No. of Villages	Villages having any form of educational facility within boundary	No of Primary schools	No of Middle school	Secondary school	Sr. Secondary School	College
Barbarua	68	62	73	31	8	0	0
Lahowal	59	50	55	12	6	0	1
Panitola	2	2	2	1	0	0	0
Tengakhat	1	1	2	1	1	0	0
Khowang	4	3	5	1	1	0	0
Total	**134**	**118**	**137**	**46**	**16**	**0**	**1**

130. The school facilities are available at about 1 km radius from existing settlements. High schools and college are available at a maximum distance of about 8–10 km. The schools located on elevated platforms in the vicinity of the river bank are used as evacuation camps by flood and erosion affected persons every year. It provides temporary refuge to displaced population at times for more than 2 months. The school buildings also get damaged due to the flood and erosion in the villages along the river bank.

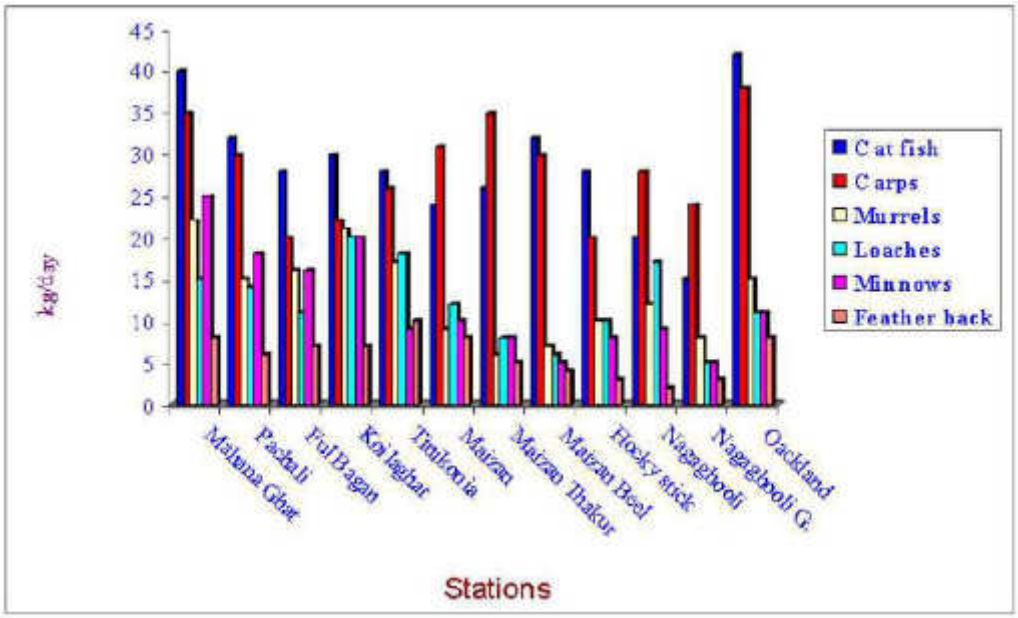
Table.22 : Block wise Literacy rate of the Dibrugarh reach

Block		Total Population	Literate	Male	Female	Literate %	Male literate %	Female litearate %
Barbarua	Total	166835	115097	62936	52161	69.0	54.7	45.3
	Rural	154988	105760	58124	47636	68.2	55.0	45.0
	Urban	11847	9337	4812	4525	78.8	51.5	48.5
Lahoal	Total	149306	84243	48616	35627	56.4	57.7	42.3
	Rural	146422	82075	47435	34640	56.1	57.8	42.2
	Urban	2884	2168	1181	987	75.2	54.5	45.5
Panitola	Total	124723	72642	42657	29985	58.2	58.7	41.3
	Rural	124723	72642	42657	29985	58.2	58.7	41.3
	Urban	-	-	-	-	-	-	-
Tengakhat	Total	220478	148249	81730	66519	67.2	55.1	44.9
	Rural	183100	116758	64847	51911	63.8	55.5	44.5
	Urban	37378	31491	16883	14608	84.3	53.6	46.4
Khowang	Total	169759	118143	65054	53089	69.6	55.1	44.9
	Rural	161325	110930	61275	49655	68.8	55.2	44.8
	Urban	8434	7213	3779	3434	85.5	52.4	47.6

4.6.3. Peoples Dependence on Flora and Fauna

131. As previously mentioned, most of the people residing near the Brahmaputra dyke in Dibrugarh are economically very poor and rely on gathering natural resources for their livelihood. Majority of the people depend their livelihood on fishing at Brahmaputra River and Maijan beel. Limited number of people depends on selling the fuel woods for their livelihood. Fishing communities are present in the adjoining areas of Koilaghat, Maijan Borsaikia Gaon, Nagaghuli Ghat areas depending on the adjoining areas of Brahmaputra River and Maijan Beel for fishing. The landing of various aquatic fauna in Dibrugarh reach at 12 major landing sites has been shown in Figure 7.

Figure 7: Fish Landing at Various Landing Sites along the Dibrugarh Reach



4.6.4. Manufacturing Activities

132. Based on available data, tea and silk are the main manufacturing activities in the entire area along the Dibrugarh Reach. The tea industry is spread from large areas owned by companies generating employment opportunities. About 55% of the total gardens in state located in Dibrugarh and most of them are found in subproject area. The tea production is also higher in Dibrugarh 250,366,000 kg per year (2011); (2,109 kg/per ha) compared to state average of 1,830 kg/ha. Small tea growers are rapidly increasing in the area. Farmers who own their land are also shifting from paddy cultivation to tea plantations on a small scale. The distribution of these industries in various development blocks along the Dibrugarh Reach are given in Table 23.

Table.23 : Dibrugarh Reach: Manufacturing Activity Profile

Block	Tea	Muga Cloth
Barbarua	7	1
Lahowal	3	0
Panitola	1	0
Tengakhat	0	0
Khowang	0	0
Total	**11**	**1**

(Source: Statistical hand book, 2013)

133. Dibrugarh location was strategic in terms of service sector. It is developed as market for tea, grocery, stationary, and most of the commodities. The market was growing with high pace catering needs of Lakhimpur, Dhemaji, Sibsagar, Jorhat, Tinsukia in Assam and adjoining districts in riparian state. Dibrugarh was also known for medical treatments due to existence of Government Medical College.

4.6.5. Commuting Facilities

134. In Dibrugarh District, there are 155 km state highway, 163 km major district road, 1,357 km rural road and 63 km urban road (as on 31 March 2013). The villages in the 5 Development Blocks are mostly connected through unpaved roads. Only 29 villages having paved road

connectivity. During rainy season, most of the roads are unpassable due to muddy or flooded conditions which renders many settlements isolated. The details of the connectivity have been shown in Table 24.

Table.24 : Dibrugarh Reach: Connectivity

Blocks	Total No. of Villages	Approach Paved Road	Approach Mud Road	Approach Footpath	Approach Navigable River	Approach Waterway other than River
Barbarua	68	23	61	11	0	0
Lahowal	59	3	58	2	0	0
Panitola	2	1	2	0	0	0
Tengakhat	1	1	1	0	0	0
Khowang	4	1	4	0	0	0
Total	**134**	**29**	**126**	**13**	**0**	**0**

4.6.6. Power Facilities

135. In Dibrugarh district number of villages are electrified till 31 March 2013 in 1,035 and number of domestic consumers are 61,883 and commercial consumers 8,182. Power facility in the Dibrugarh Reach area is available in most of the villages. Only seven villages do not have any electrical connections. Mostly, power is available only for domestic usage. Only in six villages, power is also available for agricultural activities. Power interruptions are common in the subproject area affecting most of the village settlements. Main sources of lighting are electricity, 50.08%; kerosene, 49.32%; solar, 0.2%; other oils, 0.07%; and no lighting facility, 0.26%.

Table.25 : Dibrugarh Reach: Power Facilities

Blocks	Total Number of Villages	Villages having Power Supply	Villages with Power for Domestic Use	Villages with Power for Agricultural Use	Villages with Power for Other Uses
Barbarua	68	62	62	0	1
Lahowal	59	59	59	6	1
Panitola	2	2	2	0	0
Tengakhat	1	1	1	0	0
Khowang	4	3	3	0	0
Total	**134**	**127**	**127**	**6**	**2**

4.6.7. Drinking water

136. Main source of drinking water in the entire Dibrugarh reach is groundwater. Water is available through wells, tube wells, handpumps, and river. The available drinking water facilities throughout the year in the villages are given in Table 26. During summer season, out of 134 villages, drinking water is available from tapped water, wells and tube wells in 5, 91 and 34 villages, respectively.

Table.26 : Household with Drinking Water Facility

Total/ Rural/ Urban	Total Number of household	Sources of drinking water								
		Tap water from Treated source	Tap water from un Treated source	Covered well	Un-covered well	Hand-pump	Tube well/ Bore well	Spring	River/ cannel	Tank/ pond/lake
Total	272,941	25,069	4,639	1,077	8,469	162,642	65,235	1,931	665	2,950
Rural	218,256	7,504	2,310	937	8,364	143,414	50,238	1,811	632	2,800
Urban	54,685	17,565	2,329	140	105	19,228	14,997	120	33	150

Source: Census Report, 2011.

137. The tube wells that were dug by the government are now being maintained by the villagers. The urban water supply is being managed by the Dibrugarh Town Authorities.

4.6.8. Sanitation

138. There is no sanitation and sewerage disposal system in the villages. The villagers are following practice of open defecation. In Dibrugarh Town, most of the slums are on the vicinity of embankment and have no sanitary facilities provided. They are also following open defecation.

Table.27 : Sanitation facility in Dibrugarh district

	Flush / Pour Latrine			Pit Latrine		Night soil disposed in open drain	Service Latrine		No latrine within premises	
	Piped sewer system	Septic tank	Other System	With Slab/ Ventilated Imported Pit	Without Slab/ Open pit		Night soil removed by Human	Night soil removed by animals	Public Latrine	Open
Total	22,775	61,418	21,109	30,460	74,510	2,375	504	1,570	5,732	52,488
Rural	11,281	28,505	18,694	27,366	72,513	2,109	240	1,284	4,789	51,475
Urban	11,494	32,913	2,415	3,094	1,997	266	264	286	943	1,013

Source: Census of India, 2011

4.6.9. Medical Facilities

139. The medical facility is not satisfactory in most of the villages in the Dibrugarh reach. The details of the health care facilities are given in Table 28.

Table.28 : Medical Facilities

Blocks	Villages	Tap	Well	Tank	Tubewell	Handpump	River
Barbarua	68	2	37	0	25	3	0
Lahowal	59	2	49	0	8	0	0
Panitola	2	0	2	0	0	0	0
Tengakhat	1	1	0	0	0	0	0
Khowang	4	0	3	0	1	0	0
Total	**134**	**5**	**91**	**0**	**34**	**3**	**0**

Source: Census of India 2001

4.6.10. Land Use

140. As per the revenue records. the areas under different land use categories in the area falling under Dibrugarh District are given in Table 29 and Figure 8.

Table.29 : Land use Analysis Report for Dibrugarh District

LULC Class	Area (km^2)	LULC Class	Area (km^2)
Builtup,Urban	38.19	Builtup,Rural	14.61
Builtup,Mining	1.64	Agriculture,Crop land	985.06
Agriculture,Plantation	496.37	Agriculture,Fallow	7.08
Forest,Evergreen/ Semi evergreen	200.76	Forest,Deciduous	669.93
Forest,Scrub Forest	16.77	Grass/Grazing	233.63
Barren/unculturable/ Wastelands, Scrub land	1.99	Barren/unculturable/ Wastelands, Sandy area	0.45
Wetlands/Water Bodies, Inland Wetland	42.52	Wetlands/Water Bodies, River/Stream/canals	671.51
Wetlands/Water Bodies, Reservoir/Lakes/Ponds	0.47		
Total			**3,381.00**

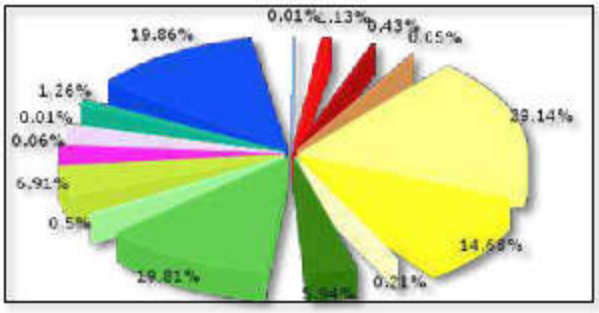


Figure 8: Land Use Analysis of Dibrugarh

141. As per baseline survey covering 10% of the villages, the succeeding table presents the proportion of households in each of the land holding category. The landless households accounts for 81.54% of the total population in the reach. This proportion is however changing with the continuous increase of marginal farmers becoming landless due to riverbank erosion. The proportion of households by land holding category in Dibrugarh subproject area indicate that almost all households live on employment opportunities in industry, tea gardens and other service sector, and the livelihood is not mainly dependent on land asset.

Table.30 : Distribution by Land Holding Category: Dibrugarh Reach

Class	Land Holding Category	Category as defined by Government of India	% of households in each category
A	Large Land Holder	Land owned more that 7.01 ha.	0.77
B	Medium Land Holder	Land Owned 4.01 ha to 7.00 ha	1.41
C	Small Land Holder	Land Owned 2.01 to 4.00 ha.	3.47
D	Marginal Land Holder	Up to 2.00 ha	12.81
E	Land Less	Household without land holding	81.54

4.6.11. Occupational Pattern

142. The detail of working population is presented in tables 31 and 32. Distribution of working population is illustrated as bar diagram in Figure 9.

Table.31 : Distribution of Working Population

		Number	%
Total Worker (main and marginal)	Person	560,557	42.26
	Male	368,013	54.40
	Female	192,544	29.63
Main Worker	Person	391,597	29.52
	Male	284,955	42.13
	Female	106,642	16.41
Marginal Worker	Person	168,960	12.74
	Male	83,058	12.28
	Female	85,902	13.22
Non-Worker	Person	765,778	57.74
	Male	308,421	45.60
	Female	457,357	70.37

Source: Census Report, 2011.

Figure 9: Distribution of Working Population

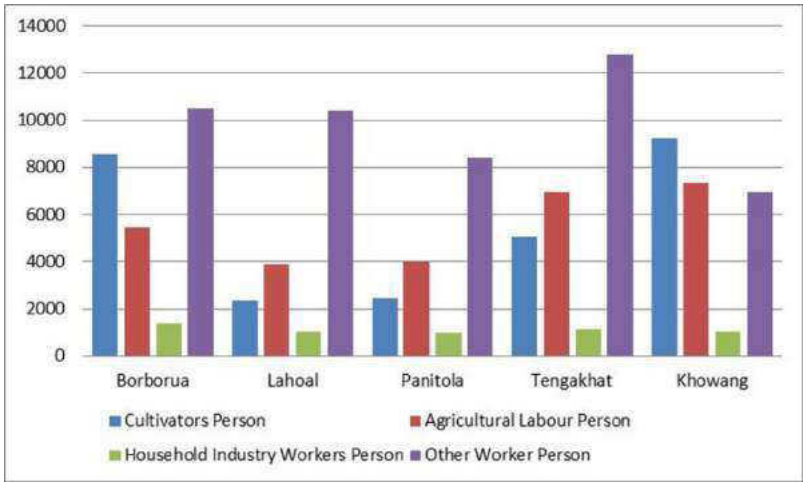
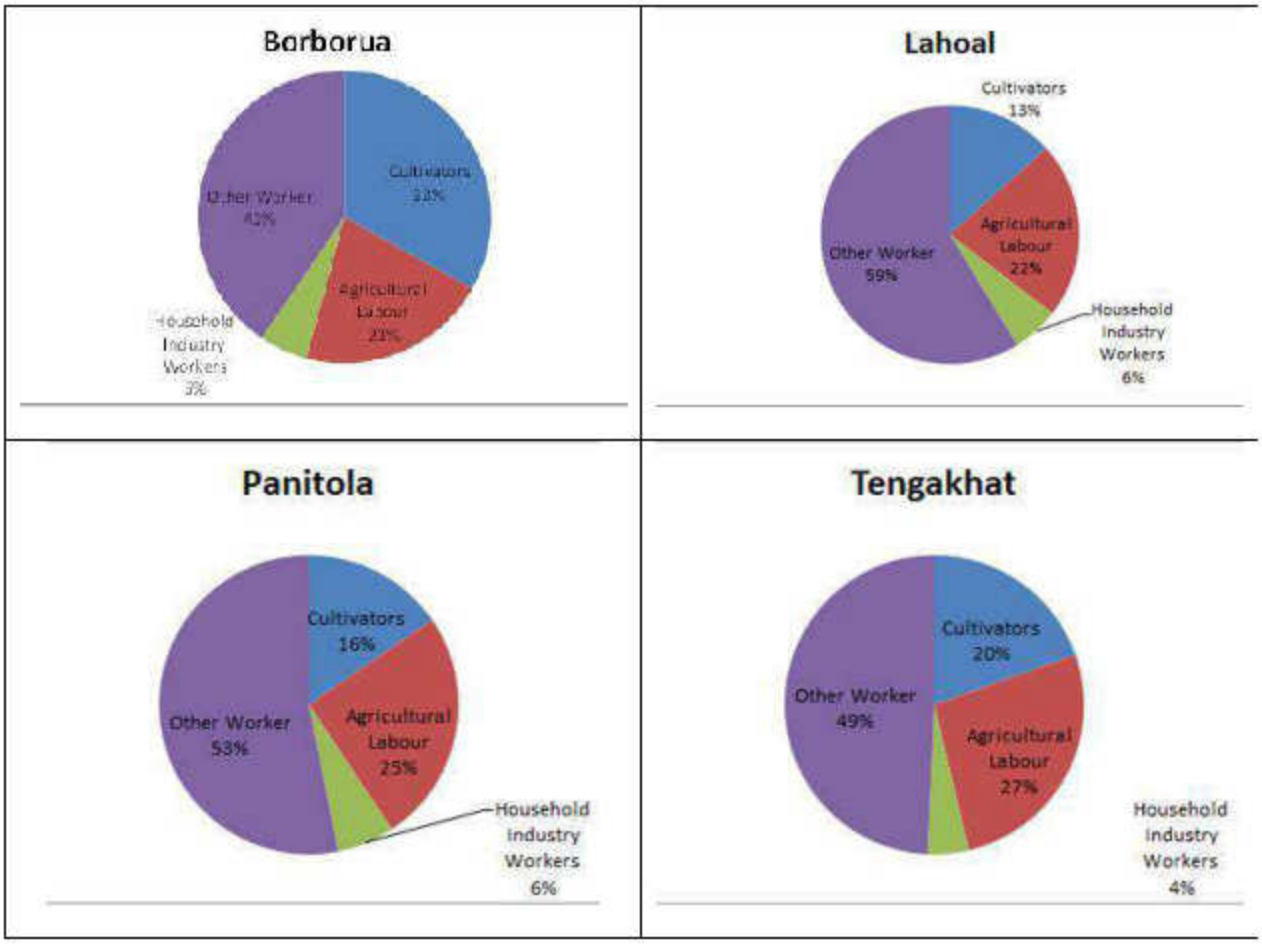


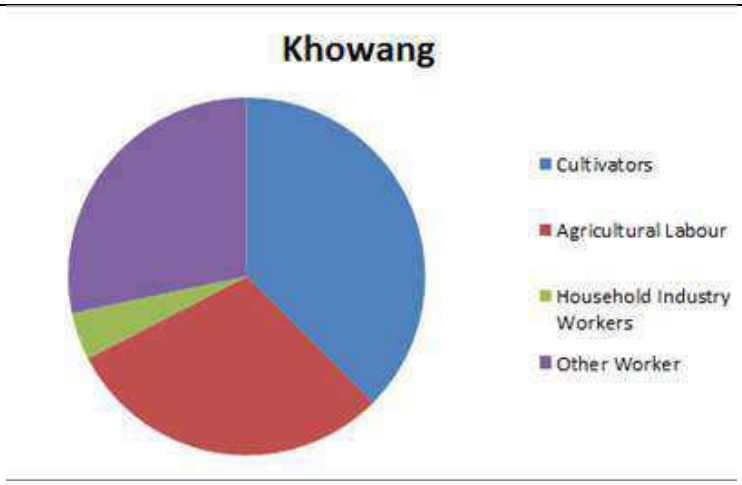
Table.32 : Category of Industrial Workers in 5 Blocks

	Total Worker			Cultivators	Agricultural Labor	Household Industry Workers	Other Workers
	Person	Male	Female	Person	Person	Person	Person
Borboruah	25,836	12,335	13,501	8,564	5,433	1,376	10,463
Lahowal	17,673	9,470	8,203	2,366	3,896	1,038	10,373
Panitola	15,820	8,401	7,419	2,440	3,992	980	8,408
Tengakhat	25,922	13,176	12,748	5,072	6,934	1,136	12,780
Khowang	24,560	11,473	13,123	9,209	7,349	1,049	6,953

District Census Handbook, Golaghat, Directorate of Census Operation, 2011

Figure 10: Distribution of working population




Khowang
Cultivators
Agricultural Labour
Household Industry Workers
Other Worker

5. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1. Potential Environmental Impacts

143. Potential environmental impacts associated with the proposed project at Dibrugarh reach are classified as: (i) impacts during design and construction phase, and (ii) impacts during operation phase. Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major. The mitigation measures have been presented along with the impacts required.

