Initial Environmental Examination
(updated)

Project Number: 38412-033
August 2018

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

Kaziranga Subproject (Golaghat District)
(1 of 2)

Prepared by the Flood and River Erosion Management Agency of Assam, Government of Assam for the Asian Development Bank. This is an updated version of the initial environmental examination originally posted in July 2018 available on https://www.adb.org/sites/default/files/project-documents/38412/38412-033-iee-en_1.pdf.

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Project Number: 38412-033
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INDIA: ASSAM INTEGRATED FLOOD AND RIVERBANK EROSION RISK MANAGEMENT INVESTMENT PROGRAM – PROJECT 2

KAZIRANGA SUBPROJECT
GOLAGHAT DISTRICT

CURRENCY EQUIVALENTS

(As of 11 June 2018)

Currency Unit – Indian Rupee (₹)
₹1.00 = $0.014810
$1.00 = ₹67.52

ABBREVIATION

ADB	-	Asian Development Bank
AIFRERMIP	-	Assam Integrated Flood and Riverbank Erosion Risks Management Investment Programme
As	-	Arsenic
C_6H_6	-	Benzene
BGL	-	Below ground level
CITES	-	Convention on International Trade in Endangered Species
CMS	-	Conservation of Migratory Species
CR	-	Critically endangered
CWC	-	Central Water Commission
DHM	-	distributed hydrological model
DMO	-	disaster management organization
CWC	-	Central Water Commission
EA	-	executing agency
EARF	-	environmental assessment and review framework
EIA	-	environmental impact assessment
EIRR	-	economic internal rate of return
EMOP	-	environmental monitoring plan
EMP	-	environmental management plan
EN	-	Endangered
FRERM	-	flood and riverbank erosion risk management
FREMAA	-	Flood and River Erosion Management Agency of Assam
GHG	-	Greenhouse Gas
GIS	-	Geographic Information System
GoI	-	Government of India
IBA	-	International Bird Area
IMD	-	India Meteorological Department
IRC	-	Indian Road Congress
IUCN	-	International Union for Conservation of Nature
IWAI	-	Inland Water Transport Authority
KKL	-	Kaziranga–Karbi Anglong Landscape
KNP	-	Kaziranga National Park
KRF	-	Kaziranga Reserve Forest
MOEF&CC	-	Ministry of Environment Forest and Climate Change
MFF	-	Multitranche financing facility
NAAQS	-	National Ambient Air Quality Standards
NWBL	-	National Board for Wildlife
NGO	-	nongovernment organization
NH	-	National Highway

Ni	-	Nickel
NOx	-	Nitrogen Oxides
NT	-	Near threatened
PM10	-	Particulate Matter <= 10 micron
PMGSY	-	Pradhan Mantri Gram Sadak Yojana
PMU	-	project management unit
PPTA	-	project preparatory technical assistance
SEIA	-	summary environmental impact assessment
SEU	-	Social and Environment Unit
SIO	-	subproject implementation office
SIU	-	Subproject implementation Unit
SIU-T	-	Subproject implementation unit-Technical
SIU-DRMC	-	Subproject implementation unit - disaster risk management and coordination team
SO2	-	Sulfur Dioxide
SPCB	-	State Pollution Control Board
SPS 2009	-	Safeguard Policy Statement, 2009
WB EHS	-	World Bank Environment, Health, and Safety
WRD		Water Resources Department

WEIGHTS AND MEASURES

dBA	-	decibel
Ha	-	hectare
Km^2	-	kilometer
km	-	square kilometer
m	-	meter
mm	-	millimeter
m^3/s	-	cubic meters per second
l	-	liter

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 armored with these heavy materials).
Critical Habitat.	A subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities. (ADB SPS, 2009)

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., FY2018 ends on 31 March 2018.

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

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

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Executive Summary

1. The Government of India with assistance from the Asian Development Bank (ADB) has implemented the Assam Integrated Flood and Riverbank Erosion Risks Management Investment Program. The investment program (MFF) will enhance the reliability and effectiveness of flood and riverbank erosion risk management (FRERM) in Assam. The MFF focuses on three existing flood embankment systems, namely Dibrugarh, Kaziranga, and Palasbari are currently protecting key urban and productive rural areas along the Brahmaputra River. These areas are vulnerable to flooding because of infrastructure deterioration and continuous riverbank erosion. The Investment Program and its Tranche 1 was approved in October 2010, became effective in August 2011, and will closed by 2018.

2. Originally classified as environment Category A in consonance with the ADB Safeguard Policy Statement, 2009 (SPS) as two subproject components are located adjacent to the Kaziranga National Park (KNP). The construction of a new 7.25 kilometers (km) embankment from the Diffalupathar to NH-37 and the upgrading of the existing 19.88 km Brahmaputra Dyke to include increasing the height and the embankment width will share boundaris with the KNP. The KNP is a critical habitat that supports numerous critically endangered mammals including tiger, Asian elephant, asiatic wild buffalo, capped langur, hoolock gibbon, and river dolphin. KNP support 2/3rd of the entire world's One-horned rhinoceros; birds like the White bellied heron, Greater adjutant, Bengal Florican, and Spotted greenshark. The KNP is a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site representing one of the last unmodified natural areas in north-eastern India, the single largest undisturbed representative area in the Brahmaputra Valley Floodplain, and one of the finest wildlife refuge in the world. KNP is also classified as an Important Bird Area by Birdlife Interational and a Tiger Reserve by the Government of India.

3. In 2009, the Kaziranga subproject was classified as environmental category A as some of its activities are adjacent to the KNP boundary. Originally proposed under Tranche 1 of the MFF, the subproject was not implemented as scheduled due to delays in securing the environment clearance from the Ministry of Environmnet, Forest, and Climate Change that took 7 years. The Flood and Riverbank Erosion Management Association of Assam (FREMAA) and ADB decided to move its implementation during project 2. However, the MFF ends on October 2020 leaving the Kaziranga subproject with 2 years implementation period. This constraint necessitated FREMAA to redesign and truncate the initial structural works. The reduction in project scope was significant both from the investment and environmental safeguard perspectives. The truncated design cancelled the construction of a new 7.25 km embankment from Diffalupathar to NH-37 to envelop the Bokhakat. The proposed raising and strengthening of the entire 19.850 km Brahmaputra Dyke was scaled down to the rehabilitation of six sections vulnerable with a total length of 3.075kms. The installation of multilayer pre-stressed concrete (PSC) porcupine screens was reduced to maintenance of the works previously made by the Water Resources Department (WRD) along the northern bank of the Brahmaputra River starting immediately downstream of the Dhansiri River confluence towards the KNP boundary. In contrast to the previous proposal, two sections of the river that are currently subjected to extreme river erosion will receive upgraded bank protection works in the form revetments with apron and slope pitching made of geotextile bags. Construction of three sluice gates remains the same.

4. The truncated subproject design for project 2 was recategorized to Category B based on the following: (i) removal of environmentally critical activities that may pose significant adverse environmental risk to the KNP, considered a critical habitat, namely the construction of the 7.25 km long new embankment and upgrading/increasing the height of the existing Brahmaputra Dyke; and (ii) scale down of the works in the existing Bhrahmaputra Dyke to rehabilitation rather than upgrading that focuses on six vulnerable sections with a total length of 3.825 km. No works will be undertaken by the subproject inside or along the KNP boundary. All environmental impacts from the implemnetation of truncated subproject are less than than than previously anticipate, site-specific,

most to occur during the costruction phase, and readily mitigated. No unprecedented impacts are expected from the rehabilitation of the existing Brahmaputra Dyke and the maintenance and extension of the Water Resources Department's porcupine screens. The agreement support the KNP's implementation of the protected ardea management plan to strengthen the KNP's wildlife protection and enforcement, and monitoring of erosion along the KNP riverbank, the subproject will construct six watch towers along the sub-project boundary equipped with surveillance equipment and the procurement of a monitoring boat.

5. During the construction phase, several trees along the embankment are likely to be cut and will be mitigated through compensatory afforestation. Other impacts attributed to embankment formation, sluice gate construction, and river revetment works including porcupine screens include dust, noise, borrow area, compaction of access roads, damaged to existing rural roads from hauling and equipment transport, camp site, and health and safety will be mitigated through good engineering practices and compliance to permit and environmental clearance conditionalities. These activities are co-terminus with the construction phase and can easily be mitigated through good engineering practices to avoid or mimimize noise, dust, occupational and community hazards, camp management, and water quality deterioration.

6. From 1965 to 2000, the bankline of the Kaziranga reach incuding the KNP bankline has migrated by almost 4.3 kilometers with a loss of 7,336.2 hectares. The revetment and porcupine screens with underwater toe protection to be installed along the Kaziranga Reach terminating upstream of the KNP are expected to stabilize the riverbank against erosion. Adverse impacts on the KNP riverbank line are not anticipated downstream along the KNP with the terminus of the screens designed to slope away from the river bank and towards the main Brahmaputra River channel to redirect flow towards the main river and promote siltation. The porcupine screens will be installed along the bank line in to maintain the natural character of the banks and avoid erosion downstream. The extent of the screens are very small compared to the total width of the Brahmaputra River and the lower sediment load of the Dhansiri River which joins the main channel upstream of the subproject reach will have limited morphological impact it will be very difficult to establish that there is either more or less erosion at the Kaziranga National Park downstream. Monitoring of impacts downstream will be a joint effort of the KNP and WRD. Continuous monitoring will be conducted by the KNP authorities through the operation of two monitoring boats provided by the subproject and the sharing of information with FREMAA and WRD to assess the effectivity of the pro siltation works. Any unanticipated impacts detected will allow FREMAA and WRD to implement further mitigation measures.

7. The assessment also indicated no potential loss of threatened and vulnerable species due to increased risk of flooding on the KNP side with the operation of the 3 sluice gates. The Kaziranga Reach, including the KNP is subject to periodic flooding. Annual flooding is important to the KNP as it rejuvenates the unique eco-system of grassland, swamps and ponds which in turn sustain large population of rhinos, elephants, deer, wild buffaloes, tigers, and leopards. According to UNESCO, the KNP is the largest undisturbed and representative area in the Brahmaputra valley floodplain. It was declared a heritage site because of its unique habitat shaped by the flood pattern that is covered by wet alluvial tall grassland interspersed with numerous broad shallow pools fringed with reeds and patches of deciduous to semi-evergreen woodlands. However, extreme floods have resulted to wildlife drownings and in 2017 the KNP lost 361 animals, including 31 rhinos. Between 2002-2017, 130 rhinos drowned and perished. Wildlife lost was not limited to rhinos, the 2017 floods also killed 9 elephants, 282 hog deer, 1 tiger, 16 sambar deer, and 8 buffaloes. The same flooding affected more than 1 million individuals in 1,700 villages of Golaghat District. The construction and operation of the sluice gates will have insignificant impact on the animal movement towards higher grounds of the Karbi Anglong hills to take refuge during flood season. The sluice gates are not located in known wildlife corridor that connects the KNP with the Karbi Anglong Landscape. The operation of the sluice

gate will be able to alleviate floods on both sides of the embankment, i.e. when flood levels are higher inside the dyke, the sluice gate will allow waters to exit towards the KNP and drain around dyke towards NH-37 and Goshanibar and finally rejoining the Brahmaputra west. When flood levels are higher on the KNP side of the embankment due to high rainfall, the sluice gate will be operated to drain waters towards the Geelabeel River. The joint operation of the sluice gates by WRD and KNP will be crucial. These agencies have partnered to establish three watch towers to monitor among others, the flood level and advice the WRD on the operation of the sluice gates.

8. Potential adverse impact to the River Dolphins particularly during the construction of the revetments and porcupine screens was identified and assessed. It was concluded that the cessation of all construction activities in the water area between April to August breeding and spawning period avoids these impacts.

9. The predicted increase in peak and volume of flood due to climate change poses threat to the communities behind the embankment and the KNP. The subproject components comprised of infrastructure and community capacity building will provides resilience to flood and allow the community to adapt to the challenges of flooding.

10. The institutional arrangement for implementing the environmental management plan (EMP) 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 the 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.

11. The grievance redress mechanism 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.

12. Considering the technical, institutional and budgetary measures recommended it is expected that the project will avoid severe, permanent and regional impacts. There will be no net loss in biodiversity. Tremendous social and economic benefits will be generated reducing the risk of flooding in the Bokhakat area. The revetment works, and pro-siltation porcupine screens will protect the sub-project area including the KNP from a catastrophic avulsion of the river bank and the embankment.

I. Introduction

1. The Government of India with assistance from the Asian Development Bank (ADB) is implementing the Assam Integrated Flood and Riverbank Erosion Risks Management Investment Programme. The investment program will enhance the reliability and effectiveness of flood and riverbank erosion risk management (FRERM) in Assam. The program has the following components: (i) development of flood and riverbank erosion risk management (FRERM) planning, institutional and knowledge bases; (ii) establishment of comprehensive FRERM systems that support priority interventions to strengthen the FRERM systems of 3 subprojects, namely: Dibrugarh in Dibrugarh district, Kaziranga in Golaghat District, and Palasbari-Gumi in Kamrup District; and (iii) provision of multidisciplinary project management systems.

2. The investment program has two component projects or Tranches; Tranche 1 provided immediately required protection works in the three subproject areas and made basis for the needed institutional arrangement, and Tranche 2 will complete the remaining protection works in the same three subproject areas and continue institutional strengthening activities. The multitranche facility (MFF) investment program was approved in October 2010 to be implemented until 2020. The approved amount for Tranche-1 was $56.9 million and later reduced to $48.5 million mainly due to the due to the inability of the project to complete the Kaziranga subproject civil works component for the remaining 2 years implementation period. Works proposed under Tranche-1 of the Kaziranga subproject cannot be initiated without securing the environmental clearance from Ministry of Environment, Forrest, and Climate Change (MOEF&CC) which took almost 7 years to process. The environmental clearance was issued in October 2014 while Tranche-1 Implementation ended in 2015.

3. The Kaziranga subproject has two major components: controlling riverbank erosion, and rehabilitation of the existing flood control embankment. Delays[1] in securing the environment clearance from MOEF&CC necessitated a truncated redesign of the subproject to be implemented in 2 years. The original intention of Kaziranga subproject to construct a 7.25 kilometers (km) new embankment from Diffalupathar to NH-37 was cancelled. The original proposal of raising and strengthening the entire 19.850 km Brahmaputra dyke was scaled down to the rehabilitation of six sections with a total length of 3.075 km. Construction of three sluice gates remains the same. The original design of installing of multilayer pre-stressed concrete (PSC) porcupine screens was reduced to maintenance of the works previously made by the Water Resources Department (WRD) along the northern bank of the Brahmaputra River starting immediately downstream of the Dhansiri River confluence until the Kaziranga National Park (KNP) boundary. In contrast to the previous proposal, two sections of the river that are currently subjected to extreme river erosion will receive upgraded bank protection works in the form revetments with apron and slope pitching made of geotextile bags.

A. Kaziranga Subproject Environmental Categorization

4. The Kaziranga subproject, as originally designed to be implemented under Tranche-1 was classified as environment Category A in consonance with the ADB Safegurad Policy Statement, 2009 (SPS). The subproject components of constructing a new embankment from the Diffalupathar to NH-37 and increasing the height of the entire Brahmaputra Dyke share boundaries with the Kaziranga National Park (KNP). The KNP is a critical habitat that supports numerous critically endangered mammals including Tiger, Asian elephant, Asiatic wild buffalo, Capped langur, Hoolock gibbon, and River dolphin. KNP supports two-thirds of the entire world's One-horned rhinoceros; birds like the White bellied heron, Greater adjutant, Bengal Florican, and Spotted greenshark. KNP is a UNESCO World Heritage Site representing one of the last unmodified natural areas in north-

[1] Environmental Clearance was granted by the Ministry of Environment, Forest and Climate Change (MoEF&CC) only on August 2014.

eastern India, the single largest undisturbed representative area in the Brahmaputra Valley Floodplain, and one of the finest wildlife refuge in the world. KNP is also classified as an Important Bird Area and a Tiger Reserve. An environmental impact assessment was conducted in 2008 and the report was disclosed in 2009.

5. The truncated subproject design for project 2 was re-categorized to Category B based on the following: i) removal of environmentally critical activities that may pose significant adverse environmental risk to the KNP, considered a critical habitat, namely the construction of the 7.25 km long new embankment and upgrading/increasing the height of the existing Brahmaputra Dyke; and ii) scale down of the works in the existing Bhrahmaputra Dyke to rehabilitation rather than upgrading that focuses on 6 vulnerable sections with a total length of 3.825 km. No works will be undertaken by the subproject inside or along the KNP boundary. All environmental impacts from the implemnetation of truncated subproject are less than than than previously anticipate, site-specific, most to occur during the costruction phase, and readily mitigated. No unprecedented impacts are expected from the rehabilitation of the existing Brahmaputra Dyke and the maintenance and extension of the Water Resources Department's porcupine screens. The agreement support the KNP's implementation of the protected ardea management plan to strengthen the KNP's wildlife protection and enforcement, and monitoring of erosion along the KNP riverbank, the subproject will construct six watch towers along the sub-project boundary equipped with surveillance equipment and the procurement of a monitoring boat.

6. An initial environmental examination (IEE) was prepared to assess the potential environmental imopacts of the truncated subproject design.

B. Extent of the IEE Study

7. This IEE updated environmental assessment was done in tandem with the preparation of the feasibility report for Tranche 2 using the revised subproject details/ concept design provided by the Design Team. The IEE study covered all activities proposed for the integrated flood and riverbank erosion management in Kaziranga subproject. The impact area covers a section of the Brahmaputra River which includes the complete reach length, its immediate upstream and downstream sections, area within 100 m either side of the reach,[2] project benefit area, and beels/wetlands/ tributaries connected with the river in the reach area. The study area covers a buffer zone of 8 km wide[5] on either side of the embankment to analyze land use, identify environmentally sensitive locations if any, and understand the overall drainage pattern of the area. Geographical Information System (GIS) technique was implemented using the most 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. Impacts on aquatic life particularly Dolphins in terms of their breeding and spawning areas, migratory route of fishes was specifically assessed. Vegetation cover, migratory route of animals, and sourcing of construction material particularly borrow earth and aggregate investigation were undertaken.

1. Approach and Methodology

8. The IEE study was carried out using reconnaissance survey, review of previous studies, field visits, consultation with stakeholders, nongovernment organizations (NGOs), review of existing data, assessment to identify adverse impacts, and the preparation of environmental management plan (EMP). The assessment also builds on the Brahmaputra morphology studies using satellite imagery, risk maps, and studies on the influence of spurs and anti-erosion activities of the Water Resources Department (WRD), Assam. 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

[2] 100 meter area around the reach is considered as the primary impact zone

and proposed measures and to the extent possible, 8-km radius as the general impact zone. The immediate 100-meter corridor centered along the embankment alignment was considered primary impact zone where most of the adverse impacts are likely to occur. The decision to expand the environmental assessment impact zone to 8-km radius is to ensure that environmental impacts attributable to the project are comprehensively identified and assessed, and provide flexibility in the detailed design of project 2 to consider the rapid changes in Brahmaputra River. This IEE report provided information on river morphology, environmental baseline, and recognized that FRERM measures to influence the flow direction and promote siltation in strategic areas pose environmental impacts downstream.

9. A new round of consultations was conducted by Flood and River Erosion Management Agency of Assam (FREMMA) during the preparation of this environmental examination. Public consultations were carried out in February, July, and November 2015 and January 2016. As part of FREMAA regular activities, continuous consultations and coordination are being held during project implementation and highlight of these consultations are reflected in this report.

2. Data Collection

10. The preparation of IEE started with scoping exercise to identify key parameters to be considered and outline the activities for data collecting. Secondary data were collected on the physical, biological, and socio-economic aspects of the environment. This is supplemented by field visits, review of engineering designs including discussions with the Water Resource Department in Bokakhat, Tranche-II feasibility report, and economic assessment prepared by the Institute of Social Development. Primary data on noise, water quality, air quality and soil were gathered on sensitive sites. Dolphin sightings were recorded to identify breeding grounds in coordination with the KNP authorities. Data collected, sources, and application are summarized in the succeeding Table.

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	KNP, Department of Ecology, 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; ARSAC reports, Brahmaputra Board, WRD, and GSI Reports, Census reports	Project and environmental descriptions, and impact assessment

3. Structure of the Report

11. This IEE report has been presented based on the requirements of the ADB's Safeguard Policy Statement (SPS) 2009. The report has ten chapters, a brief of each chapter is described below. An executive summary is also provided at the beginning of the report.

(i) Chapter 1 - Introduction: This section describes the background information about the project and EIA study.
(ii) Chapter 2 - Policy, Legal, and Administrative Frameworks: This section summarizing the national and local legal and institutional frameworks that guided the conduct of the assessment.
(iii) Chapter 3 - Project Description: This section presents the key features and components of the proposed project.
(iv) Chapter 4 - Description of the Environment: This section discussing the relevant physical, biological, and socioeconomic features that may be affected by the proposed project.
(v) Chapter 5 - Anticipated Environmental Impacts and Mitigation Measures: This section presents the environmental assessment of likely positive and adverse impacts attributed to the proposed project and concomitant mitigation measures.
(vi) Chapter 6 - Analysis of Alternatives: This section covers analysis of various alternatives considered to minimize the overall impacts of proposed development and suggest most appropriate alternatives based of detailed analysis of impact and risk associated with each alternative.
(vii) Chapter 7 – Consultation, Information Disclosure, and Grievance Redress Mechanism: This section describes the consultation process undertaken during the environmental examination and its results, their consideration in the project design, and manner of compliance to the ADB's Publication Policy and related national laws. It is also describing the formal and informal redress procedures for registering, resolving, and reporting complaints.
(viii) Chapter 8 – Grievance and Redress Mechanism: This section presents the procedures and action centers to document, receive, and resolve grievances
(ix) Chapter 9- Environmental Management Plan and Institutional Arrangement: This section discussing the lessons from the impact assessment and translated into action plans to avoid, reduce, mitigate or compensate adverse impacts and reinforces beneficial impacts. This plan is divided into three sub-sections; mitigation, monitoring, and implementation arrangements.
(x) Chapter 10 - Conclusion and Recommendation: This section stating whether there is a need for any further detailed specific studies/assessments and highlights key findings and recommendations to be implemented by the borrower.

II. Policy, Legal, and Administrative Framework

12. This section briefly presents the international, national, and local legal and institutional requirements for environment safeguard issues. A description of the environment safeguard requirements of the Government of India (GoI) and its sectoral laws governing the development flood control, river erosion, and working near national parks is described. This is followed by descriptions of specific acts and rules on environmental assessment and pertinent sectoral laws prescribing mitigation measures. The ADB environmental safeguards requirement is presented next as the Kaziranga subproject was re-clasified as environmental Category B. Finally, the GoI is one of the leading countries supporting international treaties, agreements, and covenants in the protection of biodiversity and these are briefly examined.

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

1. Environmental Regulatory Requirements

13. **National (India) Environmental Policy Framework**. The legal framework of the country consists of several acts, notifications, rules and regulations to protect environment and wildlife. In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to conserve the environment. Environmental legislations can be classified according to themes covering environmental protection, forests conservation, and wild life protection.

14. **The Environment (Protection) Act 1986**. Provides the legal bases for the protection and improvement of the environment. It empowers the central and local national government levels to establish authorities mandated to prevent environmental pollution in all its forms. Rules are framed for granting environmental clearance for any developmental project, resources conservation and waste management.

15. **The Forest (Conservation) Act 1980**. Mandates the conservation the country's forests by providing restrictions and regulations of de-reservation of forests or use of forest land for non-forest purposes without the prior approval from Central Government. The Act lays down the pre-requisites for the diversion of forest land to other purposes.

16. **The Wildlife (Protection) Act 1972 amended 2003.** Enacted to effectively protect the wildlife of the country and control poaching, smuggling and illegal trade of wildlife and its derivatives. It defines rules for the protection of wildlife and ecologically important protected areas.

17. **Environmental (Protection) Act, 1986**. An environmental impact assessment is required under the Environment (Protection) Act, 1986, the Environmental Impact Assessment Notification, 2006 (amended 2009) and all its related circulars covering wildlife protection, embankment construction, and erosion control. It also provides guidance in the establishment of temporary workshops, construction camps, hot mix plants, and opening of quarries for road/bridge construction work require to comply with provisions of The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003): The Wildlife (Protection) Act, 1972 (Amended 1993); The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974; The Air (Prevention and Control of Pollution) Act, 1981 (Amended 1987) and Rules 1982; The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002) and Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009).

18. The Environmental Clearance was secured from National Wildlife Board, Ministry of Environment, Forest, and Climate Chage (MoEF&CC), Government of India (GoI) for original Kaziranga subproject design. During the 31st Meeting of the Standing Committee of National Board for Wildlife (NBWL) held on 12–13 August 2014 in the MoEF&CC, New Delhi, cleared the project proposal for 'Kaziranga Sub Project of Assam Integrated Flood and River Bank Erosion Risk

Management Project' (see Appendix-1). The proposal was for strengthening the existing embankment from Moriaholla to Diffalupathar to avoid any breach resulting flash flood in eastern range of Kaziranga National Park and neighboring communities. The environmental clearance for the sub-project entailed several key conditions stipulated by the State Chief Wildlife Warden to be complied and these are: i.) entire work shall be executed under close supervision of park authorities; ii.) top of the dyke shall be graveled; iii.) Three new sluice gates shall be constructed to regulate flow of water across the dyke; iv.) All the sluice gates shall be operated during high flood as well lean season jointly by the water Resources Department and Kaziranga National Park officials; and v. Material for porcupine works shall be transported through river route only.

19. The succeeding Table presents key regulatory requirements applicable to the Kaziranga subproject the Air and Water Acts and the Eco-Sensitive Zone Notification - Unmilitary (East of Kaziranga).

2. Social Regulatory Requirements

20. There are many rules and regulations framed by the Government of India for the protection of workers. Most of these legislations will be applicable to contractors in charge of construction. FREMMA will ensure compliance to these social legislations through contractual obligation and regular checks & penalties. These legislations include The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996; Child Labor (prohibition and Regulation) Act, 1986; Minimum Wages Act, 1948; Workmen Compensation Act, 1923; Payment of Gratuity Act, 1972; Employee State Insurance Act; Employees P.F. and Miscellaneous Provision Act, 1952; Maternity Benefit Act, 1951; Payment of Wages Act, 1936; Equal Remuneration Act, 1979; Inter-State Migrant Workmen's (Regulation of Employment & Conditions of Service) Act, 1979; Equal Remuneration Act, 1979 etc.

21. Figure 1 depicts the legislative interface between the central and state authorities in the implementation of the Government of India's environmental policy.

B. International Treaties and Relevance to the Project

22. Government of India is a party to several international treaties and has framed several enabling laws to meet its obligations.

(xi) **Kyoto Protocol to the United Nations Framework Convention on Climate Change (Ratified by India in 1997)**: The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. This amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.

(xii) **Convention Concerning the Protection of the World Cultural and Natural Heritage (Ratified by India in 1972)**: The most significant feature of the 1972 World Heritage Convention is that it links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. The Kaziranga National Park was nominated and inscribed to the World Heritage List in 1985. As a World Heritage Site, KNP receives guidance and funding support from international and GoI to protect and preserve for future generation. The GoI has provided the highest legal, administrative, and enforcement protection to KNP detailed in the provisions of the Indian Wildlife (Protection) Act, 1972 and Indian

Forest Act, 1927/Assam Forest Regulation 1891. KNP has evolved to its status from a Forest Reserve in 1908. The GoI has added six park areas from its original territory to improved management and protection efforts.

(xiii) **Convention on Biological Diversity (Ratified by India in 1994)**: Is an international treaty and considered a key document for "sustainable development". This entered into force in 1993 to develop national strategies for the conservation and sustainable use of biological diversity. It has 3 major goals: (1) conservation of biodiversity, (2) sustainable use of its components, and (3) fair and equitable sharing of benefits arising from genetic resources. As an impact of this convention, the year 2010 was considered as International Year of Biodiversity.

(xiv) **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Ratified by India in 1976)** - Is a multilateral treaty to protect endangered plants and animals and known as "Washington Convention". Opened for signature in 1973 and entered into force in 1975, it ensures that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild. This treaty protects about 5,000 species of animals and 29,000 species of plants by listing them in 3 specific appendices that affords different levels or types of protection from over-exploitation. Appendix I lists species that are the most endangered, Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled, and Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.

(xv) **Convention on the Conservation of Migratory Species of Wild Animals (CMS) (India is signatory since 1983)**: This treaty is also known as "Bonn convention" and aims to conserve terrestrial, marine and avian migratory species throughout their range. The convention has 119 parties and the depository is the government of the Federal Republic of Germany. This treaty facilitates the cooperation of different countries to protect the migratory species. There are 176 threatened migratory species that are conserved under this treaty.

(xvi) **Ramsar Convention on Wetlands of International Importance (Ratified by India in 1982)**. Is an international treaty for the conservation and sustainable utilization of wetlands by recognizing the fundamental ecological functions of 15 wetlands and their economic, cultural, scientific, and recreational value. It was signed in 1971 and came into force in 1975. Currently, The Ramsar List of Wetlands of International Importance (Ramsar Sites) includes 2,122 sites having an area of 507,470,800 acres.

C. ADB's Environmental Safeguard Policy and Requirement

23. The Asian Development Bank has defined its Safeguard requirements under its Safeguard Policy Statement 2009 (SPS 2009). The objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB's SPS 2009 classify a project depending on following three categories.

(i) **Category A**: A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or

facilities subject to physical works. An environmental impact assessment is required.

(ii) **Category B**: A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.

(iii) **Category C**: A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

24. The ADB SPS 2009 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's 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 must 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.

25. The KNP is considered as a critical habitat. The ADB prohibits 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 impact is mitigated.