5.1.1. Land Use

5.1.1.1 Land Use Change due to Project Activities and Borrow Areas

Design and Construction Phase

144. Impacts. The project activity involve rehabilitation and strengthening of the existing embankments - River bank protection works, from downstream end point of Rohmoria protection work up to Nagaghuli Spur, upstream of Mothola Reach, for a length of 2700m. Pro-Siltation measure with Porcupine screens from Oakland to Bogibeel area, Up-gradation of Oakland dyke- from 0km to 9.16 km, Construction of pump house including installation of pump at selected location of DTP dyke, riverbank protection work along the DTP dyke (1950 m in two locations of the DTP dyke)

145. Substantial quantity of earth will be required for construction of river embankment of about 5 m height above the ground level with a top width of 7.5 m which is designed based on 100 years flood return period. The demands for earth will be fulfilled by excavating borrow pits in the vicinity of the river embankment or away from the embankment towards country side, if unavoidable and depending on quality of earth material, which has to be of sufficient quality with cohesive elements. The unplanned selection of borrow areas/ no rehabilitation of the borrow areas may cause loss of productive use of the land. The transportation of borrow earth may also cause air pollution, if transported in uncovered trucks.

146. Due to such construction activities along the river bank, the land use of about 50 m buffer around the embankment is likely to be affected or changed. As per the satellite imagery and GIS interpretations, in the Dibrugarh reach currently about 141.9 ha land (42.8%) of this buffer area is used as agricultural land and about 77.5 ha (23.4%) area is built-up land.

147. The access to the embankment construction sites will be mostly through the roads connecting to NH-37. In addition, 2-3 construction camps are likely to be located about 10-15 km apart, close to the embankment along the 40 km Dibrugarh reach. This will also temporarily change the land use of the area.

148. Due to the proposed interventions, most of the agricultural and built-up land around the embankment site and construction camp areas may be affected adversely. Loss of topsoil from agricultural land is also one of the most potential impacts due to project intervention. Besides, compaction of soil along the haulage route may also take place, if proper mitigation measures are not employed

149. Mitigation Measures. Since the impact zone around the embankment covers productive agricultural land and tea plantations, the conversion of land for project purposes shall be minimized to the extent feasible. Adjacent cultivable lands shall not be occupied for storage and/or handling of construction materials. Construction camps shall preferably be located on uncultivated

areas. All requisite facilities (drinking water supply, sanitation, domestic solid waste collection and disposal, fuel supply etc.) shall be provided at these camps. The land used for construction camps shall be made reusable/cultivable after closure of construction camp. No construction debris shall be deposited on agricultural land. Loss of land or loss of crops for construction camp area shall be compensated to the landowners in accordance with the RAP.

150. Borrow Area Location and Rehabilitation: The borrow pits shall be on river side since borrow pits on the river-side get silted up in the course of time whereas on the country-side remains a permanent disfiguration. Further the borrow pits next to embankment on the countryside can induce seepage to the foundations. In case borrow earth has to be sourced from the country side, the borrow pits should be away from embankment even at the expense of comparatively long hauls. In the scenario that sourcing earth from country side is unavoidable, the preference to be given for the following options:

(i) Land which farmers want to either convert into a fishpond or lowering the agriculture field level to increase its water retention capacity.
(ii) Exploring the option of using combination of soil and sand in embankment construction i.e. using soil as outer cover and sand as filler in between.
(iii) Exploring technical feasibility of using soil from sandbars existing away from the bank.
(iv) No land acquisition shall be made for borrow areas.

151. Follow the WRD guidelines for locating borrow pits near the embankment. All efforts shall be made to avoid or minimize tree loss due to borrowing. The trucks shall be covered while transporting the earth.

152. While borrowing the earth top soil shall be preserved. The borrow pits shall be rehabilitated after borrowing the earth. The WRD guidelines for rehabilitation of the pits shall be strictly followed. The Indian Road Congress (IRC):10-1961 guideline will govern the selection of borrow pits. In all cases good engineering and construction practices shall be followed. The construction contractor shall submit in advance the borrow area identification details along with borrow area rehabilitation plan.

153. WRD Guidelines with respect to borrow area location and rehabilitation:

(i) For high embankments no excavation shall be done within 45 m of the riverside toe of the embankment. From 45 m to 60 m the borrow pits must not be more than 1.8 m deep and from 60 m to 90 m not more than 2.4 m deep and beyond 90 m they can be of 3 m depth.
(ii) If earth is to be taken from land-side of the embankment, no borrow pits shall be excavated within 24 m of the land-side toe of the embankment. The depth of excavation in 24 m to 36 m shall not be more than 0.6 m. For low embankments the borrow pits on the riverside and on the land-side shall not be located at less than 24 m from the toe.
(iii) For low embankments the borrow pits on the river-side and on the land-side shall not be located at less than 24 m from the toe.
(iv) The borrow pits shall be staggered and on undisturbed ground 6 m wide left at regular intervals to prevent the velocity of flow through the river-side borrow pits. The staggering will also help in inducing silting and filling up of these borrow pits.
(v) On the country-side the waterlogged areas (bandhis) shall be cut and interconnected to permit ordinary drainage. These shall be connected to the nearest drainage channel so as to carry away the drainage water.
(vi) The borrow areas selected for taking earth shall be cleared of all trees, shrubs, grass and vegetation mounds.

(vii) No borrow pits shall be made on roads, village tracks, graveyards, canals or embankments.

154. The Indian Road Congress (IRC):10-1961 guidelines for selection of borrow pits and amount that can be borrowed is summarized below.

(i) Borrow areas shall not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth shall not exceed 45 cm. The topsoil to a depth of 15cm shall be stripped and set aside for its later use for the purpose of turfing on slopes of the embankments. Thereafter, soil may be dug out to a further depth not exceeding 30 cm and used in forming the embankment.
(ii) Borrow pit shall be selected from wasteland;
(iii) Priority shall be given to the borrowing from humps above the general ground level within the road land;
(iv) Priority shall be given to the borrowing by excavating/enlarging existing tanks;
(v) Borrowing shall be from land acquired temporarily and located at least 500m away from the road;
(vi) Borrowing shall be from mounds resulting from the digging of well and lowering of agricultural fields in vicinity of the road;
(vii) In case of settlements, borrow pits shall not be selected within a distance 800 m from towns or villages. If unavoidable, earth excavation shall not exceed 30 cm in depth; and
(viii) The haulage distance from site shall not be too far.

Operation Phase[18]

155. Impacts. Encroachment on embankment for habitation and cultivation purpose may affect embankment stability. Villagers/local residents also cut the embankment to create approach to river side for their movement for toileting, cattle grazing, farming etc. Borrow areas if not rehabilitated may have landscape and accidental hazards. Also, if the borrow areas are not rehabilitated as per the intended end use of the owner, some social impacts e.g. loss of income may occur.

156. Mitigation Measures. Provision shall be made in the embankment design for providing access to the river bank close to the settlement areas. Where possible, platforms will be attached to the embankments to provide space for the possible squatter, with regular monitoring and guidance by the executing agency so that encroachers will not affect the integrity of the embankment structure. Provision of nine drainage sluices has already been made in the project design to reduce the possibility of cutting of embankment by the villagers. The construction contractor shall ensure rehabilitation of borrow area before handing over the project.

5.1.1.2 Land use Change due to construction material sourcing (Quarrying)

Design and Construction Phase

157. Impacts. A project of this magnitude would require significant amount of construction material. Illegal quarrying may lead to land use change, unstable rock formation, air and noise pollution. The aggregate demand for construction of river embankment with paved road on the top in Dibrugarh Reach will be met through approved Bihora quarry located at distance of about 225 km from the reach and Namrup quarry. The environmental aspects and control of pollution due to quarrying operation of these approved quarries are controlled and monitored by the State Pollution

[18] Operation phase in this section means post-construction use period.

Control Board (SPCB). Thus, adverse impacts as result of quarrying operations are not envisaged in the proposed project.

158. Mitigation Measures. Aggregates required for construction of embankment and roads shall be procured from quarries approved by SPCB. Air and noise emissions from quarry shall be well within the prescribed limits. Setting up of stone crushers, if required, shall be done only after obtaining consent from SPCB and taking adequate measures for air pollution control. While finalizing the site, proper land use assessment shall be done. The land to be earmarked for dumping construction waste, if any shall be free from any social or resettlement and rehabilitation issue.

5.1.2. Soil Environment

5.1.2.1 Soil Erosion

Design and Construction Phase

159. Impacts. Soil erosion potential of an area depends on its topography, geological structure, rainfall, soil type, and land use/ land cover. In the Dibrugarh reach, the topography of the terrain comprises of alluvial floodplain. There is a general lowering of the gradient of the area from southeast to the northwest. From the highlands in the south-eastern side covering foothills of the Barail range with elevation of 200 m, the gradient reduces towards the Burhi-Dihang outfall with an elevation of 99 m. Due to the relatively steeper slopes and friable rocks structure, the soils in the upland areas are easily erodible and during heavy rainfall, the rivers in the valley part of the basin show more of a depositional character due to their greatly reduced slope, transport of higher sediment load from upstream areas and congestion of drainage.

160. Mitigation Measures. Following mitigation measures can prevent the soil erosion:

(i) Construction shall be scheduled such that large areas of soil particularly at borrow areas near the embankment are not laid bare during the monsoon.
(ii) Exposed surface shall be resurfaced and stabilized as soon as possible. This shall also be covered by straw or mulch to avoid soil loss in the intervening period.
(iii) Ground disturbances shall be phased so that it is limited to workable size. Stabilizations of soil around approach roads/slopes shall be done by turfing and tree plantation in ROW.
(iv) Other slope stabilization measures like selection of less eroding materials around water bodies/water streams shall be adopted.
(v) Soil erosion shall be visually checked on potential erosion zones during construction phase. In case soils erosion is found, suitable measures shall be taken to control the same.

Operation Phase

161. Impacts. Due to bank erosion, the bank line at various sections throughout the reach has shifted up to maximum of 7.0 km from 1973–1990. A total of 3,616.42 ha land was eroded between 1967-2008 and still ongoing. The proposed project will have net benefits in terms of soil erosion and preventing progression of land loss which is about 90 ha per year at present in the Dibrugarh Reach. Soil erosion may still occur during the operation phase and early detection and remedial measures shall need to be taken for safety of the embankment and roads.

162. Mitigation Measures. Periodic checking shall be carried out to assess the effectiveness of stabilization measures already taken. A detailed inventory and study to assess the location, reasons of soil erosion along the embankment during third year of the operation phase shall be undertaken. Suitable strengthening measures shall be taken to prevent re-occurrence of soil

erosion at existing erosion prone locations and prevent erosion at newer locations. To combat the menace of soil erosion and to ensure its conservation on a sustainable basis, efforts shall be made to develop watershed management plans by Assam Government.

5.1.2.2 Soil Compaction and Contamination

Design and Construction Phase

163. Impacts. Soil around construction site, haulage road, construction camp, and workshop, will be compacted due to transportation of man, machine and materials. Since about 42.8% of land in the closed vicinity of river embankment is used for agricultural purposes in Dibrugarh Reach, and construction period is for 3 years, the agricultural yield may be reduced. Soil may also get contaminated around the construction site, machine maintenance area, fueling station, construction camp, hot mix plant site, and haulage road.

164. Mitigation Measures. The movement of construction vehicles, machinery and equipment shall be restricted to the embankment site and pre-defined haulage road. Adequate provision for approach roads capable of handling movement and haulage of heavy vehicles and machineries shall be made to avoid damage to existing village roads, crop lands, and settlement areas. The non-usable, non-saleable, and non-hazardous construction waste shall be dispose of in the properly delineated places. Usable or saleable waste shall not be disposed to landfill.

165. All efforts shall be made to prevent soil contaminations. Following measures shall be taken to prevent the same:

(i) The construction vehicles shall be fueled or repaired/serviced at the designated place with proper arrangement of waste collection and disposal. The arrangement shall include, cemented floor with dyke around for fuel storage and filling as well repairing of construction equipment.
(ii) To avoid the soil contamination at the wash down and re-fueling areas, —oil interceptors shall be provided.
(iii) The demolition waste if any shall also be used to the extent feasible for construction.
(iv) Oil and grease spill and oil-soaked materials shall be sold off to State Pollution Control Board (SPCB)/ MoEF&CC authorized vendors.

Operation Phase

166. Impact. During the operation phase, contamination of soil is not likely to happen other than due to accidental spillage from vehicle movement.

167. Mitigation Measure. Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the concerned authorities.

5.1.3. Hydrology and Morphology

Design and Construction Phase

168. Impact. No impact is expected during this phase. The aspects associated with design and construction of various project components associated with hydrology and morphology have been addressed under land use, soil, flora and fauna, air and noise and water quality section. The impacts associated with the operation stage are presented under various sub- sections below:

5.1.3.1 Effects on River Morphology - Upstream and Downstream Effect

Operation Phase

169. Impacts. The impact of the planned flood protection measures along the Brahmaputra is considered negligible, as they focus on strengthening existing embankments. The proposed bank protection measures will confirm and stabilize the present bank line; the pro-siltation measures will have no discernible effect on general bed levels. In summary, the proposed works are expected to have no adverse effects on the dynamic river morphology.

170. The construction of riverbank protection leads to a river response to the implemented work, commonly deepening of the channel alongside the protection work. This is a consequence of flow concentration and/or a reduction of sediment entrainment from eroding bank. It is commonly believed that the Brahmaputra instability is largely associated with excessive sediment transport. The proposed interventions, revetments and anti-erosion measures, reduce the sediment. Both measures further reduce turbulences and the impact on the currents as opposed to spurs, which actively deflect the currents, and as a consequence minimize negative effects. The reduced sediment entrainment alongside the protected reach has the tendency of encouraging more pronounced and stable channels without affecting the opposite bank or the upstream area. In order to avoid downstream riverbank erosion, the project places the downstream termination with a slight curvature away from the existing bank, which results in passive protection of a certain downstream length. This does not alter the dynamic pattern of constantly changing in-stream channel bars, locally called, chars chaporis.

171. The project will not build new river training works, namely spurs. In some cases, existing spurs will be rehabilitated, not changing their length or orientation, but concentrating on repairing local damages. As the existing spurs are long established, limited rehabilitation under the Project will inflict no change on their impact on the dynamic river and char system.

172. A number of char lands in the project area are used for seasonal cropping and other uses. It is expected that the current adaptive land use patterns of these char lands will continue into future to ensure their beneficial use. Char land in the immediate vicinity of the project sites does not have permanent settlements.

173. The impact of the pro-siltation measures proposed at Dibrugarh will have no discernible effect on general riverbed levels or flood levels. Over the last 100 years (i.e. over the period of record), flood levels at Dibrugarh have increased at more-or-less constant rate of 0.33 m per decade because of periodical slugs of extreme sediment load resulting in an overall aggradation of the riverbed. The aggradation is caused by an excess of sediment inflow over sediment outflow. Any impact of the pro-siltation measures on the southern bank will be indiscernible against this ongoing basin-wide sediment behavior and the expected impact from downstream river training work. Exact effects of the currently constructed Bogibeel Bridge on the aggradation tendency at Dibrugarh are unknown. It can be expected that the constriction downstream of Dibrugarh caused by Bogibeel Bridge will increase this tendency.

174. Mitigation Measures. The project envisages a process of systematic annual analysis and prediction of sedimentation and erosion behavior, which includes the analysis of the structural response to riverbank protection work. The analytical tools consist of (i) low-water satellite imagery based large-scale morphological analysis of Brahmaputra reaches, supported with (ii) large-scale bathymetric surveys covering the near bank channel pattern starting from several kilometers upstream of locations of interventions and typically ending around 10 km downstream, and (iii) near-bank surveys, providing a detailed picture of the river response and structural performance. In case unexpected downstream effects are observed, the Project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies.

5.1.3.2 Flood and Drainage

175. Impacts. The proposed structural flood protection works at Dibrugarh, which merely confirm existing flood behavior and provide better protection from mainstream flooding, will have no discernible effects on flooding behavior in the Brahmaputra River or its tributaries. The proposed ant-erosion and pro-siltation works will not significantly affect flood behavior, gross cross-section-wide sediment behavior of river morphology. The embankment alignment will follow largely its present position, so there is no change in floodplain storage or cross- section conveyance. No discernible change in downstream flood levels will occur. The proposed bank protection measures will stabilize the banks and have no discernible effect on flood behavior.

176. It is noted that WRD and the Railways Department are repairing/strengthening the Bogibeel Dyke and that this dyke forms part of the Dibrugarh subproject. This provides an opportunity for the Project to work with Railways Department at a technical level and foster institutional cooperation and technical exchange.

177. Mitigation Measures. Under the Project, it is proposed to develop and use a numerical hydraulic model to investigate flooding and drainage behavior, both within and outside the protected areas, associated with mainstream, tributary and local flooding. This model will be used to ensure that there is adequate freeboard against embankment overtopping and that adequate provision has been made for sluice gates to facilitate drainage from the protected areas. Natural drainage systems shall be left undisturbed to the greatest extent possible; the flooding behavior of beels and wetlands will be assessed and where possible improved and/or preserved. Adequate provisions shall be made in designing embankments to withstand extreme meteorological and other geophysical events.

5.1.3.3 Changes in Water Levels

178. Impacts. The conveyance capacity of the Brahmaputra River at Dibrugarh Town is enormous - the river cross-section is some 8 km wide - and proposed works on the southern bank will have no discernible effect on river water levels. The long-term trend in the increase in water levels caused by accretion of the river at Dibrugarh is a much more significant driver of water level changes. In passing, it is noted that changes in cross-section and the accretion of the river channel need to be monitored at regular intervals to ensure that the bunds continue to deliver the design level of protection against overtopping. An improved embankment network will reduce the risk of sudden devastating flooding and as such provide more predictable and stable water levels on the flood plains especially for areas upstream and downstream of the town (especially from temporary local inundation during the flood season).

179. Mitigation Measures. Changes in cross-section will be monitored at regular intervals to detect any changes and initiate corrective measures. The project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies. Under the Project, the numerical hydraulic model of the sub-project area will be used to identify low lying areas with a potential risk of deep inundation when major floods occur. The option of providing raised flood refuge platforms in appropriate locations will be explored.

5.1.3.4 Effect on Flow Velocity/discharge Intensities

180. Impacts. The proposed interventions are not expected to have any significant effect on the overall velocity profile of the river as the works are limited to the bank areas of the river and a combination of largely passive river training and flow regulating measures will be taken up to provide an optimum flow velocity in the section. Recognizing instability and unpredictability of the Brahmaputra River, clearly two different scales need to be distinguished for studying effects of flow velocity and discharge changes: (i) the total river cross section, many kilometers in width, and (ii) the cross section of the near bank channel, typically less than 1 kilometer in width. Limited interventions along the bank do not change the cross section average flow velocities in alluvial rivers. Areas of faster flow are compensated through areas of slower flow and lower discharges,

which on average even out. The average flow velocity and discharge is affected by different river stages with increasing discharges resulting in increasing flow velocities. The lack of systematic measurements limits the present ability of quantifying this satisfactorily.

181. The magnitude and variation of discharge in the Brahmaputra River undergoes drastic changes on seasonal as well as annual basis due to the unique hydro-meteorological and geophysical characteristics of its basin. The potential increase of these natural perturbations in the river hydrograph in the wake of unfolding climate change scenario appears to be more significant compared to any minor change that may be introduced as a result of the proposed activities on or near the river bank. The river being very wide with appreciable channel roughness due the presence of multitudes of sandbars and bed forms, transmission of any minor disturbance in the flow close to the bank to areas midstream or across the channel to the other bank appears quite unlikely. Only major proactive river training interventions like spurs protruding into the river may have direct impact on the flow pattern and channel configuration affecting it significantly.

182. Large numbers of hydroelectric projects (57 since February 2008 with a total generation capacity of 15,114 MW) are under implementation in the upstream parts of the Brahmaputra basin in India. It is likely that these dams will have a significant effect on mainstream flood behavior in the Dibrugarh Reach. Any effect of upstream dams will be to reduce flood peaks. The dams will act as sediment traps on the tributaries and lessen the inflow of sediments to the main stem Brahmaputra River. The impact of this reduction in sediment inflows on main stream channel cross-sections and flood behavior in the Dibrugarh Reach is difficult to predict, but any effects are likely to lead to a reduction in flood levels as reduced sediment load supports a more stable channel pattern with deeper channels characterized by higher conveyance.

183. Mitigation Measures. Flow velocity changes along the bank line will be systematically monitored as part of the near-bank surveys. This includes establishing systematic records of discharges and flow velocities during the hydrological cycle. It is expected that this monitoring will contribute to a better understanding and a gradual optimization of the layout of structural flood and erosion countermeasures. Open revetments, such as dumped stone (rip-rap) placed on geotextile filters or multi-layers of sand-filled geotextile bags shall be preferred. Impermeable bituminous or interlocked revetments shall not be preferred as they have impact on the natural environment by interrupting exchange between flowing water and ground water. Any of the eco-friendly local resource-based methods may be used in preference to the impermeable surfaces like bituminous or cement slab.

5.1.3.5 Impact on Silt Deposition and Bed Level Change

184. Impacts. The Brahmaputra River carries the second highest sediment load of all major rivers in the world. The high amount of sediment is largely mobilized during the high flood season flows and often leads to dramatic changes of the platform (river appearance on maps). While the riverbed is largely formed by the coarser sediments especially sand and more upstream gravel, the floodplains are built from finer silts and clay. The latter constitute the wash load in the river, which means they are transported within the channels to the sea without settlement. Only after inundation and in areas without noticeable flow do the finer sediments settle. Part of this settlement has been cut-off through the construction of embankments in many places since minimum 25 years (the end of the major embankment construction program). It is noted that the inhibited deposition of the fertile finer clay and silt requires the use of alternative fertilizing methods in order to maintain overall soil fertility.

185. Problematic at this moment are breaches in the embankments, which result in high velocities in the breach area allowing the flowing water to transport coarser, infertile sand through the breached section. The sand gets deposited downstream where the area widens and the flow velocities drop. The resulting sand carpets are disastrous for the overwhelmingly small and

marginal farmers as they render the fertile floodplain land unusable and can only be removed at great cost.