Table 2: Applicability of Key Environmental Legislations at a Glance[3] (of Government of India)

Legislation	Key Requirement	Applicability	Remark	Granting Agency	Reporting Requirement	Monitoring Agency
Water (prevention and control of pollution) Act, 1972 and rules there under	An Act to Prevent and Control of Water Pollution	Applicable	Applicable during construction stage for discharge of waste from construction camps or maintenance of construction equipment.	SPCB	Normally compliance monitoring report is to be submitted once in a year or as indicated in the consent letter	SPCB
Environmental (Protection) Act, 1986 and rules there under including EIA Notification, 2006.	Requires prior environmental clearance for all River Valley projects for 10,000 ha. of cultivable bank command area protection. 2. Requires prior permission Applicable[14]as falls within 10 km of NP.	Not Applicable	The proposed project includes only activity related to existing river and embankment	MoEF&CC/ SEIAA	Once in six months	Regional Office of MOEF&CC
Forest (conservation) Act, 1980 & rules there under	Restriction on the reservation of forests or use of forest land for non-forest purpose	Not Applicable[5]	No diversion of forests land in the whole stretch	MoEFCC/ State Forest Department	Once in six months	Regional Office MoEFCC/ State Forest Department

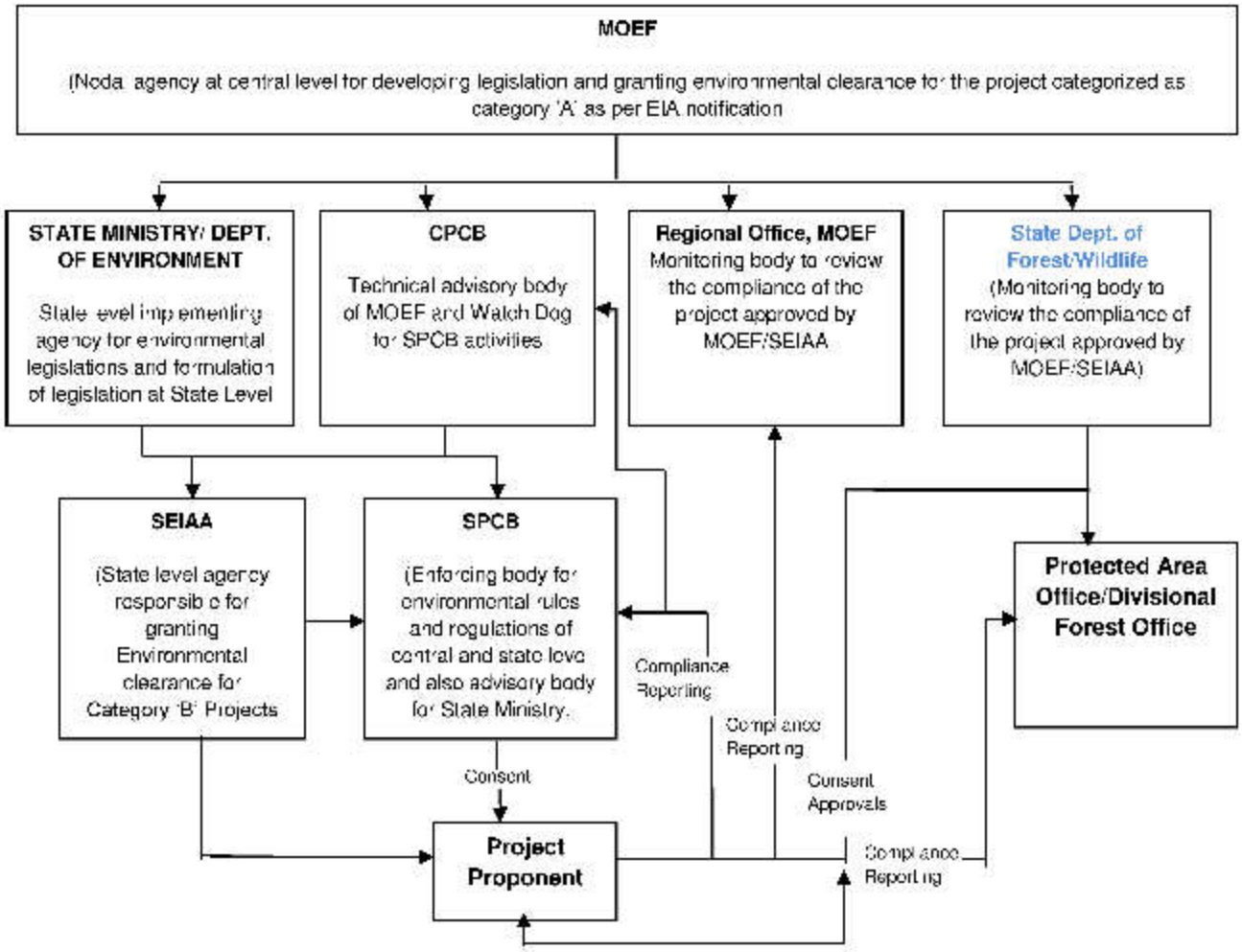
[3] Time to time amendments is issued to legislations in India. The environmental legislation applicability shall be established at the time of start of project implementation. Necessary clearances, if any becomes applicable shall be obtained from concerned authorities accordingly.

[4] Permission taken from National Wildlife Board, MoEF & CC

[5] The land revenue records need to be verified again to ascertain if any forest land is require 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.

Legislation	Key Requirement	Applicability	Remark	Granting Agency	Reporting Requirement	Monitoring Agency
Eco Sensitive Zone Notification - Numaligarh (East of Kaziranga) Zone SO 481 5th July 1996	The expansion of industrial area, townships, infrastructure facilities and such other activities which could lead to pollution and congestion shall not be allowed within "No Development Zone" except with the prior approval of the Central Government.	Applicable	To be obtained prior to start of construction	MoEFCC Central Government	As per NOC conditions	MoEFCC
Wildlife (protection) Act, 2002 & rules there under	No person shall destroy, exploit or remove any wild life including forest produce from a sanctuary/National park or destroy or damage or divert the habitat of any wild animal by any act whatsoever or divert, stop or enhance the flow of water into or outside the sanctuary, except under and in accordance with a permit granted by the Chief Wild Life Warden	Not Applicable	No wild life sanctuary/ National Park exist in the project area. However, portion of project boundary runs adjacent to Kaziranga National Park Boundary.	Chief Wildlife Warden	As per the consent letter area office/	Concerned protected Chief Wildlife Warden

Figure 1: Legislative Interface between various Central and State Authorities



III. Description of the Project

A. Kaziranga Sub-project Background

26. The Kaziranga sub-project is located along the banks of the Brahmaputra River and confined between the Bankoal-Moriaholla-Diffalupathar section[6] spanning 29 kilometers. It is located near the Kaziranga National Park in Bokakhat civil sub-division, Golaghat District, Assam. The project area is defined along the Brahmaputra Dyke and the south bank of the Brahmaputra River, technically between latitude 26°36'0.00"N to 26°39'45.00"N and longitudes 93°29'56"E and 93°33'0.00E. The sub-project area is divided by the Diffalu River and bounded to the north by the Brahmaputra Dyke, to the south by NH-37, and to the east is Dhansiri left bank embankment (see Figure 2)

27. The western boundary of sub-project area is the existing Brahmaputra Dyke which is near the Kaziranga National Park (KNP). The sub-project and KNP boundaries are separated by the Brahmaputra Dyke, a strip of agricultural lands, and a stretch of electric fence installed and maintained by the KNP to control wildlife movement across habituated areas. The strip of agricultural land becomes wider going from the north to the south which increases the distance of the project area from the KNP boundary (see Figure 7). The nearest sub-project work to the KNP boundary are the dyke emergency repair located between chainage 10200-10300m at a distance of 133 meters. KNP is considered a critical habitat that supports numerous critically endangered mammals including Tiger, Asian elephant, Asiatic wild buffalo, Capped langur, Hoolock gibbon, and River dolphin. KNP support two-third of the entire world's One-horned rhinoceros population; birds such as the White bellied heron, Greater adjutant, Bengal Florican, and Spotted greenshark. KNP is a UNESCO World Heritage Site epresenting one of the last unmodified natural areas in north-eastern India, the single largest undisturbed representative area in the Brahmaputra Valley Floodplain and one of the finest wildlife refuges in the world. KNP is also classified as an Important Bird Area by Birdlife International and a Tiger Reserve by the Government of India.

28. Flood embankments have been placed along the Kaziranga Reach since the early 1960s until 1977. The existing embankment extends inland for 13.3 km near the the KNP boundary on the western side continuously from Moriaholla to Diffalupathar. There is also a 5.5 km flood embankment along the west riverbank of the Dhansiri River. These embankments have provided protection to Bokakhat communities covering an area of 6,300 hectares. This protected area are inhabited by tribal and schedule caste surrounded by fertile agricultural lands, connected with roads and bridges to the district and divisional centers, and with a network of public and private institutions. Bokakhat Township and its civil headquarters is located within the sub-project area.

29. The Brahmaputra flood embankments have been retired several times due to riverbank erosion. Embankment are retired when it has sustained numerous breaches making regular repairs costly. A new embankment is then constructed behind the retired embankment to offer the same if not better level of flood protection. About 5.5 km of dykes have been constructed along the west bank of Dhansiri River and from Brahmaputra River extending inland 3.5 km along the boundary of KNP. Upstream of Dhansiri River, 7 km of the Brahmaputra Dyke has been retired multiple times and at present has been replaced by the Krishibundh. Since 2006 approximately 2.2 km of the Krishibundh has been eroded and replaced by a low temporary dyke. Discussions with local villagers during the conduct of the environmental assessment recalled episodes of riverbank erosions dating back to 1968 when floods forced the residents of Riri Village to fall back away from the riverbank several times as their areas are taken by the Brahmaputra River. In Bonkwal, riverbank erosion from 1980 to 1985 has completely wiped out the community. In 1988, the subproject area

[6] Called the Kaziranga Reach in Assam Integrated Flood and River Erosion Risk Management Project

experienced severe flood which damage small embankments around Bimagnon and Tilia Bari. Approximately 20 people died of water-borne diseases and 1,500 families lost their agricultural land. An estimated 3,000 cattle died in one month due to drowning and later starvation. The same incident happened in 1998 when 300 families lost their land in Kaziranga area from riverbank erosion. On average, each family lost about 25 *bigha*[7] of agricultural land, and approximately 2,000 livestock died.

30. The general trend of the south bank tributaries like the Dhansiri River is to run parallel to the Brahmaputra River for several kilometers. The southbank tributaries of the Dhansiri River generally carry very little sediments as compared to the main Brahmaputra channel. When the Dhansiri River joins silted section of the Brahmaputra River, riverbank erosion occurs at the mouth of these south bank tributaries and their channel length can be shortened significantly. This in turn has a destabilizing effect on the platform of the upper portions of the tributaries as they adjust to the new channel slope. Within the Kaziranga sub-project area, the Dhansiri River appears to be undergoing rapid lateral erosion at the outside of meander bends, which is directly threatening a portion of the Dhansiri embankment.

31. The area upstream of KNP[8] has eroded substantially over the last 30 years with the Brahmaputra River moving towards the south (see Figure 4). A major tributary, the Danshiri River joins the Brahmaputra River upstream of the KNP. The KNP's unique wildlife that includes rhinos, elephants, hog and sambar deer, wild buffaloes, tiger, and leopards normally leaves the plains during the monsoon to avoid inundation from moving towards the southern hills through a depression running parallel to the National Highway-37 (NH37). A breach in the existing Brahmaputra embankment and upstream of the KNP caused deep flooding in this natural depression cutting the animals off from the safer highlands. Over time, these depressions could lead to the formation of a channel of Brahmaputra River cutting off the wildlife movements permanently from the plains.

B. Objectives of the Proposed Structural Measures

32. The proposed structural measures originally comprised of: i) installing of porcupine screens from Dansirimukh to Dhanbari, ii) raising and strengthening of Dhansirimukh to Diffalupathar embankment, iii) providing gravel layer over the embankment used for rural connectivity, and iv) construction of new embankment from Diffalupathar to NH-37.

33. Delays in securing the environmental clearance prevented the implementation of structural measures during Project 1, and with Project 2 implementation being limited to about 2 years due to the availability period of the MFF, the scope of sub-project had to be reduced. A side-by side comparison of the original and proposed structural measures under the Kaziranga sub-project is presented in Table 3.

34. The truncated scope of work for Project 2 primarily focuses on carrying out emergency repairs at 6 of the most vulnerable sections of the Brahmaputra dyke due to recurrent breaching and overtopping, domesticated and animal movements, seepage, sliding[9], and boiling[10]. A better treatment of the on-going active riverbank erosion that threatens the dyke system in Dhansirimukh, Agaratoli, and Dhanbari reach is included in the current project through the construction of two riverbank revetments made of geobags pitching and aprons, each measuring about two kilometers

[7] In Assam, 1 bigha is 14,400 square feet (1,340 m^2).
[8] Or area immediately downstream of the Kaziranga subproject
[9] Sliding is a failure of a levee or embankment that has suffered from excessive seepage usually due to high flood when the slope drains with horizontal channel at the toe to tackle seepage is overwhelmed.
[10] Boiling is the uncontrolled seepage beneath the embankment, where fine sand particles are carried by water and appears behind the embankment as springs or boils

along the banks of the Brahmaputra River is nearest to the dyke. Underwater embankment toe protection is also included. Between these two vulnerable riverbank sections, PSC porcupine screens will be installed as envisioned in the original design from Dhansirimukh to Bonkual, and Dhanbari to Agartoli. Finally, the construction of 3 sluice gates have been retained in the truncated scope. Despite these changes, most of the objectives in the original non-truncated design approved in 2009 remain valid, these are:

(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 of riverbank protection works along critical reaches with the main purpose of ensuring the embankment stability.
(iv) 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.

Figure 2: Subproject Location

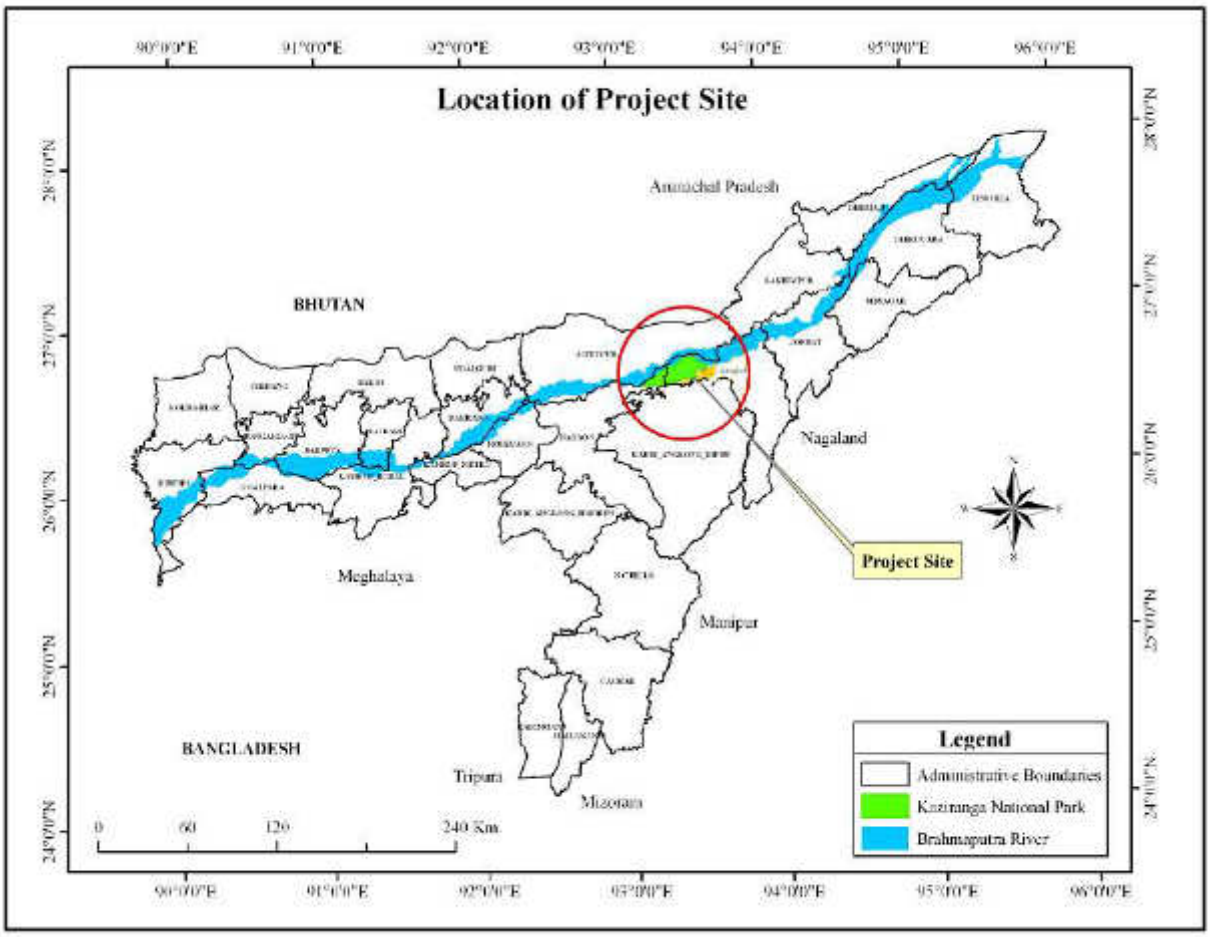
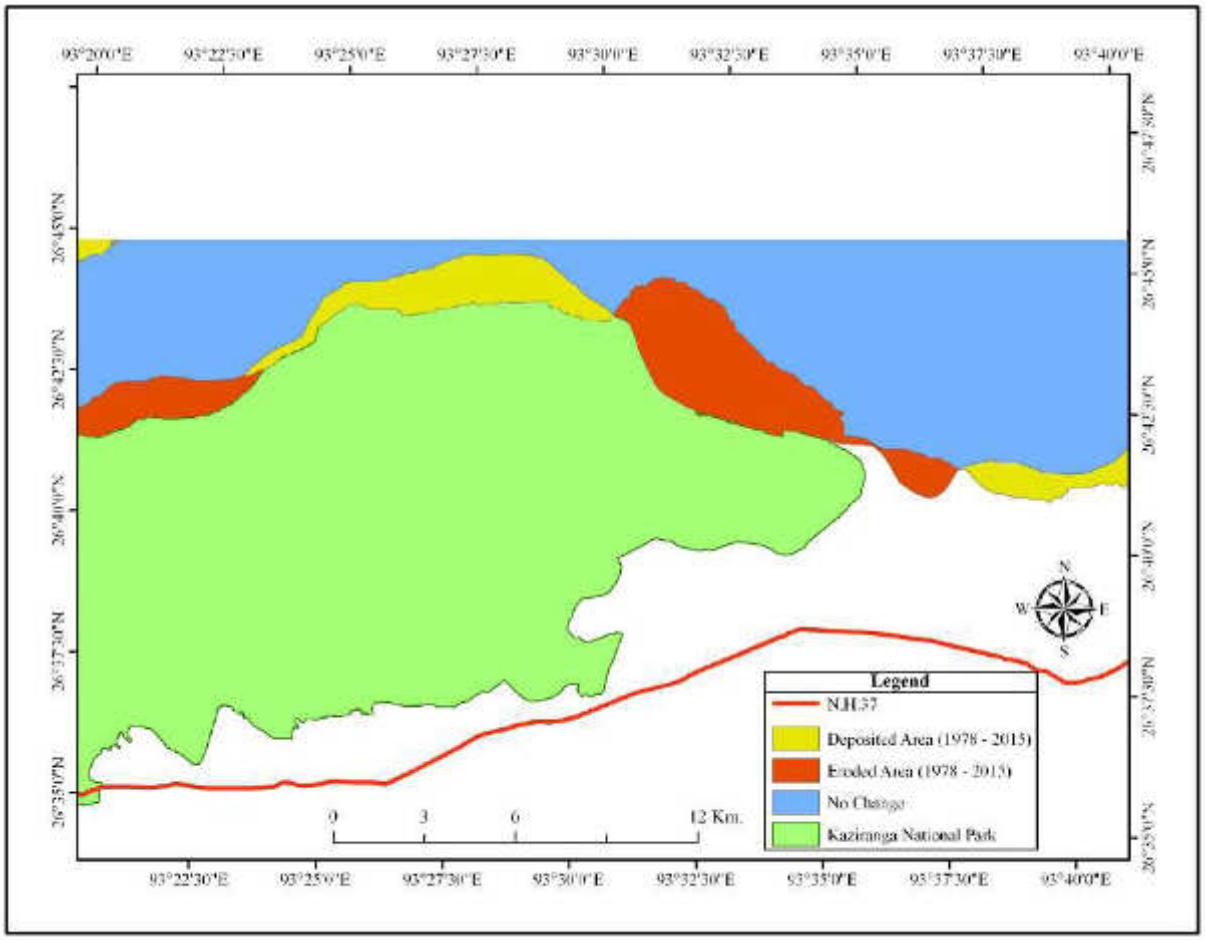


Figure 3: Kaziranga subproject reach and benefitted area

Figure 4: Past River Bank Erosion and Deposition along Kaziranga Sub-project (1978-2015)



35. Non-structural and community-based flood risk management activities previously identified in Project 1 will be undertaken during Project 2, including:

(i) **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.

(ii) **Building and Development Guidelines.** The Program will assess flood damage to buildings and public infrastructure to identify possible improvements. The project will build on the United Nations Development Program Disaster Management Project that has undertaken studies on the design and construction of flood-resilient buildings.

(iii) **Flood Forecasting and Warning.** Flood forecasting is meant to provide timely 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, considering 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 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.

(iv) **Flood Emergency Planning and Management**. This involves the review and strengthening of existing and flood emergency planning includes prevention, preparation, response, and recovery activities at the village, district, and state levels.

(v) **Community-Based Flood Risk Management (CBFRM)**. In conjunction with the flood and emergency planning and management component, the 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.

(vi) **Flood Education.** Although villagers appear are aware and have adapted to floods, the need for education in villages will be assessed through community surveys and promote cooperation and the exchange of ideas and information between the different agencies through workshops, and seminars.

C. Proposed Civil Works

36. The proposed activities for the embankment works, underwater and riverbank protection, sluice gates construction, and porcupine screens installation are:

(i) Upgrading a total of 3.775km in various locations of the Brahmaputra dyke from Moriahola to KNP Boundary, and from KNP Boundary to Diffalupathar at chainages: 4025-4450m, 6975-7225m, 8025m-8150m, 8575m-8150m, 10200m-10300m, and 14600m-16000m. The existing embankment sections have reduced crest levels[11] (RL) of about 78 m which will be increased to match the adjacent parts of the embankment level (FL) of 79.45 based on the design high flood level (DHFL) of 77.65m and a 1.8m freeboard.

(ii) Riverbank protection/revetment will require the launching of 4 layers of geobags weight 125kg each in the apron with a total length of 30 meters starting at the working low water level[12] (LWL) of 71.02 meters towards the river. A toe-key just above the LWL will be installed composed of 2 levels of wire netting box filled with geobags with dimension of 1.5m x 1.5m x 0.45m. Towards the bank until the natural level, slope pitching will be constructed underlain with geobags and covered with earth.

(iii) The proposed multi-layer pre-stressed concrete (PSC) porcupine screens will have 3 rows of porcupine at the berm above the water line and below will have a configuration of 5 rows at the bottom, 3 rows in the middle, and 2 rows of more than 500 meters towards the centre of the river.

[11] Based on a datum of 66m
[12] Datum of 57.00m

(iv) The proposed sluice gates will have different dimensions based on the channels and conveyance parameters, in general they will be constructed of concrete cement (CC) blocks, reinforced concrete cement slabs, at least 1.0m x 5.0m toe wall, and launching aprons. The operation of the sluice gates will be a collaborative effort between WRD and KNP.

D. Implementation Schedule and Project Cost

37. The subproject will be implemented over a period of 2 years from 2018 to 2020. The total estimated cost of the subproject for structural works is estimated as ₹589.642 Million (2017 prices). Detailed scope of work includes clearing and grubbing of the embankment, felling of trees, supply of anti-termite, earthwork and construction of embankment, turfing of embankment, sluice culvert construction, anti-erosion works with geo-synthetic materials, and pro-siltation works with PSC porcupine screens.

Table 3: Side-by-Side Comparison of the 2009 Original and 2018 Revised Scope of Works for the Kaziranga Subproject

Proposed Work and Specification	Original Scheme and Basis for 2009 EIA Report	Revised Scheme Basis for 2018 Update	Key Differences
Construction of new embankment	Specification: Increase the crest width to 7.50m; river side slope 2:1; countryside slope 3:1; free board 1.8m over DHFL; embankment height not to exceed 6m. Construction of a 7.25km long new embankment, from Diffalupathar to NH37	None	Deleted
Brahmaputra dyke works	Specification: Increase the crest width to 7.50m; river side slope 2:1; countryside slope 3:1; free board 1.8m over DHFL; embankment height not to exceed 6m Raising and Strengthening works of the Brahmaputra dyke, from Moriaolla to Kaziranga Reserve Forest boundary from ch. 3500m to ch. 10250m and KRF boundary to Diffalupathar from ch. 0m to ch. 13100m Total length 19.88 km	Specification: Increase the crest width to 7.50m; river side slope 2:1; countryside slope 3:1; free board 1.8m over DHFL; embankment height not to exceed 6m. Sections of the Brahmaputra Dyke (Moriaholla-NH 37) to be upgraded: Ch.4025-4450m Ch.6975-7225m Ch.8375-9850 Ch.10200-10300m Ch.1460-1600m Total: 3.775	proposed works are considered "emergency works" to address existing weaknesses and breaches in the Brahmaputra dyke
Construction of Sluice Gate	At 16/1 (16.08 km) = 4 shutters sluice At 19/1 (19.37 km) = 1 shutter sluice At 20/1 (20.72 km) = 1 shutter	At 16/1 (16.08km) = 4 shutters sluice At 19/1 (19.37km) = 1 shutter sluice At 20/1 (20.72km) = 1 shutter	The same
Bank Protection Works	None	Specification: Apron with Type-A geobags with thickness of 0.60m and width of 30m; slope pitching with Type-A geobags with thickness of 0.45m on 2:1 slope; freeboard of 1.8m above DHFL 2 reaches of 2 kms each from Dhansirimukh to Agartoli reach of Brahmaputra	
Porcupine Screens of different lengths at selected location	Specification: Without boat, 3 rows per screen; with boat in order of 5,3,2 rows bottom to top. Continuous reach from Dhansirimukh to Agartoli reach of Brahmaputra with a total length of 8 kms	Specification: Without boat, 3 rows per screen; with boat in order of 5,3,2 rows bottom to top. From Dhansirimukh to Agartoli in 3 sections with total length of 10 kms.	The same specification