186. The impact of the pro-siltation measures proposed at Dibrugarh will have no discernible effect on riverbed levels. Over the last 100 years (i.e. over the period of record), flood levels at Dibrugarh have increased at more-or-less constant rate of 0.33 m per decade because of continuing aggradation of the riverbed. This aggradation is caused by an excess of sediment inflow over sediment outflow. Any impact of the pro-siltation measures on the southern bank will be indiscernible against this ongoing basin-wide sediment behavior.

187. Mitigation Measures. The bank stabilization and strengthening of the embankment system in the Dibrugarh Reach will reduce the risk of embankment breaches with associated deposition of infertile land in the area of the breach. This will help in supporting agriculture and livelihood of the dominant small and marginal farmers. In general, about 35.5% of the land within an eight kilometers buffer behind the embankments is used for agricultural activities. The dynamic pattern of silt deposition in the river and areas adjacent to the bank, especially in the vicinity of anti-erosion and river training works, will be monitored at regular intervals in order to contribute to the knowledge base and understanding of the Brahmaputra morphology, and initiate necessary corrective measures if required.

5.1.3.6 *Effect on Drainage System*

188. Impacts. Effect on the natural drainage system can not be totally avoided in the case of a structural intervention such as embankment built along a natural river like the Brahmaputra, but the impact can be minimized if adequate mitigation measures are taken.

189. Mitigation Measures. Provision shall be made to the extent possible not to obstruct the natural drainage lines from discharging into the Brahmaputra. The existing drainage system comprising the main drain and its components running through the Dibrugarh town and out falling into the Brahmaputra downstream needs to be upgraded and properly maintained. The strengthening of the existing embankment structure and provision of necessary cross- drainage facilities like sluice gates, and additionally providing bank protection and river training works at different locations will help improve the drainage system in the reach.

5.1.3.7 Effect on Wetlands/ Beels

Operation Phase

190. Impacts. There are only two wetlands in the project area that may be affected (siltation and flow restriction) during this phase, namely the Maijan beel, which is perennial, and the Nagaghuli beel, which is seasonal. Maijan beel is termed as the lifeline of the local fishermen. This beel is located about 500 m away from the existing embankment, but no feeder channel connects it to the Brahmaputra at present.

191. Mitigation Measures. Since, various terrestrial and aquatic wildlife species depend on these wetlands, due care should be taken to ensure that no direct or indirect impact like siltation or flow of construction waste is caused to any wetland located in the close vicinity of project construction activities.

5.1.3.8 Water Quality

Design and Construction Phase

192. Impacts. The major source of surface water pollution during project construction phase will be sewage and wastewater generated from labor camp/ colonies as well as workshop areas. The

project construction is likely to last for a period of 3 years. Most of the laborers would come from nearby areas. About 50–60 labor families (total population 250 to 300) are likely to stay in each construction camp. The domestic water requirements in each construction camp will be about 45 m^3/day. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 36 m^3/day. However, it may pollute land and other nearby water bodies if discharged untreated, especially during the low flow season. No arsenic pollution is noticed either in river water or ground water in this area. Hence no impact of arsenic is anticipated in this area. As significant quantity of groundwater is not likely to be extracted as part of this project, any appreciable quantitative impact on ground water because of the construction activities is also ruled out. In addition to that ground water is easily available in 5 m BGL even during the lean periods.

193. Mitigation Measures. Septic tanks shall be provided in each camp to treat the domestic sewage. Provision of mobile toilets may also be considered with the provision of channeling the sewage to septic tank in a closed loop system. Discharge of untreated domestic sewage to the Brahmaputra River or to any natural waters will not be permitted. No debris shall be dumped in the water bodies. Impact on ground water quality is not likely due to the project activities as the wastewater generated from the project will be trapped for treatment before it will discharge/ percolate from the project sites

Operation Phase

194. Impacts. No impact is anticipated due to the project in this phase.

5.1.4. Climate

Design and Construction Phase

195. Impacts. Short term impact in terms of minor increase in temperature may happen in the immediate vicinity of the embankment due to the construction activities and cutting of trees falling in the project intervention zone. Based on field assessment, about 1.439 trees of different varieties have been observed in the 100 m core zone around the embankment which is likely to be affected due to the project intervention. The impact of climate change screening is based on the Aware™ geographic data set, compiled from the latest scientific information on current geological, climate and related hazards together with projected changes for the future where available. These data are combined with the project's sensitivities to hazard variables, returning information on the current and potential future risks is 'medium'. High flood is expected in future.

196. Mitigation Measures. Efforts have to be made to minimize cutting of the trees while designing the embankments. Compensatory tree plantation to be undertaken on the basis of trees planted against each tree cut.[19] Special design considerations were made keeping water level rise due to climate change.

Operation Phase

197. Impacts. No direct impact is anticipated on the climate of the study area due to the proposed project. However, changes in the catchments area of the river and extreme events due to possible climate change (global warming) can have indirect impacts on the project and project area. With respect to the proposed project, climate change can play a major role due to its implications on water resources, water availability, and inland/ fresh water wetlands. The climate change impacts on water resources for throughout[20] the country were studied as part of the India's

[19] The rate of compensatory afforestation mentioned here is as per the consultation with Chief Conservator of Forests, Forest Department, and as per Assam Government's Guidelines for Compensatory Afforestation, 2000.

[20] The SWAT water balance model has been used in this study for the river basins to carry out the hydrologic modelling of the country. The SWAT model has been used on each of the river basins separately using daily weather generated by the HadRM2 control

Initial National Communication (Natcom 1) Project. The study revealed that climate change impacts on the inland wetlands would be a complex issue dependent on several variables, including temperature increase, rate of evaporation, changes in precipitation of the catchment, changes in nutrient cycling and the responses of a variety of aquatic species. Although tropical lakes are less likely to be impacted by climate change as compared to temperate lakes, an increase in temperature would alter the thermal cycles of lakes, oxygen solubility and other compounds, and affect the ecosystem. Shallow-water marshes and swamps would be even more vulnerable to increased temperatures and lower precipitation. The increased evaporation of water and reduced inflow from rainfall could desiccate the marshes, swamps and shallow lakes. GCM model projections (by HadCM2) for India indicate an increase in precipitation by up to 30% for the north-eastern region in addition to a relatively moderate increase in temperature of about 2°C by the period 2041-2060. This could increase the incidence of flooding in the Brahmaputra basin. Since, there are divergent views on the above findings; these cannot be taken into consideration for any design change at this stage till more in precipitation by up to 30% for the north-eastern region in addition to a relatively moderate increase in temperature of about 2°C by the period 2041-2060. This could increase the incidence of flooding in the Brahmaputra basin. Since, there are divergent views on the above findings; these can not be taken into consideration for any design change at this stage till more specific and dependable information related to climate change effect on river hydrology in this region is available.

198. Mitigation Measures. The likely impact framework shown above is generalized. However more information has to be collected based on newer studies and monitoring data. Further action on this account can be considered only in the following phases of the project. The flood pattern shall have to be closely analyzed during proposed life span of the embankment and take appropriate timely protective measures in case the flood levels increase earlier than the projected levels for 2041-2060 due to climatic changes.

5.1.5. Air Environment

5.1.5.1 Design and Construction Phase

199. Impacts. The ambient air quality of the area is good. The level of SPM, RSPM, NOx, SO_2, Pb, CO, is much lower at both the locations monitored (Majirgaon, Khanajan and under tranche 1 at DTP Dyke and Mothola Oakland) than the prescribed National Ambient Air Quality Standards for rural areas (Appendix-3). While various construction activities will increase the ambient air quality, but the level is likely to remain within the prescribed standards. During construction phase there will be two main sources of air emissions, i.e. mobile sources and stationary sources. Mobile sources are mostly vehicles involved in construction activities, whereas emissions from stationary sources include construction equipment and machinery, diesel generator sets, excavation/ grading activities etc. Hot Mix Asphalt (HMA) plants will be one of the major sources of emission, which will be used for road carpeting. In addition to these, fugitive emissions will also form a major proportion of air pollution in the form of particulate matter from storage and handling of construction material. HMA plants have two major categories of emissions: ducted sources (those vented to the atmosphere through some type of stack, vent, or pipe), and fugitive sources (those not confined to ducts and vents but emitted directly from the source to the ambient air). Dryers are the most significant ducted sources of emissions from both batch mix and drum mix HMA plants. Emissions from these sources consist of water (as steam evaporated from the aggregate); PM; products of combustion (carbon dioxide [CO_2], NOx, and sulfur dioxides [SO_2]); CO; and small amounts of organic compounds of various species (including VOC, methane [CH_4],). The CO and

climate scenario (1981-2000). The model has been run using climate scenarios for the period 2041 to 2060, without changing the land use pattern. The outputs of these two scenarios have been analyzed with respect to the possible impacts on the run-off, soil moisture and actual evapotranspiration.

organic compound emissions result from incomplete combustion of the fuel and also are released from the heated asphalt.

200. Fugitive dust sources associated with construction phase include vehicular traffic generating fugitive dust on paved and unpaved roads, aggregate material handling, and other aggregate processing operations. Fugitive dust generated from these activities may range from 0.1 µm to more than 300 µm in aerodynamic diameter. The emission of particulate matter during the construction phase will be generated from the activities like receipt, transfer and screening of aggregate, crushing activity, road dust emissions. The likely emission levels from these sources are indicated at Appendix 14. In addition to that emissions from various construction machinery fueled by diesel and from mobile source will be in the form of PM10, VOC, CO, NOx and SO_2. The emissions from stationary and mobile diesel engines with respect to their working/ movement are presented in Table 33:

Table.33 : Exhaust Emissions for Stationary and Mobile Machinery

Source	PM_{10}	VOC	CO	NOx	SO_2
Diesel exhaust emissions (idle)	0.043 g/min	0.208 g/min	1.57 g/min	0.917 g/min	18.8 S g/l
Diesel exhaust emissions (moving)	0.4 g/mile	3.18 g/mile	18.82 g/mile	8.5 g/mile	18.8 S g/l

201. Mitigation Measures. Hot mix plants should be located away from the populated areas and be fitted with the air pollution control devices. They should be tested and certified to confirm that emissions comply with National/SPCB standards. Further, the hot mix plants must be sited at least 1 km in the downwind direction from the nearest human settlement. It shall be ensured that the dust emissions from the crusher and vibrating screen of the stone quarries do not exceed the standards. While vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing road. Water may be sprayed on earthworks, on a regular basis. During and after compaction of the sub- grade, water will be sprayed at regular intervals to prevent dust generation.

202. The following mitigation measures will also be taken to mitigate the dust entrainment and fugitive emissions from the various sources in Dibrugarh reach:

(i) Covering of loads in trucks, and the paving of access areas to unpaved lots or construction sites, are examples of preventive measures. Examples of mitigation controls include water flushing, and broom sweeping and flushing.
(ii) Redistribution of loose material onto the travel lanes will actually produce a short-term increase in the emissions. In general, preventive controls are usually more cost effective than mitigation controls.
(iii) Sprinkling water will control fugitive dust entrainment.
(iv) Sprinkling of water on the dust prone areas and construction yard.
(v) Regular maintenance of machinery and equipment will be carried out.
(vi) Ambient air quality monitoring should be carried out during construction phase. If monitored parameters are above the prescribed limits, suitable control measures must be taken.
(vii) Care shall be taken to keep all material storages adequately covered and contained so that they are not exposed to situations, where winds on site could lead to dust/ particulate emissions.
(viii) Fabrics and plastics for covering piles of soils and debris is an effective means to reduce fugitive dust from the material stores/ warehouses.

(ix) Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled materials do not become a source of fugitive emission.
(x) Spilled concrete slurries or liquid wastes shall be contained/ cleaned up immediately before they can infiltrate into the soil/ ground or runoff in nearby areas.
(xi) All slopes and embankments will be turfed as per best engineering practices to help minimize the dust generation during operation of the road.
(xii) Plantation along the embankment should be maintained.
(xiii) Ambient air quality monitoring should be done for the first 3 years of the operation phase. If monitored parameters are above the prescribed limits, suitable control measures must be taken.

203. A wide variety of options exist to control emissions from unpaved roads in the form of:

(i) Vehicle restrictions that limit the speed, weight or number of vehicles on the road;
(ii) Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and
(iii) Surface treatment, such as watering or treatment with chemical dust suppressants.

5.1.5.2 Operation Phase

204. Impacts. The prime source for air pollution during operation phase will be vehicular movement on the paved road on top of the embankment, which will be used for transportation as well as maintenance of the embankment.

205. Mitigation Measures. Plantation along the embankment and turfing on the embankment slopes should be maintained and their survival rates should be monitored. In addition to that regular maintenance of the road on the top of embankment as well as connecting roads shall be done for reducing fugitive emissions.

5.1.6. Noise

Design and Construction Phase

206. Impacts. During construction phase, noise will be generated from various activities such as site clearing, excavation, land shaping, and finishing. The general noise levels during construction phase due to working of heavy earth moving equipment and machineries installation may reach 100 dB(A) or more at the work sites.[21] However, it needs to be noted that a lot of manual labor will also be involved in the embankment construction, and hence, the impact of construction machineries will be limited. As a worst case scenario considered for prediction of noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point[22]. The increase in noise levels due to operation of various construction equipment is expected to increase the noise level from 100.3 dB (A) at 1m to 52.4 dB (A) at a distance of 250 m from the sources. The predicted levels are presented at Table 34:

[21] The noise level from various construction equipment /machinery is (all levels are in dB(A)): Dozers (95-100), front Loaders (72-84), Backhoes (72-93), Tractors (76-96), Toppers/Truckes (82-94), Concrete mixers (75-83), Concrete pumps (75-83), Concrete pumps (81-83), Cranes (movable) (75-86), Vehicular Traffic (construction material and plant and Machinery) (85-98), Dg Set (90-95), Pumps (69-71), Compressors (74-86), Pneumatic Wrenches (83-88), Jack Hammer and rock drills (81-98), Pile Drivers (peak) (95-105)

[22] In absence of the data on actual location of various construction equipment and machinery, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. However, the noise levels shall attenuate as the sound wave passes through a barrier. The transmission loss values for common construction materials like brick, light concrete, dense concrete, concrete block with a thickness of 4 to 6 inches vary in the range of 30 to 40 dB(A). Thus, the walls of various houses will attenuate at least 30 dB(A) of noise. In addition, there will be attenuation due to Air absorption, atmospheric in homogeneities, vegetal cover.

Table.34 : Increase in Noise Levels due to Operation of various Construction

Distance (m)	Ambient Noise Levels dB(A)	Increase in Noise Level dB(A)	Increase in Ambient Noise Levels dB(A)
1	51.0	100.3	49.3
10		80.3	29.3
50		66.3	15.3
100		60.3	9.3
150		56.8	5.8
200		54.3	3.3
250		52.4	1.4

207. In addition, there will be significant increase in vehicular movement for transportation of construction material. At present, vehicular movement near the project site is of the order of 5 to 10 vehicles/ hour. During construction phase, the increase in vehicular movement is expected to increase to a maximum of 40 to 50 trucks/ hour.

208. As a part of the EIA study, impact on noise level due to increased vehicular movement was studied using Federal Highway Administration model. The results of modeling are outlined in Table 35:

Table.35 : Increase in Noise Levels due to Increased Vehicular Movement

Distance (m)	Ambient Noise Level dB(A)	Increase in Noise Level dB(A)	Increase in Ambient Noise Level dB(A)
10	51	72	21
20		67	16
50		61	10
100		57	6
200		52	1

209. During construction phase, increase in noise is expected from 25 to 30%. However, the increase in noise levels will be localized, temporary in nature and mostly will be during daytime only.

210. Mitigation Measures. Following noise control measures shall be adopted:

(i) Site Controls: Stationary equipment shall be placed along un-inhabited stretches meeting the National Noise Quality standard, particularly for residential areas (Category C) and silence zones (Category D: hospitals, educational institutions, courts, religious places, etc.), keeping the distance at least 150 m (Category C) and 250m (Category D), to minimize objectionable noise impacts. In the event potential nose sensitive receptors are identified who will fact higher noise due to construction, appropriate temporary noise barriers will be established.

(ii) Scheduling of Project Activities: Operations will be scheduled to when people would be least likely to be affected. Construction activities shall be restricted between 10 p.m. and 6 a.m. near residential areas.

(iii) Protection devices (ear plugs or ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines.

(iv) Construction equipment and machinery shall be fitted with silencers and maintained properly.

(v) Noise measurements shall be carried out along the reach as well as in nearby villages, to ensure the effectiveness of mitigation measures.

(vi) Use of manual labor will be promoted.

Operation Phase

211. Impacts. The prime source of noise pollution during operation phase will be the vehicular movement. However, as the roads will be paved and will provide smooth traffic movement, the impact due to vehicular movement will be less significant.

212. Mitigation Measures. Adequate signage shall be provided restricting use of pressure horn particularly in noise sensitive locations particularly near schools, hospitals and populated areas. Noise measurements shall be carried out along the road to ensure the effectiveness of mitigation measures. Tree barriers between the road and village, semi urban and urban area shall be developed in a layered manner as suggested under air environment mitigation measures.

5.1.7. Terrestrial Ecology

5.1.7.1 Disturbance to Vegetation

Design and Construction Phase

213. Impacts. There would be no major impact on terrestrial flora except cutting of trees during project intervention in the Dibrugarh Reach, as there is no protected forest, reserved forest or sanctuary, etc. present in this area. The entire natural terrestrial ecosystem (biodiversity) has already been damaged by the heavy floods and erosions in the past in this area. The present

vegetation is the cultural one which can always be compensated by afforestation programme. The proposed project will help to improve the terrestrial biodiversity of the area. The baseline survey along the Dibrugarh Reach and during RP survey, taking into consideration of sub- zones 50 m from either side of the embankments revealed a total of 1,439 trees. Out of these, there are 1,073 trees of timber trees and 366 fruit bearing trees recorded in Dibrugarh reach.

214. There will be less impact on the terrestrial ecosystem due to project intervention. The project site has not supported much terrestrial vegetation except tea gardens. So, the protection of tea gardens is more important than any other loss of terrestrial ecosystem.

215. Mitigation Measures. Provision shall be made for planting 3 trees for every tree cut. Plantation programme shall be initiated from the initial parallel to construction activity. The native and existing vegetation profile shall be maintained during plantation programme, so that local inhabitants can utilize their resources. The indigenous plants namely Jati-bet- Calamus erectus, Bamboo- Bambusa balcooa, Bamboosa tulda, Delbergia sisso, Artocarpus heterophylus, Dimoru-Ficus lipidosa and Ahot-Ficus religiosa shall be preferred. A green belt is necessary along the sides of embankment for transitional wildlife species like birds and herpitofauna as well as fuel wood for local inhabitants

Operation Phase

216. Impacts. No direct impact is anticipated during operation stage except accidental damages or absence of tree management.

217. Mitigation Measures. Arrangement shall be made for tree management to ensure survivability of the tree plantation. The Social Forestry Wing of the Department of Forestry and Environment may be consulted or involved in this programme. The tree survivability audit shall also be conducted at least once in a year to assess the effectiveness of the programme.

5.1.7.2 Habitat Fragmentation and Destruction

Design and Construction Phase

218. Impacts. No habitat fragmentation will be happened due to project intervention, because no such important habitat was found nearby.

Operation Phase

219. Impacts. Inappropriate opening of the sluice gate may have substantial damage to the eco system.

Mitigation Measures. Appropriate management will have to be made for the operation of the sluice gate as resident around are not very favorable to its effective operation and fear of increased flood from Brahmaputra. The maintenance of this water connection is important for the movement of the aquatic life between river and ponds.

5.1.7.3 Animal Distribution/ Migratory Route

Design and Construction Phase

220. Impacts. There is no migratory route of wildlife species in entire Dibrugarh reach area; hence, there is no possibility of impact on animal distribution. On the other hand, dolphins are seen particularly in the rainy season near Maijan confluence. Dolphin is sensitive to polluted water and any obstruction of the channels at this stage may disturb the breeding activities. No impact

envisaged on to the dolphins in other seasons (except breeding period) since, they are confined to the deep water channels of the Brahmaputra River.

221. Mitigation Measures. All care shall be taken to ensure that construction waste does not find its way to water in this area and pollute it. Care shall also be taken to ensure those channels are not obstructed in any way. Given that the breeding season for almost 80% of fish species starts in April and ends in August (i.e., during the pre-monsoon and monsoon seasons), construction will be restricted during this period at the concerned breeding and spawning sites.

Operation Phase

222. Impacts. No impact is anticipated during operation stage with regards to animal distribution and migration. There was no endemic wildlife species found in the study area, but few species of endangered species were recorded during survey. Study recorded 2 endangered mammalian fauna, 5 reptilian species and 10 endangered avian faunas in Dibrugarh reach. But the project activity shall not affect these species in any way.

5.1.8. Aquatic Ecology

5.1.8.1 Effect on Fishing Activities/productivity

Design and Construction Phase

223. Impacts. There would be no major impact on aquatic ecology during project intervention in the Dibrugarh site. However, the breeding habitat of the riparian zones must not be disturbed. Heavy silting due to construction activities would result in high turbidity should be avoided. Temporary flushing of the fish species towards the deeper part of the river may happen during construction of bank line protection measures.

224. The construction work will not affect the fish activity in the river as they move with the river current. The construction activity may increase the turbidity on the bank temporarily, however, fish species are accustomed to high siltation level and no impact is anticipated.

225. Mitigation Measures. Adequate provision has been made in the design to ensure access to the temporary fish landing site/ boat ghat during construction. Adequate requisite facilities shall be restored or maintained for undisturbed movement of the fisherman. The provision of sanitary facilities and concreted platform area with grease trap for collection of spill over or waste oil shall be provided at fish landing site/boat ghat to prevent contamination of river water specially at boat ghat which is also the fish/dolphin breeding site.

Operation Phase

226. Impacts. No impact is anticipated during operation stage with regards to fish activities.

5.1.8.2 Migratory Routes

227. Impacts. There is no migratory route of fish in the Dibrugarh Reach, which can be affected due to the proposed project. The migratory fish species like Hilsa (anadromous[23]) and Anguilla (catadromous[24]) migrate through the main channel of the river i.e. through the deeper zones of the river. Therefore, project will not have any impact on the migratory route of these fishes.

5.1.8.3 Effect on Spawning and Breeding Grounds

[23] Migration of fish from sea to fresh water for breeding.
[24] Fish that lives in fresh water and breeds in sea.

Design and Construction Phase

228. Impacts. A few spawning and breeding grounds were observed near the riverbank along the Dibrugarh Reach. During construction of the revetment works and placement of pro-siltation flow retarding screens, fish species may be temporarily flushed towards the deeper part of the river. Construction may also increase the turbidity on the bank temporarily, although fish species are accustomed to this and little impact is expected.

229. Mitigation Measures. Possible impacts to the identified breeding and frequented area near the Maijan confluence will be minimize by scheduling the construction activity and avoid breeding season. Given that the breeding season for almost 80% of fish species starts in April and ends in August (i.e., during the pre-monsoon and monsoon seasons), construction will be restricted during the period at the concerned breeding and spawning sites. In addition, channel between the Maijan beel and the Brahmaputra will be kept permanently open during the construction period. All care shall be taken to ensure that construction waste does not contaminate the river waters.

Operation Phase

230. Impacts. No impact is anticipated during operation stage with regards to fish activities.

5.1.8.4 Effect on Pond Fisheries

231. Impacts. No pond fisheries activities are found along the existing embankment. However, pond fisheries are found in the study area at least 500 m away from the embankment, and current productivity of these places are low. Once the structural measures are implemented, siltation problem is minimized and fish productivity will improve.

232. Mitigation Measures. The fish productivity can be improved substantially with use of better fish culture and increasing the capacity of fish ponds as well institutional strengthening support. Fish productivity audit may also be undertaken to assess the effect of institutional support

5.1.9. Socio Economic

5.1.9.1 Social Conflict

Design and Construction Phase

233. Impacts. Owing to the proposed project, there will be establishment of construction camps that will add to the population of the study area. Migrant workers will have the potential impacts of conflicting culture and lifestyle compete with local laborers over job opportunities, and potential health issues such as HIV/AIDS. This shall also exert pressure on the natural resources in the project area. However, this will only be a temporary phase lasting only during the construction period.

234. Mitigation Measure. Early consultations will be made by the contractor with the local communities to determine the appropriate location of work camp sites with the encouragement that local people are given preference in employment when they meet basic job requirements. All migrant workers will undergo workshop/briefings to sensitize them on local culture and lifestyle awareness.

5.1.9.2 Establishments

Design and Construction Phase

235. Impacts. Good number of houses and establishments are located close to the existing embankment. Even some of the habitat has their hutments on the embankment itself. The household likely to be affected shall be detailed under the RAP report.

236. Mitigation Measures. The household likely to be affected shall be detailed under the RAP report.

5.1.9.3 Establishments

Design and Construction Phase

237. Impacts. Various educational, physical or cultural heritage facilities are located close to the embankment in 50 m impact corridor, which may be affected partially/ fully due to construction activities.

238. Mitigation Measures. Efforts shall be made to prevent any relocation or demolition of these establishments. Where inevitable, the social infrastructure shall be rehabilitated with corresponding social and cultural values. Temporary noise barrier will be installed close to school and place of worship during the construction stage. Thick plantation shall be made close to these establishments.

5.1.9.4 Archaeological Sites to be Impacted

239. Impacts. No archaeological sites will be impacted due to the proposed construction of river embankment along the Dibrugarh Reach

5.1.9.5 Places of Pilgrimage and Tourism to be Impacted

240. Impacts. There are no pilgrimage or tourist spots along the Dibrugarh reach. Hence, no impact to this valuable component is expected. In fact, with the strengthening of embankment and improvement of roads will have positive impact on the accessibility of the villages along the reach.

5.1.9.6 Water Supply and Sanitation

Design and Construction Phase

241. Impacts. Local residents are dependent on ground water for meeting their drinking water supply. The quality of groundwater in this reach was found fit for drinking purposes. Project activities are not likely to affect the water supply of the area. Sanitation facilities are poor in the rural areas. Residents go to river bank for their daily needs. Many places along the bank have been damaged to create access to the river. Drinking water and sanitation becomes one of the major problems during floods. In the Dibrugarh municipal area, untreated domestic as well as commercial/ industrial wastes create a high pollution load. The present dumping ground for municipal solid waste is located close to the Brahmaputra embankment on the river side within 50 meters from the settlement areas.

242. Mitigation Measures. Access shall be provided to river near community settlements. Awareness shall be created among the residents about the upkeep of the embankment.

Garbage shall be collected at designated locations. No sewage shall be discharged into the surroundings, especially the water bodies. It was initially predicted that the dumping ground for municipal wastes shall be removed from its present riverbank location close to the existing embankment to a suitable location, but it was impossible and ramps have been created for garbage disposal over the DTP dyke. No significant impact on water, surface as well as ground water, with regard to abstraction of water is anticipated in and around the Dibrugarh Reach.

Provision shall be made for providing mobile toilets and drinking facilities during the floods. Provision of hand pumps at flood platform near the residential area may be explored for the same.

Operation phase

243. Impacts. Unplanned development, encroachment of the embankment, tree plantation on the embankment may affect the stability of the embankment.

244. Mitigation Measures. Uncontrolled and unplanned development should be prevented. Awareness shall be created amongst the people for the upkeep of the embankment.

5.1.10. Land Use

Design and Construction Phase

245. Impacts. A large number of households get affected by flood and erosion. In the Dibrugarh reach about 69.15% of household surveyed by socio-economic team are affected due to flood and erosion. The proposed project will bring relief to all the residents in this area. The project will also provide employment to a large number of people for about 3 years. The project will also boost the local economy as small businessmen and entrepreneurs will provide the daily needs of the workers and officers of the proposed project. The project intervention will cause impact on land and structures affecting the households.

246. Some of the subproject infrastructure would require land acquisition and resettlement, including the renovation of existing embankments. Riverbank protection and associated structures will also require a certain amount of land acquisition and resettlement of embankment squatter population (details in the resettlement plan).

247. The subproject area also has existing embankments and associated structures of which land acquisition process has not been completed. It is a strong demand of the concerned local population that the past dues of the land acquisition and resettlement payments should be provided in association with the improvements of the concerned infrastructure.

248. Mitigation Measures. Embankment strengthening will be designed to minimize the impacts of land acquisition. All resettlement activities will be implemented in accordance with ADB's voluntary resettlement and other social safeguards policies, as well as the applicable laws and regulations of the Government of India and the Assam State. In the context of the project, a resettlement framework and an indigenous people's development framework (IPDF) were prepared to cover the subproject infrastructure. To mitigate the impact and to ensure there is no impoverishment or affected households, a detailed resettlement plan was prepared for tranche-2 civil works, and further plans will be prepared and implemented to ensure timely payment of compensation and restoration of assets and livelihoods of all affected households. Their specific scopes will be finalized following the detailed design and prior to the tendering of the concerned civil works.

249. Regarding the pending compensation of past structure works, if any subproject sections to be covered by the proposed project have any outstanding grievances from past acquisition for embankments that are being strengthened and/or improved, a due diligence would be undertaken to assess the scope of the problem with detailed recommendations to address the grievances prior to launching the subproject work.

250. With the stabilization of the area and prevention of land loss due to erosion every year (about 103 ha/year) land availability for multiple crops will increase bringing positive impact on the local economy.

251. Benefits and Enhancement Measures. The project will also provide employment to a large number of people for about 3 years in tranche 2. The project will also boost the local economy as small businessmen and entrepreneurs will provide the daily needs of the workers and officers of the proposed project. It is recommended that the project-affected peoples (PAPs) are given preference as daily wage laborers. Proper income generation program should be included in RAP for the post construction period. The training programmes for agriculture and fish production improvement shall be implemented so that the local economy is positively impacted by the proposed project. Farmers can also consider switching over to shallow water rice cultivation means from anaerobic verity to aerobic variety of rice cultivation. Farmers will be able to get three crops instead of two crops. Appropriate provision shall be made to provide alternate fish landing station so that economic activities of the fishermen are not disturbed due to project activities.

5.1.11. Accidents and Safety

Design and Construction Phase

252. Impacts. The risks associated with the proposed project are minimal. However, roads being narrow, efforts shall be made that no hazardous traffic conditions are created due to construction vehicle movement. Local people may encroach to construction area and get hurt.

253. Mitigation Measures. Adequate lighting and fluorescent signage shall be provided at the construction sites. Signage shall be made in local language. Workers shall be provided with necessary Personal Protective Equipment and a First Aid unit including adequate supply of dressing materials, transport means, nursing staff and an attending doctor, shall be available at each construction site. Health check-up camps shall also be organized six months.

Operation Phase

254. Impacts. Due to improved road condition, drivers may have tendency to drive fast on embankment road resulting in accidents.

255. Mitigation Measures. Speed limits shall be prescribed for vehicular movement on the embankment road to avert the accidents. Adequate signage and light reflectors shall be places along the road side.

5.1.12. Navigation

Design and Construction Phase

256. Impacts. This river section is navigated by people for moving to one place to another located at riverbank and moving to char lands for fishing and farming. They use small motor boats and temporary fish landing sites or boat ghats for these movements. There are few fish landing sites in this subproject area. These landing sites could be temporarily disturbed due to project activities. However, there will not be any impact on the general navigability of the river due to the project since project activities are limited to river bank and beyond.

257. Mitigation Measures. During construction, contractors are asked to provide alternate landing sites (ghats) with similar berthing facilities, access, and other common infrastructure, as part of the tender documents. In places the riverbank protection will provide steps to facilitate landing of local boats in support of trade and river crossings. The project design has additional provisions to closely monitor the general river behavior as well as its response to the new works and, within the concept of adaptive approach, to mitigate any negative impacts (through phased implementation).

5.2. Summary of Impacts and Residual Impact

258. Almost all the impacts are occurred during the construction period and the physical intervention associated with the civil works are not significant, therefore, the environmental impacts are temporary and reversible. With implementation of proposed mitigation measures, most of the impacts will be minimized, and no residual and cumulative impact is expected.

6. ANALYSIS OF ALTERNATIVES

6.1. Introduction

259. The analysis of alternative is an effective tool to examine the number of options (locational and technological) and establishing most environmentally favorable alternative or which cause minimum environmental loss to the natural and social environment. Under the circumstance, the "without project" option was considered and compared against the "with project" option as an alternative analysis. Since, the proposed project aims to provide protection to large number of people and landmass from frequent devastating flood of the Brahmaputra river, the scope of assessing alternatives to the project is limited to the —with and —without subproject (means do nothing or status quo) options, along with "repeated embankment" option (means- the embankment which retires needs repeated construction of embankment).

6.1.1. 'Without Project' Option

260. Physical Environment. In the 'without project' scenario, loss of precious land at the rate of about 34 ha/year (reaching 1,000 ha in 30 years) will continue due to riverbank erosion. Siltation of land due to flood will also happen resulting in reduced productivity or loss of single crop. There is also a risk that the present depression along Brahmaputra near Dibrugarh may develop into a permanent river course through Brahmaputra avulsion, leading to further land loss and isolation of areas adjoining Dibrugarh, Mohanbari Airport, medical college, etc. The floodplains and wetlands will be flooded annually, reverting to their former function supporting aquatic life during the flood season. No effect is anticipated on ambient air and noise quality.

261. Biological Environment. In the 'without the project' scenario, the eroded land will turn into a river channel turning into an aquatic environment. Floodplain and wetlands will eventually revert to their former function supporting aquatic life during the flood season. However, there will be a loss of vegetation and productivity in agriculture and culture fishery. For other seasons, no change is anticipated in fish productivity of wetlands, or productivity of agricultural land. On the other hand, under this scenario, there is a risk of Brahmaputra avulsion into the natural depression, which would affect the loss of habitat of wildlife including birds and fishes.

262. Socioeconomic Environment. Without the project, large number of population will remain vulnerable to flood effect. 7,128 ha of cropland, excluding the tea estates, from regular flood inundation and damages. Flood damage in Dibrugarh is ₹414.4 million in project areas In the unprotected villages of Dibrugarh area, estimated damage of public infrastructures done by floods during past five years is ₹1.2 million per village. Specifically, there will be displacement of people associated with 1,000ha of land in 30 years to be lost due to river erosion, many of whom may have to be resettled to the flood embankment as landless squatters. Due to more frequent flooding, the agriculture productivity of the presently protected area by the embankment will be reduced, affecting the livelihoods of the population in the subproject areas, although this may be slightly offset by the increased capture fish production during the flood season. Flood also causes many linked socio-economic and health problems.

6.1.2. 'With Project' Option

263. Physical Environment. In the "with project" scenario, no change is expected in air, soil and water media. The air pollution and noise level are likely to increase during construction phase but that will be confined within the close vicinity of construction sites and will be temporary in nature. The bank protection measures will prevent loss of about 22 ha/year of productive land (out of 37 ha/year to be lost without project), which in turn would reduce the sedimentation load of the Brahmaputra River.

264. Biological Environment. In the 'with project' scenario, there is likelihood of improved fish productivity from wetland. No significant impact is expected in terms of increase in sedimentation level or fish productivity during construction stage. With the implementation of mitigative measures the overall impact of the project is likely to be positive on the biological environment except in terms of loss of trees which will be minimized and also regenerate over a period of time due to proposed tree plantation. In this option, there will be no change in the biological environment. The impact of sudden water intrusion into the Dibrugarh town and adjoining wetlands originated from the breach of the Brahmaputra embankment will be avoided.

265. Socioeconomic Environment. The "withproject" scenario is also likely to bring stability to the economy of the area. It will facilitate conservation of large area from erosion (34 ha/year). With more reliable and effective functioning of the existing flood embankments, agricultural produce would increase where farmers can increase the number of crops in a year with better yields facilitated by investments under more flood secure environment. Wetland fisheries productivity would improve due to reduced siltation load and improved fishery practices. The project will also provide better commuting opportunities to the people of the area through the paved road on the embankment and protected land inside, which means reduced commuting time to reach the markets and education, health, and other facilities. The flood protected environment may also promote agro-based industries in the area. The post project scenario will enhance the overall economy of the area. The project will also provide better commuting opportunities to fishermen and people of the area through the paved road on the top of embankment, which means reduced commuting time to reach the markets. Results of the economic analysis show that the IRR on investments for 30-year period are 11.7 % in Dibrugarh. Field survey data indicate higher household income from agriculture in the protected villages – ₹3,617 in Dibrugarh villages (unprotected ₹1,642).

6.1.3. Without Rehabilitation of Embankment Option

266. Physical Environment. This option involves the retirement of flood embankments in response to the riverbank erosion process, with the acquisition of land and compensation to the affected people. In this scenario, loss of land at the rate of about 34 ha/year (reaching 1,000 ha in 30 years) will continue due to riverbank erosion. There is also a possibility of frequent flood inundation in the subproject area, unless the retired embankment can be constructed before the existing embankment is breached due to the river bank erosion.

267. Biological Environment. In this option, the eroded land will turn into a river channel turning into an aquatic environment. The environment of floodplain and wetlands during the monsoon season will depend on the timing of constructing the retired embankment against the breach of existing embankment due to erosion. For other seasons, no change is anticipated in fish productivity of wetlands, or productivity of agricultural land.

268. Socioeconomic Environment. Since this option involves continuous river erosion, there will be displacement of people associated with 1,000 ha of land in 30 years to be lost due to river erosion, of which agriculture productivity will be lost. The similar economic benefits may be delivered in case of timely construction of retired embankment prior to the breach of existing embankment due to river erosion. However, there is a risk of failure given the lengthy procedures for land acquisition and opposition from the concerned population in the subproject areas (when compared with the "with project' option), in which case there will be repeated flood damages, affecting the confidence of local population on the reliability and effectiveness of FRERM systems leading to much less positive socio-economic impacts as compared with the "without-project' option.

7. INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

7.1. Public Consultation and Participation

269. Meaningful consultation with affected people were carried out, and the consultation processes are appropriately documented in the updated EIA. The team pays special attention to ensure that vulnerable groups have sufficient opportunities to participate in consultations. The projects classified as 'category A' for environment, the project team participates in consultations to understand the main concerns of the project-affected people so that these concerns and recommendations can be adequately addressed in project design and safeguard plans.

270. To hold public consultation, following principles were followed (i) affected people were invited; (ii) project implementation schedule and matrix EMP were distributed; (iii) the team from WRD, District administration, PMC and FREMAA explained about the project and potential impacts as well as how the project will handle the impacts: and (iv) names of contact person, and contact number of PMU staff who will be acting as the grievance redress mechanism officer, to the participants were given (in this case SIO, the local WRD officer) and let them know, in case, they have concerns about the project to contact this PMU staff. Local people were also consulted from different socio- economic backgrounds in the villages along the Dibrugarh reach.

271. For the preparation of the EIA report 2009 three state level workshops were conducted. The first workshop was held in December 2007 on the interim progress of project preparation, and the second workshop in June 2008 on the draft findings of the study. Stakeholder consultations and socio economic and poverty surveys were done in 6 villages in the first phase up to Sept 2007, followed by more detailed surveys in 13 villages out of 134 villages in the subproject area, along with one village in char land and another village outside of the subproject area using focus group meetings (FGMs) and participatory rural appraisal techniques. Group discussions with women facilitated by Women Enumerators on impact of disaster on their livelihood and their present coping mechanism were held in each village surveyed.

272. The third state workshop was conducted in February 4, 2009 at the Brahmaputra Hotel in Guwahati organized by the WRD, Government of Assam, and ADB. During the state workshop technical features of the project design, and social and environmental impacts and corresponding mitigation measures were presented by the technical experts. A special session was also allocated as a special focus group discussion on any subject of the participant's interest.

273. For updating EIA as part of preparation of tranche 2, public consultations were carried out at least twice on 14 and 15 February 2015, July 2015 and 11 November 2015. The consultations with villagers in the fringe of Dibrugarh reach discussed about potential environmental and social impacts including potential physical displacement of people living in the embankment as part of preparation of resettlement plan. In between these two consultation dates, several visits were made in the fringe villages to assess the implication of programme on social and environment aspects in the month of July 2015. The official public consultation that address only for updating EIA were carried out in the affected villages in Dibrugarh subproject reach on 11 November 2015.

274. As part of implementation of EIA, future public consultations are also envisaged in the implementation stage. The EMP provides for monitoring the effectiveness of the mitigation measures proposed, gathering feedback from the public and NGOs, and taking corrective actions. Provision has also been made for regular information dissemination and an awareness program during the construction and operations phases. The specific environmental impacts observed, mitigation measures adopted, and the prospects for impacts on further structural works will also be consulted and reported at the time of the processing of the second tranche of the Program.

7.2. Information Disclosed

275. The EIA report 2009 has been disclosed in ADB website, and the hard copy has been placed in the offices of FREMA and SIO Dibrugarh to make the report available for interested parties. The 2009 EIA report was also being submitted to obtain environmental clearance.

276. The information disclose during public consultation is mainly to drive the discussions for receiving maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the project. Issues were discussed in depth with the government officials and NGOs while in case of the villagers those issues were touched upon which are relevant to them. To begin with, they were given a brief outline of the project's objectives, type and components of the project in a simplified manner and in their native language. A set of pre-determined common questions were provided to the stakeholders to seek their perception of the proposed subproject.

277. The information provided on public consultation with the stakeholders were focused on the following points:

(i) problem(s) related to environment as result(s) of flood and erosion of the Brahmaputra river;
(ii) whether the proposed project will help in providing safety to the people, their property and environment of the area;
(iii) any significant negative impact of the project on the overall environment of the area;
(iv) possible impacts of the project on agriculture, wetlands, drinking water facilities, and local economy;
(v) grievance redressal mechanism; and
(vi) cooperation during execution of the work.

278. Impact on the flora and fauna was mainly discussed with the officers of the Dibrugarh DFO office and Range Office under forest department. The effect of air and noise pollution due to the project (during the design and construction stage) and disturbance in river water was discussed at length.

279. The consultation process was undertaken after studying the project design and identifying the possible impacts due to the project execution and commissioning. The impact assessment study focused mainly on the findings of the assessment and acceptability of the proposed mitigation measures. Issues of tree cutting, impact on physical environment, disturbance on fishing activities and fish productivity, productivity of beels in the study area and proposed mitigation measures were discussed at length.

280. For the purpose of the state-level workshop for both the tranches, the executive summaries of the study findings were shared in advance with the invited participants including the NGOs. The first workshop presented and discussed the interim findings of the project preparatory studies, including the problems and issues related flooding and riverbank erosion in Assam including lessons, key strategic elements for integrated FRERM, and peoples' perspectives on living conditions and aspirations. The second workshop presented the draft final findings, including the rationale and preliminary objective and scope of the IFRERM Assam, social impact assessment and safeguards, and environmental impact assessments. After the workshops, press briefings were organized with the circulation of the executive summaries. The presented materials at the workshops are posted in the following ADB websites on the IFRERM-Assam:

(i) 1st Workshop held on 1 December 2007 at Administrative Staff College of India, Guwahati (http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-IND-TACR.pdf)

(ii) 2nd Workshop on 25 June 2008 at the Institute of Engineers Conference Hall, Guwahati
(iii) (http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-01-IND-TACR.pdf
(iv) 3rd Workshop held on 4 February 2009 at Brahmaputra Hotel, Guwahati
(v) (http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-02-IND-TACR.pdf)

7.3. Major Comments Received

281. While a wide range of stakeholders from different administrative, social and economic backgrounds were consulted, their concerns can be summarized in the following three categories of discussion of issues.