Figure 5: Subproject Location Map

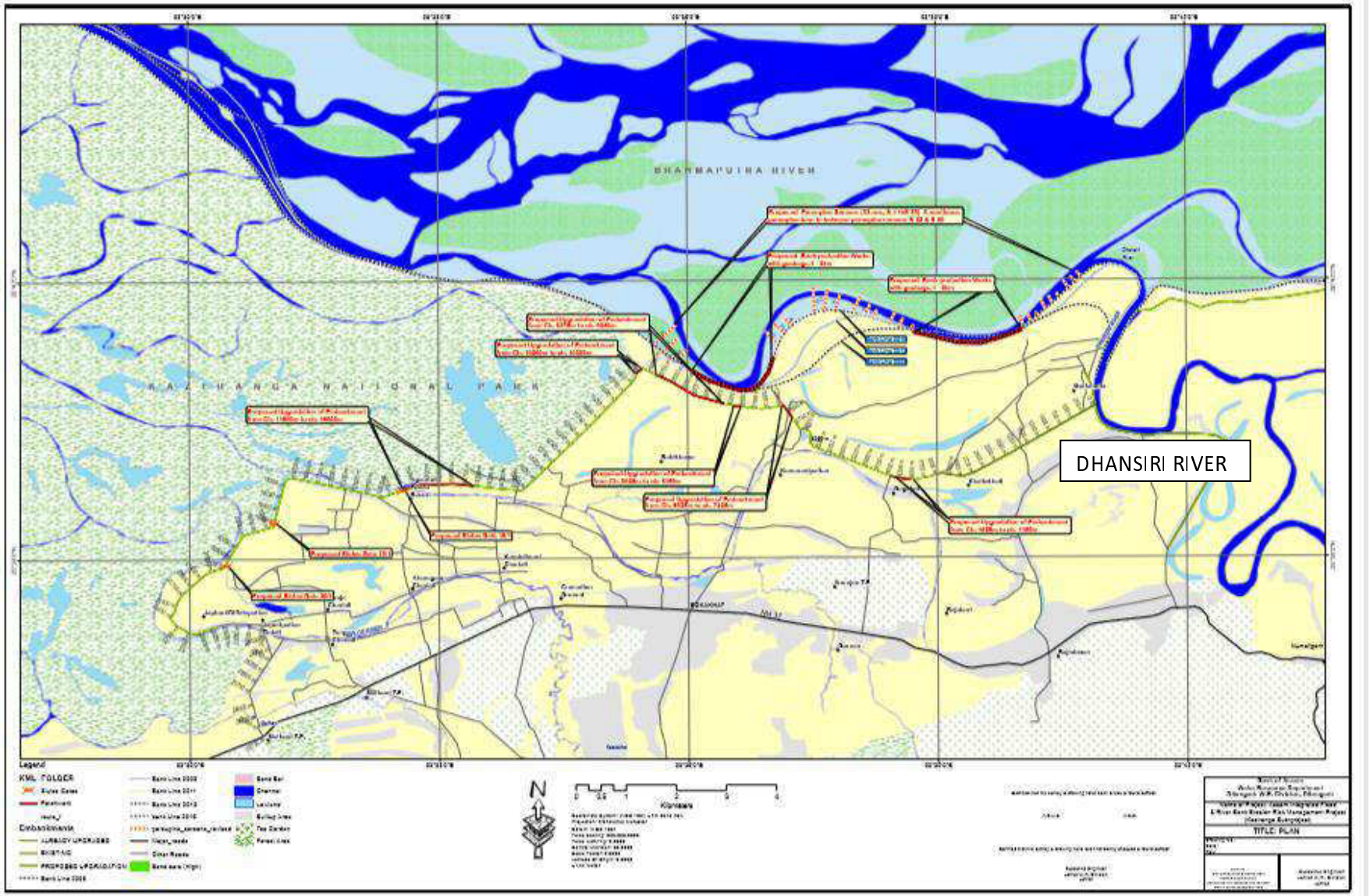
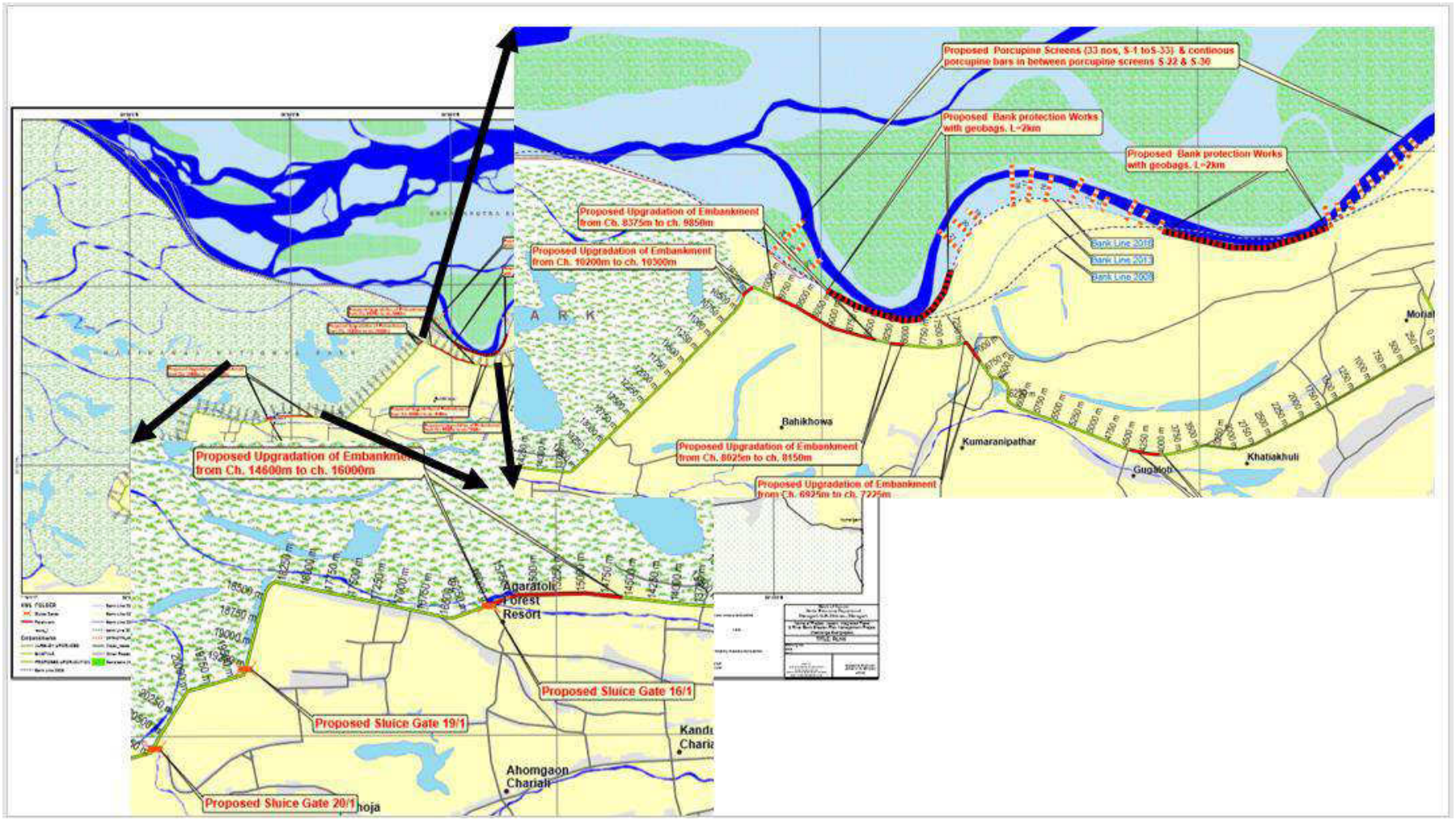


Figure 6: Proposed Flood and Bank Erosion Works for the Kaziranga Subproject (details enlarged)



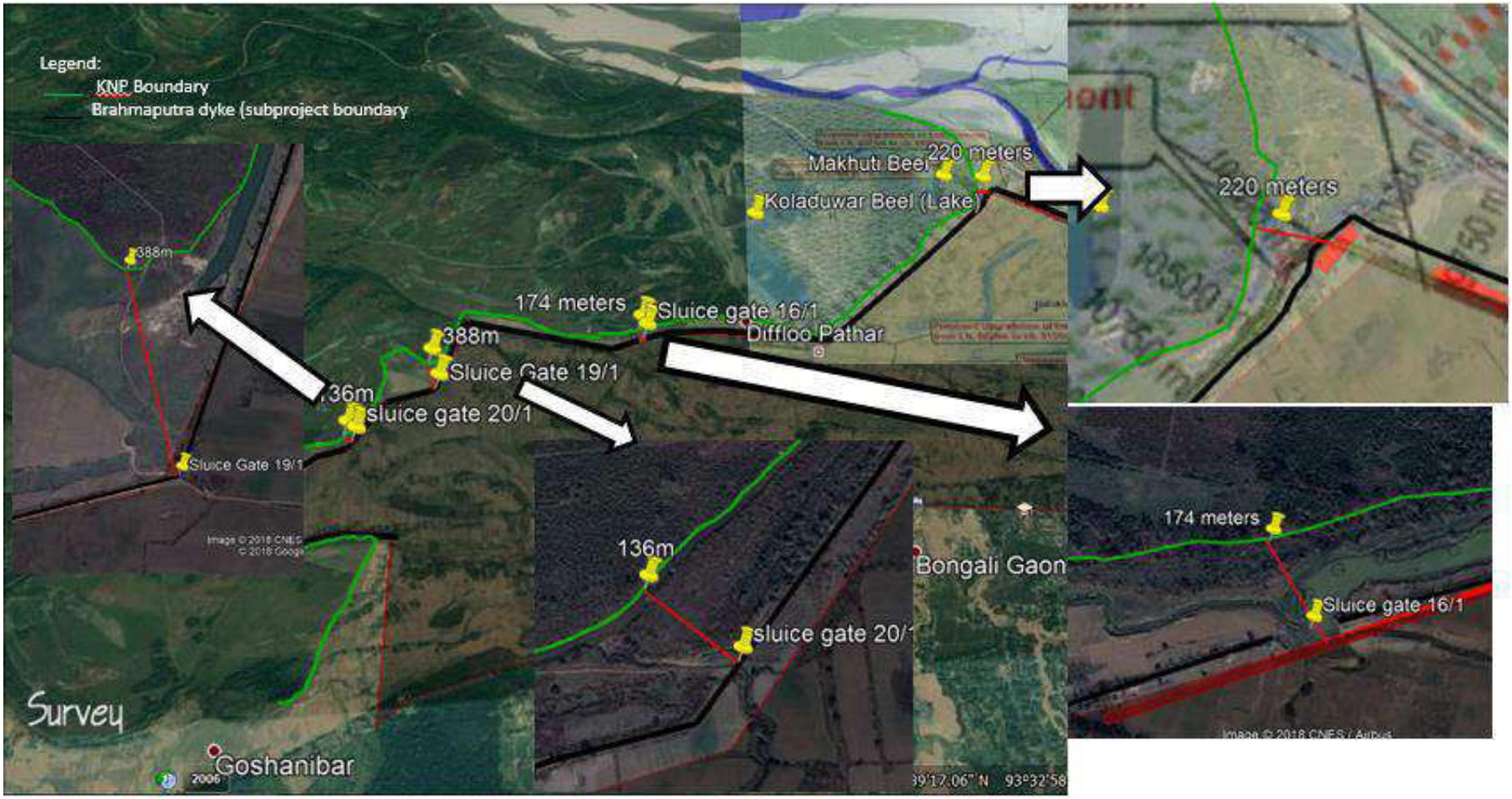


Figure 7: Location of the Subproject and KNP Boundaries, highlighting the distances of the proposed civil works

Figure 8: Typical Cross-Section of the Proposed Embankment Works under the Kaziranga Subproject

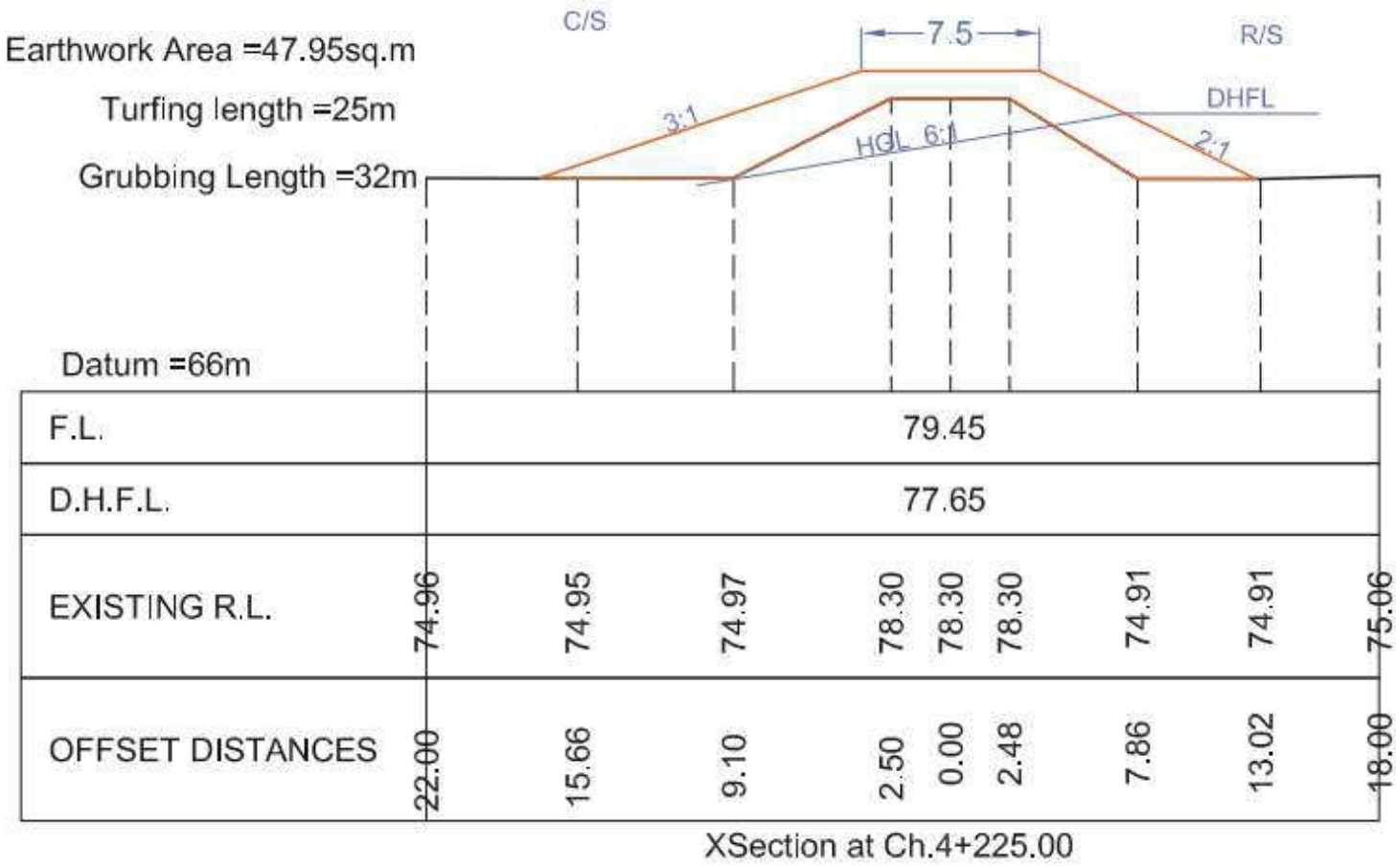


Figure 9: Typical Cross-Section of the Proposed Bank Protection Works under the Kaziranga Subproject

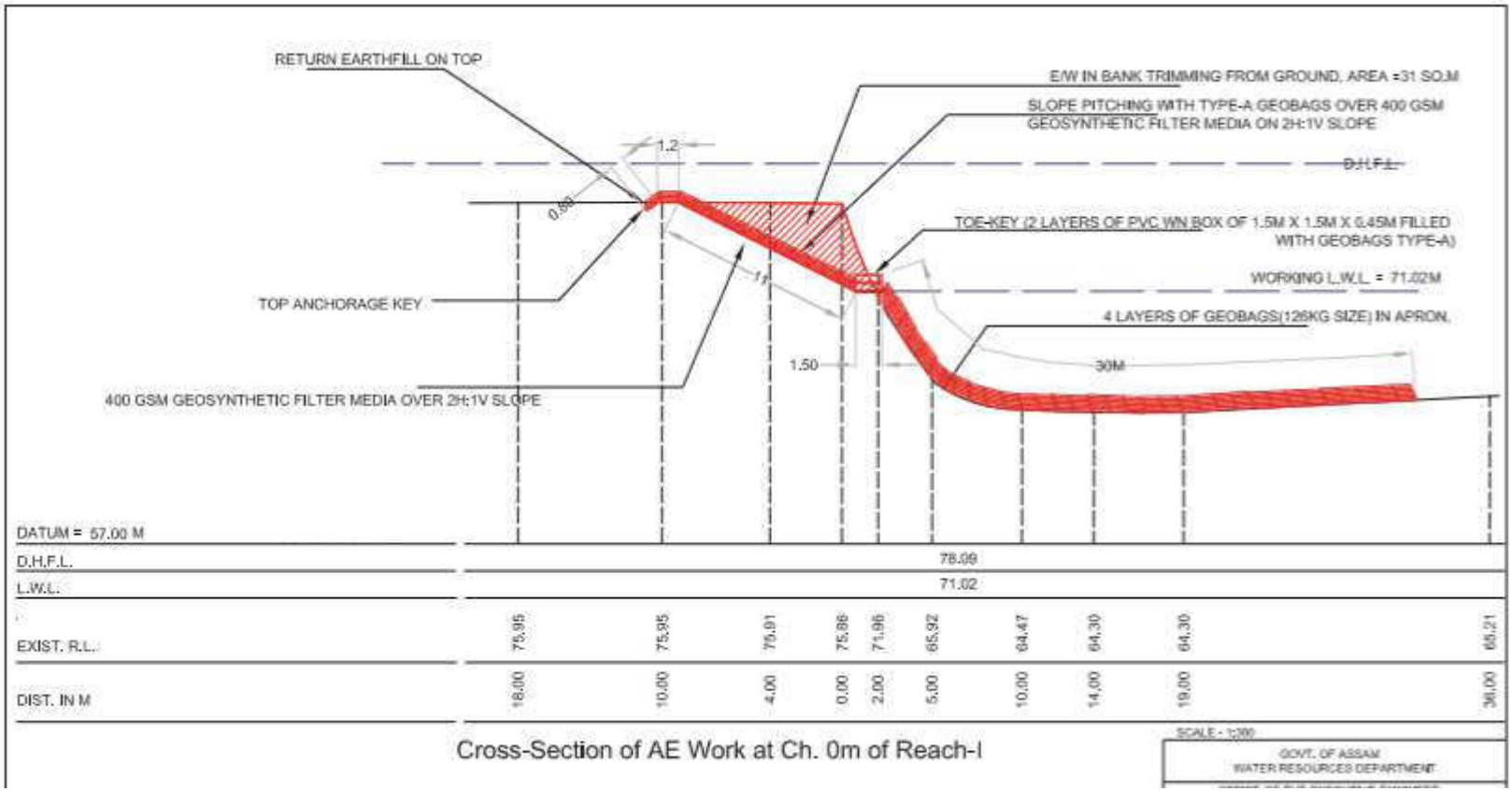
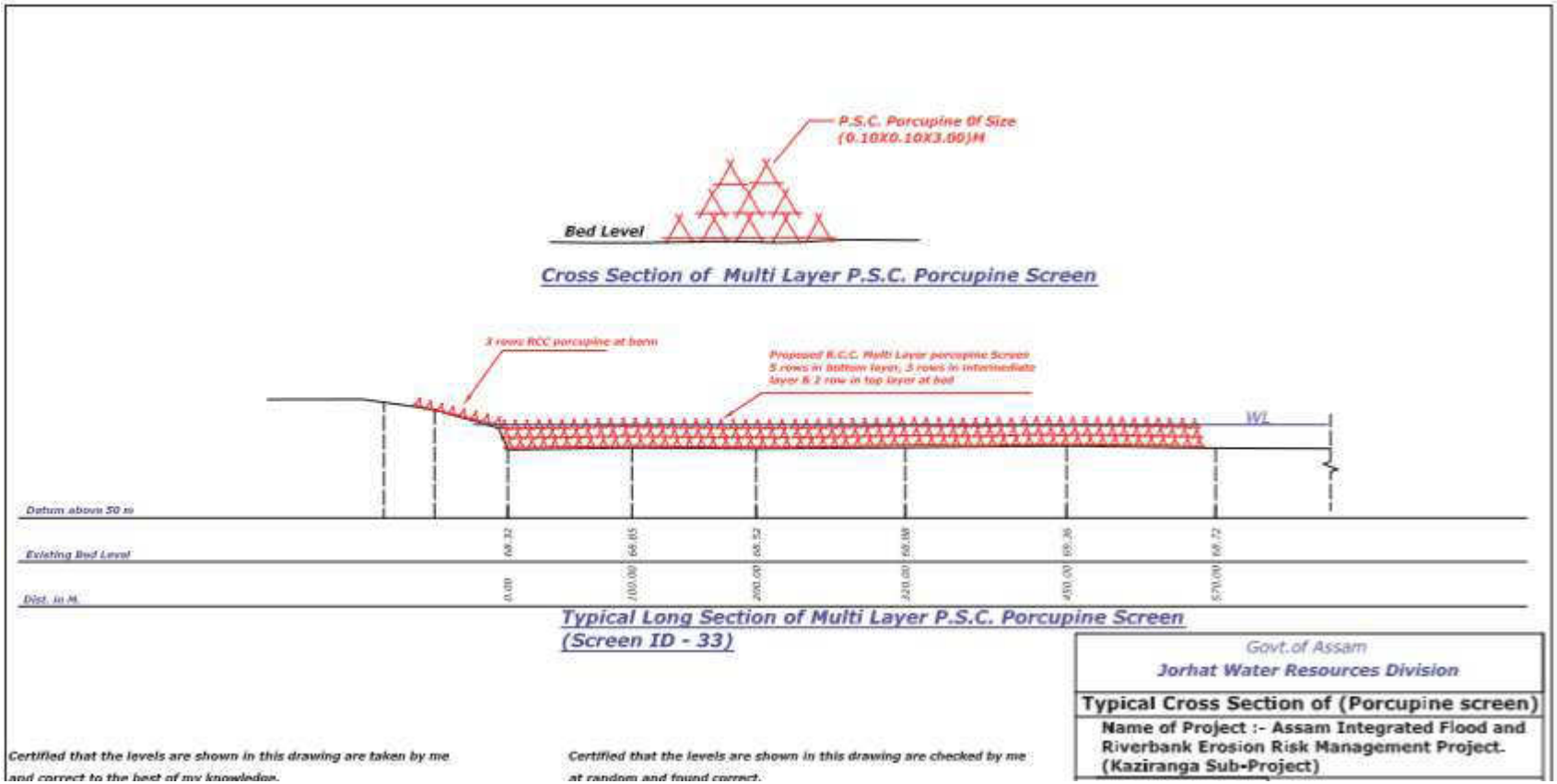


Figure 10: Typical Cross-Section of the Proposed Porcupine Screens under the Kaziranga Subproject



IV. Description of the Environment Baseline

A. Introduction

38. To assess the impacts of the proposed improvement for the Kaziranga sub-project, field visits were made to understand the environmental profile of the influence area. This involved collection of secondary information for all the environmental components and discussions with the officials, NGO's and local community. The profile presented below comprises of the following:

(i) Physical environmental components such as meteorology, geology, topography, soil characteristics, air quality, surface and sub-surface water quality;
(ii) Biological environmental components such as aquatic, biotic and marine flora, fauna and mammals, and
(iii) Land environment in terms of land use, soil composition.

39. Significant baseline information were gathered from 2008 to 2009 remains relevant and were retained in this IEE, these include: (i) physiography and drainage, (ii) topography, (iii) geology, (iv) soil conditions, (vi) biological and (v) hydrology. This IEE updated the data on: (i) climate especially data on mean monthly rainfall (2012), (ii) water quality on selected Kaziranga areas (2011), (iii) environment quality such as ambient air quality (2011, 2012) and, (iv) morphology with update data on pattern of erosion and accretion. A special study was commissioned by FREMAA to study the biodiversity of the Kaziranga National Park in 2016 and key findings are included in this report. Finally, the socio-economic data were also updated using the most recently available population and economic census.

B. Description of Physical Environment

1. Climate

40. 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- monsoon (retreating) season from last part of September to mid-October generally represents fair weather conditions with declining rainfall as well as temperature.

41. The Brahmaputra valley in Assam forms an integral part of the subtropical monsoon regime of eastern Asia receiving a mean annual rainfall of 230 cm with a variability of 15-20%. Distribution of rainfall over different river basins in Assam shows marked spatial variations, 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 Matmara reach in upper Assam. The isohyet map of the Brahmaputra valley and adjoining highlands (based on India Meteorological Department data) is shown in the succeeding Figure.

42. Monsoon season is from June to September which accounts for 60-70 % of the annual rainfall in the region. Pre-monsoon season extending from March through May provides 20-25 % of the rainfall caused primarily by depressions moving from west and by local conventional storms. The pre-monsoon rains are primarily controlled by the position of a belt of depressions called the monsoon axis extending from northeast India to the head of the Bay of Bengal. During its north-south oscillations in summer when this axis moves closer to the foothills of the Himalayas, heavy precipitation is caused in Assam and adjoining highlands.

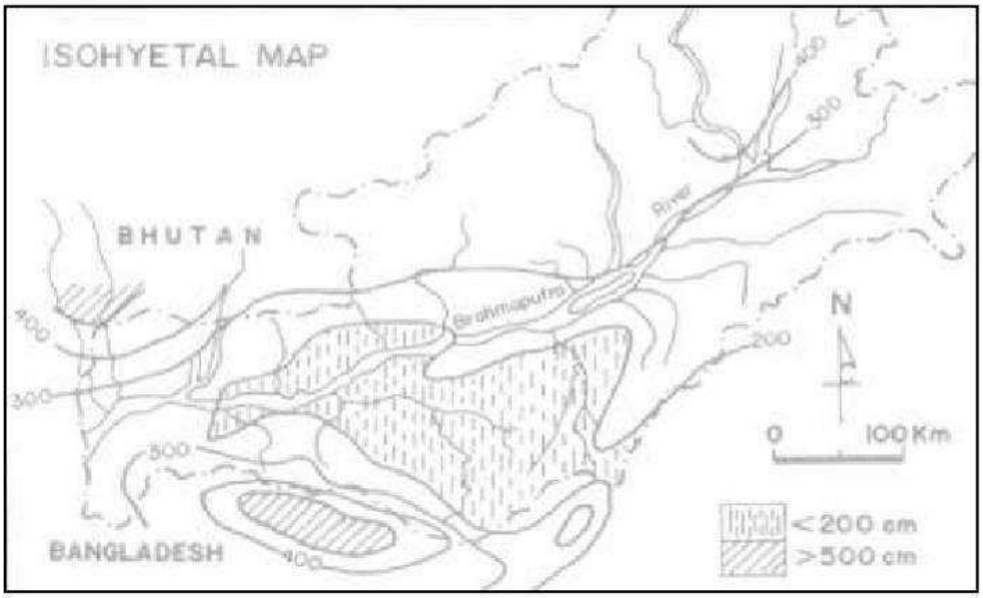
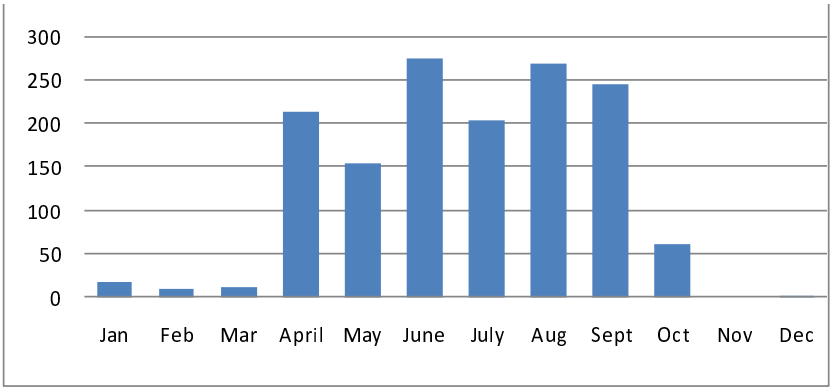


Figure 11: Isohyetal Map of the Brahmaputra Valley and Adjoining Highlands

43. The Kaziranga reach has a subtropical monsoon climate typical of northeast India. It receives an average annual rainfall of 1,456.4 mm. The pattern of mean monthly rainfall in a station close to the reach is shown in the succeeding Figure. The highest monthly mean rainfall occurs in June with 273.4 mm and the lowest monthly mean rainfall is recorded in the month of November with no rainfall.



Source: IMD, RMC, LGBI Airport, Borjhar

Figure 12: Mean Monthly Rainfall in mm for the Year 2015 at Golaghat (close to Kaziranga Reach)

44. 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 foothill region of and in the immediate downstream areas in the Brahmaputra plains. The situation is aggravated further when these events trigger landslide and slope failures in the upper watersheds that 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 that created a dam which eventually collapsed and released a deluging 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 because of a sudden failure of a landslide induced dam in neighboring uplands. Cloudburst and landslides related flash floods occurred in 2004 in the Manas and Beki rivers of Assam due to failure of landslide dam upstream of Kurichu hydro-electric project in Bhutan that caused highly destructive flood and channel avulsion. On October 7 of the same year, 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.

2. Physiography and Drainage

45. There is a good measure of homogeneity among the project areas in terms of their riverine locations in active floodplain tract along the bank of the Brahmaputra River. Their composition consisting almost entirely of young alluvial soil and vulnerable to flood and erosion during the last few decades. However, in terms of biodiversity, urbanization, socioeconomic base, minerals and industries, and infrastructure, there are considerable variations in each sub-project. 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. These divisions are shown in Figure 13.

46. The Kaziranga reach like the other two reaches under the IFRERM-Assam is in the active floodplain zone along the bank of the River Brahmaputra. The reach has a variety of landscape elements like rivers, floodplains, wetlands, swamps and occasional hillocks.

47. The Dhansiri River (see Figure 14), a major south bank tributary of the Brahmaputra and Gelabeel, flows through the subproject reach and almost dividing it into two sub- reaches near its outfall in the Brahmaputra at Dansirimukh. The Dhansiri River's total drainage area is 10,240 km^2 and carries an average annual discharge of 188.42 m^3/s with a suspended load of 146 ha.m near its confluence with the Brahmaputra. The Dhansiri River used to flow through the Kaziranga National Park area, due to sedimentation the present point of confluence with the Brahmaputra lies about 5 km east of the park boundary. The eastern part of the reach extends from Bankoal to Moriaholla for 7.0km while the western part extends downstream from Kaziranga National Park to Diffalupathar and further up to the NH-37. The Diffolu River originating from the Karbi - Anglong hills flows through the middle of the park area. Its original course along the southern boundary of Kaziranga now survives as a dead channel of the river known as Mora Difflou. Similarly, there is an abandoned channel of the Dhansiri River flowing through the park which is known as Mora Dhansiri River.