7.3.1. The Concerns of Local Stakeholders

282. The project received unanimous support and consent from all local people including those who will be rehabilitated, provided adequate compensation is paid. People in Dibrugarh reach welcomed the project wholeheartedly as the project will benefit the complete area by saving the town and tea industry from flood and erosion. They also highlighted the need of its urgent implementation. The only concern of the villagers was pertaining to compensation against loss of land and the mode of payment. People are looking forward for quick compensation and early start of the project.

283. People welcomed the initiative of the State Government of Assam for strengthening of embankment and providing revetment to the riverbank, as many of them were inundated during 2004 flood and recently in 2015. Condition of the Panchayat Bundh has emerged as the major area of concern for the local people. They were looking forward for enhancement of ghat facilities and environment around it.

284. The local stakeholders were especially supportive of the project as it can reduce the flood inundation scenario as well as protect the land from erosion, which will result in significant safety scenario as well as socio-economic development of the region. The local people did not perceive any adverse impact due to the proposed project. A few people commented that the present embankment is very weak and because of which, flood water enters their houses and paddy fields.

285. The potential project affected people repeatedly stated their resettlement and compensation worries and on being informed of increased air and noise pollution from induced traffic and construction activities, remarked that it does not concern them much.

7.3.2. NGOs' Concerns

286. There are limited NGOs' active in the study area and directly dealing with environmental issues. All the NGOs' consulted had welcomed the flood control project and said that it will help in protection of agricultural land, domestic animals, fishermen communities etc. They also highlighted the importance of maintaining the natural drainage system along the project site. The NGOs during interaction also highlighted the relief work they are carrying out during the flood situations. They also suggested increasing forest cover through afforestation programme. Dr. Sanjay Hazarika of CE-NES also indicated the need of enhancing institutional capacity and strengthening review mechanism. He also emphasizes on the following:

(i) Prevent any change to natural drainage,
(ii) Consider provision of alternate platform then only attached to embankment for use by animals and people during flood, and
(iii) Protection of the fish spawning grounds during construction and operation.

7.3.3. Local Officers' Concerns

287. Dr. Baruwa from Environmental Council of Assam had raised concern of leaching of arsenic into groundwater which is generally used for drinking water supply from the river bank filtration wells in the floodplains of Brahmaputra River and also asked about the possibility of integration of drinking water and irrigation projects. The analysis of water quality of surface and groundwater samples taken in Dibrugarh reach revealed very low arsenic content and the water quality was well within the desirable standards as per IS 10500:1991.

288. Mr. Biren Thukuria (EE, WRD) has highlighted the importance of study for impact on fish productivity due to reduced siltation, which can emerge as a benefit to local fishermen. Mr. B. B. Hagjer (Secretary, Department of Environment and Forests) has pointed out requirement of study of impact downstream and upstream of the reach which can be affected after protection of the reach.

289. During the interaction, Mrs. E. Choudhary (Principal Secretary, Soil Conservation) raised the issues of bed level raising, seepage of embankment/ softening of embankment, erosion and increase in sedimentation as well as the requirement of catchments area treatment plan. He also revealed the requirement of soil conservation, study of earthquakes and its effect on siltation in the river.

290. The interaction with Department of Minority Welfare and Charland Development Directorate revealed that most of the chars in Brahmaputra are semi-permanent and as per their record there are 2,251 char villages. Drinking water is mainly supplied from the handpumps and tube wells. The department also supports in the form of seed distribution, construction of raised platforms with and without sheds, repairing of schools, vocational training to local villagers,

291. The interaction with Chief Conservator of Forests, Forest Development Department and Head Assistant of the CCF office on May 19, 2008 has provided the useful comments and suggestions on possible intervention of proposed project on Forest and Wildlife. No specific suggestion or comment was made with respect to Dibrugarh reach as no protected area is in the project area. However, prior permission is needed from the Chief Conservator of Forests (Wildlife) for cutting of trees within the boundary demarcated as wildlife sanctuaries and national parks. If land is outside the protected areas, then the permission is not necessary from CCF or Forest Department. However, afforestation is needed if there is any loss of tree species during project intervention. At least three plants must be planted in place of one such tree cut during project intervention. For afforestation programme, bamboo, simul trees and banana plants must be planted along the side of embankment. These trees have no side roots to destroy the embankments. Again, in the borrowing sites water resistant plants such as Salix tetrasperma, Buwal and Panihizol should be planted.

292. The detail of formal and informal consultation held with various stakeholders with outcome is summarized at Table 36 and Appendix 15.

Table. 36: Detail of the consultation during study for Tranche-2

Date	Area	Topic of Discussion	Important Outcome
14.02.15	Dibrugarh Reach, WRD office, Circle Office	1.Regarding any specific problem(s) related to environment as a result of flood and erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their	During Economic assessment -No adverse impact visualized. Will help to protect the area from erosion and flood. -- The work is necessary. It should be done urgently. No bad effect

Date	Area	Topic of Discussion	Important Outcome
		property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy	seen. Will benefit the people and the Dibrugarh Town. Should be properly done. Benefits will be there.
Month of February, 2015	Different villages under Dibrugarh Reach on the south Bank	1.Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy	During Economic assessment -No adverse impact visualized. Will help to protect the area from erosion and flood. -- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the Town Chabua and Dibrugarh. Should be properly done. Benefits will be there both for the peoples life and agrarian economy.
July 2015	Effected villages within the benefited area of Dibrugarh Reach on the south Bank	1.Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy	RP Survey Government must be compensated for their land or alternative land should be allotted in nearby safe place. -Government should be very careful during the process of embankment and the actual value of the land should be given during land acquisition for embankment. -If Government gives proper compensation for land during the embankment project and has no objection otherwise people will oppose the embankment. Because many people might lose their land during this project.

Date	Area	Topic of Discussion	Important Outcome
		5.Suggestion or comment on issues other than those discussed so far	
11th November , 2015	People from different villages came to Oakland School for public Hearing. Attended by School teachers, officers from the WRD, Bokakhat; FREMAA, PMC, Village headman, etc. (List of the participants with their signature is attached below)	1.Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy 5.Suggestion or comment on issues other than those discussed so far 6. Mitigation measures proposed by WRD were discussed 7. Grievance redressal Mechanism	- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the Dibrugarh town. Should be properly done. Benefits will be there. -They highlighted the maintenance of water outlets. - Increase of forest cover by plantation -Suggested not to block any existing drainage - protection of the fish spawning grounds during construction and operation. - No adverse impact visualized. Will help to protect the area from erosion and flood. -Our agriculture productivity will improve. Land will be protected. Agricultural lands will be secured from erosion. - So far local prople were satisfied with the plan of the mitigation measures - They also supported the grievance redressal mechanism.

7.4. State Level Workshops

293. Public consultation was also held with the stakeholders during the three state workshops, which were held in the months of December 2007 and June 2008 in Guwahati. Taking into consideration the environmental importance of the project, a number of environmental NGOs were invited during these state workshops. However, only a few had turned up. The list of delegates and invitees of the workshops held during December 2007 and June 2008 have been kept with WRD.

294. During the workshops most of the delegates and NGOs present in the workshops have supported the project. While similar comments as recorded for individual meetings were received, key recommendations in the workshops included (i) wider implications beyond the subproject

areas should be assessed including downstream hydrology and sediment transport, impacts of global climate change, etc.; (ii) interventions should be carefully defined considering the data unavailability and unreliability, for which progressive knowledge development and adaptive approach learning lessons are critical; (iii) performance and lessons of FRERM (including its hydrological, social, and environmental implications) should be studied and reflected; (iv) livelihood implications of the poor should include those who live outside of the embankments and chars, and appropriate supporting measures should be included in the project design; (v) willingness of WRD to adopt people-centered approach as suggested by the team would remain a concern calling for serious pursuit; (vii) effective quality control and sustainability assurance measures should be put in place for FRERM structural measures with effective stakeholder participation; and (vi) details of the study finding should be made available to the local research organizations and interested groups.

7.5. Integration of comments

295. As observed from their responses, almost everyone interviewed was supportive of the project and believes that it will help provide the needed protection against the recurrent ravage of erosion and flood and bring prosperity to the region.

296. During discussions, notes were taken for any issue raised and suggestions made. These were then tabulated for a comprehensive analysis of the concerns raised. References have been taken from public opinion where no official data were available, while the officially available data have been extensively used for understanding of the study area characteristics. Each of the issue was then analyzed on practical and scientific basis and accorded a likewise importance in terms of their magnitude in Chapter 5: Anticipated Environmental Impacts and Mitigation Measures. For any significant concern, preventive or mitigative measures have been suggested drawing points from all the suggested measures.

8. GRIEVANCE REDRESS MECHANISM

297. The updated EIA for tranche-2 was prepared and will be implemented in close consultation with the stakeholders and involve public for consultations, small group meetings, focus group discussions and meetings, particularly with the affected households. This is a new section which is added in the updated EIA 2017. A grievance redressal mechanism developed for the programme will be followed in the tranche-2. GRC for Environment and Social issues will be uniform under the project. GRC are formed at three levels (i) Project level, (ii) District Level and (iii) Executing agency level to receive, evaluate and facilitate the resolutions of the affected person's concern, complaints and grievances as per FREMAA notification No. FREMAA(P)/PROJ/209/2017/4 dated 28.08.2017

298. This framework will be made available in local language (s) and will be distributed on the public meetings at the community level that will be carried out as part of public consultation during project implementation. The updated EIA report will be disclosed on ADB, WRD and FREMAA websites and consultation will continue throughout the project implementation period.

299. Detailed procedure for community complaint and grievance redressal on implementation of EMP or environment related issues during the project implementation stage will be redressed at the local level by a Grievance Redressal Committee (GRC) in a consultative manner with the full participation of the affected households including women, or their representatives; the Executive Engineers, Assistant Engineers and representatives from the panchayats/ municipality, local NGO, and vulnerable groups.. Grievance will be redressed within two to four weeks from the date of lodging the complaint. At the project site level, the SIO is the secretariat of the GRM. All costs incurred in resolving the complaints will be borne by the project. A comprehensive report will be maintained by EA of all the grievance proceedings for future checking and/or auditing. This proposal was discussed during public consultation.

300. At district level under the Deputy Commissioner's Chairmanship grievances will be resolved if not resolved at project /local level. The GRC will meet regularly at least once a month on a prefixed date. Decisions of the District level GRC will be final, unless an appeal is preferred with the CEO, FREMAA. The PMU is the secretariat of the GRM at the state level.

301. In addition to disputes/ complaints relating to environmental safeguards will be resolved at SIO level. If not resolved will be referred District Level and later to state GRM in the PMU (FREMAA) under the CEO. However, the GRM is not substitute any Court of Law. While complaints files to the GRM of the project, complainant has its freedom to submit the case to the court.,

WORKING PRINCIPLE OF GRC

Figure 11: Grievance Readdress Mechanism

9. ENVIRONMENTAL MANAGEMENT PLAN

9.1. Environmental Management Plan (EMP) and Monitoring Plan (EMoP)

302. The aim of the EMP is to ensure that the various adverse impacts associated with the project are properly mitigated; either by preventing the impacts or by mitigating those to reduce the effect to an acceptable level by adopting the most suitable techno-economic option. The EMP also ensures that the positive impacts are conserved and enhanced.

9.2. The EMP

303. The EMP consists of a set of mitigation, monitoring and institutional measures to be taken during the design, construction and operation stages of the project. The plan also includes the actions needed for implementation of these measures.

304. The major components of the EMP are:

(i) Mitigation of potentially adverse impacts
(ii) Monitoring during project implementation and operation
(iii) Institutional Capacity Building and Training
(iv) Implementation Schedule and Environmental Cost Estimates
(v) Integration of EMP with project planning, design, construction and operation

305. The EMP is detailed at Appendix 16.

9.2.1. EMP Implementation Timetable

306. The mitigation measures shall be implemented depending on the nature and time of impact. The implementation schedule has been prepared considering 36 months of construction phase starting from year 2018 and operating phase for 30 years.

9.2.2. Authorities and Their Responsibilities for Implementation of the EMP

307. The authorities and responsibilities for the implementation of the environmental management plans shall be tiered based on the activity. The suggested hierarchy and information flow is given in at Figure-12.

308. All the policy decisions, including incorporation of the EMP requirements in compliance to loan covenants shall be the responsibility of the recommended Flood and River Erosion Management Agency of Assam (FREMAA) as the executing authority and will be registered under the Societies Act. The FREMAA composed of representatives from State: departments of water resources, agriculture, char development, finance, fisheries, forest and environment, planning and coordination, public works, disaster management and revenue, rural development, soil conservation, and welfare of plain tribes and backward classes.

309. The current program management unit (PMU) will continue on behalf of FREMAA to take responsibilities to implement overall EMP. One of the units in the PMU is the social and environmental unit, which include a senior environmental specialist seconded from the State Forestry and Environment Department or engaged externally from the market. The PMU will continue to be assisted by a multidisciplinary team of consultants for institutional strengthening and project management (ISPM) for capacity development, quality control, and project management. The PMU-Social and Environmental Unit (SEU) will ensure that the environmental mitigation measures are being implemented by the subproject implementation offices (SIOs). The

PMU will, among others ensure that the EIA reports comply with national and Bank guidelines, monitor the status of implementation, and preparation of monitoring reports.

310. In each subproject, there is SIO comprising technical team (SIO-T). The SIO will coordinate the implement or cause the implementation of the monitoring and mitigation measures under the supervision of the PMU. The Executive Engineer (EE) is responsible for day today activities with support from PMC. Assistant Engineers under the EE directly monitor and supervise field work and report to SIO. The head of the SIO under the Assam State Disaster Management Authority (ASDMA) is the District Commissioner of the respective district.

9.2.3. Mechanisms for Feedback and Adjustment

311. **Environment Management Plan**- The implementation of environmental management plan is guided by the EMP matrix in appendix 16 and good practice in appendix 17. All the EMP related with the construction work will be implemented by the contractor. The implementation of other aspects of EMP will be led by the PMU with support from PMC and ISC as well as SIO.

312. The contractor will report the implementation of EMP in its monthly report and the PMU will submit semi-annual report on the implementation of overall EMP.

9.3. Environmental Monitoring Plan (EMoP)

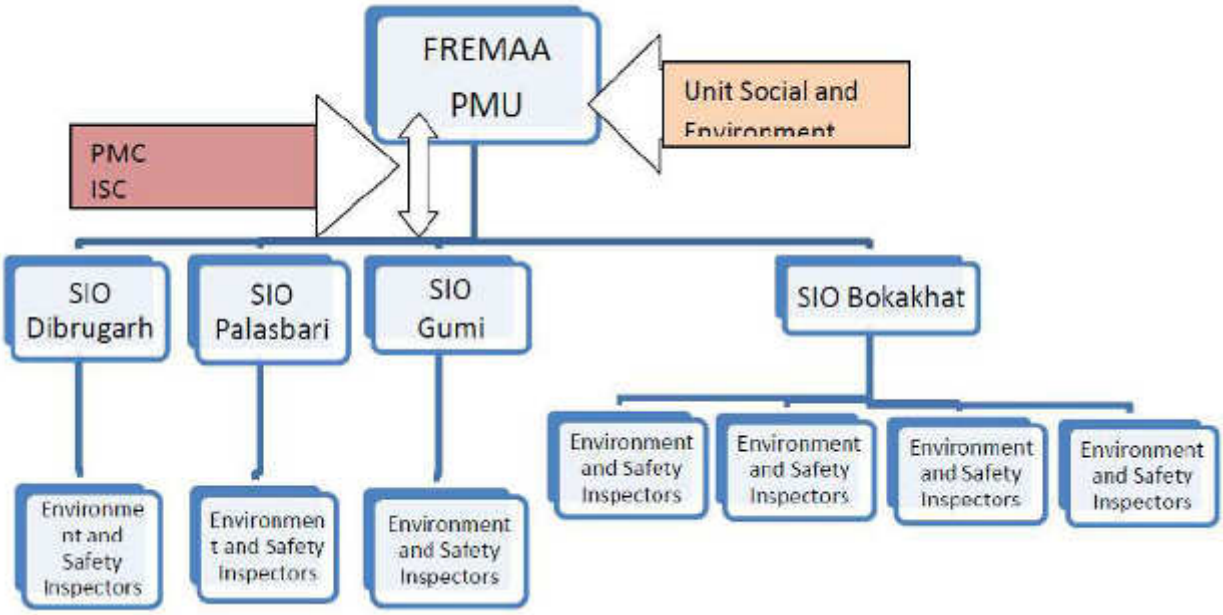
313. The aim of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards.

314. A monitoring schedule has been drawn up based on the environmental components that may be affected during the construction and operation of the project. Since project is likely to have impact on various components of environment, a comprehensive monitoring plan covering wildlife, soil erosion, drainage congestion, tree plantation, air quality, noise and vibration are provided as Appendix 18. Monitoring Plan has been separately suggested for construction phase and operation phase. Monitoring points have been selected based on the sensitivity of the location with respect to sensitive receptors.

9.4. Institutional Capacity

315. The proposed organization structure to implement the environmental management plan in FREMAA is shown at Figure -12.

Figure 12: Proposed Organization Structure



9.5. Institution Strengthening Cost

316. To enhance the capacity of the project staff in implementing EMP for effective implementation of proposed mitigation measures and monitoring the resultant effect, some training programs are proposed. The detailed training plan is provided at Appendix 19.

317. The environmental budget has been worked out for the entire three projects for tranche 2 together since various costs are common in nature. However summary table below highlights sub projects specific costs component. The mitigation cost, inclusive of monitoring cost and training during the project life cycle (construction and operation phase) amounts is estimated to be ₹15.95 million for Dibrugarh sub project in tranche 2.

318. The mitigation cost, inclusive of monitoring cost and training during the project life cycle (construction and operation phase) amounts is estimated to be ₹15.95 million for Dibrugarh sub project in tranche 2. The mitigation cost including monitoring is estimated as ₹6.13 million during construction phase and ₹2.5 Million during operation phase. The costs of establishment and training are estimated as ₹5.92 million. The detailed break up is given at Appendix 20.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1. Conclusions

319. The conclusions are based on EIA carried out for the Dibrugarh Reach, which is one of the three reaches identified as most vulnerable to flood and erosion of the Brahmaputra river, under the Flood and Riverbank Erosion Risk Management Agency of Assam (FREMAA). The project is needed to safeguard the people, property and environment from the risk of devastating floods of the Brahmaputra River. The project involves renovation of existing embankments, construction of retired embankment behind the existing embankments (facing riverbank erosion), and riverbank protection.

320. The subproject at Dibrugarh was considered as environmental category B under ADB SPS 2009 and the finding of the updated EIA supported this categorization as no significant impact generated from the Dibrugarh subproject. With the structural works focusing on sustaining the functions of the existing embankment systems through renovation of deteriorated embankments, provision of inner secondary embankment and sluice gates, and riverbank protection works, the present EIA indicates no significant adverse environmental impacts that are sensitive, diverse, or unprecedented, and affect an area broader than the sites.

321. The update study was carried out from February 2015 to January 2016 (information collected till September 2017) and is based primarily on secondary data. However, primary data were also collected where secondary data were not available or not up to date. The environmental study covered the project area, as well as the area of direct and indirect impacts. The environmental assessment report was prepared in accordance with relevant applicable laws and regulations of the Government of India; and in conformity with the ADB's SPS.

10.1.1. Environmental Gains Due to Proposed Work Justifying Implementation

322. The project entails various impacts on the project setting. There are many impacts bearing benefits to the area against the limited number and magnitude of negative impacts. These include the following:

(i) The Brahmaputra River carries more water per unit area of basin than any other river in the world, with the average annual rainfall in the subproject area reaching 4,100 mm. The proposed project-through strengthening the reliability of the existing embankments-will prevent people from the impacts of devastating floods.

(ii) The Dibrugarh Reach has considerable significance from the socio-economic, terrestrial ecological as well as hydrological perspectives. Although the protection of Dibrugarh town from erosion of the Brahmaputra River that started in 1960's is rightly being claimed to be a success story, yet over the years the problem resurfaces itself in newforms as the river configuration vis-à-vis the adjoining river bank areas have changed considerably and reaches upstream and downstream of the town are being affected by chronic erosion hazards eating away large chunks of productive tea cultivated lands. A dense settlement of permanent nature has come up on the river side of the embankment which has undergone considerable degradation and lowering over the years and often affected by seepage during high flood level. Strengthening of Titadimaru dyke (4.70 km) along south bank of Maijan beel as per highest HFL is equally essential for the protection of vital installations like Airport, Medical College.

(iii) Therefore, safeguarding the area and protection of tea and oil industries through integrated flood and riverbank erosion management is considered highly essential.

(iv) There are only two wetlands in the subproject area - Maijan beel, and the Nagaghuli beel. These are not likely to be affected due to the project intervention. The proposed project will likely to enhance the fish productivity in these water bodies

due to reduced sedimentation and seed containment during high water level in the river Brahmaputra.

(v) There is no migratory route of fish, or wildlife species in entire Dibrugarh Reach area; hence, there is no possibility of impact on animal distribution

(vi) The people resides near Brahmaputra Dyke in Dibrugarh are economically very poor, mostly depending on the harvesting natural resources for livelihood. Majority of the people rely on fishing at river Brahmaputra and Maijan beel for their livelihood. While a; limited number of people depend on selling fuel woods.

(vii) The project area does not pass through any protected area (reserved forests, wild life sanctuaries, national park) or ecologically sensitive areas.

(viii) The afforestation will not only help in compensating loss of trees but also increase tree cover in the long run due to the compensatory afforestation at the rate of 1:3 as per the state government policy.

10.2. Potential Negative Impacts, Mitigation, Management and Monitoring

323. The main adverse environmental impacts attributable to the Dibrugarh subproject are related to construction activities that includes dust and noise generation, occupational health and safety particularly related to borrow pit and hauling of soil for embankment construction. These impacts are relatively easy to mitigate with good engineering practices and are short- term being co-terminus with the construction phase. These impacts shall be monitored continually by implementing and updating the Environmental Management Plan and Environmental Monitoring Plan. During RP for tranche 2 around 1,439 trees will be affected. Out of which 366 were fruit bearing trees and 1,073 were timber producing trees. These affected plants will be replaced at a ratio of 1:3. No sensitive ecosystem will be adversely affected in the Dibrugarh Reach

324. No significant external negative impacts are anticipated on river hydrology, morphology, and sediment transport due to the nature of the project to support the strengthening of the existing embankment systems to maintain or restore their intended functions. They will formalize the existing flooding behavior that has persisted since these embankments were constructed. Riverbank protection measures-with their focus on revetments and pro-siltation measures along the naturally developing bank lines in an adaptive manner-will not alter the existing unstable channel formation pattern of the Brahmaputra morphology. However, systematic monitoring of river hydrology, morphology, and sediment transport will be put into operation under the project, and due mitigation measures will be provided in case any unexpected effects caused by the subproject are observed. The monitoring will include silt deposition in the river and areas adjacent to the bank, especially in the vicinity of anti-erosion and river training works, and changes in cross-section at regular intervals to detect any changes and initiate corrective measures. The Project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies. Also, under the project, numerical hydraulic model will be used to identify low lying areas with a potential risk of deep inundation when major floods occur and systematic annual analysis and prediction of sedimentation and erosion behavior, which includes the analysis of the structural response to riverbank protection work. The monitoring and numerical analysis will contribute to the knowledge base and understanding of the Brahmaputra morphology. Natural drainage systems shall be left undisturbed to the greatest extent possible; the flooding behavior of beels and wetlands will be assessed and where possible improved and/or preserved. Adequate provisions shall be made in designing embankments to withstand extreme meteorological and other geophysical events.

325. There is a possibility that the subproject areas may be affected by the impacts of climate change and other external events including major earthquakes and upstream development works such as hydropower development. While the impacts of these events may well extend the economic life of the subproject investments (of 30 years), available study indicates the possible climate change impact of increased precipitation by up to 30% in the north-eastern region by 2040-

60, although diverse anticipation still coexists. A large-scale earthquake (and landslides) may exacerbate the sediment loads of the Brahmaputra, whereas the hydropower dams upstream may reduce the sediment inflow. On these accounts, the systematic monitoring of the river dynamics to be strengthened under the project will facilitate the identification and implementation of necessary measures to adapt to any emerging changes in the construction and post-construction phase of the subproject.

326. During the construction stage, some trees along the embankment are likely to be cut, but if the proposed compensatory afforestation plans are effectively implemented and survival rate is monitored and sustained, the positive benefits are likely to be accrued. Project activities are likely to generate other adverse environmental impacts during construction. However, these will be temporary. Implementation of the prescribed mitigation measures will minimize the adverse impacts, with the stipulated environmental management and monitoring plans.

327. The project involves strip acquisition of land for strengthening the existing embankments and associated structural relocation. There are also pending land acquisition cases for infrastructure constructed in the past. The concerned land acquisition and resettlement cases including the pending cases will be addressed following the Government's and the SGOA's laws and regulations, and ADB's Involuntary Resettlement Policy, which has been stipulated in the resettlement framework, based on which resettlement plans are prepared and implemented to address all the cases. For tranche 1 works, extensive public consultation has been carried out, consistent with state guidelines. For affected persons, support will be provided to improve, or at least restore, the pre-intervention income and livelihoods standards, and productive capacity. In addition, the subproject will provide construction labor opportunities and community development assistance to nearby communities and to landowners whose land is acquired or structures be affected, including nontitle holders.

10.3. Irreplaceable Resources

328. Dolphin and other endangered species found in the river Brahmaputra and other nearby areas are not exclusive to the project site. No damage to the habitat of these species is anticipated. There are no other environmental sensitive resources found in the project area which is likely to be affected due to the project.

10.4. Post EIA Surveillance and Monitoring

329. While an EIA is meant to provide a comprehensive understanding of the environment status of the area under the study, post EIA surveillance is the means to ensure that the significant impacts identified are adequately mitigated as per the proposed mitigation plan. A detailed monitoring plan has been provided as part of the Environmental Management Plan. Air, surface water quality, ground water quality, noise, soil erosion, drainage congestion and tree survival rate monitoring and reporting along with the follow up actions in case of deviation from the norms have been detailed out. The frequency has been set in consideration of the likely impacts.

10.5. Public Consultations

330. The project received unanimous support and consent from all local people including those who will be rehabilitated, provided adequate compensation is paid. People welcomed the initiative of the SGOA for strengthening of embankment and providing revetment to the riverbank, as many of them were inundated during 2004 flood. The subproject will result in significant safety scenario as well as socio-economic development of the region. The local people did not perceive any adverse impact due to the proposed project. Environmental awareness and likewise concern were found generally low and issues such as probable reduction in fish catch also did not raise any significant concern amongst the fishermen.

331. Nevertheless, local stakeholders as well as NGOs emphasized on the need to ensure the effectiveness of institutions and their program delivery mechanisms to implement the subproject structural and non-structural measures. In particular villagers were concerned on the compensation against loss of land and the mode of payment, stating that the compensation payment of past land acquisition is still to be provided. Capacities and willingness of the project organizations to adopt people-centered approach as suggested by the project also remains a constraint. The project has included necessary provisions to address these concerns, including the time-bound actions to address these institutional constraints with institutional reforms and capacity development support.

10.6. Recommendations

332. The update study was carried out while the feasibility study was being done for tranche 2. The detailed engineering design was consulted with the SIO as per DPR. If any major changes during detailed design, or any major additional work other than the proposed project activities under tranche 2, the additional assessment of environmental impact needs to be carried out. This additional assessment will have to be submitted to concerned Government authorities, if any clearance is involved. It shall also have to be sent to ADB for concurrence before civil works commence. Moreover, the executing agencies have to submit the detailed engineering designs to ADB, which will review them and examine whether major changes or major additional works have been included. In this context, changes that need to be reported to ADB.

333. The flooding and riverbank erosion pattern of the river shall have to be closely monitored and analyzed during the proposed life span of the embankment and riverbank protection measures, and appropriate and timely measures need to be taken to adapt to any changes in the natural river environment. Over the medium to long term, effective knowledge base needs to be established including the modeling of flooding and morphological behavior and sediment transport mechanisms of the Brahmaputra River and its tributaries to quantitatively assess the implications of any past and new water sector investments.

334. WRD has limited capacity to address the environmental measures in house. There is a need to enhance institutional capacity of the WRD with regard to environmental training, monitoring infrastructure and environmental guidelines. Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned EA officials. It is recommended to develop environmental guidelines focused on effective implementation of mitigation measures. Performance indicators may also be developed as part of these guidelines to monitor and assess the effectiveness of the mitigation measures.

335. Awareness programme for public shall be launched for flood embankment strengthening and river bank protection works, and conservation of natural environment and sanitation during construction and operation phase of the project.

APPENDIX 1: USE OF GEOTEXTILE BAGS FOR RIVERBANK EROSION MITIGATION

The use of geotextile bags plays a major role in mitigation of erosion in a way that is both economical and flexible. Geotextile bags have the two most important properties for erosion control, the filter function to prevent the undermining of the riverbank and the ability to withstand the hydraulic load of the current. Geotextiles were first introduced in the market in 1950's and their use has increased rapidly due to the properties, flexible use and stability. Nowadays geotextile sand containers are used in the river and coastal engineering field as construction elements for erosion control, scour fill, artificial reefs, groynes, dams as well as in breakwater and dune revetments.

Geosynthetic containers are multi-purpose elements that can be manufactured according to almost any demand. The additional functions of geotextile bags, which make them so attractive, are as follows:

> **Filtration:** Filtration restricts the migration of fine soil while remaining permeable to water movement at least greater than or at least to the permeability of the protected soil.
> **Reinforcement**: The geotextile bags must also withstand the hydraulic load of the current which can reach up to 3m/s. This function involves the stabilization of a soil mass by providing a closed compartment.

The gradual natural changes to environment may not have much impact as it slowly occurs and fish may get opportunity to adapt. However, any manmade and quick changes might have a more important impact. The various field studies and observations show that the overall number of species were better in geotextile bag areas than in areas exposed to erosion or protected by CC-blocks. Therefore, geotextile bags do not have any negative impact on fisheries rather the situation is slightly better. Small pockets in between bags, where flow velocity is decreased, may create shelter places for fishes (Munir Ahmed, 2007). After the geotextile gets the characteristics of the environment, fish species adapt to the new environment and hide in the shelter holes. During diving inspection, they feel the fishes and shrimp (Atiqur Afur, 2007).

There are no negative effects known on the flora if geotextile bags are used for river bank protection. The roots are small enough to pass through the geotextile. However, roots have negative effects on geotextile bags and on the whole protection design. In particular when roots dry out after having passed through the geotextile big pores remain where sand can be washed out. In this case the stability of the structure is reduced.

Under normal conditions polypropylene does not present any toxic hazard, either from skin contact or inhalation. The material is inert and shows no toxicity (Dow, 2007). Additionally, it can be said that polypropylene fibers are widely accepted. It is assumed that restrictions in these industries are much tighter. Therefore, it can be postulated that PP fibers for geotextile are harmless from a toxicological point of view. (Naue Fasertechnik, 1995). Hence, the use of geotextile bags has no negative effect on the environment, neither to the water quality nor the flora and fauna.

APPENDIX 2: WATER QUALITY CRITERIA FOR DESIGNATED BEST USE

Designated-Best-Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • dissolved Oxygen 6mg/l or more • biochemical Oxygen Demand 5 days 20°Cmg/l or less
Outdoor bathing (organized)	B	• total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more • biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 • dissolved Oxygen 4mg/l or more • free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH between 6.0 to 8.5 • electrical Conductivity at 25°C micro mhos/cm Max 2250 • sodium absorption Ratio Max 26 • boron Max 2mg/l
	Below-E	• not Meeting A, B, C, D & E Criteria

APPENDIX 2 A. IS:10500 Drinking Water Quality Standard

	Parameters	Unit	Acceptable Limit IS:10500	Permissible Limit IS:10500
1	Color	Hazen units	5	15
2	Odor	-	Agreeable	Agreeable
3	Taste	-	Agreeable	Agreeable
4	Turbidity	NTU	1	5
5	Total Dissolved Solids	mg/l	500	2000
6	pH	-	6.5 to 8.5	No Relaxation
7	Total Hardness as $CaCO_3$	mg/l	200	600
8	Iron as Fe	mg/l	0.3	No Relaxation
9	Aluminum	mg/l	0.03	0.2
10	Copper as Cu	mg/l	0.05	1.5
11	Manganese as Mn	mg/l	0.1	0.3
12	Zinc as Zn	mg/l	5	15
13	Magnesium as Mg	mg/l	30	No Relaxation
14	Barium	mg/l	0.7	No Relaxation
15	Calcium as Ca	mg/l	75	200
16	Silver	mg/l	0.1	No Relaxation
17	Selenium as Se	mg/l	0.01	No Relaxation
18	Molybdenum	mg/l	0.07	No Relaxation
19	Boron	mg/l	0.5	1.0
20	Nitrates as NO_3	mg/l	45	No Relaxation
21	Sulphate	mg/l	200	400
22	Sulphide		0.01	No Relaxation

23	Fluoride as F	mg/l	1.0	1.5
24	Chlorides as Cl	mg/l	250	1000
25	Ammonia	mg/l	0.5	No Relaxation
26	Chloramines	mg/l	0.2	No Relaxation
27	Residual, Free chlorine	mg/l	0.2	1.0
28	Total Alkalinity as calcium carbonate	mg/l	200	600
29	Phenolic compounds (as C_6H_5OH)	mg/l	0.001	0.002
30	Mineral Oil	mg/l	0.03	No Relaxation
31	Anionic detergents (as MBAS)	mg/l	0.2	1.0
32	Chromium	mg/l	0.05	No Relaxation
33	Arsenic as As	mg/l	0.01	0.05
34	Mercury as Hg	mg/l	0.001	No Relaxation
35	Cadmium as Cd	mg/l	0.003	No Relaxation
36	Lead as Pb	mg/l	0.01	No Relaxation
37	Nickel as Ni	mg/l	0.02	No Relaxation
38	Cyanide as CN	mg/l	0.05	No Relaxation
39	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	0.0001	No Relaxation
40	Polychlorinated biphenyls	mg/l	0.0005	No Relaxation
41	Total Coliform	MPN/100ml	Nil	No Relaxation

APPENDIX 3: NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutants	Time-weighted average	Concentration in ambient air			Method of measurement
		Industrial Areas	Residential, Rural and other Areas	Sensitive Areas	
SulphurDioxide (SO_2)	Annual Average*	80 µg/m^3	60 µg/m^3	15 µg/m^3	- Improved West and Geake Method - Ultraviolet Fluorescence
	24 hours**	120 µg/m^3	80 µg/m^3	30 µg/m^3	
Oxides of Nitrogen as (NO_2)	Annual Average*	80 µg/m^3	60 µg/m^3	15 µg/m^3	- Jacob and Hochheiser Modified (Na-Arsenite) Method
	24 hours**	120 µg/m^3	80 µg/m^3	30 µg/m^3	- Gas Phase Chemiluminescence
Suspended Particulate Matter (SPM)	Annual Average*	360 µg/m^3	140 µg/m^3	70 µg/m^3	- High Volume Sampling, (Average flow rate not less than 1.1 m3/minute).
	24 hours**	500 µg/m^3	200 µg/m^3	100 µg/m^3	
RespirableParticulate Matter (RPM) (size less than 10 microns)	Annual Average*	120 µg/m^3	60 µg/m^3	50 µg/m^3	- Respirable particulate matter sampler
	24 hours**	150 µg/m^3	100 µg/m^3	75 µg/m^3	
Lead (Pb)	Annual Average*	1.0 µg/m^3	0.75 µg/m^3	0.50 µg/m^3	- ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 µg/m^3	1.00 µg/m^3	0.75 µg/m^3	.
Ammonia1	Annual Average*	0.1 mg/ m^3	0.1 mg/ m^3	0.1 mg/m^3	.
	24 hours**	0.4 mg/ m^3	0.4 mg/m^3	0.4 mg/m^3	.
CarbonMonoxide (CO)	8 hours**	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/ m^3	- Non Dispersive Infra Red (NDIR)
	1 hour	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3	Spectroscopy

Pollutants	Time-weighted average	Concentration in ambient air			Method of measurement
		Industrial Areas	Residential, Rural and other Areas	Sensitive Areas	
*	Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.				
**	24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.				

APPENDIX 4: NATIONAL AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE

Area code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70 55
(B)	Commercial area	65	45
(C)	Residential area	55	40
(D)	Silence Zone	50	

Notes:-

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* **dB(A) Leq** denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A ―decibel‖ is a unit in which noise is measured.

―A‖, in **dB(A) Leq,** denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specified period.

Note: The Principal Rules were published in the Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2000 vide S.O. 1046(E), dated 22.11.2000 and by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2002 vide S.O. 1088(E), dated 11.10.2002, under the Environment (Protection) Act, 1986.

APPENDIX 5: COUNTING OF TOTAL IMPORTANT TREE SPECIES IN EMBANKMENT SITE (COVERING TRANCHE 1 AND TRANCHE 2)

Tree Species	Abbreviated forms of Tree Species	Total Numbers
Pakori-Ficus rumphii	FR	5750
Acacia-Acacia auriculiformes	AA	575
Sagina-Moringa oleifera	MO	2415
Amlakhi-Phylanthus ambilica	PA	115
Bhimkol-Musa balbasiana	MB	4025
Atlas-Annona squatamosa	AS	3910
Owtenga-Dillenia indica	DI	345
Jatibanh-Bambusa tulda	BT	460
Aam-Mengifera indica	MI	2530
Kadam-Anthrocephalus cadamba	AC	2875
Ahot-Ficus religiosa	FG	6900
Bot-F. bengalensis	FB	690
Simul-Bombax ceiba	BC	920
Gamari-Gmelina arboria	GA	5290
Narikol-Cocos nucifera	CN	1495
Jolphai-Elaeocarpus fleribundus	EF	460
Segun-Tectona grandis	TG	2530
Indian Rubber-Ficus elastica	FE	115
Ghoranim-melia azedarach	MA	1380
Deodaru-Polialthia longifolia	PL	575
Satiana-Alstnia scolaris	Asc	11500
Amita-Carica papaya	CP	345
Kathal-Artocarpus heterophyllus	Ahs	2185
Bogori-Zizyphus jujuba	ZJ	10925
Siris-Albizia lebek	AL	5980
Rangakanchan-Bauhinia purpurea	BP	805
Krishnasura-Delonix regia	DR	1150
karash-Pungamia pinnata	PP	1150
Areca catechu	Acat	5750
Bijuli Banh-Bambusa pallida	BAP	230
Total		**83375**

APPENDIX 6: COMMUNITY DOMINANCE INDEX OF TREE SPECIES IN VARIOUS STUDY ZONES OF DIBRUGARH REACH

Zones	Study Zone	1st Dominant	2nd Dominant	Index Value	Lat./Long.
1a	Mohanaghat Zero point Inside Embankment	*Annona squatamosa*	*Ficus rumphii*	86.66	27°29′11″N 94°54′33″E
1b	Mohanaghat Zero point Outside Embankment	*A. squatamosa and Anthrocephalus cadamba*	*Acacia auriculiformes and Mengifera indica*	81.08	27°29′11″N 94°54′33″E
2a	Pachali Inside Embankment	*Gmelina arboria*	*Annona squatamosa*	75	------
2b	Pachali Outside Embankment	*Ficus religiosa*	*Annona squatamosa*	56.66	----------
3a	Phulbagan Outside Embankment	*Melia azedarach*	*Polialthia longifolia, and Musa balbasiana*	54.84	----------
3b	Koilaghat (Phulbagan)Inside Embankment	*Ficus religiosa*	*Tectona grandis*	92.86	------
4a	Tinikuria Outside Embankment	*Alstnia scolaris*	*Gmelina arboria and Moringa oleifera*	72	------
4b	Tinikuria Inside Embankment	*Bombax ceiba and A.squatamosa*	Nil	100	------
5a	Maijan Borsaikia Outside Embankment	*Artocarpus heterophyllus*	*Mengifera indica*	60.46	27°30′10″N-94°56′26″E
5b	MaijanBorsaikia Inside Embankment	*Ficus religiosa*	*Gmelina arboria*	100	27°30′10″N-94°56′26″E
6a	MaijanThakurbaril Outside Embankment	*Zizyphus jujuba*	*Anthrocephalus cadamba*	57.45	27°30′14″N-94°56′55″E
6b	MaijanThakurbaril Inside Embankment	Nil	Nil	Nil	27°30′14″N-94°56′55″E
7a	Maijanbeel MaijanTE Inside Embankment	*Ficus rumphii*	*Gmelina arboria and Alstnia scolaris*	68.25	
7b	Maijanbeel MaijanTE Outside Embankment	*Alstnia scolaris*	*Albizia lebek and Delonix regia*	100	
8a	MotlaTE Inside Embankment	*Zizyphus jujuba*	*Albizia lebek*	58.97	
8b	MotlaTE Outside Embankment	*Zizyphus jujuba*	*Albizia lebek*	62.86	
9a	Nagaghuli Armycamp Inside Embankment	*Zizyphus jujuba*	*Ficus rumphii*	54.34	
9b	Nagaghuli Armycamp Outside Embankment	*Zizyphus jujuba*	*Ficus rumphii*	54.34	
10a	NagaghuliStone spur Inside Embankment	Zizyphus jujuba	Cocos nucifera,, A. scolaris and Moringa oleife	78.18	
10b	NagaghuliStone spur Outside Embankment	Zizyphus jujuba	A. scolaris and Pungamia pinnata	76.19	
11a	Oackland TE Zero Outside Embankment	Areca catechu	A. scolaris and Musa balbasiana	95.85	
11b	Oackland TE Zero Inside Embankment	Alstnia scolaris	Nil	100	

APPENDIX 7: COMPREHENSIVE LIST OF AVIAN FAUNA RECORDED IN DIBRUGARH REACH

English Name	Family/Scientific Name	Status	Status of IWPA/GS/habitat
Little Cormorant	Phalacrocoracidae Phalacrocorax niger	*R*	aq
Little Egret	*Ardeidae* *Egretta garzetta*	*R*	aq
Intermediate Egret	*Mesophoyx intermedia*	*R*	aq
Cattle Egret	*Bubulcus ibis*	*R*	aq
Great Egret	*Casmerodius albus*	*R*	aq
Indian Pond Heron	*Ardeola grayii*	*R*	aq
Black-Crowned Night Heron	*Nycticorax nycticorax*	*R*	aq
Grey Heron	*Ardea cinerea*	*R*	aq
Purple Heron	*Ardea purpurea*	*R*	aq
Chinese Pond Heron	Ardeola bacchus	*R*	aq
Yellow Bitern	*Ixobrychus sinensis*	*R*	aq
Black Bittern	*Dupetor flavicollis*	*R*	aq
Cinnamon Bittern	*Ixobrychus cinnamomeus*	*R*	aq
Little Bittern	*Ixobrychus minutes*	*R*	aq
Asian Openbill	Ciconidae *Anastomus oscitans*	*R*	aq
Lesser Adjutant Stork	*Leptoptilos javanicus*	*R*	GT, aq
Greater Adjutant	L. dubius	*R*	Schedule-I/GT,aq
Lesser Whistling-Duck	*Dendrocygna javanica*	*R*	------
Bar-Headed Goose	Anatidae *Anser indicus*	*M*	Schedule-I/GT,aq
Grey-Lag geese	*Anser anser*	*M*	GT, aq
Ruddy Shelduck	*Tadorna ferruginea*	*M*	aq
Gadwall	*Anas strepera*	*M*	aq
Mallard	*Anas platyrhynchos*	*M*	aq
Spot-billed Duck	*Anas poecilorhyncha*	*M*	aq
Common Teal	*Anas crecca*	*M*	aq
Garganey	*Anas querquedula*	*M*	aq
Northern Pintail	*Anas acuta*	*M*	aq
Northern Shoveler	*Anas clypeata*	*M*	aq
White-breasted Waterhen	Rallidae *Amaurornis phoenicurus*	*R*	aq
Water Cock	*Gallicrex cinerea.*	*R*	aq
Common Moorhen	*Gallinula chloropus*	*R*	aq
Water Rail	*Rallus aquaticus*	*R*	aq
Common Coot	*Fulica atra*	*M*	aq
Pheasant-tailed Jacana	Jacanidae *Hydrophasianus chirurgus*	*R*	aq
Bronze-winged Jacana	*Metopedius indicus*	*R*	aq