Figure 13: Physiographic Divisions in Assam

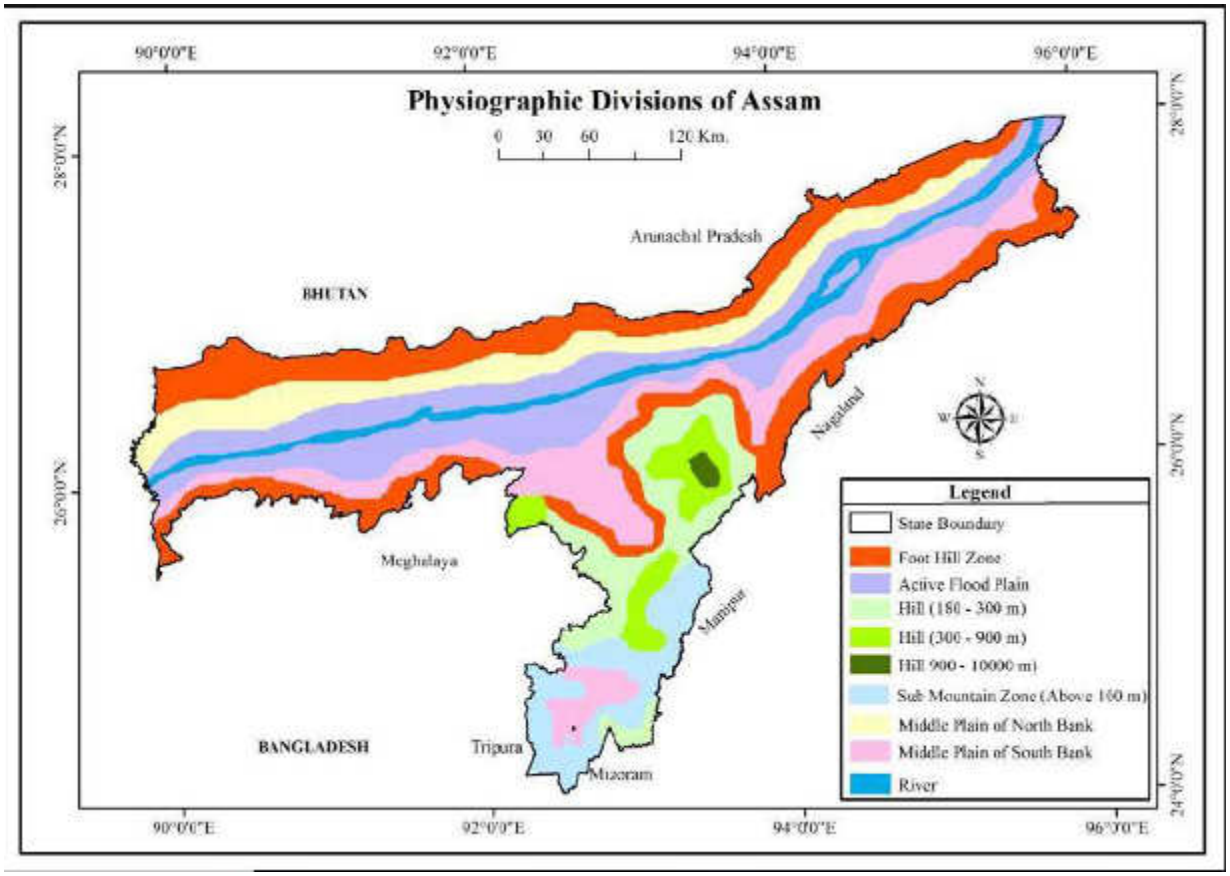
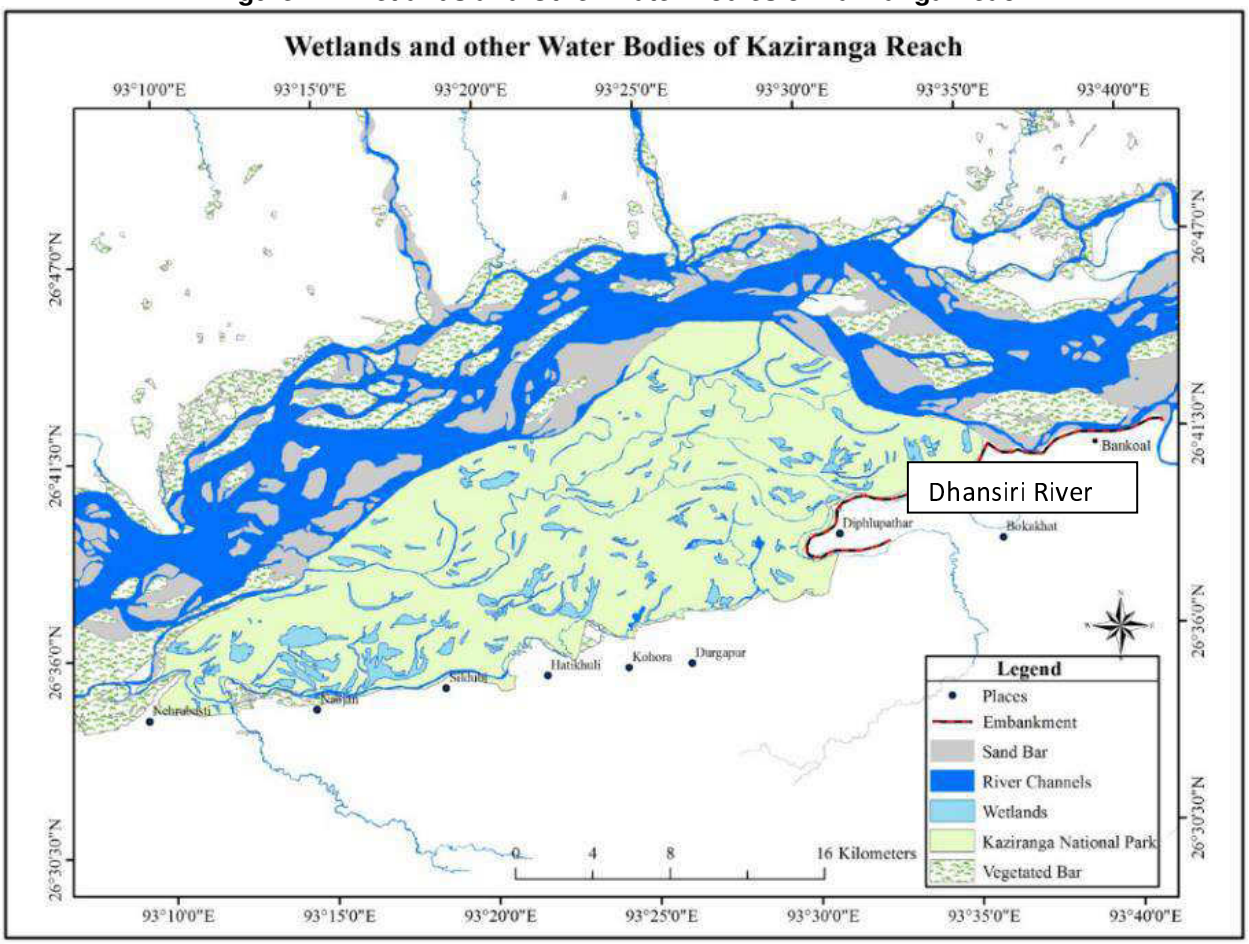


Figure 14: Wetlands and Other Water Bodies of Kaziranga Reach

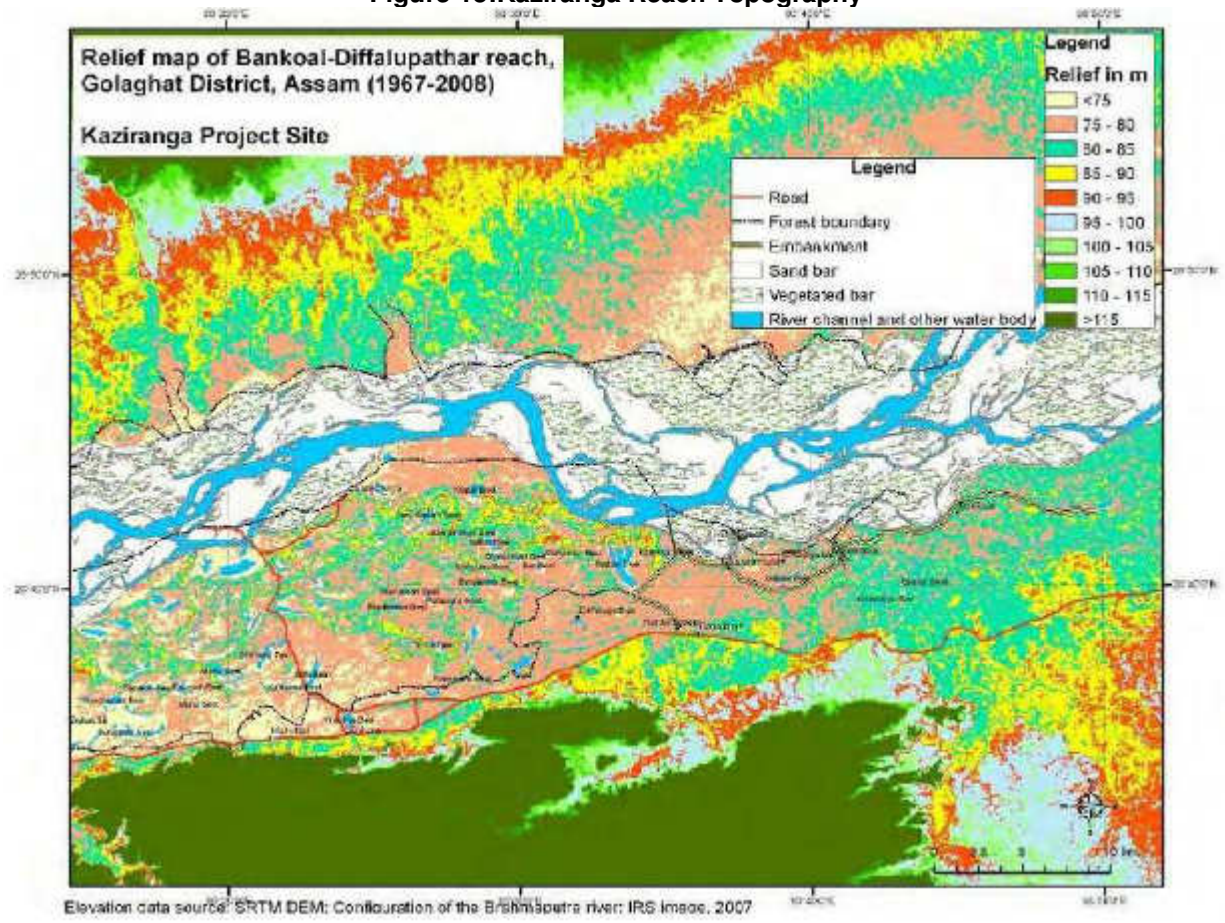


48. There are a number of wetlands, marsh, swamp areas meander cut-off channels and ox-bow lakes in the subproject area. Most of these wetlands are inside the KNP including the Sohola Beel is located outside the embankment in the riverside. Also, there is no wetland in the Moriaholla area, where project activities are likely to be undertaken. An elongated depression with a string of wetlands running along the southern boundary of the park close to the NH-37 has developed. This depression links the Garumarajan with the Mora Diffalu extending close to the currently eroding southern channel of the Brahmaputra. Based on satellite imagery this depression appears as a potential flash point for a major avulsion of the channel, creating a situation of grave consequence about safety of the park.

3. Topography

49. The relief map based on analysis of satellite data showing topography of the Kaziranga reach is presented in succeeding Figure. It shows that the relief of the area represents monotonously flat lowland (less than 115 m above MSL) except the adjoining hilly uplands in the south.

Figure 15:Kaziranga Reach Topography

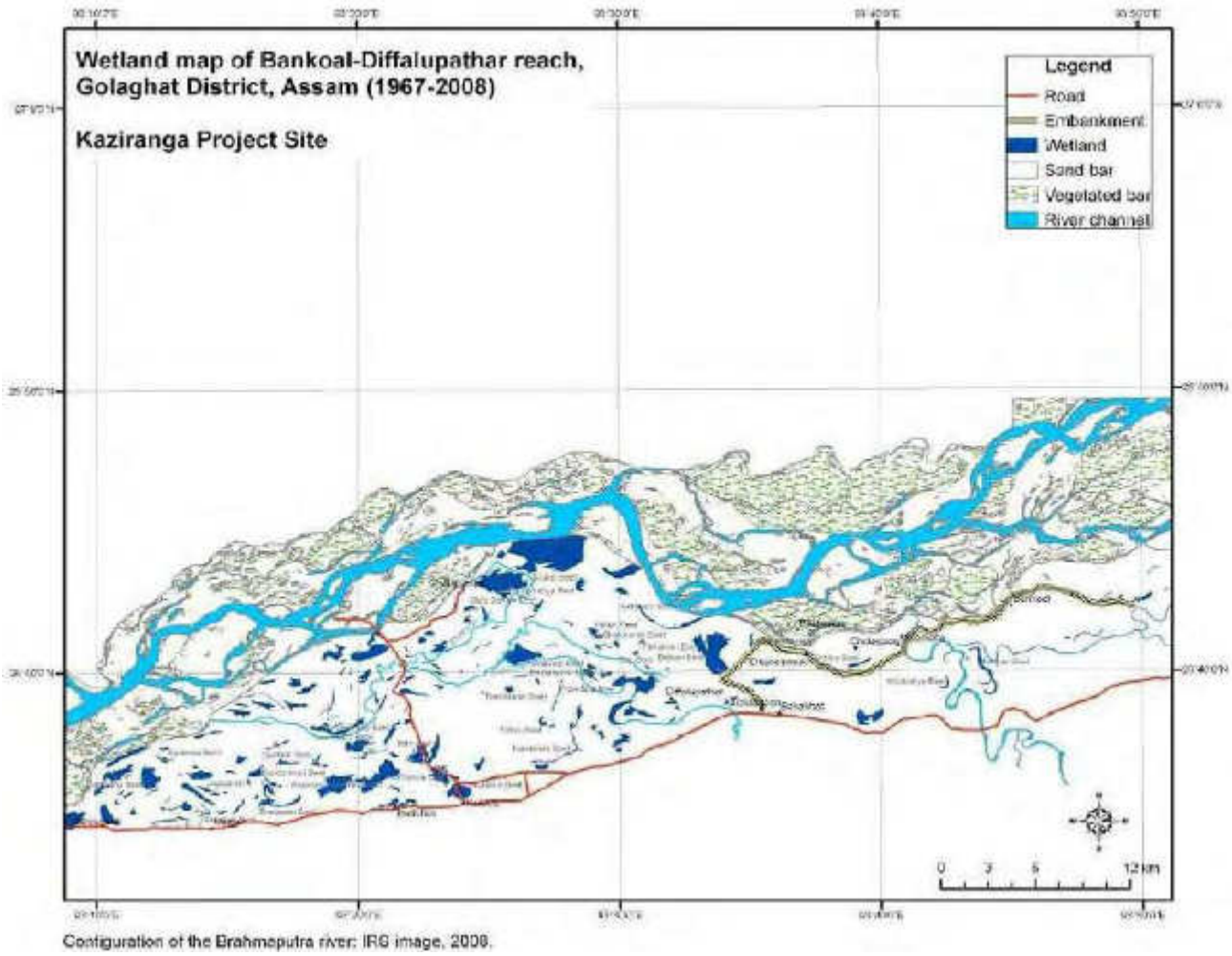


4. Water Environment

50. The state of Assam in general and the Brahmaputra valley in particular, is endowed with vast water resources. The Brahmaputra River and the 33 major tributaries joining it in Assam including the main trans-Himalayan tributaries of Subansiri, Jia Bharali, and Manas carry about 30% of the country's total water resources potential. Surface water bodies covering about 8,251 km^2 which accounts for 10.5% of the total geographical area of the state. Of this, the river systems including waterlogged areas occupy 6,503 km^2. The annual surface water availability is over 53 million ha-m. There are 3,513 wetlands in the Brahmaputra valley covering 1,012.3 km^2 area. Groundwater is also plentifully and available at shallow depth in the valley with a potential storage of over 2 million ha-m.

51. The water environment of the Kaziranga reach is dominated by the Brahmaputra River, its tributary Dhansiri, Diffolu, Geelabeel, numerous small streams, abandoned channels, wetlands, and marshy areas. The locations of major wetlands and other water bodies in the Kaziranga reach are shown in the map below.

Figure 16: Wetlands and Other Water bodies of the Kaziranga Reach



Configuration of the Brahmaputra river: IRS image, 2008.

5. Water Quality

52. Water quality monitoring and analysis to establish physical, chemical, and biological characteristics were carried and results are as shown in the succeeding Tables and the sampling locations are illustrated in the following Figure. The water quality criteria of designated best use given by Central Pollution Control Board (CPCB) is provided Appendix 3. The comparison of the surface water sampling and analysis against the water quality criteria for designated best use shows the water quality in the subproject area meets the criteria of Class C —Drinking Water Source after Conventional Treatment. The water qualities with respect to almost all the essential parameters were observed to be good and of acceptable for drinking and other domestic uses. No arsenic pollution is noticed either in river water or ground water in the project area.

Figure 17: Sampling Locations of Water, Soil and Air

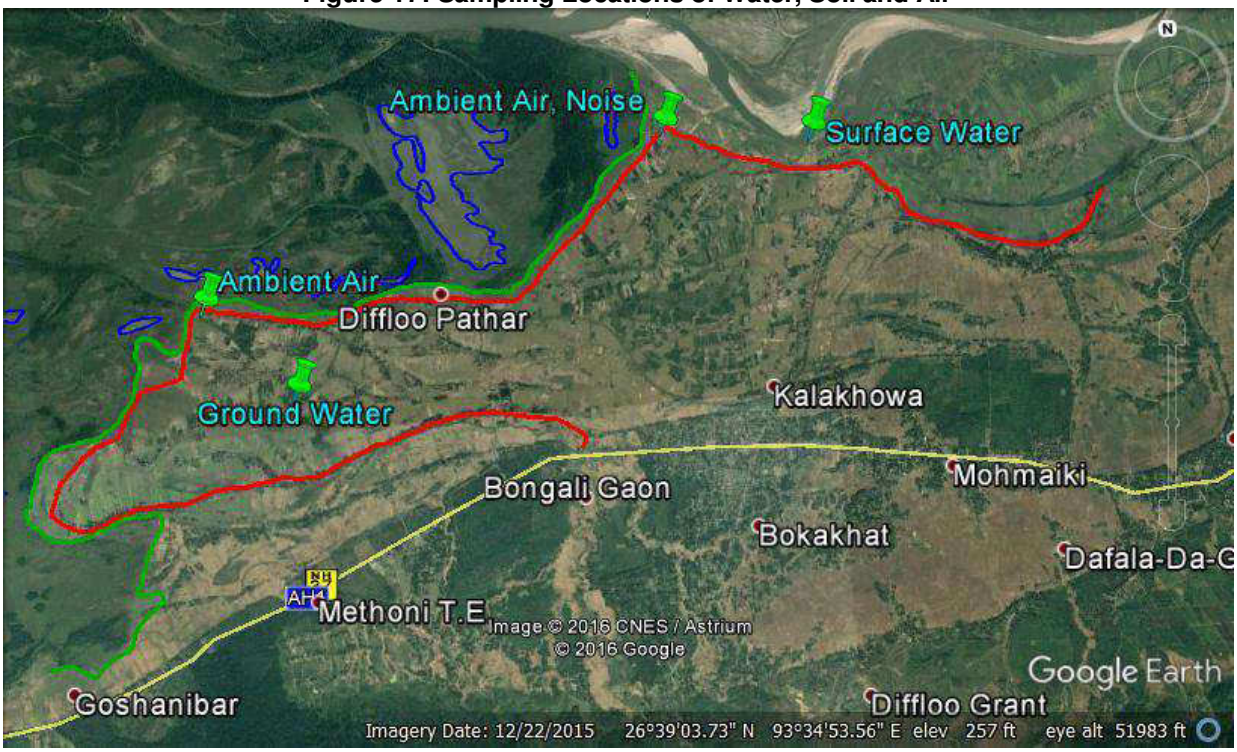


Table 4: Water Quality of Rivers of Assam

Dissolved Oxygen (mg/l)			pH		Conductivity (µmhos/cm)				BOD (mg/l)			Total Coliform (MPN/100ml)			Fecal Coliform (MPN/100ml)		
Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
0	18	7.2	5.8	8.1	7.2	43	868	193	0.3	32	1.9	1	240 000	3816	0	24000	653

Source: Compendium of Environment Statistics India 2014 Central Pollution Control Board.

Table 5: Surface Water Quality Assessment of Dhansiri River, Kaziranga Subproject, 2016

Sl.no	Parameter	Test Method	Results	Units
1	pH Value	IS 3025 P-11	7.4	--
2	Appearance		Slightly turbid	
3	Temperature	IS 3025 P-9	18	°C
4	T. Hardness ($CaCO_3$)	IS 3025 P-21	189	mg/l
5	Chlorides (as Cl)	IS 3025 P-32	8	mg/l
6	Total Solid		173	mg/l
7	Total Iron (as Fe)	IS 3025 P-53	0.28	mg/l
8	Total Alkalinity		166	mg/l
9	Dissolved oxygen		10.8	mg/l
10	Oil and Grease		BDL	
11	Arsenic (as As)	IS 3025 P-37	BDL	mg/l
12	Nitrate NO_3		10	
13	Sulfate as So_4	IS 3025 P-24	52	mg/l
14	Total Coliform	IS 1622	900	MPN/100ml
15	F. Coliform	IS 1622	Nil	--

Sl.no	Parameter	Test Method	Results	Units
16	BOD	3 days at 27^0C	9	mg/l

Source: Primary Analysis. Test carried out on 14.12.2016 by Greenviron

Table 6: Groundwater Quality in the Kaziranga Subproject, CBCP, 2011

Locations	Temperature °C			pH			Conductivity (µmhos/cm)			B.O.D (mg/l)			Nitrate N+ (mg/l)			Total Coliform (MPN/100ml)			Fluoride		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Water Quality Criteria							6.5-8.5			<3mg/l						<5000 MPN/100ml			<1.0 mg/l		
Jorhat	22	30	28	6.1	7	6.6	115	430	273	1.4	3.1	2.25	0.12	0.28	0.2	1	1	1	0.29	0.29	0.29
Numaligarh	27	32	29.5	5.1	6.3	5.7	66	104	85	1.3	2.3	1.8	0.1	0.22	0.2	1	1	1	0.26	0.26	0.26
Nagaon	28	29	28.5	6.4	6.8	6.6	519	839	679	0.8	0.8	0.8	01	0.15	0.1	1	1	1	0.6	0.6	0.6

Source: Compendium of Environment Statistics India 2014, Central Pollution Control Board.

Table 7: Groundwater Quality Assessment, Kaziranga Subproject, 2016

Sl.no	Parameter	Test Method		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	220	mg/l
5	Chlorides (as Cl)	IS 3025 P-32	10.8	mg/l
6	Total Solid		180	mg/l
7	Total Iron (as Fe)	IS 3025 P-53	0.45	mg/l
8	Total Alkalinity		190	mg/l
9	Arsenic (as As)	IS 3025 P-37	BDL	mg/l
10	Nitrate NO_3		BDL	
11	Sulfate as So_4	IS 3025 P-24	48	mg/l
12	Total Coliform	IS 1622	Nil	MPN/100ml
13	F. Coliform	IS 1622	Nil	--

Source: Primary Analysis. Test carried out on 14.12.2016 by Greenviron

6. Basin Morphology

53. The hydrology and morphology of the Kaziranga reach, stretching from Bankoal to Diffalupathar, with a total length of 28.88 km is dominated by frequent flooding and vigorous erosion of the Brahmaputra and its tributary rivers originating in the Karbi - Anglong hills that flow through the KNP. The Dhansiri River, a tributary of Brahmaputra River, is protected partly near the mouth on the western side. This embankment is connected to a PWD road which connects to NH-37. On the eastern side of Dhansiri River no embankment or protection is provided. Also, there is a branch river of Dhansiri called Geelabeel River, flowing almost parallel to the Brahmaputra River on an east - west direction. During flood season the Geelabeel River spills its banks flooding the immediate surrounding areas. The Krishibundh, a low bund providing limited flood protection, is located on eastern side of Dhansiri River.

54. The KNP is located inside a bend of the Brahmaputra and buttressed by the Karbi hills on the south that helped in the emergence of the low swampy environment with numerous wetlands

and extensive grass cover. Floods also help in the formation of different types of soils in different locations of the area. During high floods when the beels and grasslands are submerged, the animals in the Park suffer from shortage of fodder. During this period, animals often migrate to the neighboring hills of Karbi - Anglong across the NH-37 southwest of the subproject area. Erosion has been a major threat to the Park as it has already lost considerable area.

7. Sediment Transport

55. The Brahmaputra River carries more water per unit area of its basin than any other river of the world and second only to the Yellow river in the People's Republic of China in terms of sediment yield[13]. The pattern of sediment yield in the major tributaries of the Brahmaputra River is shown in the succeeding Table. The high sediment yield in the tributary rivers as well as in the mainstream of the Brahmaputra is attributed to the extremely potent rainfall regime, easily erodible rock formations, frequent seismic events causing massive landslides in the hill slopes, and human depredations in the watersheds. Such examples of human-induced activities for high sedimentation are harmful land use practices, encroachment of water bodies, forest areas and hill slopes.

Table 8:Water and Sediment Yields of Selected Tributaries of the Brahmaputra River, Assam

River	Drainage area (Km2)	Water yield (m2 s-1 km2)	Sediment yield (tons km-2 yr-1
Brahmaputra at			
Tsela d Zang (People's Republic of China)	191,222	0.0105	100
Pasight (India)	244,700	0.0231	340
Pandu (India)	500,000	0.0306	804
Bahadurabad (Bangladesh)	580,000	0.0331	1128
Dibang	12,120	0.1066	3765
Lohit	22,077	0.0709	1960
Subansiri	27,400	0.0756	959
Jia Bharali	11,300	0.0858	4721
Puthimmari	1,787	0.0403	2887
Pagladia	383	0.1087	1883
Manas	36,300	0.0232	1581
Kulsi	750	0.0797	135
Buridhing	4,923	0.0788	1129
Desang	3,950	0.0382	622
Dhansiri	10,240	0.0184	379
Kopili	13,556	0.0182	230

8. Existing Flood Control and Erosion Works in the Kaziranga Reach

56. The existing flood and erosion protection works in the Kaziranga subproject were mainly constructed by the WRD. These works have evolved into an elaborate system of riverbank erosion control, flood control embankments, spurs, and pro-siltation porcupine screens. Embankments have been constructed along the Brahmaputra, both upstream and downstream of the Dhansiri

[13] Goswami, D.C.1985. Brahmaputra River, Assam, India: Physiography, basin denudation and channel aggradations. *Water Resources Research*. 21: 959-978. (The reference although old , still get referenced in many recent articles, Vijay Singh, Nayan Sharma, C. Shekar, P. Ojha, 2013 https//books.google.co.in/books?isbn-9401705402)

River. About 5.5 km of dykes have been constructed along the west bank of Dhansiri River, and from Brahmaputra River extending inland 3.5 km along the border with Kaziranga Park. Upstream of Dhansiri River, 7 km of the Brahmaputra Dyke has been retired multiple times and at present has been replaced by the Krishibundh. Since 2006 approximately 2.2 km of the Krishibundh has been eroded and has been replaced by a low temporary dyke.

57. Some of the portions of these embankments were recently renovated and widened to provide protection against the risk of Dhansiri River flood. This recent works by the WRD includes sections of the Dhansiri River embankment and 3.5 km section of the Brahmaputra Dyke from Moriaholla to Dhansirimukh (Chainage 0.0km-3.5km). Other areas of the embankment are in poor condition with numerous weak points created by unplanned road crossings and general deterioration of the structure due to inadequate maintenance. Five sections along the Brahmaputra dyke bordering KNP were breached by the surrounding communities to facilitate rapid drainage of flood waters. These breaches have not been repaired posing serious threat to both KNP and the benefitted area.

58. Erosion protection efforts have mainly focused on the use of porcupines and porcupine bullheads. Significant installations are present along the Dhansiri River where direct attack on the embankment is imminent. Porcupine screen consisting of three rows of porcupines has been installed near the 0 km point of the Krishibundh, extending 1.2 km into the Brahmaputra River to link the shoreline with a char. Many portions of this porcupine are now silted over, and the main channel has shifted to the north away from the bank demonstrating the successful pro-siltation works in this section.

9. Flood Inundation in the Subproject Area and KNP

59. The Kaziranga reach, including the KNP is subject to periodic flooding. Annual flooding is important to KNP as it rejuvenates the unique eco-system of grassland, swamps and ponds which in turn sustain large population of rhinos, elephants, deer, wild buffaloes, tigers, and leopards. The KNP is the largest undisturbed and representative area in the Brahmaputra valley floodplain (UNESCO). It was declared a heritage site because of its unique habitat shaped by the flood pattern that is covered by wet alluvial tall grassland interspersed with numerous broad shallow pools fringed with reeds and patches of deciduous to semi-evergreen woodlands. Maintenance of functional connectivity between the park and Karbi Anglong Hills and the formation of a buffer zone to the south of the park would greatly add to the integrity of the park.

60. The flood inundation in the Kaziranga reach is captured in the succeeding satellite Figure revealing the area extent within the 8 km impact zone covering an area of 7,412 hectares. This area is the most severely affected by flood in the region during the 2004 monsoon.