English Name	Family/Scientific Name	Status	Status of IWPA/GS/habitat
Painted Snipe	*Rostratulidae* *Rostratula bengalensis*	*R*	aq
Common Snipe	Scolopacidae *Gallinago gallinago*	*R*	aq
Solitary Snipe	*Gallinago solitaria*	*R*	aq
Common Sandpiper	*Actitis hypoleucos*	*M*	aq
Marsh Sandpiper	*T. stagnatalis*	*M*	aq
Little Stint	*Calidris minuta*	*M*	aq
Collared Patrincole	*Glareolidae* Glareola lecta	**M**	aq
Small Indian Patrincole	*G. pratincola*	*M*	aq
Red-wattled Lapwing	*Vanellus indicus*	*R*	aq
Grey-headed Lapwing	*Vanellus cinereus*	*M*	aq
Northern Lapwing	*Vanellus vanellus*	*M*	aq
River Tern	Laridae *Sterna aurantia*	*M*	aq
Whiskered Tern	*Chlidonias hybridus*	*R*	aq
Osprey	Accipitridae *Pandion haliatus*	*R*	Schedule-I/GT,T
Black Kite	*Milvus migrans*	*R*	T
Red-headed Vulture	*Sarcogyps calvus*	*R*	GT,T
Crested Serpent Eagle	*Spilornis cheela*	*R*	T
Eurasian Marsh-Harrier	*Circus aeruginosus*	*M*	T
Pied Harrier	*Crcus melanoleucos*	*M*	T
Hen Harrier	*C. cyaneus*	*M*	T
Pallied Harrier	*C. macrourus*	*M*	T
Shikra	*Accipiter badius*	*M*	Schedule-I/GT,T
Lesser Kestrel	*Falco naumanni*	*M*	Schedule-I/GT,T
Common Kingfisher	Alcidinidae *Alcedo atthis*	*R*	aq
Blyth's Kingfisher	*Alcedo hercules*	*R*	aq
Blue-eared Kingfisher	*Alcedo meninting*	*R*	aq
White-throated Kingfisher	*Halcyon smyrnensis*	*R*	aq
Stork-billed Kingfisher	Dacelonidae *Halcyon capensis*	*R*	aq
Pied Kingfisher	Cerylidae *Ceryle rudis*	*R*	aq
	Passeridae	*R*	T
House Sparrow	*Passer domestica*	*R*	T
Tree Sparrow	*Passer montanus*	*R*	T
Blackheaded Munia	*Lonchura malacca*	*R*	T
White-rumped Munia	*Lonchura striata*	*R*	T
White Wagtail	*Motacilla alba*	*M*	aq
Yellow Wagtail	*Motacilla flava*	*M*	aq

English Name	Family/Scientific Name	Status	Status of IWPA/GS/habitat
Grey Wagtail	*Motacilla cinerea*	*M*	aq
Paddy-field Pipit	*Anthus rufulus*	*M*	aq
Richard's Pipit	*Anthus richardi*	*M*	aq
Citrine Wagtail	*Motacilla citriola*	*M*	aq
Golden Fronted Leaf bird	Irinidae *Chloropsis auriforns*	*R*	T
Orange Billed Leaf bird	*Chloropsis hardwiskii*	*R*	T
Black-hooded Oriole	Corvidae *Oriolus xanthornus*	*R*	T
Rufous Treepie	*D endrocitta vagabunda*	*R*	T
House Crow	*Corvus splendens*	*R*	T
Large-billed Crow	*Corvus macrorhynchos*	*R*	T
Black Drongo	*Dicrurus macrocercus*	*R*	T
Crow-billed Drongo	*Dicrurus annectans*	*R*	T
Common Iora	*Aegithina tiphia*	*R*	T
Ashy Wood Shallow	*Artamus fuscus*	*M*	T
Blue Throated Barbet	Megalaimidae *Megalaima asiatica*	*R*	T
Coppersmith Barbet	*Megalaima haemocephala*	*R*	T
Lineated Barbet	*Megalaima lineata*	*R*	T
Blue-eared Barbet	*Megalaima australis*	*R*	T
Asian Pied Starling	Sturnidae *Sturnus contra*	*R*	T
Common Myna	*Acridotheres tristis*	*R*	T
Jungle Myna	*Acridotheres fuscus*	*R*	T
White-vented Myna	*A. grandis*	*R*	T
Grey-headed Myna	*Sturnus malabaricus*	*R*	T
Creg Martin.	Hirundinidae *Hirundo rupestris*	*M*	T
Barn Swallow	*Hirundo rustica*	*R*	T
Northern House Martin	*Delichon urbica*	*R*	T
Sand Martin	*Riparia riparia*	*M*	T
Red-Whiskered Bulbul	Pycnonotidae *Pycononotus jocosus*	*R*	T
Red-Vented Bulbul	*Pycononotus cafer*	*R*	T
Blue-tailed Bee-ater	Meropidae *Merops philippinus*	*R*	T
Green Bee-eater.	*Merops orientalis*	*R*	T
Chestnut-headed Bee-eater	*Merops leschenaulti*	*R*	T
Purple Sunbird	*Necterinidae:Nectarinia asiatica*	*R*	T
Purple-throated Sunbird	*Necatrinia seperata*	*R*	T
Mrs Gould's Sunbird	*Aethopyga gouldiae*	*R*	T
Crimson Sunbird	*Aethopyga siparaja*	*R*	T

English Name	Family/Scientific Name	Status	Status of IWPA/GS/habitat
Plain Flower-packer	*Dicaeum concolor*	R	T
Common Tailor Bird	Sylvidae *Orthotomus sutorius*	R	T
Jungle Babbler	*Turdoides striatus*	R	T
Oriental Magpie Robin	Muscicapidae *Copsichus saularis*	R	T
Dark-sided Flycatcher	*Muscicapa sibirica*	R	T
Black-headed Shrike-Babbler	*Pteruthius rufiventer*	R	T
Common Stonechat	*Saxicola torquata*	M	T
Great Tit	Paridae *Parus major*	R	T
Graybacked Shrike	Lanidae *Lanius tephronotus*	M	T
Indian Roller	Coracidae *Coracias benghalensis*	R	T
Oriental Skylark	Alaudidae *Alauda gulgula*	M	T
Crested Lark	*Galirida cristata*	M	T
Rufous-winged Bushlark	*Mirafra assamica*	M	T
Common Swift	Apodidae *Apus apus*	R	T
House Swift	*Apus affinis*	R	T
Alpine Swift	*Tachymarptis*	R	T
Fork-tailed Swift	*Apus pacificus*	R	T
Asian Palmswift	*Cypsturus balasiensis*	R	T
Rose-ringed Parakeet	Psittacidae *Pisttacula karmeri*	R	T
Alexandrine Parakeet	*Psittacula eupatria*	R	T
Blossom-headed Parakeet	*Psittacula roseata*	R	GT,T
Spotted Dove.	Culombidae *Streptopelia chinensis*	R	T
Red Collared Dove	*Streptopelia tranquebarica*	R	T
Eurasian Collared Dove	*Streptopelia decaocto*	R	T
Oriental Turtle Dove	*Streptopelia orientalis*	R	T
Emerald Dove	*Chalcophaps indica*	R	T
Yellow-footed Green Pigeon.	*Treron phoenicoptera*	R	T
Orange-breasted Green Pigeon	*Treron bicincta*	R	T
Black-rumped Flameback.	Picidae *Dinopium bengalensis*	R	T
Yellow-crowned Wood pecker	*Dendrocoposmahrattensis*	R	T

English Name	Family/Scientific Name	Status	Status of IWPA/GS/habitat
Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	*R*	T
Greater Coucal	Centropodidae *Centropus sinensis*	*R*	T
Lesser Caucal	*Centropus bengelensis*	*R*	T
Asian Koel	Cuculidae *Eudynamys scolopacca*	*R*	T
Common Hawk Cuckoo	*Hierococcyx varius*	*R*	T
Hodgson's hawk Cuckoo	*Hierococcyx fugax*	*R*	T
Large Hawk Cuckoo	*Hierococcyx sparverioides*	*R*	T
Indian Cuckoo	*Cuculus micropterus*	*R*	T
Oriental Cuckoo	*Cuculus canorus*	*R*	T
Lesser Cuckoo	*Cuculus poliocephalus*	*R*	T
Chestnut-winged Cuckoo	*Clamator coromandus*	*M*	T
Pied Cuckoo	*Clamator jacobinus*	*M*	T
Plantative Cuckoo	*Cacomantis merulinus*	*M*	T
Green-billed Malkoha	*Phaenicophaeus tristis*	*R*	T
Common Hoopoe	Upopidae *Upupa epops*	*R*	T
Spotted Owlet	Strigidae *Athene brama*	*R*	T
Collared Scops Owl	*Otus bakkamoena*	*R*	T
Asian Barred Owlet	*Glaucidium cuculoides*	*R*	T
Jungle Owlet	*Glaucidium radiatum*	*R*	T
Great Eared Nightjar	*Eurostopodus macrotis*	*R*	T
Brown Fish Owl	*Ketupa zeylonensis*	*R*	T

(Note: aq = Aquatic; T= Terrestrial habitat; IWPA: Wildlife Protection Act 1972; GT: Globally threatened)

APPENDIX 8: COMPREHENSIVE LIST OF MAMMALIAN FAUNA RECORDED IN DIBRUGARH REACH

S. No.	English Name	Order/Family Scientific Name	Status of IWPA, 1972
1	Himalayan Hoary-bellied Squirrel	Order: Rodentia: Family: Sciuridae Callosciurus pygerythrus	
2	House Shrew	Family: Soricidae Suncus murinus	
3	House Mouse	Family: Muridae *Mus musculus*	
4	Large Bandicota Rat	*Bandicota indica*	
5	Lesser Bandicota Rat	*Bandicota bengalensis*	
6	Black Rat	*Rattus rattus*	
7	Indian flying fox	Order: Chiroptera: Family: Pteropodidae Pteropus gigenteus	
8	Long-winged tomb bat	*Family: Emballonuridae; Taphozous longimanus*	
9	Rhesus Macaque	Primate Family: Cercopithecidae *Macaca Mulatta*	
10	Asiatic Jackel	Order: Carnivora Family*: Canidae Canis aureus*	
11	Leopard	Panthera pardus	Schedule-I
12	Common Otter	Family: Mustelidae *Lutra lutra*	
13	Large India Civet	Family: Viverridae *Viverra zibetha*	
14	Small India Civet	*Viverricula indica*	
15	Indian Mongoose	Family*:* Herpestidae *Herpestes javanicus*	
16	River Dolphin	*Order: Primate: Family:* Planista gengeticus	Schedule-I

APPENDIX 9: COMPREHENSIVE LIST OF AMPHIBIAN FAUNA IN DIBRUGARH REACH

Amphibian Species	Study Zones										
	Mohanaghat	Phulbagan	Kahai Spur	Maijan Thakurbari	Tinik-unia	Naga ghuli	Near land Spur	Maijan beel	Motla Tea Estate	Oakland Tea Estate	Pancali
Rana typiensis	1	1	1	1	1	1	1	1	1	1	1
Haplobtrachus tigerina	1	1	1	1	1	1	1	1	1	1	1
Rana syanophylectes	1	1	1	1	1	1	1	1	1	1	1
Fezerzerya pieri	1	1	1	1	1	1	1	1	1	1	1
F. synhendrense	1	1	1	1	1	1	1	1	1	1	1
Polypedatus leucomystes	1	1	1	1	1	1	1	1	1	1	1
Buffo melanostictus	1	1	1	1	1	1	1	1	1	1	1
Rana leptoglosus	1	1	1	1	1	1	1	1	1	1	1

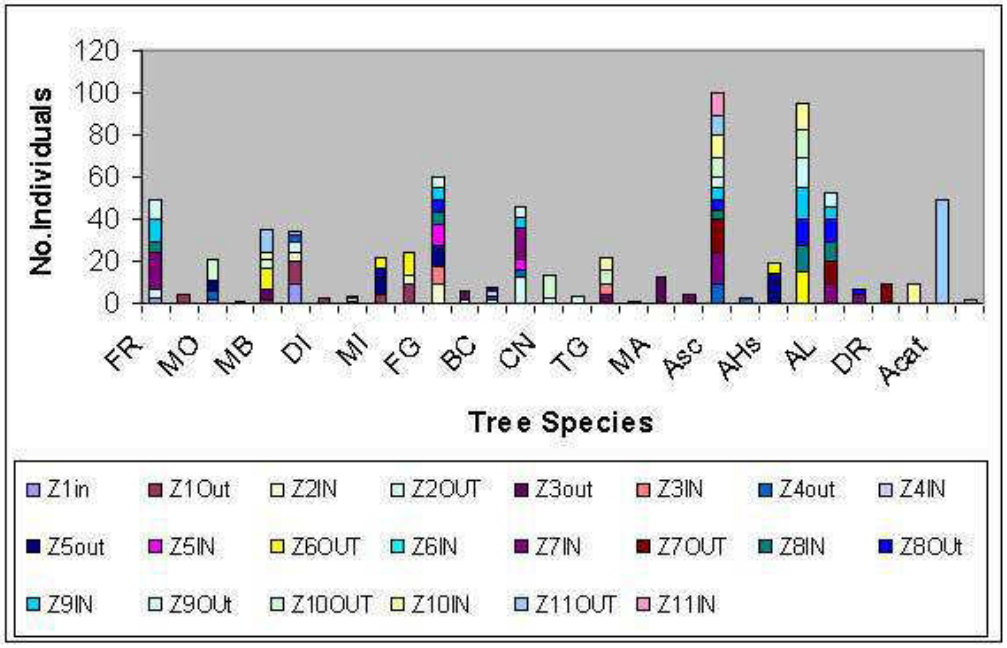
APPENDIX 10: COMPREHENSIVE LIST OF REPTILIAN FAUNA IN DIBRUGARH REACH

Reptilian Species/family	Present absent data of Reptilian fauna in different study sites										
	Mohana ghat	Phul bagan	Kahai Spur	Maijan Thakurbari	Tinik-unia	Naga ghuli	Near land Spur	Maijan beel	Motla Tea Estate	Oakland Tea Estate	Pancali
Typhlopidae: *Typhlops diardii* Schlegel, 1839	1	1	1	1	1	1	1	1	1	1	1
Colubridae *Ptyas mucosa* (Linnaeus 1758)	1	1	1	1	1	1	1	1	1	1	1
Oligodon albocinctus (Cantor, 1839)	1	1	1	1	1	1	1	1	1	1	1
Dendreaphis pictus (Gmelin, 1789)	1	1	1	1	1	1	1	1	1	1	1
Lycodon aulicus (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1
Xenochrophis piscator (Schneider, 1799)	1	1	1	1	1	1	1	1	1	1	1
Amphiesma stolatum (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1
Amphiesma platyceps (Blyth, 18540)	1	1	1	1	1	1	1	1	1	1	1
Enhydris enhydris (Schneider, 1799)	1	1	1	1	1	1	1	1	1	1	1
Elapidae : *Naja kaouthia* Lesson, 1831	1	1	1	1	0	0	1	1	1	1	1
Bungarus caeruleus (Schneider, 1801)	1	1	1	1	1	1	1	1	1	1	1
Agamidae *Calotes versicolor* (Daudin 1802)	1	1	1	1	1	1	1	1	1	1	1
Gekkonidae: *Hemedactylus frenatus* Schlegal 1836	1	1	1	1	1	1	1	1	1	1	1
Hemedactylus garnoti Dum. And Bibr. 1836	1	1	1	1	1	1	1	1	1	1	1
Hemedactylus brooki Gray, 1845	1	1	1	1	1	1	1	1	1	1	1

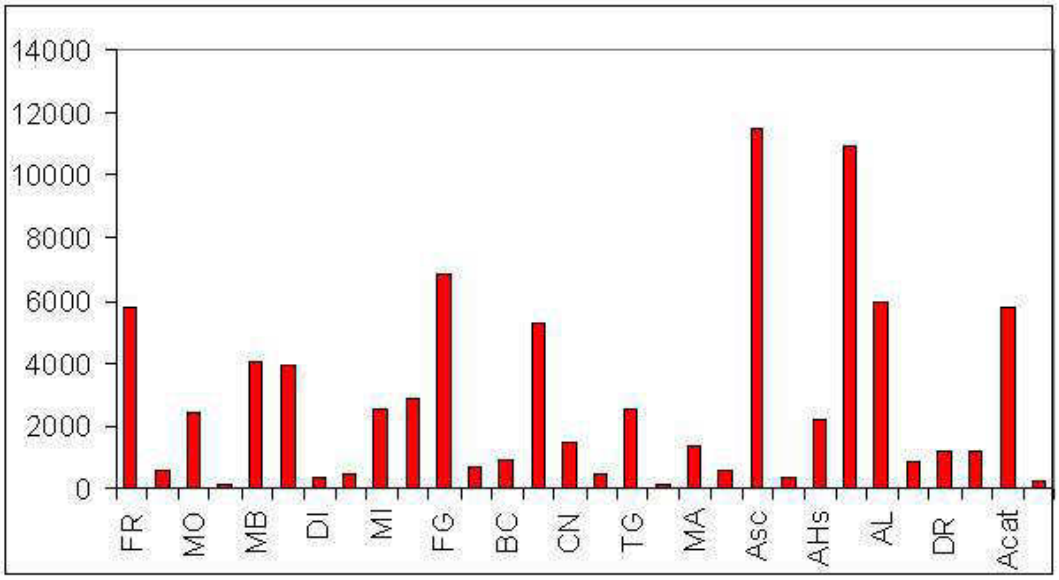
Reptilian Species/family	Present absent data of Reptilian fauna in different study sites										
	Mohanaghat	Phulbagan	Kahai Spur	Maijan Thakurbari	Tinik-unia	Naga ghuli	Near land Spur	Maijan beel	Motla Tea Estate	Oakland Tea Estate	Pancali
Scincidae *Mabuya carinata* (Schneider, 1801)	1	1	1	1	1	1	1	1	1	1	1
Sphenomorphys maculatus (Blyth, 1853)	1	1	1	1	1	1	1	1	1	1	1
Riopa punctata (Linnaeus, 1766)	1	1	1	1	1	1	1	1	1	1	1
Anguidae *Varanus bengalensis* (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1
Kachuga tecta (Gray)	1	1	1	1	1	1	1	1	1	1	1
Kachuga smithi (Gray)	1	1	1	1	0	0	1	0	0	0	0
Geoclemys hamiltoni (Gray)	1	1	1	1	1	1	1	1	1	1	0
Hardella thurgii (Gray)	1	1	1	1	1	1	1	1	1	1	1
Lacepede *Lissemys punctata*	1	1	1	1	1	1	1	1	1	1	1
Trionix hurum (Gray)	1	1	1	1	1	1	1	1	1	1	1
Chitra Indica (Gray)	1	1	1	1	1	1	1	1	1	1	1
Trionix gangeticus	1	1	1	1	1	1	1	1	1	1	1

APPENDIX 11: BIODIVERSITY INDEX

Altogether 83375 individuals of trees counted near embankment site that were likely to be loss during project intervention.