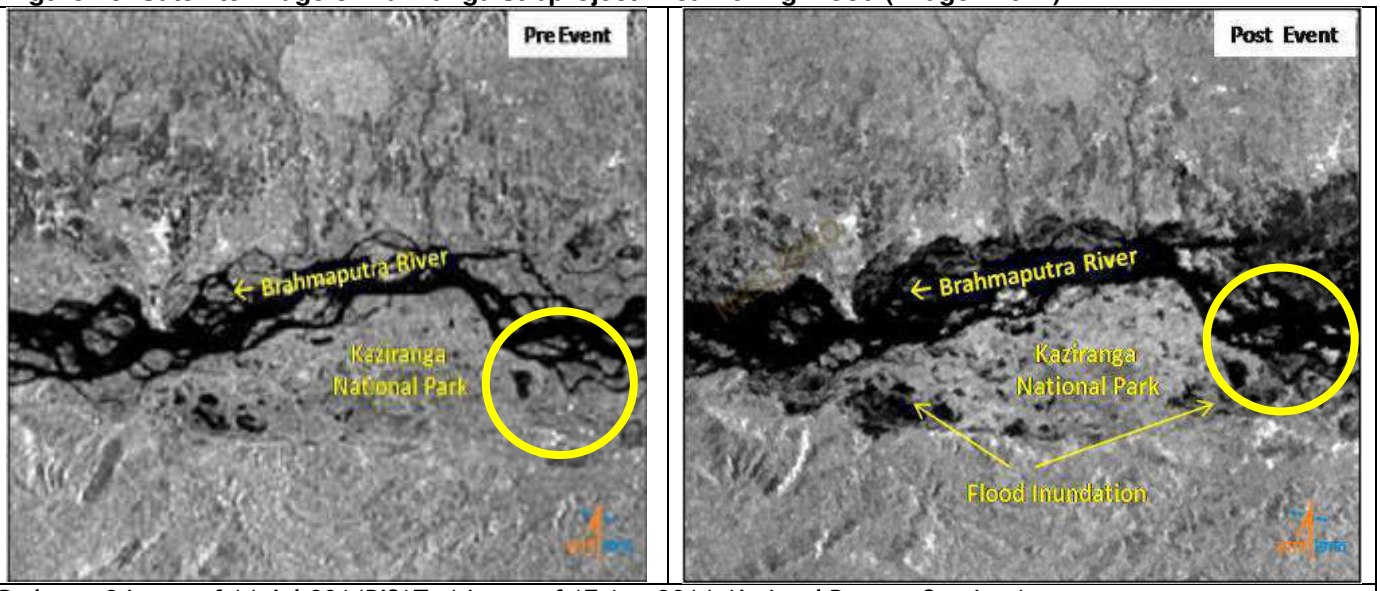
Table 9: Pattern of Flooding in Buffer Zone of Kaziranga reach (as on July, 2016)

Particular	Area (ha)	Area (%)
Flooded Area	7,412	10.72
Total Area in Buffer	69,133	100

Source: WRD, 2016

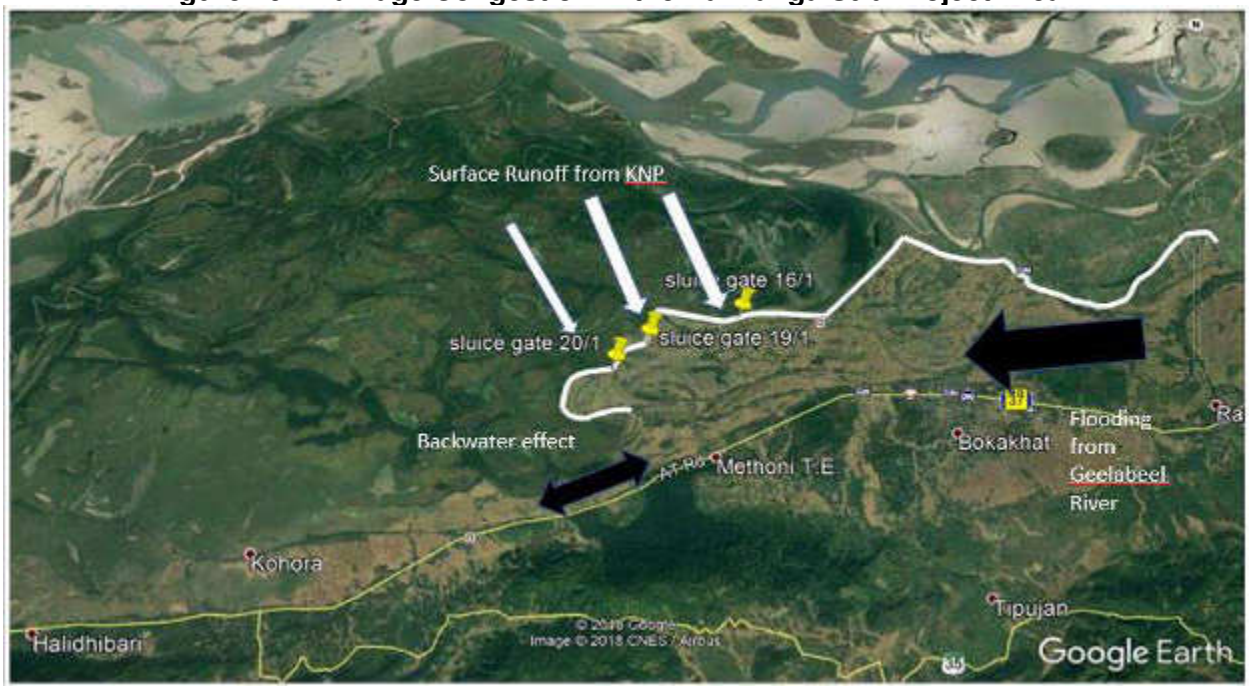
61. The sub-project area suffers from flood congestion. The populated area enclosed by the Brahmaputra dyke and NH-37 is generally lower than the KNP and acts as a small catch basin. Flood congestion occurs when the Geelabeel river to the east overtops its banks inundating the project area in the northwesterly direction and at the same time surface run-off from KNP flows towards the populated area either through the gaps along the Brahmaputra or from back water effect of flood water flowing westerly parallel NH-37 where there is no embankment as shown in **Figure 19**.

Figure 18: Satellite Image of Kaziranga subproject Area During Flood (Image –2014)



Radarsat-2 image of 14-Jul-2014RISAT -1 image of 17-Aug-2014, National Remote Sensing Agency

Figure 19: Drainage Congestion in the Kaziranga Sub-Project Area



10. Kaziranga Reach Morphology

62. The morphology of the Brahmaputra River is characterized by intense braiding, bar formation, and extremely dynamic bank line and bed configuration. 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. Several water bodies of permanent nature (beels), marshy and swampy areas and numerous channels, characterized the entire landscape. The

Brahmaputra River flowing along the northern boundary of the reach exhibits an intensely braided channel pattern with numerous chars (sandbars) some of which are of considerable size and semi-permanent covered with tall grasses.

63. 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. 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 define river morphology.

64. 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 stratum and a coarser substratum. The dynamic pattern of the channel configuration and movement of the Brahmaputra in the Kaziranga reach from 1973, 1990, 2000, 2007 and 2008 shows a continuous shift in the channel towards south causing massive erosion in the area. The movement of the *thalweg* towards the south bank and its present position hugging the backline where existing protection measures that include embankments are under serious threat is well evidenced in the succession of images presented. The pattern of channel configuration and thalweg movement from 1973 to 2008 are presented in the succeeding Figures focusing in the Dhansirimukh bank. In 1973, a development of a bend with minor confluences was observed in the Dhanisirimukh causing erosion on the left bank where the sub-project is located. In between Dhansirimukh and Nebrubasti, the main Brahmaputra river channel shifted from right to the left bank. In 1990, major attacks developed near Dhansirimukh threatening the sub-projects more specifically Bokhahat settlements and the KNP. Attacks were also observed downstream of the Charghariya with the development of a curved channel, this time threatening the lower reach of the KNP. By year 2000, the attacks shifted away from Dhansirimukh towards the southern bank between Charghariya and Nebrubasti running almost parallel the main Brahmaputra river channel. In 2007, minor attacks by the curved channel in Dhansirimukh still persist but upstream of the Bankoal channel and Changhaniya became more pronounced. The succeeding Figures illustrates the thalweg movement from 1973 to 2008.

65. Figure 20 and Figure 21 show the pattern of erosion and accretion of the bank from 1965 to 2014 based satellite data analysis and conventional data using GIS. The rates of erosion and accretion estimated from this analysis for the period 1967–2008 are 7,336.42 ha and 3,329.46 ha, respectively, giving a net loss of around 4,006.96 ha of land.

Figure 20: Pattern of Channel Configuration and Thalweg Movement of the Brahmaputra River in Kaziranga Reach (1973–1990)

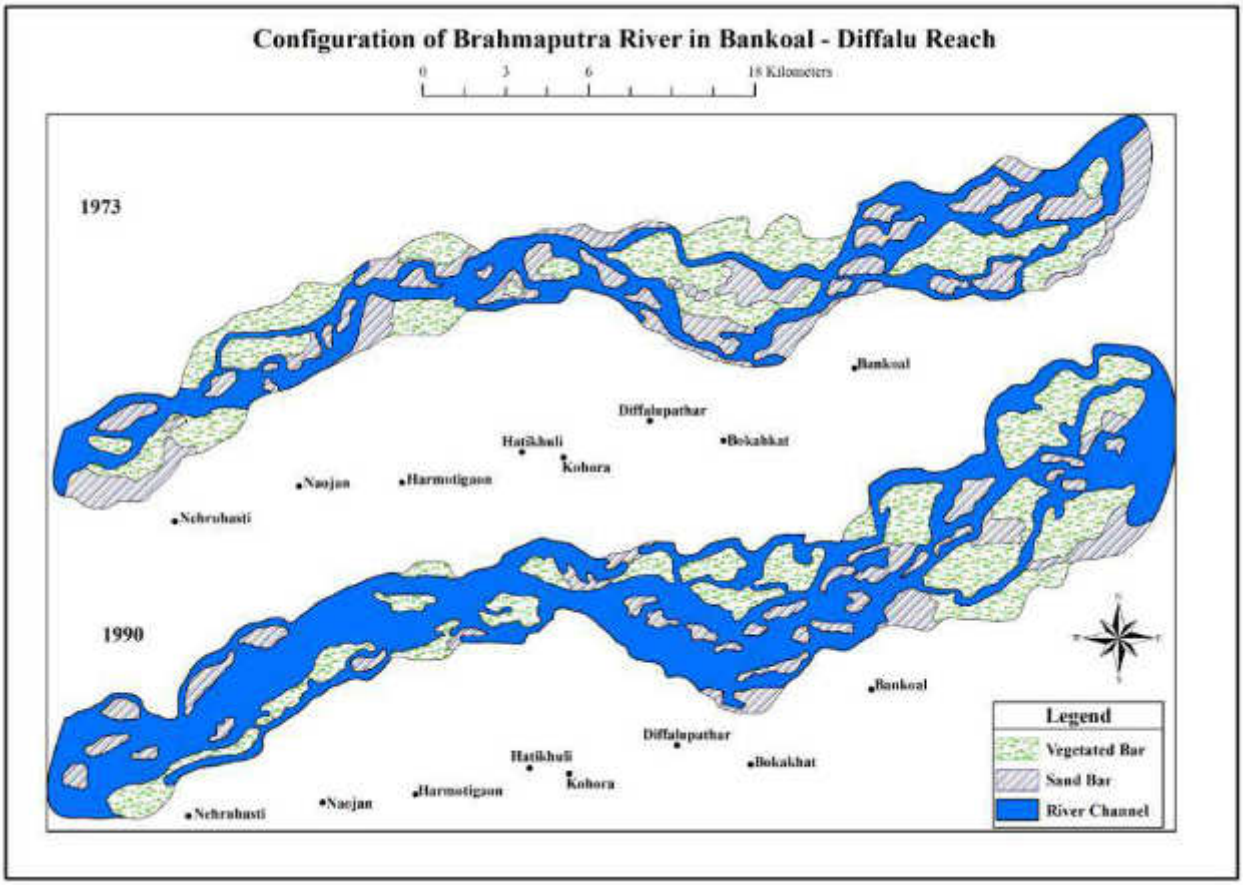
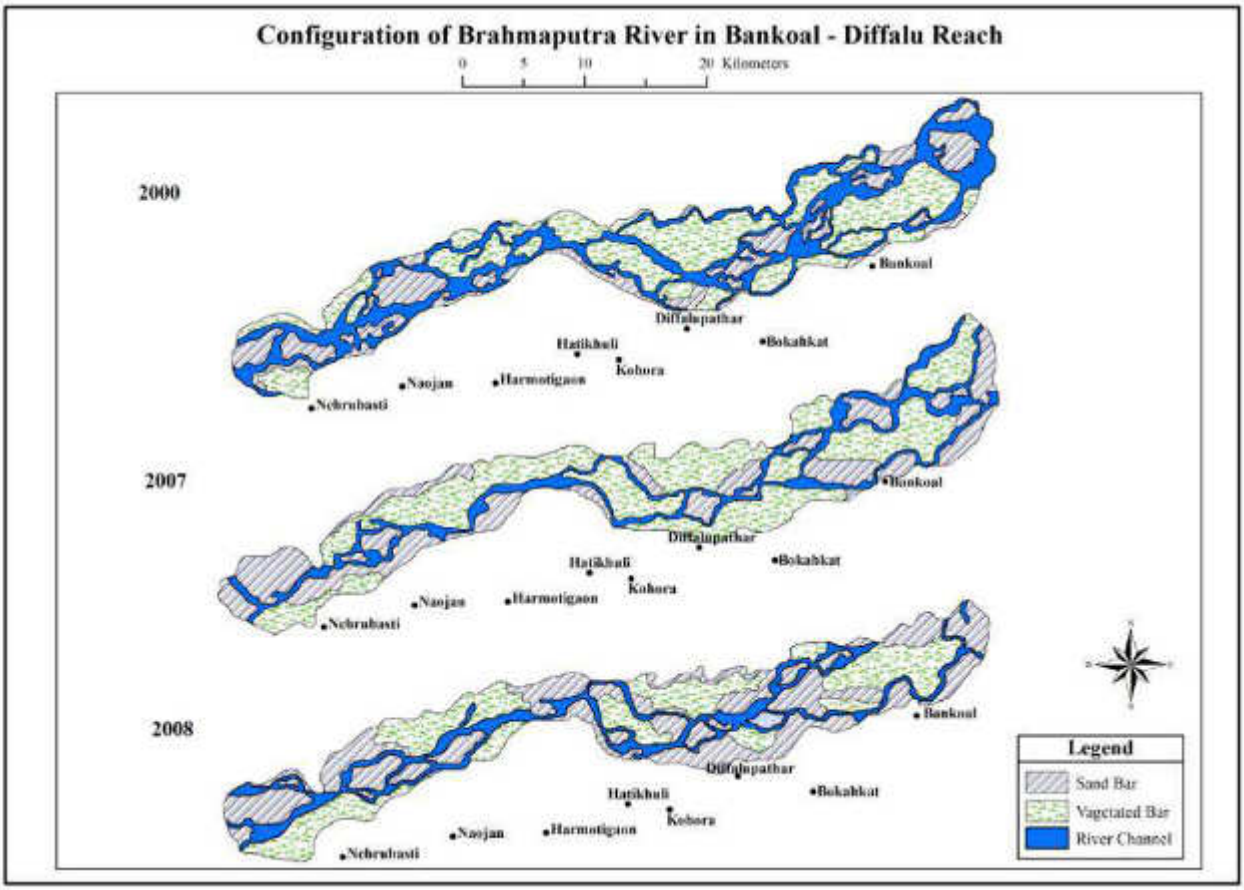


Figure 21: Pattern of Channel Configuration and Thalweg Movement of the Brahmaputra River in Kaziranga Reach (2000 - 2008)



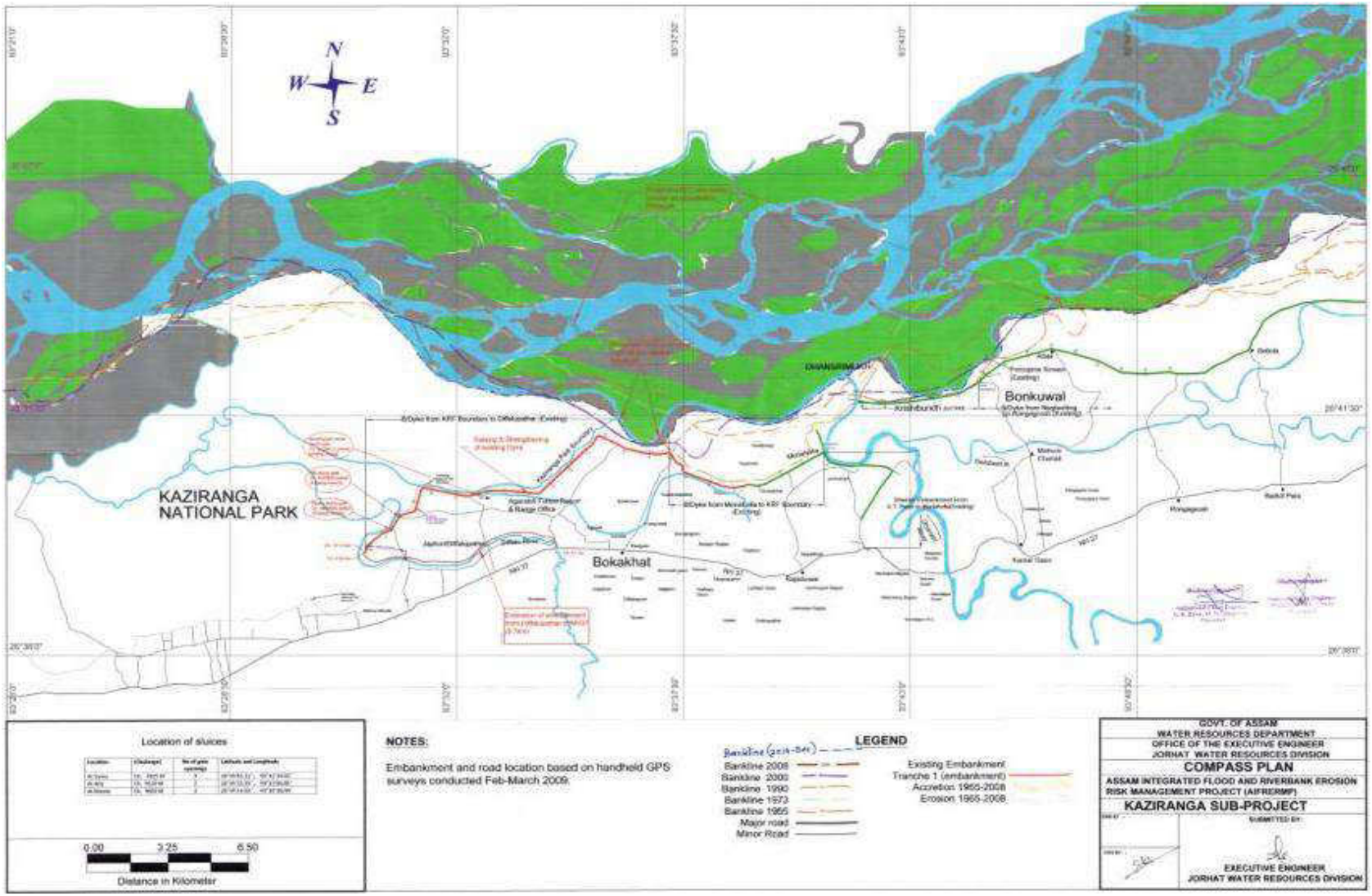
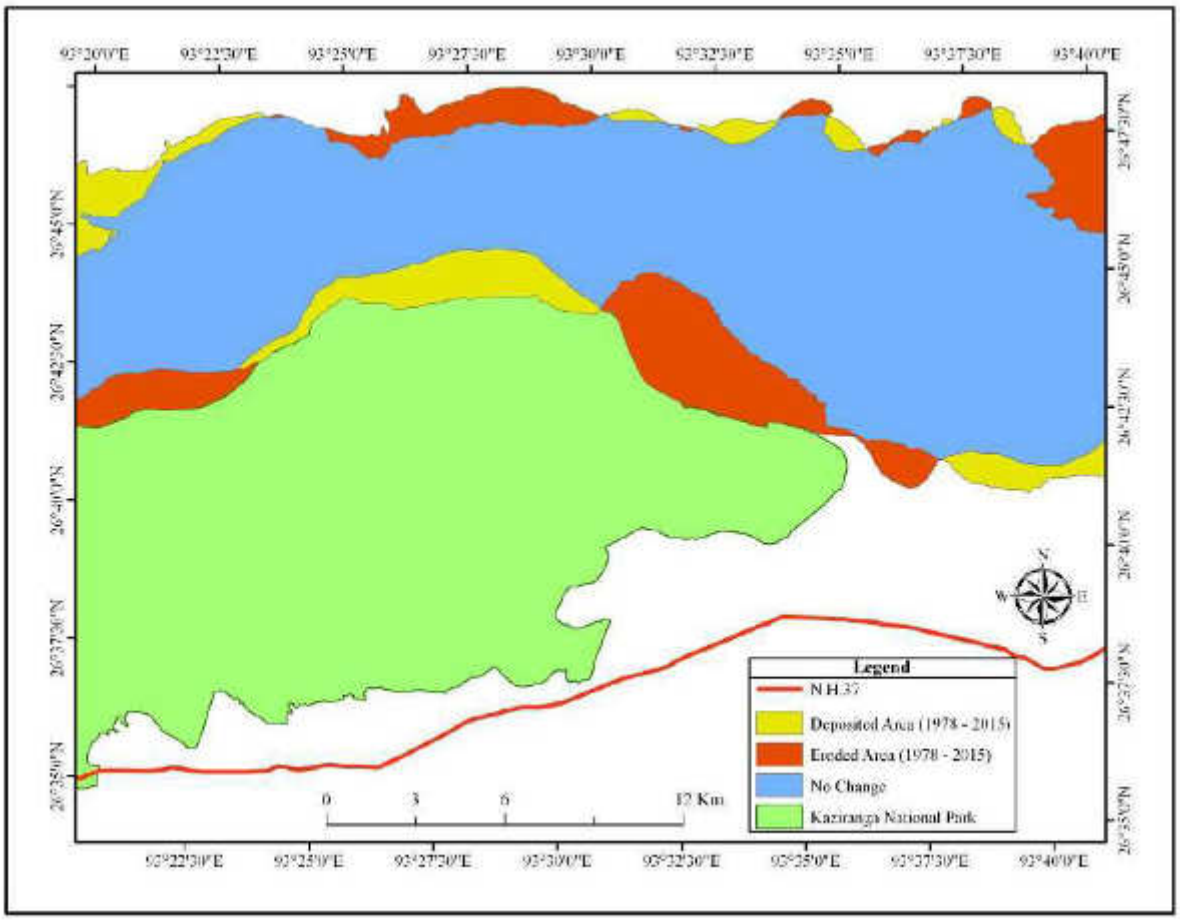


Figure 22: Showing the Change in the Bankline from 1965 to 2014

Source: Kaziranga DPR

Figure 23: Pattern of Erosion and Accretion of the Brahmaputra Bank in the Kaziranga Reach (1967 - 2015)



66. The pattern of bank line migration in the reach during different periods is shown in Figure 24 illustrating a persistent regression of the backline in most of the locations where cross sections are taken although at varying rates. Maximum bank line shifting was observed during 1973 - 1990 period, when it had shifted by more than 4 km. The pattern of shifting of the bank line during the present decade as depicted on the for the period 2000 - 2007 shows progression in all the sections except a major amount of regression (backward shifting) in one cross-section.

Figure 24: Bankline Migration (in m) of the Brahmaputra River in the Kaziranga reach at Selected Cross-sections during different Time Periods

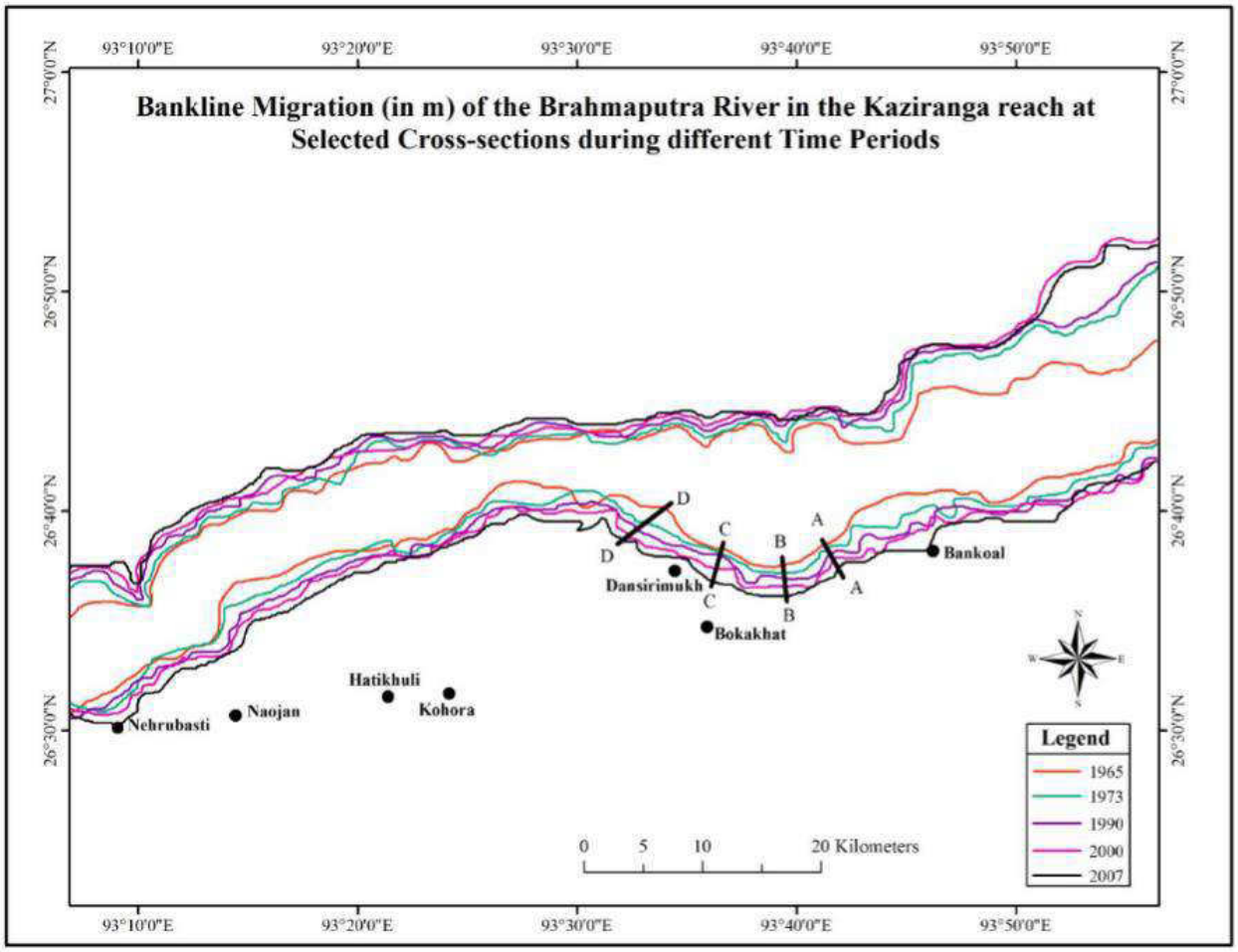


Table 10: Rates of Bank Line Migration (in m) at Selected Cross-sections in the Kaziranga Reach during different Time Periods

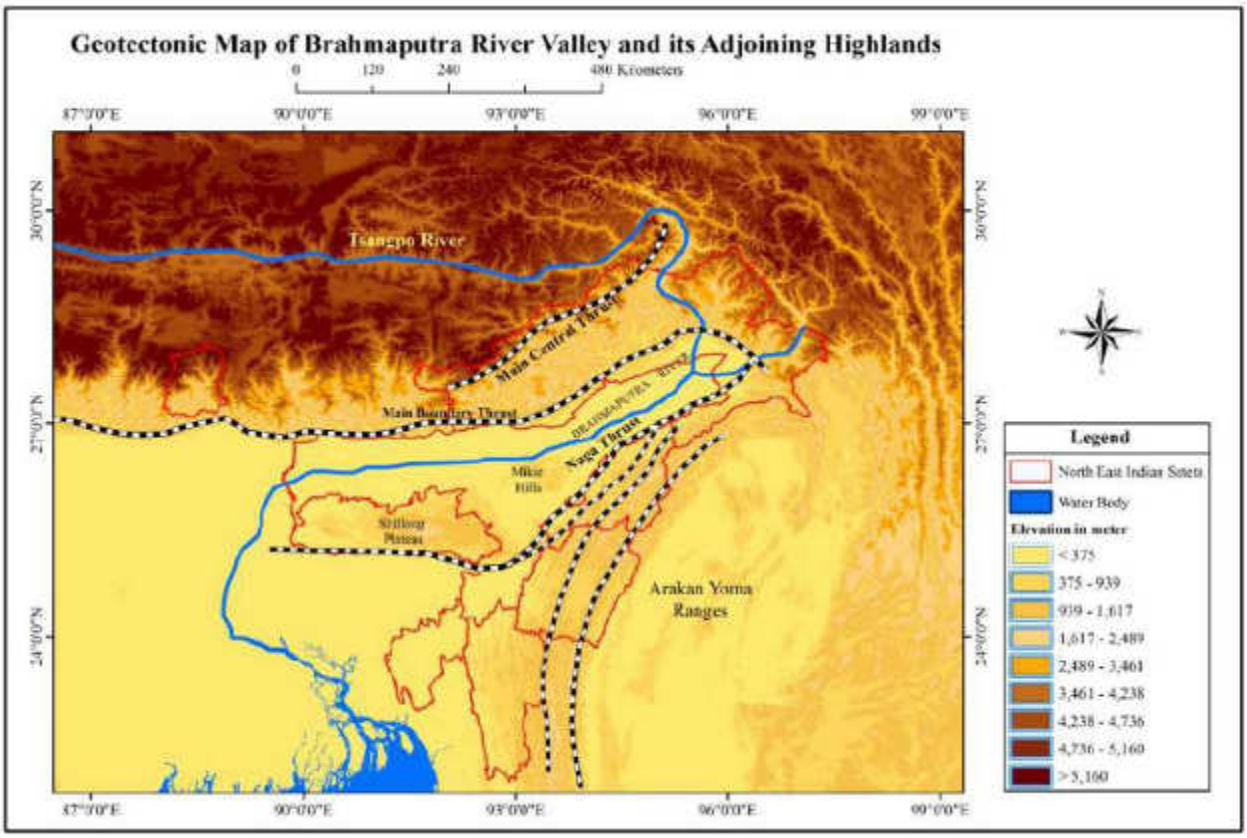
Cross- Section	Period			
	1965 – 1973	1973 - 1990	1990 - 2000	2000 - 2007
AA'	-552	-233	717	148
BB'	-393	-1791	2750	79
CC'	-573	-1200	-442	65
DD'	-1500	-1125	-820	-893
Total	**-3018**	**-4349**	**2205**	**-601**

11. Geology

67. 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 a tectonic-sedimentary basin, 720 km long and 80-90 km wide, underlain by recent alluvium approximately 200-300m thick consisting of clay, sand and pebble. 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 permanent with a veneer of fertile soil on the top that supports vegetation, crops and settlements.

68. The area in and around the Kaziranga reach is formed by recent alluvium deposited by the Brahmaputra River and several tributaries like the Dhansiri, the Diffolu, and the Gelabeel. A host of geomorphic features including abandoned river channels, cut-off meanders, meander scars, backs swamp deposits are found in the active floodplain belt comprising this reach. The palae channels occurring in this area belong to the lfolocene period.

Figure 25: Geotectonic Map of Brahmaputra River Valley and its Adjoining Highlands



12. Seismology

69. Due location where the colliding Eurasia (Chinese), Indian and Burmese tectonic plate boundaries, the Brahmaputra valley and its adjoining hill ranges are seismically very unstable. Earthquakes have caused extensive landslips and rockfalls on the hill slopes, subsidence and

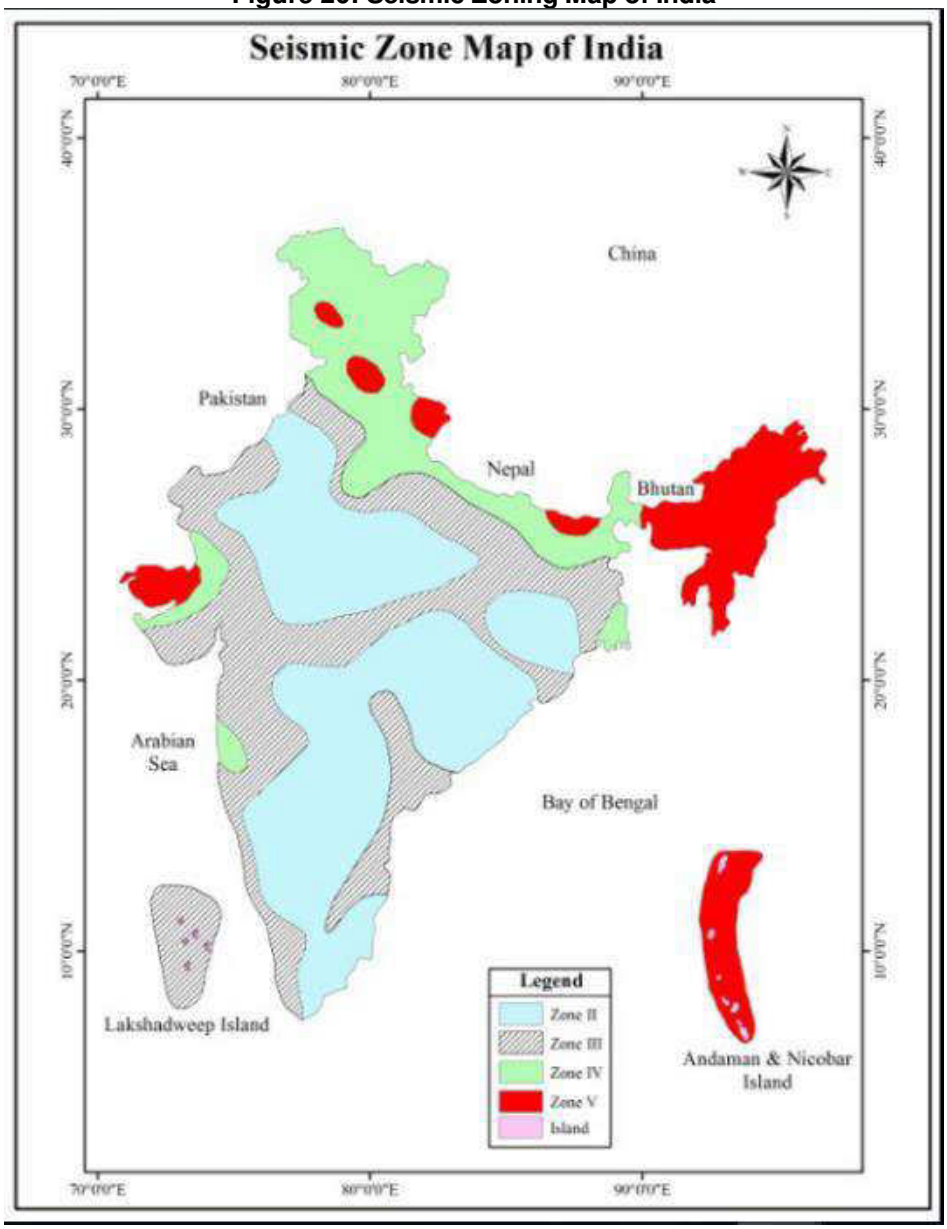
fissuring of ground in the valley, and changes in the course and configuration of several tributary rivers as well as the mainstream. The geo-tectonic map of the Brahmaputra valley and its adjoining highlands is presented in the following Figure.

70. There are phases of rapid aggradations of the Brahmaputra River associated with earthquakes, mainly due to deposition of sediments received from landslides followed by relatively slower removal of accumulated debris over longer time periods. Active seismicity of the northeast (NE) region has significant impact on the hydrologic regime and morphology of the Brahmaputra River including its tributaries and wetlands distributed across its floodplains. Occurrence of these episodic events led to intensification of flood hazards, especially in the aftermath of the 1897 and 1950 great earthquakes.[14] This is demonstrated after the 1950 earthquake when the Brahmaputra channel was raised due to accelerated rates of sedimentation, worsening floods, and erosion conditions. The bank line of the river close to the Kaziranga Reach is considerably steeper and highly unstable at several places causing heavy erosion in recent times. A considerable part of the reach including portions of KNP has already been eroded by the Brahmaputra.

71. Based on the seismic zoning map of India, the entire subproject area falls in Zone V, considered as the most severe seismic intensity zone in the country. The seismic zoning map of India is shown in Figure below. The distribution of major earthquakes above Richter magnitude 7.0, in the NE region since the 1897 Shillong earthquake is shown in succeeding Table.

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

Figure 26: Seismic Zoning Map of India



Map 1: Seismicity Map of Northeast India (1897 – 2002)

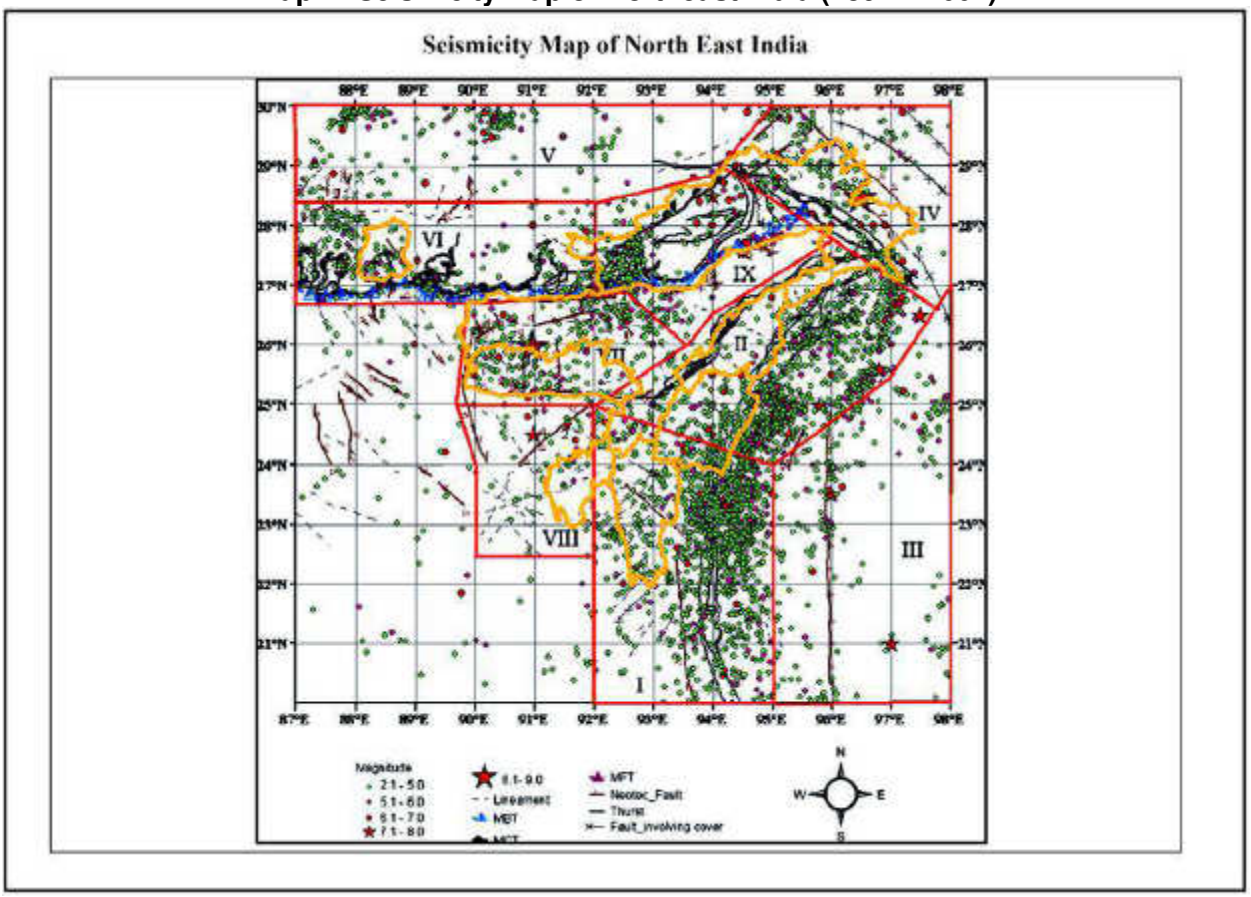


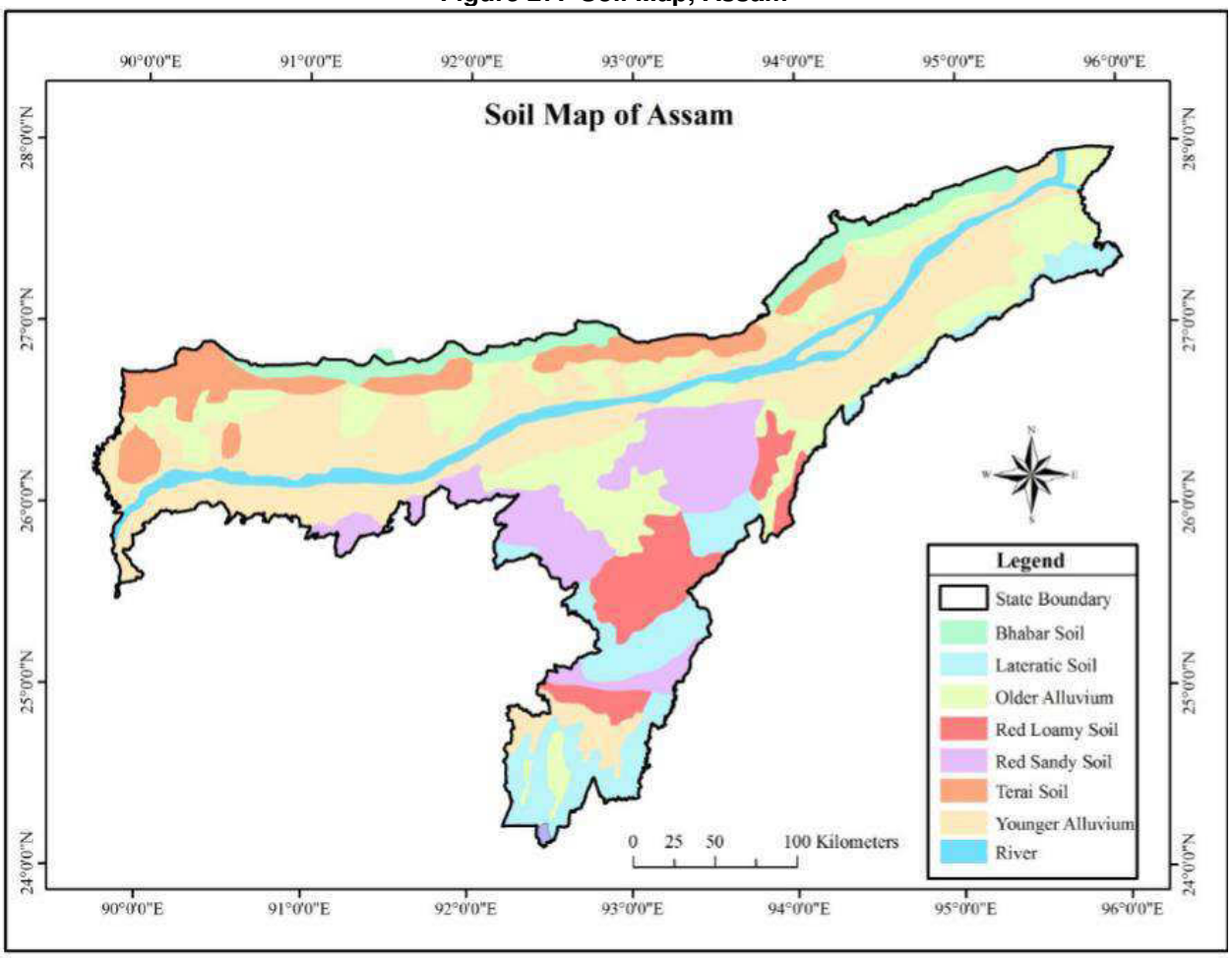
Table 11: Major Earthquakes in Northeastern India and Adjoining Regions since 1897

Date	Epicenter Area	Lat (°N)	Long. (°E)	Magnitude
12-06-1897	Shilong, Meghalaya	26°00'	91°00'	8.7
31-08-1906	India-Myanmar Border	27°00'	97°00'	7.0
12-12-1908	Kachim, Myanmar	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,Myanmar	25 36	96 48'	7.6
04-08-1932	India-Myanmar Border	26 00'	95 30'	7.0
23-10-1943	Hojai,Assam	26 00'	93 00'	7.2
29-07-1947	Tammu	28°30'	94°00'	7.8
15-08-1950	India-Myanmar-People's Republic of China Border			8.7
06-08-1988	Manipur-Myanmar-Border	28°50' 25 14'	96°30' 95 12'	7.2

13. Soil

72. The subproject area, and in fact the entire project area, is almost entirely made of alluvial soils formed on recent river deposits called new alluvium. Also called fluvisols or fluvents, these are mostly composed of sandy to silty loams and are neutral to slightly acidic in reaction. In limited upland areas within the valley and in the foothill region there are few isolated pockets of deeply weathered Pleistocene deposits of older alluvium. A study of the lithologs of the Quarternary sediments of the Brahmaputra valley extending down to more than 100 m reveals repeated sequence of clay, pebbles, and boulders[15]. In the hill areas, especially to the south of the reach, laterites and red loams are found. The distribution of soil types in Assam is shown in below.

Figure 27: Soil Map, Assam



73. The soil quality of the sub project area was sampled and analyzed in two locations, namely, Dhansirimukh and Sakopara. The soil quality in the Kaziranga Reach shows medium organic carbon, medium available nitrogen, and low available phosphorous and low available potassium.

Table 12: Soil Quality

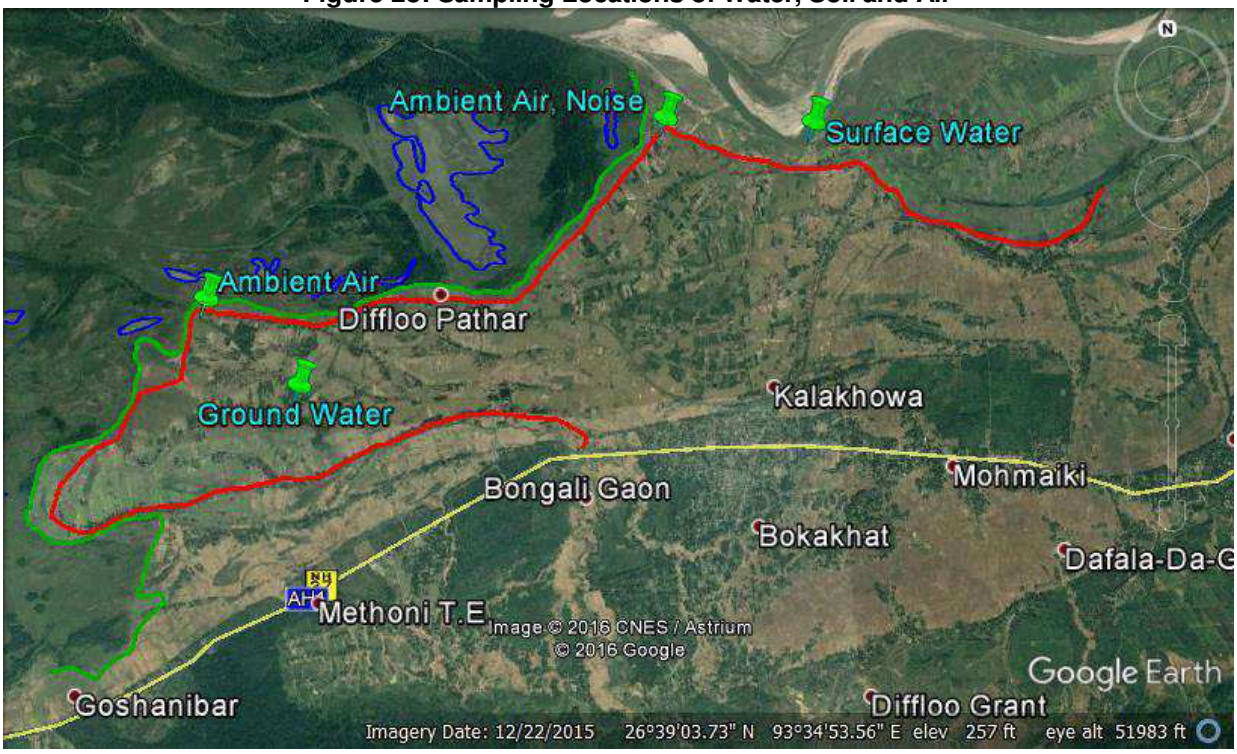
Parameters	Unit	Dhansirimukh
Organic carbon	%	0.67
Organic matter	%	1.74
Available nitrogen	Ppm	27.8
Available phosphorus	Ppm	0.003

[15] GSI. 1977. Contributions of geomorphology and geohydrology of the Brahmaputra Valley. Miscellaneous Pub. 32.

Parameters	Unit	Dhansirimukh
Iron	Ppm	0.106
Copper	Ppm	0.017
Manganese	Ppm	BDL
Lead	Ppm	BDL
Chromium	Ppm	BDL
Zinc	Ppm	0.025
Mercury	Ppm	BDL
Arsenic	Ppm	0.001
Potassium	Ppm	39
CEC		0.85
Textural Classes		Clay
Clay	%	47.28
Silt	%	25
Sand	%	4.2
Bulk Density	g/cc	30.3
Water Holding Capacity	%	41.3
Pore Space	%	1.36
Specific Gravity	%	22

(Source: Field Monitoring and Analysis by Environmental Science Department, Gauhati University, 2014)

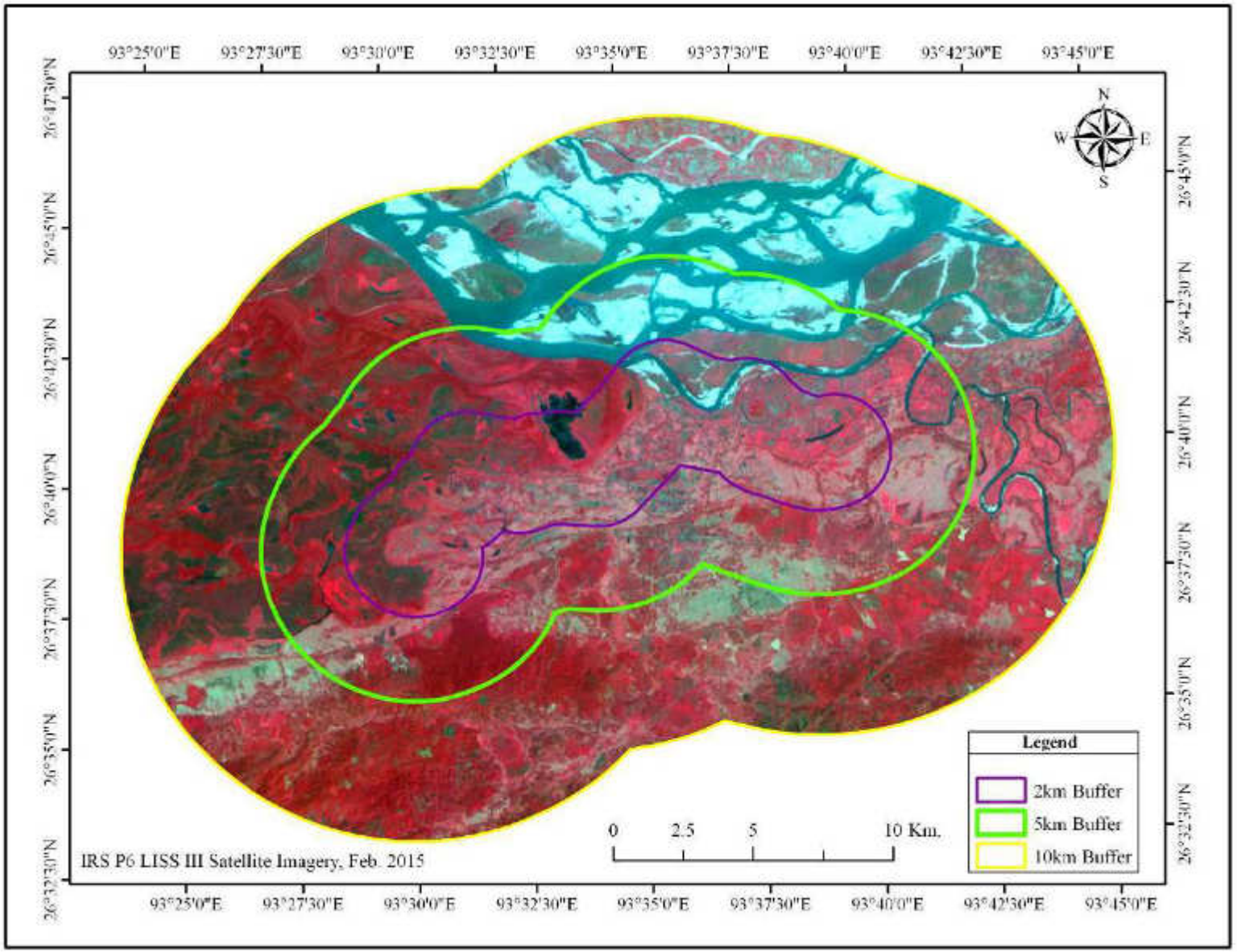
Figure 28: Sampling Locations of Water, Soil and Air



14. Land Use

74. The land use pattern in 2013 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 Brahmaputra embankment is chosen and

the land use pattern within the zone is delineated from satellite images using GIS. The size of the buffer is decided based on the consideration of topography and the location of the major wetlands or tributaries of the area. The land use map of the 8 km buffer zone around the embankment is presented in succeeding Figure and the areas covered by different categories of land use are given in following Table.


93°25'0"E
93°27'30"E
93°30'0"E
93°32'30"E
93°35'0"E
93°37'30"E
93°40'0"E
93°42'30"E
93°45'0"E
26°45'0"N
26°42'30"N
26°40'0"N
26°37'30"N
26°35'0"N
26°32'30"N
N
S
E
W
Legend
2km Buffer
5km Buffer
10km Buffer
0
2.5
5
10 Km.
IRS P6 LISS III Satellite Imagery, Feb. 2015

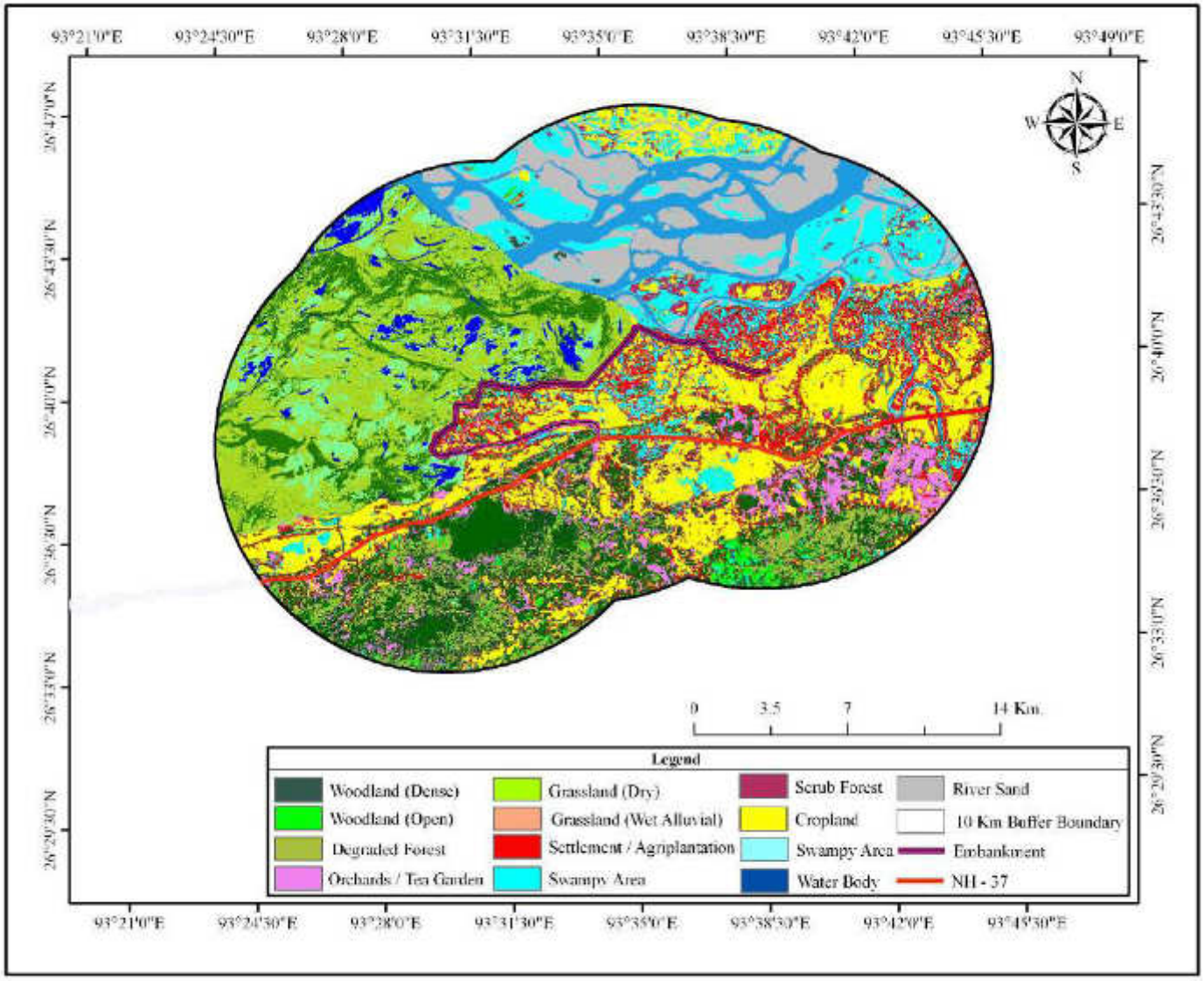


Figure 29: Landuse of Kaziranga Reach, 2013 (10 km buffer around embankment)

Table 13: Landuse in the Study Area (10 km buffer around embankment)

Land use Class	Area in Km2	% of Total
Woodland (Dense)	163.02	21.05
Woodland (Open)	38.63	4.99
Degraded Forest	73.47	9.49
Orchards/Tea Gardens	35.61	4.60
Grassland (Wet Alluvial)	56.34	7.27
Swampy Area	65.76	8.49
Scrub Forest	37.71	4.87
Cropland	111.57	14.41
Water Body	50.65	6.54
River Sand	58.58	7.56
Total Area	77.49	100.00

(Source: IRS-P6 data for Year 2013) (there is no significant change over the year as the area falls near Kaziranga National Park) (land use pattern 2012 in Golaghat district is shown in table 29)

75. Out of the total study area of 774.49 sq km, wood land occupy 191.65 sq km accounting for 26.4 % of the total followed by crop land with 111.57 sqkm or 14.41% of the total. Degraded forest, swampy areas and sand bars account for 9.49%, 8.49%, and 7.56%, respectively. River channel and water body occupy about 6.54 % area of the buffer including vegetated chars.

76. Land use pattern is also examined in a 2 km 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 2 km direct impact zone for the entire reach is shown the succeeding Figure. The land use data for the direct impact zone is presented in the succeeding Table. It indicates that the crop lands / agricultural lands occupy the largest portion of the area (25.78%) followed by settlement and homestead plantation (14.65%) and swampy area (10.67%).

Figure 30: Landuse Map of Kaziranga Reach (2 km Buffer Around Embankment)

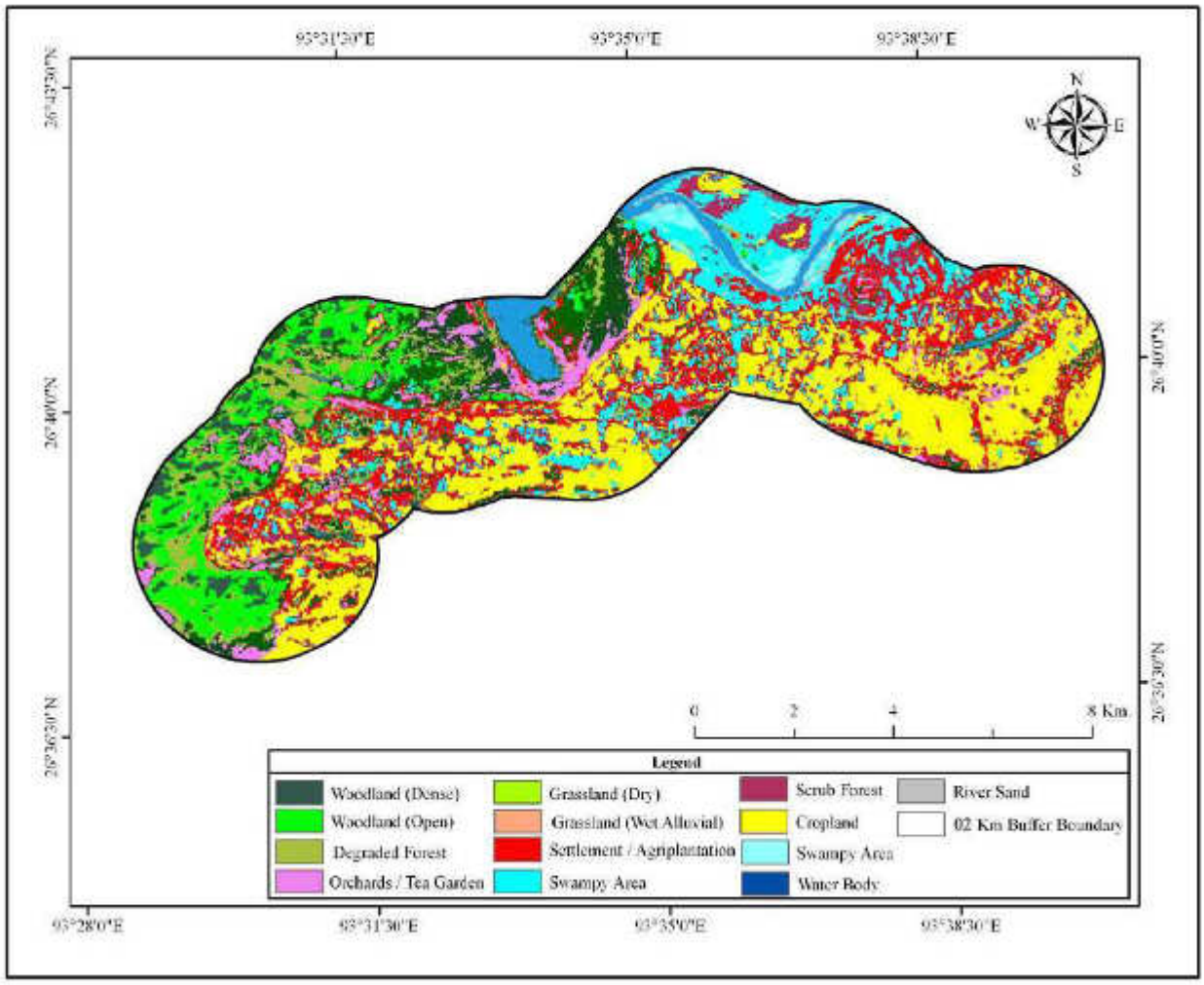


Table 14: Land use of Kaziranga reach (2 km buffer around the embankment)

Land use Class	Area in Km2	% of Total
Woodland (Dense)	3.92	4.38
Woodland (Open)	7.08	7.91
Degraded Forest	6.14	6.86
Orchards/Tea Gardens	4.88	5.45
Grassland (Dry)	5.12	5.72
Grassland (Wet Alluvial)	3.45	3.86
Settlement/ Agriplantation	13.11	14.65
Swampy Area	9.55	10.67
Scrub Forest	8.47	9.46
Cropland	1.8	25.78
Water Body	2.9	3.24
River Sand	1.8	2.01
Total Area	**89.49**	**100.00**

77. The land use pattern in the zone lying between the bank and the embankment was also mapped using satellite data and GIS. It shows that agricultural land dominates the land use accounting for 31.0% of the total area followed by agricultural fallow land (29.2%) and homestead plantation (19.8%).