Counting of tree species in Dibrugarh Project Site in Different Study Zones (Abbreviations: 1: Mohana ghat; 2:Phulbagan; 3: Kahai Spur; 4: Maijan Thakurbari; 5 Tinik-unia; 6: Naga Ghuli; 7: Near land Spur; 8: Maijan beel; 9: MotlaTE; 10: Oakland; 11: Pancali)



Counting of Total Number of Tree Species in Dibrugarh Project Site

APPENDIX 12: LIST OF AQUATIC AND MACRO INVERTEBRATE IN THE REACH

	Stations												Cons.
	1	2	3	4	5	6	7	8	9	10	11	12	Stat.
Fish Sp.													
Anguilla bengalensis	-	+	+	-	-	-	-	-	-	-	-	-	EN
Gudusia chapra	-	-	-	+	+	+	-	-	-	-	+	-	LRlc
Hilsa ilisha	-	-	+	+	+	-	-	-	-	-	-	-	Vu
Chagunius chagunio	+	+	-	-	-	+	-	-	+	-	+	-	NE
Cirrhinus reba	+	+	-	-	-	-	+	-	-	+	-	-	Vu
Labeo calbasu	-	-	-	-	-	-	-	-	-	-	+	+	LRnt
Labeo gonius	-	+	+	+	-	-	+	+	+	-	-	-	LRnt
Osteobrama cotio	+	+	+	+	+	+	+	+	+	+	+	+	LRnt
Puntius sarana	-	+	+	-	+	+	-	-	-	-	+	+	Vu
Puntius ticto	-	+	+	-	-	-	-	-	-	-	-	-	LRnt
Puntius sophore	-	+	-	-	-	-	+	+	-	-	-	-	LRnt
Tor putitora	+	+	-	-	-	-	+	-	-	-	-	-	EN
Tor tor	-	+	-	-	-	+	-	-	-	+	-	-	EN
Salmophasia bacaila	+	+	-	-	-	-	-	-	-	-	-	-	LRlc
Barilius barna	-	+	+	+	-	-	+	+	-	-	-	-	LRnt
Barilius	-	+	+	+	+	-	-	+	+	+	-	-	LRnt
Danio Devario	+	+	+	+	+	+	+	+	+	+	+	+	LRnt
Danio aequipinnatus	-	-	+	+	+	+	-	-	-	+	+	+	LRnt
Devario devario	-	+	+	-	+	+	-	-	-	-	+	+	LRnt
Raiamas bola	-	+	+	-	-	-	-	-	-	-	-	-	Vu
Crossocheilus latius	-	+	-	-	-	-	+	+	-	-	-	-	DD
Garra gotyla	+	+	-	-	-	-	+	-	-	-	-	-	Vu
Garra nasuta	+	+	-	-	-	-	-	-	-	-	-	-	NE
Psilorhynchus balitora	-	+	+	+	-	-	+	+	-	-	-	-	NE
Acanthocobitis botia	-	+	+	+	+	-	-	+	+	+	-	-	LRnt
Schistura scaturigina	-	-	-	-	-	-	+	+	-	-	-	-	Vu
Lepidocephalichthys guntea	-	+	+	+	+	-	-	+	+	+	+	+	NE
Cantophrys gongota	+	-	-	-	-	-	-	+	-	-	-	-	LRnt
Botia Dario	-	-	-	-	+	+	-	-	-	-	+	+	NE
Sperata aor	-	-	-	-	-	-	-	-	-	+	-	+	NE

	Stations												Cons.
	1	2	3	4	5	6	7	8	9	10	11	12	Stat.
Batasio batasio	-	+	+	-	-	-	+	-	+	-	-	-	NE
Ailia coila	-	-	+	-	-	-	-	-	-	-	-	+	Vu
Clupisoma garua	-	-	-	+	-	-	+	-	-	+	+	+	Vu
Eutropichthys vacha	+	-	-	+	-	-	+	-	-	-	+	+	NE
Pseudeutropius atherinoides	-	-	+	-	-	-	-	+	-	-	+	+	NE
Bagarius bagarius	-	-	-	-	-	-	-	-	-	+	-	+	Vu
Erethistes pussilus	+	+	-	-	-	-	+	+	-	-	+	+	NE
Erethistoides montana	-	-	+	+	+	-	-	-	-	-	-	-	CR
Gagata cenia	-	-	-	-	-	+	-	-	-	+	+	+	NE
Gagata gagata	-	-	-	-	-	-	-	-	-	-	+	+	NE
Glyptothorax telchitta	-	-	-	-	-	+	-	-	-	-	-	+	LRnt
Hara hara	-	+	-	-	+	+	+	-	-	+	-	+	NE
Pseudochenesis sulcatus	+	+	-	-	-	-	-	-	-	-	-	+	Vu
Laguvia shawi	+	+	+	+	+	-	+	+	+	+	+	+	EN
Clarias batrachus	+	+	+	+	+	-	+	+	+	+	+	-	Vu
Heteropneustes fossilis	-	-	-	-	-	-	-	-	-	+	+	+	Vu
Olyra longicaudata	+	+	-	+	+	-	-	-	+	+	+	-	NE
Xenentodon cancila	-	-	-	-	-	-	-	-	+	+	+	+	LRnt
Macrognathus pancalus	-	-	-	-	-	-	-	-	-	+	-	+	NE
Mastacembelus armatus	-	-	+	-	+	-	-	-	-	+	-	+	NE
Chanda nama	-	+	+	+	+	+	-	+	+	+	+	+	NE
Parambassis ranga	-	+	+	+	+	+	-	+	+	+	+	+	NE
Glossogobius giuris	-	-	-	-	-	-	-	-	-	+	+	+	LRnt
Channa punctatus	-	-	-	-	-	-	-	-	-	+	+	-	LRnt
Channa striatus	-	-	+	+	+	-	-	-	-	-	-	-	LRnt
Gastropods													
Pila globosa	+	+	-	+	+	+	+	-	+	+	+	+	

	Stations												Cons.
	1	2	3	4	5	6	7	8	9	10	11	12	Stat.
Pila scutata	+	+	-	+	+	+	+	-	+	+	+	+	
Paludomus pustulosa	+	-	+	-	+	-	-	+	+	-	+	-	
Prawn													
Macrobrachium malcomsoni	+	-	+	-	+	-	+	-	-	-	-	+	
M. lanchesteri	-	+	+	-	+	-	+	+	+	+	+	+	
Crabs													
Sterteriane spinigera	+	-	+	-	+	+	-	+	+	+	+	+	
Peratelphusa eduntula	+	-	+	-	+	+	-	+	+	+	-	-	
P. spingera	+	-	+	-	+	+	-	+	+	+	+	+	
Potaman woodmansoni	+	-	+	-	+	+	-	+	+	+	-	-	
Amphibians													
Chirixalus simus	+	+	+	+	+	-	-	+	+	+	+	-	
Bufo melanostictus	+	+	-	+	-	+	+	-	-	-	-	+	
Hoplobatrachus tigerinus	+	+	+	+	+	-	-	+	+	+	+	-	
Limnonectes laticeps	+	+	-	+	-	+	+	-	-	-	-	-	
Turtles and Tortoises													
Kachuga sylhetensis	+	-	+	-	+	+	+	-	+	+	+	+	Sc-I
Aspideretes gangeticus	+	+	-	-	-	+	+	+	-	-	-	+	
Kachuga tecta	+	+	-	-	-	+	+	+	-	-	-	+	Sc-I
Lizards													
Gecko gecko	+	-	+	+	+	-	+	-	+	+	+	+	
Varanus bengalensis	+	+	-	-	-	+	+	+	-	-	-	+	
Varanus salvator	+		+	-	+	+	+		+	+	+	+	
Calotes emma	+	+	+	-	-	+	+	+	+	+	-	+	
Calotes maria	-	-	+	+	+	+	-	-	+	+	+	+	
Snakes													
Ophiophagus hannah	-	-	-	+	+	-	-	+	-	-	-	+	
Naja naja	+	+	-	+	+	+	+	+	+	-	-	+	
Mammals													
River Dolphin	-	+	-	+	-	+	-	+	-	+	+	-	
Plankton													

	Stations												Cons.
	1	2	3	4	5	6	7	8	9	10	11	12	Stat.
Bacillariophyceae													
Diatoma	+	+	-	+		+	+	+			+		
Fragilaria	+		+	+	+				+	+		+	
Synedra	+	+	+	+		+	+	+			+	+	
Cocconeis	+	+				+	+	+				+	
Achnanthes	+		+		+	+	+		+	+	+	+	
Eucocconeis		+	+	+		+	+	+		+	+	+	
Navicula	+	+	-	+		+	+	+			+		
Pinnularia	+		+	+	+				+	+		+	
Gyrosigma	+	+	+	+		+	+	+			+	+	
Frustulia	+	+				+	+	+				+	
Gomphonema	+		+		+	+	+		+	+	+	+	
Cymbella	+		+	+	+				+	+		+	
Nitzschia	+	+	+	+		+	+	+			+	+	
Surirella	+	+				+	+	+				+	
Melosira	+		+		+	+	+		+	+	+	+	
Chlorophyceae													
Ulothrlx		+	+	+		+	+	+		+	+	+	
Microspora	+	+	-	+		+	+	+			+		
Cladophora	+		+	+	+				+	+		+	
Closterium	+	+	+	+		+	+	+			+	+	
Cosmarium		+	+	+		+	+	+		+	+	+	
Spirogyra	+	+	-	+		+	+	+			+		
Myxophyceae													
Oscillatoria		+	+	+			+	+	+	+	+		
Rivularia	+	+	+	+	+	+							
Anabaena	+	+	+			+	+	+		+	+	+	
Zooplankton													
Vorticella	+			+	+			+	+	+	+	+	
Cyclops	+			+	+	+	+	+		+	+	+	
Daphnia		+	+	+			+	+	+	+	+		
Zoea larva	+	+	+	+	+	+							
Keratella	+	+	+			+	+	+		+	+	+	
Chironomous	+			+	+			+	+	+	+	+	
Gomphus	+			+	+	+	+	+		+	+	+	
Bosmina		+	+	+			+	+	+	+	+		
Ceriodaphnia	+	+	+	+	+	+							
Chydorus	+	+	+			+	+	+		+	+	+	
Nauplis	+			+	+			+	+	+	+	+	
Diaptomus	+			+	+	+	+	+		+	+	+	
Canthocamptus		+	+	+			+	+	+	+	+		
Asplanchna	+	+	+	+	+	+							
Kellicotia	+	+	+			+	+	+		+	+	+	
Arcella	+			+	+			+	+	+	+	+	
Paramecium	+			+	+	+	+	+		+	+	+	

	Stations												Cons.
	1	2	3	4	5	6	7	8	9	10	11	12	Stat.
Brachionus		+	+	+			+	+	+	+	+		
Asplanchna	+	+	+	+	+	+							
Semiocephalus		+				+	+	+				+	
Moinodaphnia	+		+		+	+	+		+	+	+	+	
Sida			+	+	+	-	+		+	+	+	+	
Macrothrix	+	+	-	+		+	+	+			+		
Epistilis	+		+	+	+				+	+		+	
Rotifer eggs	+	+	+	+		+	+	+			+	+	
Gomphus		+				+	+	+				+	
Benthos													
Nais	-	-	+	+	+	+	-	+	+	-	+	-	
Tubifex	+	+	-	-	-	+	+	+	-	+	+	+	
Chironomus	+	+	+	-	+	+	+	-	+	+	+	+	
Viviparus	-	-	+	+	+	-	-	-	+	-	-	-	
Gyraulus	+	+	+	-	+	+	+	-	+	+	+	+	
Pisidium	-	-	+	+	+	-	-	-	+	-	-	-	

Note : 1 - Mahana Ghat (Ch 9.42 km); 2 – Pachali (Ch 14.00 km); 3 - Ful Bagan (3rd spar); 4 – Koilaghat (Ch 14.00 Km); 5 – Tinikonia (4th spar); 6 - Maijan Borsaikia Gaon (2nd spar); 7 - Maijan Thakur Bari (Stone spar-1); 8 - Maijan Beel (Ch 0.0Km); 9 - Hockey stick Spur; 10.- Nagaghuli ghat; 11 – Nagaghuli; 12 - Oakland tea estate (Ch 9.10Km)

APPENDIX 13: IDENTIFICATION OF ENDEMIC THREATENED AND ENDANGERED SPECIES

Endangered Mammalian Fauna in Dibrugarh Embankment Site

S. No.	English Name	Order/Family/Scientific Name	Status of IWPA
1.	Leopard	***Order: Carnivora: Family: Canidae:*** *Panthera pardus*	Schedule-I
2.	River Dolphin	***Order: Primate: Family:*** *Planista gengeticus*	Schedule-I

Endangered Reptilian Fauna in Dibrugarh Reach

S. No.	Common Name	Scientific Name	Status of IWPA
1	Indian Roofed Terrapin	*Kachuga tecta* (Gray)	Schedule-I
2	Spotted Black Terrapin	*Geoclemys hamiltoni* (Gray)	Schedule-I
3	Indian Mud Turtle	*Lissemys punctata* Lacepede	Schedule-I
4	Peacock Soft-shell	*Trionix hurum* (Gray)	Schedule-I
5	Ganges Soft-shell Turtle	*Trionix gangeticus*	Schedule-I

Endangered/ Globally Threatened Avian Fauna in Dibrugarh Reach

S. No.	English Name	Family/Scientific Name	Status	Status of IWPA/GS
1.	Spot-billed Pelican	*Pelecanus philippensis*	R	Schedule-I/GT
2.	Lesser Adjutant Stork	*Leptoptilos javanicus*	*R*	GT
3.	Greater Adjutant	L. dubius	*R*	Schedule-I/GT
4.	Bar-Headed Goose	*Anatidae* *Anser indicus*	*M*	Schedule-I/GT
5.	Grey-Lag geese	*Anser anser*	*M*	GT
6.	Osprey	*Accipitridae* *Pandion haliatus*	*R*	Schedule-I/GT
7.	Red-headed Vulture	*Sarcogyps calvus*	*R*	GT
8.	Shikra	*Accipiter badius*	*M*	Schedule-I/GT
9.	Lesser Kestrel	*Falco naumanni*	*M*	Schedule-I/GT
10.	Blossom-headed Parakeet	*Psittacula roseate*	*R*	GT

APPENDIX 14: EMISSION FACTORS OF VARIOUS DUST GENERATION PROCESSES

Source	Unit	Emission Factor
Receipt of new aggregate at Hot Mix Plant	g/ton	1.86
Transfer of aggregate from storage to conveyor belt or between conveyor belts in Hot Mix Plant	g/ton	0.021
Screening of aggregate in Hot Mix Plant	g/ton	0.38
RAP crushing	g/ton	0.27
Paved road dust emissions	g/VMT	7.26
Unpaved road dust emissions	g/VMT	925.3

(Note: VMT: Vehicle Mile Traveled)

APPENDIX 15: SUMMARY OF PUBLIC CONSULTATIONS FOR TRANCHE 1 AND 2

Date	Name and Address	Topic of Discussion	Important Outcome
2/12/2007	Dr. A. K. Baruwa, Director Assam Science, Technology and Environment Council And Assam Energy Development Agency	1.Regarding any specific problem(s) related to environment as a result of flood and erosion of the Brahmaputra 2. If the proposed project will help in providing safety to the people , their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water and Local Economy 5. Suggestion or comment on issues other than those discussed so far	❖ He has raised concern of leaching of arsenic into groundwater which is generally used for drinking water supply from the river bank filtration wells in the floodplains of Brahmaputra River and also asked about the possibility of integration of drinking water and irrigation projects.
3/12/2007	Mr. B. B. Hagier (IAS) Secretary of Environment and Forests, Government of Assam		❖ He has pointed out requirement of study of impact downstream and upstream of the reach which can be affected after protection of the reach.
3/12/2007	Mrs. E. Choudhary (IAS) Principal Secretary Soil Conservation Government of Assam		❖ She has raised the issues of bed level raising, seepage of embankment/ softening of embankment, erosion and increase in sedimentation as well as the requirement of catchments area treatment plan. She also revealed the requirement of soil conservation, study of earthquakes and its effect on siltation in the river.
2/12/2007	Mr. Biren Thukuria EE, WRD		❖ He has highlighted the importance of study for impact on fish productivity due to reduced siltation, which can emerge as a benefit to local fishermen.
25/04/2008	Dr. Rafiqua Ahmed State Pollution Control Board, Assam		❖ She has highlighted the problem of water contamination in some parts of the Brahmaputra River valley. She was also asked for the pollution problems in the sub-project reaches.
3/12/2007	Mr. Md. Allauddin Department of Minority Welfare		❖ Most of the chars in Brahmaputra are semi-permanent and as per their record there are 2,251 char villages. ❖ Drinking water is mainly supplied from the hand pumps and tubewells. The department also supports in the form of seed distribution, construction of raised platforms with and without sheds, repairing of schools, vocational training to local villagers
19/5/2008	Chief Conservatory of Forests	Related to tree cutting, afforestation programme etc.	❖ Prior permission is needed from the Chief Conservator of Forests (Wildlife) for cutting of trees within the boundary demarcated as wildlife sanctuaries and national parks. If land is outside the protected areas, then the permission is not necessary from CCF or Forest Department. However, afforestation is needed if there is any loss of tree species during project intervention. ❖ At least three plants must be planted in place of one such tree cut during project intervention.

Date	Name and Address	Topic of Discussion	Important Outcome
			❖ For afforestation programme, bamboo, simul trees and banana plants must be planted along the side of embankment. These trees have no side roots to destroy the embankments. Again, in the borrowing sites water resistant plants such as Salix tetrasperma, Buwal and Panihizol should be planted.
3/3/2008	Dr. B. K. Talukdar Co-chair (South Asia) IUCN-SSC Asian Rhino Specialist Group	1.Regarding any specific problem(s) related to environment as a result of flood and erosion of the Brahmaputra 2. If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water and Local Economy 5. Suggestion or comment on issues other than those discussed so far	❖ All the NGOs' consulted had welcomed the flood control project and said that it will help in protection of agricultural land, domestic animals, fishermen communities etc. ❖ They also highlighted the importance of maintaining the natural drainage along the project sites. The NGOs during interaction also highlighted the relief work they are carrying out during the flood situations. ❖ They also suggested increasing forest cover through afforestation programme. Dr. Sanjay Hazarika also indicated the need of enhancing institutional capacity and strengthening review mechanism. ❖ Prevent any change to natural drainage. ❖ Consider provision of alternate platform then only attached to embankment for use by Animals and people during flood and protection of the fish spawning grounds during construction and operation.
5/3/2008	Mr. Mintu Handique and Mr. Gaurav Borgohain, Carrier Care Group		
10/3/2008	Mr. Sanjay Hazarika CE-NES		
28/03/2008	Mrs. Janti Gohain Kumar Gaon P.O. Gorpara Dekom, Dibrugarh	1.Regarding any specific problem(s) related to environment as a result of flood and erosion of the Brahmaputra 2. If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water and Local Economy 5. Suggestion or comment on issues other than those discussed so far	❖ We welcome the project as it will benefit the complete area. The town and the tea industry will be saved. No adverse effect anticipated as of now, however, the affected people should be properly compensated. ❖ The project will provide safety to the town and help it prosper. The tea industry and the agricultural lands will be protected. ❖ This is a valuable project to be taken up by the Government. It will provide safeguard to the town and tea industry. ❖ No ill effect can be thought of. The work needs to be implemented urgently. ❖ People affected should be properly and promptly rehabilitated and/ or compensated. ❖ The project will protect the town and neighboring areas from erosion and flooding. Those affected by the project should be given due compensation before starting the work. ❖ The project will protect the town and adjoining areas from erosion and flood. Government should take up the work. All affected people should get due compensation before the project takes off. There will be no adverse impact seen if properly executed.
	Allaudin Ahmed		

Date	Name and Address	Topic of Discussion	Important Outcome
	Pach Ali P.O.- Dibrugarh Assam		
	MuktaBori Pach Ali P.O. Dibrugarh Assam		
	G. Kalita Pach Ali Dibrugarh		
	P. Gogoi Near water Pump Dibrugarh		
29/02/2008	Dilip Munda Koilaghat (inside the existing embankment) Profession: Tea Labor	1.Regarding any specific problem(s) related to environment as a result of flood and erosion of the Brahmaputra 2. If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water and Local Economy 5. Suggestion or comment on issues other than those discussed so far	❖ The proposed embankment project is essential for the local people. It will help a lot to entire people of the area. The existing embankment is in very bad shape, and hence, new permanent embankment is requiring. There are many permanent houses inside the embankment, but, if government will provide us monitory help, then we will vacate the land for project. ❖ If the land and property of the people has been lost during the embankment project, then they should be compensated accordingly. ❖ The fishermen community regularly fishes at Maijan Beel for their daily livelihood. Maijan beel is the lifeline of these people. Hence, it should not be disturbed during embankment project. If the project did not harm the beel then the local people do not have anything to say. ❖ The natural beel and its water feeding cannels should be preserved as it is, because these are the main routes of re-colonization of living biota and the beels are the lifeline for most of the rural people. ❖ It the land and property of the people has been lost during embankment project, then that should be compensated. ❖ The proposed embankment is welcomed because it will help to protect the entire Dibrugarh city and as well as Tea Estates. The present embankment of the river is very weak, so it will create havoc if it will break down and washed away entire city people. The construction of proposed embankment is timely thinking and quite appropriate. ❖ Government is doing good job by constructing a new embankment. The permanent embankment at Dibrugarh township is inevitable to protect the city and people from flood. ❖ The people showed their support to the initiative of the government. They told that almost 20 villages can be saved from flood if embankment

Date	Name and Address	Topic of Discussion	Important Outcome
			will be constructed. Apart from that they also highlighted the need of non-disturbance to aquatic habitat.
	Kamal Das Mohanaghat (inside existing embankment) Profession: farmer		
	Laxman Tati Maijan Tea Estate Profession: Fisherman		
	Pranoy Sarkar Phulbagan Profession: Tea labor		
	Abul Aziz Graham bazaar, Dibrugarh Profession: Tea Shop owner		
	Basant Ben, Shopkeepar Fulbagan Dibrugarh		
	Raman Thapa, Daily wager Tinikonia area		
	Bhabesh Kalita, Teacher Thakur Bari Dibrugarh		
01/03/2008	Dinesh Kakati, Farmer. Thakur-bari	1.Regarding any specific problem(s) related to environment as a result of flood and erosion of the Brahmaputra 2. If the proposed project will help in providing safety to the people, their property and environment of the area	❖ It will definitely help us for transportation and cultivation to other places. ❖ The people talked about their dependence on River Brahmaputra and told about the need of transportation through river with other parts. ❖ A few people had told that they do not have land for home and hence they are occupying the existing dyke. They told that government should provide them alternative place and compensation. ❖ If dyke will be constructed, then the people can do the cultivation peacefully, which is affected regularly every year due to flood. This will solve a great problem.

Date	Name and Address	Topic of Discussion	Important Outcome
		3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water and Local Economy 5. Suggestion or comment on issues other than those discussed so far	❖ The construction and renovation works are ok, but the government should not close the channel of beel with Brahmaputra
	Bhagirath Pegu Fisherman, Nagaghuli		
	Madan Pegu Shopkeepar Nagaghuli		
	Adar Barman Farmer, Pachali		
	Khagen Das Teacher, Koilaghat		
	Harilal Pegu Student, Koilaghat		
	Kaliran Pegu Fishermen, Maizan Beel		
	Mihir Doley Worker, Oakland Tea Estate		

The three state-level workshop materials are available in the following website.

○ 1st Workshop (1 December 2007 at Administrative Staff College of India, Guwahati)
http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-IND-TACR.pdf

○ 2nd Workshop (25 June 2008 at the Institute of Engineers Conference Hall, Guwahati)
http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-01-IND-TACR.pdf

○ 3rd Workshop (4 February 2009 at Brahmaputra Hotel, Guwahati)
http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-02-IND-TACR.pdf