Figure 31: Land use Map of Kaziranga reach (Bank to Embankment)

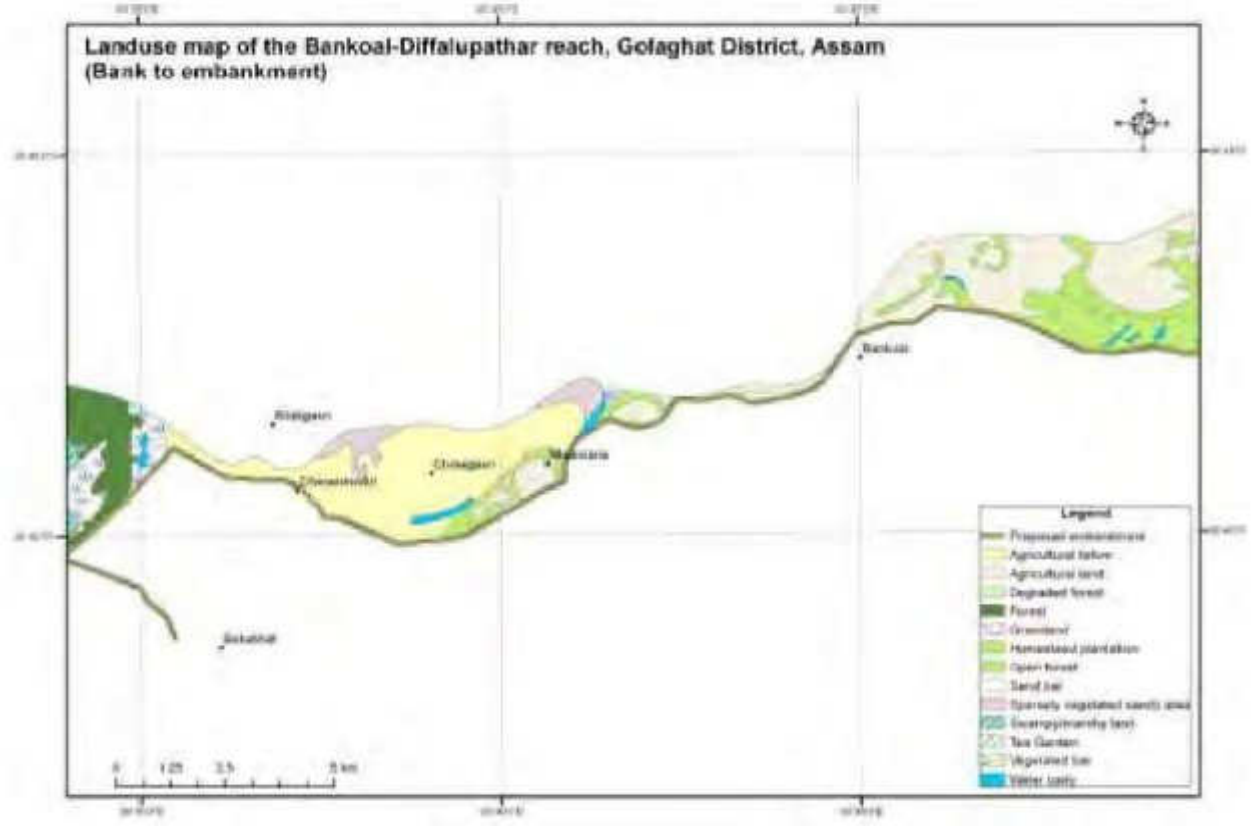


Table 15: Land Use between the Brahmaputra River Bank to the Embankment

Category	Area (ha)	Area (%)
Agricultural fallow	1216.8	29.2
Agricultural land	1290.2	31.0
Forest	326.3	7.8
Grassland	240.6	5.8
Homestead plantation	823.2	19.8
River channel	18.0	0.4
Sparsely vegetated sandy area	159.6	3.8
Swampy/marshy land	32.7	0.8
Water body	57.5	1.4
Total	4164.9	100

15. Air Quality

78. The Kaziranga Reach being rural in character with limited economic development and infrastructure has a relatively undisturbed ambient air quality. There are no major sources of air pollution in this reach except for unpaved road travel and cooking using firewood. The relatively clean air quality is substantiated by secondary data from published records of 2011 and 2012. The results of ambient air quality monitoring in the reach are presented in the succeeding Table. The

National Ambient Air Quality Standards (NAAQS) for Residential and Rural Areas in India is provided in Appendix 4 and for Noise in Appendix 5

Table 16: Ambient Air Quality for the year 2012

State	City	SO_2		NO_2		PM_{10}	
		Annual average ($\mu g/m^3$)	Air quality	Annual average ($\mu g/m^3$)	Air quality	Annual average ($\mu g/m^3$)	Air quality
Assam	Nagaon (data available for nearest city of Kaziranga Reach)	6	L	13	L	79	H
Assam	Golaghat, Numaligarh	6	L	14	L	55	M

L: Low, M: Moderate, H: High, C: Critical; Low, moderate, high, critical classification based on Pollution Level Classification,

Source: NATIONAL AMBIENT AIR QUALITYSTATUS & TRENDS – 2012, Central Pollution Control Board,

Table 17: Ambient Air Quality of the project site for the year 2016

Sl.no	Parameters	Location 1	Location 2
		KRF Boundary N26°41'0.78", E093°35'30.38"	N26°39'17.43", E093°30'57.98"
1	PM_{10}	51	63
2	$PM_{2.5}$	10	13
3	SO_x	2	2.2
4	NO_x	12	13
5	C_6H_6	< 1	< 1
6	B (a) P	< 1	< 1
7	As	< 1	< 1
8	Ni	< 1	< 1

Source: Primary analysis, done by Greenviron on 14.12.2016

Table 18: Ambient Noise Levels in the Study Area

Sl.no	Location	Average Noise Level in dB	
		Day Time	Night Time
1	N 26°41' 0.78" E 093°35'30.38" 5m from river	49.0	36.0
2	-Do- 10m from river	44.0	31.0
3	-Do- 15m from river	41.0	30.0

Source: Primary analysis, done by Greenviron on 14.12.2016

C. Terrestrial Ecology

79. Assam is one of the most important biodiversity hotspot in northeastern region of India. The area harbors great variety of wildlife species[16] in its diverse mosaic natural habitats. The wilderness habitat of Assam supports 689 species of bird[17], 194 species of mammals[18], 185 species of fish[19], 115 species of reptiles, 54 species of amphibians[20], more than 900 species of butterflies[21] and immense varieties of moths. In floral diversity, Assam has documented 6,027 species of plants, of which 3,010 are flowering plants along[22]. 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.

80. The Bankoal - Diffalupathar reach along the Brahmaputra River is in the immediate vicinity of the KNP. The reach is severely affected by continuous bank erosion and flood inundation caused by the Brahmaputra over last few decades threatening the existence of the park and survival of its unique wildlife. There is an immediate danger from potential avulsion of a spill - channel along existing depression and wetlands within the park thereby isolating the main park area from the surrounding highland which serves as vital refuge during flood events.

1. Methods for Baseline Data Collection

81. Tree identification in the sub-project site was conducted from Bankoal Bali Sapori (ch.1.0 km to ch. 5.0 km); Krishibund in Bankoal (ch. 0.0 km to ch. 5.5 km); Moriaholla to Kaziranga Reserve Forest (KRF) boundary (ch.0.0 km - ch 10.25 km); KRF boundary to Diffalupathar (ch 10.25 km to 23.38 km); extension of Brahmaputra dyke from Diffalupathar to NH 37 (ch 23.38 km to 26.88 km); and Tamul pathar (chain 31.0). Details of the sampling locations are provided Appendix 6. The data were collected based on departmental demarcation of the Brahmaputra dyke. The assessment was carried out from February to April 2008 and from June to November 2015 to provide updated information. Gathered primary data were supplemented with information from published materials.

82. The tree species identification procedure is consistent with accepted scientific methods and was done in partnership with the Department of Botany, Gauhati University. The animal species data were collected in the subproject area through direct sighting methods, indirect evidences and as well as the information of local inhabitants by displaying the animal's color plates to aide recognition. Identification data of mammalian, avian and reptilian species were compiled and statically analyzed using SPSS Software Version 11.0.1 and Species Diversity and Richness Software Version 3.0.

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[16] Biodiversity Studies at Kaziranga National Park, Assam, India. BNHS 2015: All rights reserved. This publication shall not be reproduced either in full or in part in any form, either in print or electronic, or any other medium, without the prior written permission of the Bombay Natural History Society. (Funded by ADB)

[17] Saikia, P. K. and M. Kakati 2000. Diversity of Bird Fauna in North East India.Jour. Assam Sci. Soc. Vol: 41(4): Pp 379-396.

[18] Chaudhury, A. U. 1997.Checklist of the Mammals of Assam. Gibbon books with Assam Science Technology and Environment Council. PP 1-103.

[19] Das, S. K. 2000. Fish Genetic Resources of North East India and their status of Conservation. Jour. Ass. Soc. Vol: 41(4): PP.355-362.

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[21] Evans, W. H. 1932. Identification of Indian Butterflies. Croom Helm Ltd., Kent. (BI).

[22] Mao, A. A. and T. M. Hynniewta 2000. Floristic diversity of North East India. Jour. Assam Sci. Soc. Vol: 41(4): Pp 255-266.

2. Identification of Terrestrial Flora

83. For the terrestrial species survey, a contiguous area between the Mohkhuti camp and Agoratali range along the Brahmaputra dyke was selected as the study area. This area encompass the villages of Japoripothar, Diffolupathar, Kandhulimari, Bamungaon, Balguri, Tamulipather, Juganiyati, Polashguri, and Dhansirimukh. A section of study area is inside the KNP while the rest is situated just outside the Park boundary. The vegetation compositions of the terrestrial zones includes Ajar (*Lagerstroemia flosrganae*), *Areca catechu*, *Terminalia arjuna*, *Erythrine indica*, Am (*Mengifera indica*), Kash Kol (*Musa paradisiacal*), Narikol (*Cocos nucifera*), Sajina (*Moringa oleifera*), (*Elaeocarpus floribundus*), Siris (*Albizzia lebek*), Kolajamun (*Syzygium cumini*), Bogori (*Zizipha zuzuba*), Kadam (*Anthocephalus cadamba*), Atlas (*Annona squamosa*), Segun (*Tectona grandis*), Ahot (*Ficus religiose*), Dimoru (*Ficus lipidosa*), Krishna sura (*Delonix regia*), Morapat (*Corchorus capsularis*), Palas (*Butea monosperma*), Kathal (*Artocarpus heterophylus*), Sunaru (*Cassia fistula*), Bholukabanh (*B. balcooa*), Mokal Banh (*B. nutans*), Jatibanh (*Bambusa tulda*), Chenikol (*M. champa*), BhimKol (*Musa balbiciana*), Pakori (*F. rumphii*), Khongal Dimoru (*Ficus tinctorial*), Bijuli banh (*Bambusa pallida*), Karas (*Pungamia pinnata*), Owtenga (*Dillenia indica*), Veleo (*Tetramelos nudiflora*), Satiana (*Alstonia scolaris*), Gamari (*Gmelina arborea*), Simul (*Bombax ceiba*), Kutoha banh (*Bambusa arundinacea*), Sisoo (*Delbergia sisso*).

84. Other plants found in the study area are Amita(*Carica papaya*), Phulkabi (*Brassica oleracea*) var, Ghehu (*Triticum aestivum*), Jati Bet (*Calamus erectus*), Dubari Ban(*Cynodon dactylon*), Locosa Ghanh (*Hemarthia compressa*), Birina(*Vetiveria zizanoides*), Ekora(*Saccharum ravanae*), Khagori (*Phragmites karka*), Ulukher (*Imperata cylindrica*), Hankher (*Pollinia ciliate*), Kahua (*Saccharum sponteneum*) and Borota Kher (*Saccharum elephantinus*) *etc* .The most other important plant species of the area has been eliminated due to regular flood and changing scenario of soil characters. The major climber species comprises *Stephania harnondifolia* (Tubuki lata), *Zanthoxylum hamiltonianum* (Tej-muri), *Cuscuta reflexa* (Akashi Lata), *Illegeria khasiana* (Kerkeri lata), *Dioscorea hamilttoni* (Bonoria alu), *Smilax macrophylla* (Tikoni boral), *Calamus erectus* (Jati bet), *C. gracilis* (Wahing bet). C. *latifolius* (Motha bet), *Pinaga gracitis* (Raidang Bet), *Pothos cathcartii* (Hati-poita) and *P. scandens* (Kawri Lata) etc.

3. Trees

85. Tree species found in the study area are Sisoo- (*Delbergia sisso*), Kutoha banh (*Bambusa arundinacea*), Gamari (*Gmelina arborea*), Satiana (*Alstonia scolaris*), Veleo (*Tetramelos nudiflora*), Owtenga (*Dillenia indica*), Karas (*Pungamia pinnata*), Bijuli banh (*Bambusa pallid*), Khongal Dimoru (*Ficus tinctorial*), Pakori (*F. rumphii*), BhimKol (*Musa balbiciana*), Chenikol (*M. champa*), Jati banh (*Bambusa tulda*), Mokal Banh (*B. nutans*), Bholukabanh (*B. balcooa*), Sunaru (*Cassia fistula*), Kathal (*Artocarpus heterophylus*), Palas (*Butea monosperma*), Phulkabi (*Brassica oleracea* var), Morapat (*Corchorus capsularis*), Ghehu (*Triticum aestivum*), Krishna sura (*Delonix regia*), Dimoru (*Ficus lipidosa*), Ahot (*Ficus religiose*), Segun (*Tectona grandis*), Atlas (*Annona squamosa*), Kadam (*Anthocephalus cadamba*), Bogori (*Zizipha zuzuba*), Kolajamun (*Syzygium cumini*), Siris (*Albizzia lebek*), Jalphai (*Elaeocarpus floribundus*), Amita (*Carica papaya*), Sajina (*Moringa oleifera*), Narikol (*Cocos nucifera*), Kash Kol (*Musa paradisiacal*), Am (*Mengifera indica*), *Erythrine indica*, *Terminalia arjuna* and Areca catechu. There are no invasive species found along and immediately outside the Brahmaputra dyke.

86. A comprehensive tree counting was conducted in the subproject area and an estimated 17,110 trees are along the entire embankment which includes the proposed Diffalupathar-NH-37 new embankment was inventoried. Focusing on the rehabilitation of 6 sections of the Brahmaputra

dyke and the construction of 3 sluice gates, the number of trees that will be affected was estimated at 1,480 based on the June 2015 and February 2016 assessments.

Table 19: Total Tree Count in Morihola to KRF Boundary and Diffalupathar to NH

Villages	From Japoripathar to NH-37		From KRF Boundary to Diffalupathar		Morihola to KRF Boundary		
	Fruit bearing trees	Timber /Furniture species	Fruit bearing trees	Timber /Furniture species	Fruit bearing trees	Timber /Furniture species	Fire wood
Japoripothar	1,093	339					
Diffolupathar	2,771	1,003					
Kandhulimari	1,182	2,983					
Bamungaon			684	455			
Balguri			413	188			
Tamulipather			1,062	1,627			
Japoripothar			1,329	462			
Juganiyati					48	69	21
Polashguri					140	171	2
Dhansirimukh					410	379	72
Bamungaon					11	240	10
Total	**4,992**	**4,325**	**3,488**	**2,732**	**609**	**859**	**105**
Total Trees	**9,317**		**6,220**		**1,573**		

4. Eco-sensitive, Protected and Restricted Areas

87. The KNP is a World Heritage Site located at Golaghat and Nagaon Districts with a total area of 430 square kilometers. First declared as a Reserved Forest in 1908, it was declared as a Game Reserve in 1916, Wildlife Sanctuary in 1950, and National Park in 1974, and finally as World Heritage site in 1985. Later several new areas were added to the National Park. The first addition (area 43.79 km² on 28 May 1977), the second addition (area 6.47 km² vide preliminary notification on 10 July 1985), third addition (area 0.69 km² on 31 May 1985), fourth addition (area 0.89 km² on 3 August 1988), fifth addition (area 1.15 km² on 13 June 1985), and the sixth additions (area 376.50 km² on 7 August 1999) were made. Two reserve forests Panbari (7.65 km^2)) and Kukurakata (15.93 km^2) also came under the administrative control of the Kaziranga National Park. Total area 882 km^2. The KNP land and water use is classified as follow: Eastern Wet Alluvial Grassland, Assam Alluvial Plains Semi- Evergreen Forest, Western Dillenia Swamp Forests, Wet Land, Water Bodies, and Sandy Chor. The KNP has not compiled an updated management plan to date.

88. Proposed 6th addition (Rangpur RF and stretch of Brahmaputra River on the north) 376.50 sq km is adjacent to the sub-project's river bank protection works.

Figure 32: The Kaziranga National Park and its Additional Areas

89. The KNP and immediate area harbors more than 478 bird species, including 24 globally threatened species. While it would not be possible to describe status and distribution of each threatened species, sightings during the study period coupled with community identification allowed the estimated of the extent of occurrence of these species. Out of the 478 bird species listed, 197 are residents, 165 are migrants, 46 are local migrants, and the status of the remaining species is uncertain. Notable resident species with significant populations are: spot billed Pelican (*Pelecanus philipensis*), Lesser Adjutant (*Leptoptios javanicus*), Swamp Francolin (*Francolinus gularis*), Bengal Florican (*Houbaropsis bengalensis*), Pallas's fish eagle (*Haliaeetus leucoryphus*), Greater Grey headed fish eagle (*Icthyophaga ichthyaetus*), white bellied heron (*Ardea insignis*), Black necked stork (*Ephippiorhynchus asiaticus*), Bristled Grass warbler (*Chaetornis striatus*), Marsh Babbler (*Pellorneum palustre*), Black breasted parrotbill (*Paradoxornis flavirostris*) and finn's Weaver (*Ploceus megarhynchus*).

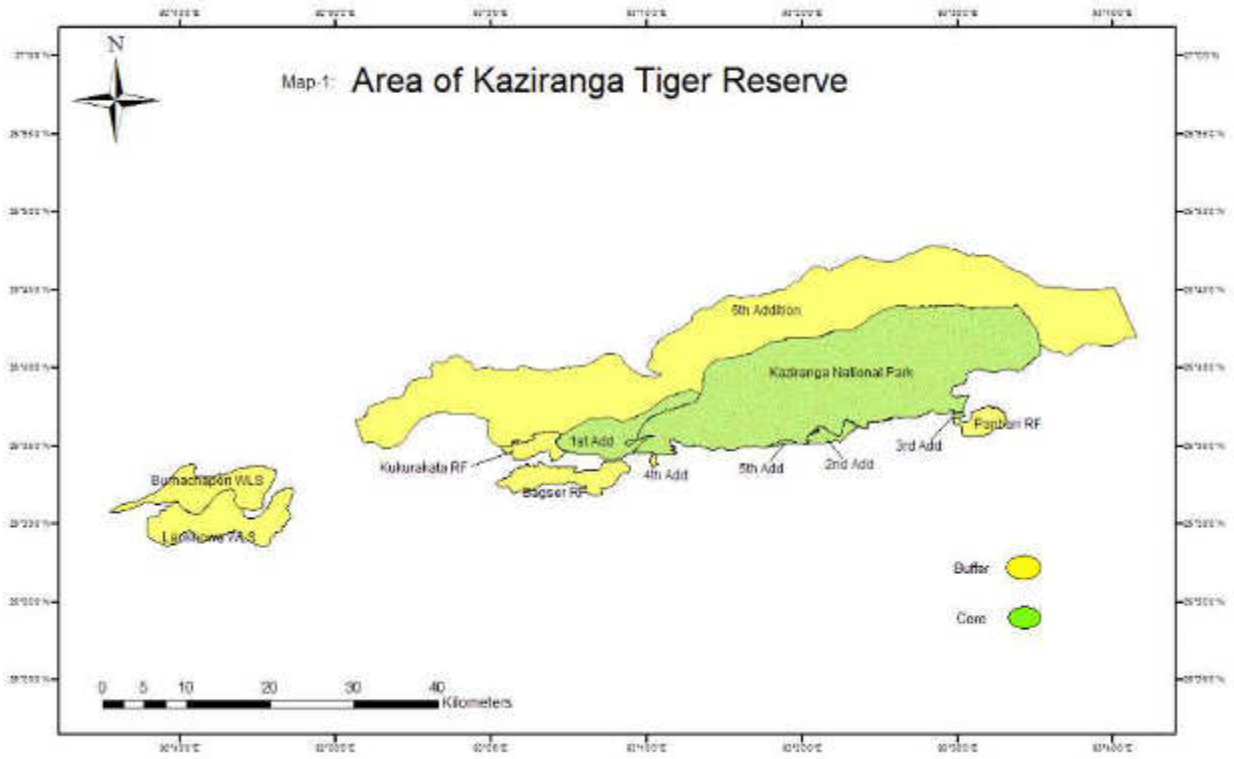
90. Some of the uncommon residents are Oriental white baked vulture (*Gyps bengalensis*), Slender billed vulture, *G. tenuirostris*, Red vented vulture (*Sarcogyps calvus*), Black bellied tern (*Sterna acuticauda*), Pied falconet (*Microhierax melanoleucos*), Greater adjutant (*Leptoptilos dubius*), Jerdon's Bushchat (*Sexicola jerdoni*), Rufous vented prinia (*Prinia burnesii*), Jerdon's Babbler (*Chrysomma altirostre*), and slender billed Babbler (*Turoides longirostris*). Some of the species especially of the tall grasslands and thick shrubs may not be as rare as thought because finding them is rather difficult, especially on brief bird watching surveys. Possibly, the globally threatened pale-capped pigeon Columba punicea breeds in the park is considered as a summer visitor.

5. Important Terrestrial Mammals

91. KNP is an internationally famed wilderness, mainly known for the Indian one horned rhinoceros (*Rhinoceros unicornis*). KNP also supports large populations of others endangered

species, notably the tiger (*Panthera tigrisi*), wild buffalo (*Bubaius arnee*), Asian elephant (*Elephas maximus*), swamp deer (*Cervus duvaucelli*) and many more (Appendix 7). The rhino population in KNP and the adjoining areas has been estimated at 2,401 ± 100 (Forest Department, 2015). The park it is equally rich in avian diversity with more than 490 bird species. Situated in the flood plains of the Brahmaputra River, it covers parts of Nagaon, Golaghat and Sonitpur districts of central Assam. Panbari and Kukurakata reserve forest, located outside the par, are small patches but serves as important habitation areas of many bird species and are included in the IBA[23] (Appendix 8).

92. KNP is also part of a bigger tiger reserve as presented in the succeeding Figure. In a 2016, the tiger density in Kaziranga is 12.72 per 100 square km, followed by the Jim Corbett National Park with 11 in Uttarakhand and Bandipur National Park with 10.28 in Karnataka according the report "Status of Tigers, Co-predators and Prey in India," published by the Wildlife Institute of India and the National Tiger Conservation Authority. The latest round of tiger estimation carried out in January to March 2017 has revealed Kaziranga has an estimated 102 tigers, a range of 96-117, within a core area of 484 sq km which one more than the 2014 survey. Preliminary estimates of 2017 suggest RG Orang National tiger density is 35.44 tigers per 100 sq km. Both the parks are under Kaziranga Tiger Reserve. Earlier, Karanth and Nichols (1998) had indicated that tigers attained their highest possible density in Kaziranga. According to Karanth and Nichols, tiger density of Kaziranga was 16.8 tigers per 100 sq.km. The Tiger Reserve is immediately to the northwest of the subproject area



6. River Interface

93. A land-water interface near Dhansirimukh was surveyed and indicated this is not a migratory route for any wildlife species. Nonetheless, the endangered herpetofauna River Dolphins were seen near the river mouth at chainage ch.25.0 km with co-ordinates: 26° 40' 19" N-93° 37' 39" E. River Dolphins are commonly found along the tract of river Brahmaputra and Dhansiri river mouth near

[23] Baruah, M., and P. Sharma. 1999. Birds of Kaziranga National Park, India. Forktail 15: 47-60

embankment site. They are usually seen during monsoon near the banks and inhabits the deeper channels during winter season when water depth reduced.

7. Forests

94. There are four main types of vegetation in the area: (as per Champion and Seth, 1968): (i) Eastern Wet Alluvial Grasslands 4D / 2S2, (ii) Assam Alluvial Plains Semi-Evergreen Forests 2B/C1a, (iii) Tropical Moist Mixed Deciduous Forests 3C3, (iv) Eastern Dillenia Swamp Forests 4D/SS5, (v) Wetlands, and (vi) Sandy "chars". Grasslands predominate in the west, with tall elephant grass on the higher ground and short grasses on the lower ground surrounding the beels. *Erianthus ravennae*, *Phragmites karka, Arundo donax, Imperata cylindrica* and *saccharum* species are the main grass species. The herbaceous *Alpina allughas* grows abundantly all over the grassland, especially in the damp areas. Amidst the grasses are numerous forbs and the scattered trees of *Bombax ceiba, Dillenia indica, Careya arborea* and *Emblica officinalis*. Tropical wet evergreen forest near Kanchajuri, Panbari and Tamulipathar blocks are dominated by trees such as *Aphanamixis polystachya*, *Talauma hodgsonii, Dillenia indica, Garcinia tinctoria, Ficus sp.*, *Cinnamomomum bejolghota* and *Syzygium sp*. Tropical semi evergreen forests occur near Baguri, Bimali and Haldibari. Barringtonia acutangula grows in the waterlogged area.

8. Economically Important Plants

95. Several economically important tree species were found in the proposed sub-project are. A total of 15 economically important tree species were recorded of which 6 have timber value, 4 have fuel wood value, 3 are economically valuable fruit tree species, and 2 are important seed producing trees.

Table 20: Economically Important Tree Species in 100 m around the Embankment

Plant Species	Used type	Outside	Inside
Sisoo (*Delbergia sisso*)	Timber	19	0
Gamari (*Gmelina arborea*)	Timber	60	35
Veleo (*Tetramelos nudiflora*)	Fuelwood	25	112
Bijuli banh (*Bambusa pallida*)	Fuelwood	0	0
Jati banh (*Bambusa tulda*)	Timber	152	35
Mokal Banh (*B. nutans*)	Fuelwood	73	0
Bholukabanh (*B. balcooa*)	Tmber	108	0
Kathal (*Artocarpus heterophylus*)	Economically Important	43	38
Segun (*Tectona grandis*)	Fruit	20	11
Kadam (*Anthocephalus cadamba*)	Timber		
Sajina (*Moringa oleifera*)	Fuel wood	25	0
Narikol (*Cocos nucifera*)	Economically Important Seed	12	10
Am (*Mengifera indica*)	Economically Important Fruit	10	0
Terminalia arjuna	Economically Important Fruit	52	0
Areca catechu	Timber	2	0
	Economically Important See		

9. Identification of Endemic, Threatened and Endangered Species within Kaziranga National Park

a) Avian Fauna

96. Kaziranga supports 40 globally threatened avian species, of which 2 are categorized as endemic, 2 critically endangered, 4 endangered and 18 vulnerable[24], these are presented in the succeeding Table.

Table 21: Globally Endangered, and Endemic Avian Fauna in Kaziranga National Park

Common Name	Scientific Name	Status		
		CR	Within 100 mtr.	Beyond 100 mtr
Oriental white baked vulture	*Gyps bengalensis*			
Slender billed vulture	*Gyps tenuirostris*	CR	Y	Y
White bellied heron	*Ardea insignis*	En	Y	Y
Greater adjutant	*Leptoptilos dubius*	En	Y	Y
Bengal Florican	*Houbaropsis bengalensis*	En	Y	Y
Spotted greenshank	*Tringa gutifer*	En	Y	Y
Spot billed pelican	*Pelecanus philipensis*	V	Y	Y
Lesser adjutant	*Leptoptilos javanicus*	V	Y	Y
Lesser white fronted goose	*Anser erythropus*	V	Y	Y
Marbled teal	*Marmaronetta angustirostris*	V	Y	Y
Baer's Poachard	*Aythya baeri*	V	Y	Y
Pallas's sea eagle	*Haliaeetus leucoryphus*	V	Y	Y
Greater spotted eagle	*Aquila clanga*	V	Y	Y
Eastern imperial eagle	*Aquila heliacal*	V	Y	Y
Lesser kestrel	*Falco naumanni*	V	Y	Y
Swamp francolin	*Francolinus gularis*	V	Y	Y
Indian skimmer	*Rynchops albicollis*	V	Y	Y
Purpel wood pigeon	*Columba punicea*	V	Y	Y
Hodgson's Bushchat	*Saxicola insignis*	V	Y	Y
Marsh babbler	*Pellorneumpalustre*	V	Y	Y
Jerdon's babbler	*Chrysomma altirostre*	V	Y	Y
Slender billed babbler	*Turdoides longirostris*	V	Y	Y
Black breasted parrotbill	*Paradoxornis flavirostris*	V	Y	Y
Finn's weaver	*Ploceus megarhynchus*	V	Y	Y
Darter	*Anhinga melanogaster*	NT	Y	Y
Black necked stork	*Ephippiorhynchus asiaticus*	NT	Y	Y
Oriental white ibis	*Threskiomis melanocephalus*	NT	Y	Y
Ferruginous Poachard	*Aythya nyroca*	NT	Y	Y
White tailed sea eagle	Haliaeetus albicilla	NT	Y	Y

[24] **Biodiversity Studies at Kaziranga National Park, Assam, India**. BNHS 2015: All rights reserved. This publication shall not be reproduced either in full or in part in any form, either in print or electronic, or any other medium, without the prior written permission of the Bombay Natural History Society. (Funded by ADB)

Common Name	Scientific Name	Status		
		CR	Within 100 mtr.	Beyond 100 mtr
Greater Grey headed fish eagle	*Ichthyophaga ichthyaetus*	NT	Y	Y
Cinereous vulture	*Aegypius monachus*	NT	Y	Y
Red headed vulture	*Sarcogyps calvus*	NT	Y	Y
White cheeked hill Patridge	*Arborophila atrogularis*	NT	Y	Y
Black bellied tern	*Sterna acuticauda*	NT	Y	Y
Blyth's kingfisher	*Alcedo herculis*	NT	Y	Y
Great pied hornbill	*Buceros bicornis*	NT	Y	Y
Long tailed Prinia	*Prinia burbesil*	NT	Y	Y
Rufous rumped grass warbler	*Graminicola bengalensis*	NT	Y	Y
Marsh babbler	*Pellorneum palustre*	Endemic	Y	Y
Black breasted Parrotbill	*Paradoxornis flavirostris*	Endemic	Y	Y

(En: Endangered; CR: Critically endangered; V: vulnerable; NT: Near threatened)

b) Mammals

97. Altogether 8 IUCN endangered, 11 vulnerable, 2 data deficient and 10 less concerned species of mammalian faunas are found in Kaziranga National Park (Appendix 9). An inventory of mammals beyond the 100m buffer zone from the embankment the study team spotted 2 endemic, 2 endangered, and 11 vulnerable avian fauna are spotted, as well as 2 endemic, 6 IUCN endangered and 7 vulnerable mammalian fauna. None of these species has its habitat around the Kaziranga reach area.

Table 22: Endangered Mammalian Fauna

Scientific Name	Common Name	IUCN Status	Within 100 mtr.	Beyond 100 mtr.
Nycticebus bengalensis	Slow Loris	DD	N	Y
Pletinista gengeticus	River Dolphin	En	Y	Y
Bunopithecus hoolock	Hoolock gibbon	En	N	Y
Macaca mulata	Rhesus macaque	LR	Y	Y
Macaca assamensis	Assamese macaque	V	Y	Y
Trachypithecus pileatus	Capped langur	En.	N	Y
Cervus duvauoelii	Swamp deer	V	N	Y
Muntiacus muntjak	Indian Muntjac	LR	N	Y
Axis porcinus	Hog deer	LR	Nn	Y
Bubalus amee	Asiatic wild buffalo	En.	Y	Y
Bos gaurus	Gaur	V	N	Y
Sus scrofa	Wild pig	LR	Y	Y
Elephas maximus	Asian elephant	En.	Y	Y
Rhinoceros unicomis	Greater one-homed rhinoceros	En.	Y	Y
Ursus thibetanus	Asiatic black bear	V	N	Y
Helarctos malayanus	Sun bear	DD	N	Y
Melursus ursinus	Sloth bear	V	N	Y

Scientific Name	Common Name	IUCN Status	Within 100 mtr.	Beyond 100 mtr.
Canis aureus	Jackal	LR	Y	Y
Cuon alpinus	Wild dog	V	N	Y
Vulpes bengalensis	Indian fox	LR	Y	Y
Panthera tigris	tiger	En.	Y	Y
Panthera pardus	Common leopard	LR	Y	Y
Neofelis nebulosa	Clouded leopard	V	N	Y
Pardofelis marmorata	Marbled cat	V	Y	Y
Catopuma temmincki	Golden cat	V	Y	Y
Felis chaus	Jungle cat	LR	Y	Y
Prionailurus bengalensis	Leopard cat	LR	Y	Y
Prionailurus viverrinus	Fishing cat	V	Y	Y
Melogale moschata	Small-toothed ferret bad-ger	V	Y	Y

(DD: data deficient; En: endangered; LR: less concern; V: vulnerable)

10. Wetlands

98. The Shohola beel is an important wetland in the KNP near the Agoratali on the river side of the embankment. A few other wetlands inside the embankment are Barpak Beel and Kolabutiya Beel. These beels are not connected to Brahamaputra River and mostly fed by rain and flood waters.

11. Flood and Wildlife Movement

99. The succeeding Figures presents the Kaziranga–Karbi Anglong Landscape (KKL) in the central part of Assam where KNP is located. The KKL is a part of the bigger Indo-Myanmar biodiversity hotspot. KKL covers an area of about 22,000 km2 south of the Brahmaputra River bounded by Meghalaya and Nagaland in north-eastern India. The KKL is being preserved ensure that large mammals, especially tigers, elephants and rhinos persist in connected ranges with minimal wildlife-human conflict.

100. KNP is the biggest protected area in the KLL and connected through wildlife corridors, namely: Panbari, Haldhibari, Amguri and Kanchanjhuri where more than 2,500 elephants, 2,000 rhinos, 70% of the Assam's tigers, black panthers move across the KKL particularly during floods. The KNP lost 361 animals, including 31 rhinos, in floods that swamped the UNESCO world heritage site in 2017. This episode was particularly tragic as the number of rhino deaths from the floods exceed total deaths past three years even from poachers and poisoning in the three separate parks where rhinos are found, KNP included. Torrential rains in the KNP area caused flooding twice in 2017 in the area straddling the Brahmaputra floodplains and Burha Pahar hills. Between 2002-2017, 130 rhinos drowned and perished. Wildlife lost was not limited to rhinos, the 2017 floods also killed 9 elephants, 282 hog deers, 1 tiger, 16 sambar deers, and 8 buffaloes[25].

[25] https://www.indiatoday.in/mail-today/story/assam-floods-kaziranga-sanctuary-one-horn-rhino-dead-animals-1030540-2017-08-21

Figure 33: Movement of Wildlife in the Kaziranga-Karbi Anglong Landscape

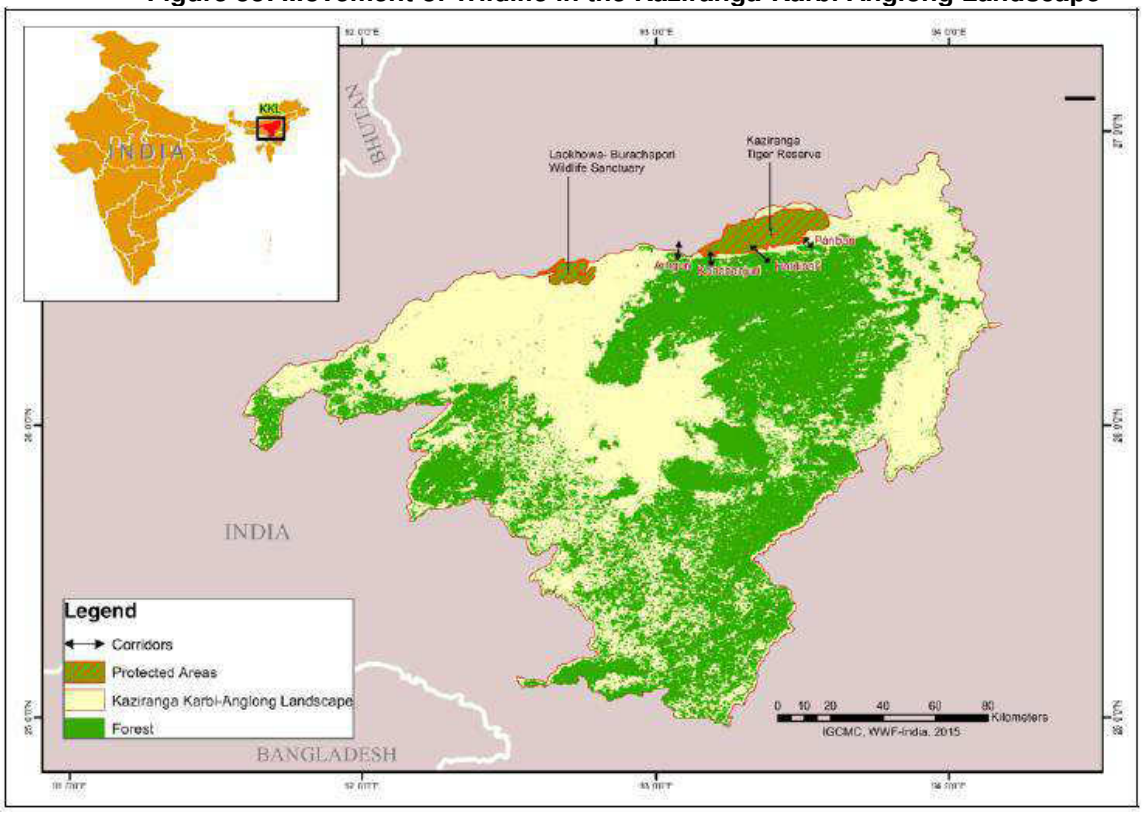


Figure 34: Designated elephant corridors in Kaziranga National Park.

101. Discussions with the Chief Conservator Forest and local communities indicated that wildlife drownings during flood events, including the 2017 floods, did not occur near the sub-project boundary. During flood event wildlife crosses the NH 37 as depicted in preceding Figure through

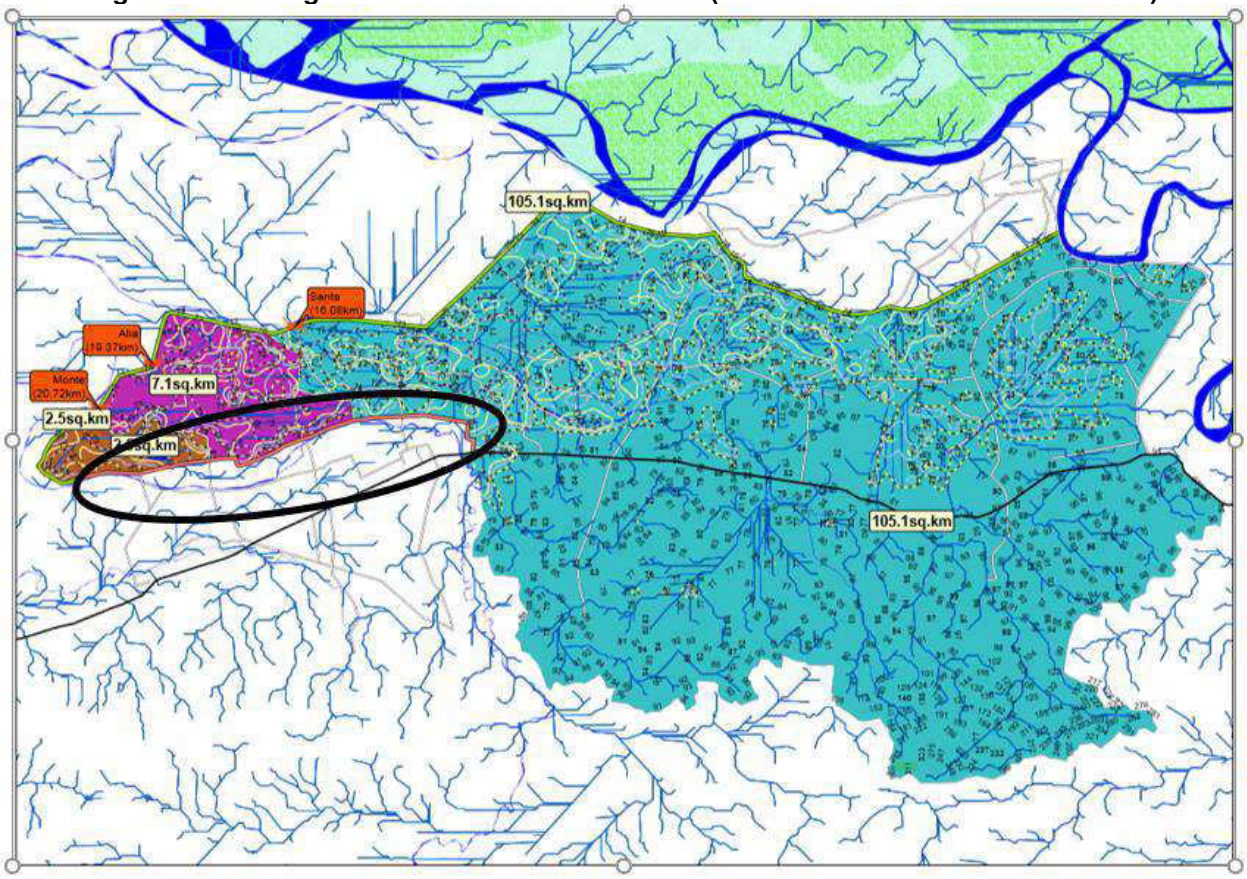
forest patches linking towards the Karbi Anglong hills, namely: Barupahad, Kanchanjur, and Panbari corridors. Wildlife do not cross the embankment towards the Bokhakat villages during flood season for two reasons: i) electric fences were installed by the Forest Department in near the embankment between the subproject are and KNP to prevent animals from depredation in the adjacent agricultural fields26; and ii) the project side of the embankment are the generally lower than the KNP where flood waters are deeper. Typical electric fences established along the KNP and sub-project boundaries are provided on succeeding Figure.

Figure 35: Electric fence near the Brahmaputra dyke and subproject boundary

102. The south-western section of the sub-project area is the lowest section where flood waters tend to converge. The succeeding Figure presents the drainage area for each sluice gate proposed under the sub-project with the new-embankment scenario that connects the existing Brahmaputra dyke to NH-37 thereby completely encircling the Bokhakat section with an embankment. The drainage areas were defined by the roads formation heights, but water tends to collect in this portion before passing around the KNP and re-joins downstream of the Brahmaputra River.

[26] The entire KNP-subproject area boundary defined along the Brahmaputra dyke is no continuously protected by an electric fence. Animals (Elephant, water buffalo, wild boar, sometimes rhino) come out of the park in the evening time when the crops are ripe through the river channels and even crosses the embankment where power fence cannot be erected.

Figure 36: Drainage Areas of the Each Sluice Gate (with the new embankment scenario)



12. Bio-Diversity Index

103. An analysis of the biodiversity within the confines of the embankment network and outsides was conducted using the Shannon diversity indices of tree species diversity. The analysis at "total inside" the embankment and "total outside' the embankment shows the tree species diversity index of outside the embankment was higher with a value of H= 2.945 and variance of 0.0005, whereas, it was H=1.988, variance of 0.001491 in the "total inside" area of the Bonkual- Diffalupathar. The difference in diversity was significantly higher outside the embankment than inside at 5% level (pair wise randomized test based on 10,000 re-samples).

Table 23: Diversity Index of Tree Species

Sample	H	Variance H	Lower 95%	Upper 95%
Total Number	2.931	0.0003186	2.888	2.958
Total Outside	2.945	0.0005	2.89	2.89
Total Inside	1.988	0.001491	1.904	2.051

13. Aquatic Biology

104. The Dhansiri and Gelabeel rivers are tributaries of the Brahmaputra River that flow through the sub-project area. The Dhansiri River bisects the subproject area into two sub-reaches near its outfall in the Brahmaputra River called Dhansirimukh. Two separate embankment systems protect these sub-reaches along the river on the south bank extending from Bankoal on upstream to Diffalupathar on downstream. The embankment systems are affected almost every flood season due to breaching because of river erosion and overtopping by flood water causing immense damage to the subproject area and the KNP.

14. Identification of Aquatic Fauna

105. Aquatic faunal data were collected from 12 locations inside the project area. The whole stretch of river bandh was surveyed these 12 different points namely: Alami, Afola, Bholukaguri, Bongkuwal, Bongkuwal ali-chapari, Ririgaon, Dhansirimukh, Kurabahi, Nikorihat, Jugonia, Jugonia Ati, Dhansirimukh, Kharugaon, Mohkhuti camp, Aageratoli, and Tamulipathar and results are summarized in Appendix 10. Some of the sampling points are adjacent to fishing communities. Secondary data was collected from published data and interviews with fisherfolks. The variability and number of each species gathered reveled trenedous variety across the subproject area due to its flood prone nature. The major fish species are Garrta, Gudusia chapra, Salmophasia bacaila, Barilius spp etc. Migratory fish Anguilla bengalensis, an endangered species was also encountered in that projected sites.

106. In the Bholukaguri, Bankoal, Bankoal Bali-chapari, and Ririgaon sampling areas benthos like *Tubifex,* and *Chironomus* were found. Two species of turtles, *Kachuga sylhetensis and Aspideretes gangeticus* were also noted. Frequent dolphin sightings were shared by the fisherfolks particularly near Ririgaon, Dhansirimukh, Kurabahi, Nikorihat, and Jugonia in addition to the main Brahmaputra River. The confluence of the Dhansiri River is a foraging area of dolphins.

15. Macro-invertebrates Ecology

107. Crabs, mollusks, snails, lizards, amphibians and aquatic mammals like dolphin and otter is a testament of the rich diversity in the project area. Besides these, phytoplankton and zooplankton were found in abundance.

a) Fish Species Diversity

108. Total 65 species of fishes belonging to 23 families has been identified in the study area. Diversity of fishes in different sites gives different results. *Salmostoma, Garra,* and Gadusia species are predominant in all project sites. Hilsa is found to be more dominant in the flood seasons because it migrates through main channel of the Brahmaputra River. In winter season also Hilsa is found to migrate in a lesser number. Other fish species like minnows are found to be less in diversity in some points. There are some species like Channa, Clarius, Heteropneustus, and Anabas are found to be predominant only in adjoining wetlands.

16. Faunal Behavior Pattern

109. These areas support 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 for feeding where fish are found in plenty. Other species like turtles and tortoises prefer to breed only in sandy ground near the bank of the river having land river interface.

17. Migratory Route of Aquatic Fauna

110. Migratory fish species like Tor and Anguilla were encountered in the project area showing anadromous and catadromous migratory behavior migrating through the deeper main channel of the Brahmaputra River. Other fish species like *Crossocheilius, Tor* show only local migration from upper to lower reaches of the river.

18. Endangered Species

111. Two endangered fish species were are found in the project area *Garra gotyla stenorhynchus* and *Laguvia shawi*. Other Schedule-1endangered species are enumerated in Appendix 11.

D. Socio-Economic Environment

1. Demography

112. In 2011, Golaghat had population of 1,066,888 of which male and female were 543,161 and 523,727, respectively. Golaghat had a population of 946,279 of which males were 490,286 and remaining 455,993 were females. Density is 305 person/ sqkm. There was an increase of 12.75% in population compared to 2001 census. Child sex ratio is almost equal to adult sex ratio of 963. The Kaziranga subproject area is divided into 3 development blocks, namely: Golaghat West, Golaghat North, and Kakodonga. The demographic details are given in the succeeding Table.

Table 24: Kaziranga Reach: General Details of the blocks

Name of the Block		Area in square Km	Number of Household	Total Population			Population in the age group of 0-6
				Person	Male	Female	
Golaghat West	Total	602.24	49,832	237,319	120,477	11,682	32,425
	Rural	597.32	48,540	231,680	117,642	114,038	31,864
	Urban	4.92	1,292	5,639	2,835	2,804	561
Golaghat North	Total	118.49	9,600	46,221	23,659	22,562	5,254
	Rural	118.49	9,600	46,221	23,659	22,562	5,254
	Urban	0.00	-	-	-	-	-
Kakodonga	Total	111.74	12,075	57,002	28,980	28,022	6,590
	Rural	11.74	12,075	57,002	28,980	28,022	6,590
	Urban	0.00	-	-	-	-	-

Table 25: Villages in the Benefitted area under Kaziranga Subproject

Village Name	ID	Village Name	ID
Ageratoli	1	Japori Pathar	21
Bej Gaon	2	Karaiati	22
Belguri	3	Khatiakhuli	23
Bejjuri T.E	4	Kumarani Pathar	24
Bohikhowa	5	Kumaranita	25
Borchapori Bagisa	6	Kuruabhai Satra	26
Borjuri Gaon	7	Lokhijan Gaon	27
Bosagaon	8	Lukhar Khanis	28
Chepena Koboa	9	Mohpora	29

Village Name	ID	Village Name	ID
Dawgaon	10	N.C	30
Dibbolu Pathar	11	Napalikhuti	31
Diring T.E.	12	No.1 Kohora	32
Durnjan No.I	13	No. 2 Kohora	33
Durnjan No.II	14	Polaghuri	34
Gpsanobor	15	Porangaria Ali Pt.I	35
Gugalati	16	Porangaria Ali Pt.II	36
Guganiati	17	Rajabari	37
Hallowa Gaon	18	Siljuri	38
Ikorajan Bagisa	19		
Ikorajangrant	20		

2. Education

113. Primary, middle, secondary, and senior secondary schools, and colleges are all available to the 115 villages in the project area. The details are provided in the succeeding Table.

Table 26: Education Facilities in the Golaghat District of Kaziranga reach

Category	Nos.
Primary school	235
High School	199
Higher Secondary	40
Junior College	8
Colleges	10

Source: District at a glance Golaghat-2011, Published by Dy. Director, Economics & Statistics, Golaghat

114. Average literacy rate of Golaghat district in 2011 increased to 77.43 as compared to 69.38 of 2001. Literacy rates based on gender literacy were 83.56 and 71.09 for male and female, respectively. Average number of class room in primary school is 2.9 and in upper primary school is 4.01. Average student class Room ratio in primary school is 24.86 against 32.14 in upper primary school in the year 2013-2014.

Table 27: Literacy Rate of Golaghat District

Items	State		District	
	Number	Percentage	Number	Percentage
Person	19,177,977	72.19	721,764	77.43
Males	10,568,639	77.85	396,475	83.56
Females	8,609,338	66.27	325,289	71.09

Source: District Census Handbook – Golaghat, Assam, 2011 Status of Classrooms in Govt. / Provincialized Primary and Upper Primary Schools, 2011-12.

3. Peoples Dependence on Flora and Fauna

115. The indigenous Mishing people inhabit the subproject site and relies mainly on the natural resources for sustenance like fishing, fuel and timber wood gathering, harvesting of horticultural plants supplement paddy cultivation. The Mishing people also collect ground dwelling insects, red ant and some of other wild animal species for consumption. Almost 55% of the subproject population depends on fishing in the surrounding areas of the Kurabahi, Nikorihat, Jugonia, Jugonia Ati, Dhansirimukh, Kharugaon, Mohkhuti camp, Aageratoli, and Tamulipathar. The river system also serves domestic and transport requirements from char to char of the subproject population.

Figure 37: Abundance of Different Aquatic Vertebrates Other than Fish

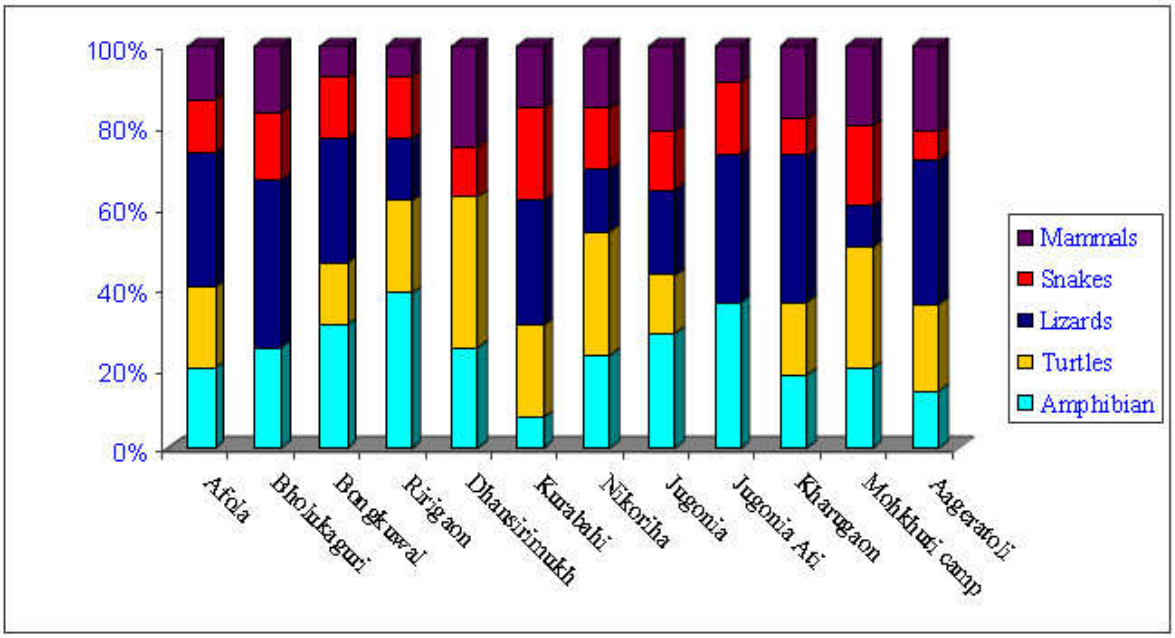
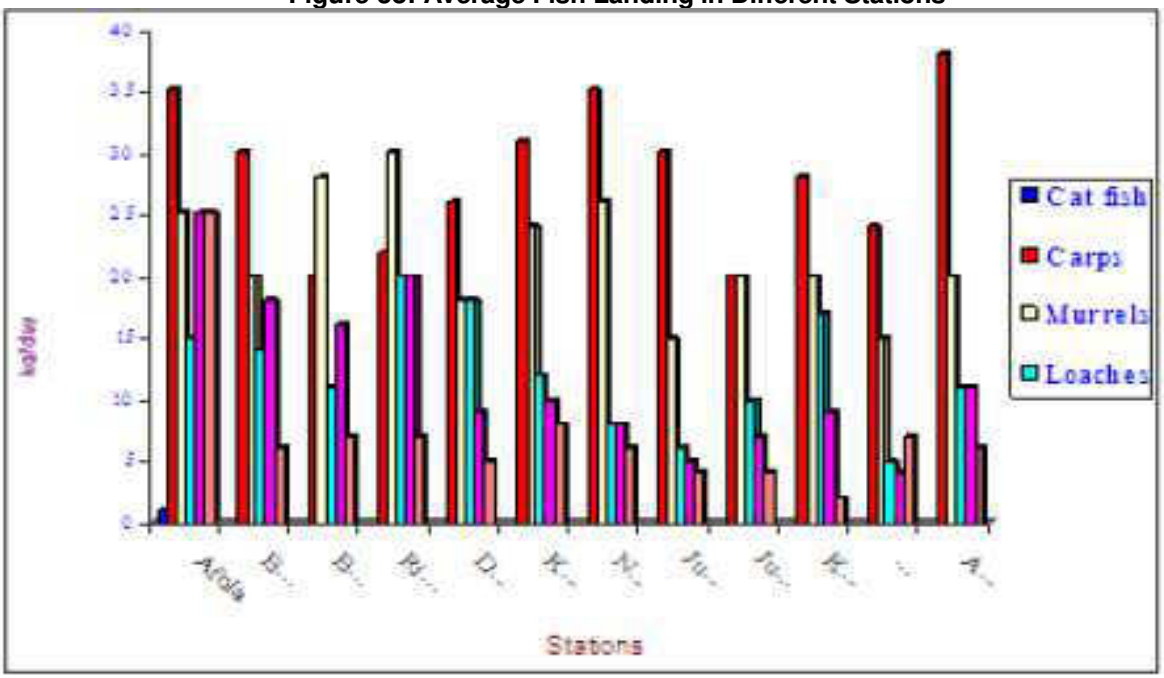


Figure 38: Average Fish Landing in Different Stations



4. Manufacturing Activities

116. The manufacturing of cane goods, furniture, and tea are the main activities in the subproject area. As of 2011, the distribution of these industries is provided in the succeeding Table. Registered MSMU Units investment in plant of Industries and Machinery and workers under the Commissioner at Commerce, Assam in Golaghat District is succeeding Table based on 2011 census.

Table 28: Kaziranga reach: Manufacturing Activity Profile

SN	Type of Industry	Golaghat	
		Nos. of Factories	Nos. of Workers
1	Manufacturing of Food Products and Beverages	154	5230
2	Manufacturing of Textiles	1	0
3	Manufacturing of Wood and products of wood and cork, except furniture, manf. of articles of straw and plaiting materials.	21	126
4	Mfg. of Coke, refined Petroleum products and natural fuel	1	252
5	Mfg. of Rubber and Plastic Products	3	32
6	Mfg. of other non-metalic mineral products.	83	1255
7	Mfg. of basic metals	1	40
8	Mfg. of fabricated metal products (except machinery & equipment)	1	13
9	Manufacturing of Electrical machinery and computing machinery	1	10
10	Sale, Maintenance and Repair of Motor Vehicles and Motor Cycles; retail sales of automotive fuel	4	51
11	Supporting and auxiliary transport activities; activities of travel agencies (including Storage and Warehousing)	1	10
	Total	**271**	**7019**

Source: Statistical Handbook Assam 2012

Table 29: Registered MSMU Units investment in plant of Industries and Machinery and workers under the Commissioner of Commerce, Assam in Golaghat District.

Unit registered during the year								Investment (Rs Lakh)		No. of Workers	
2011-2012				2012-2013				2011-2012	2012-2013	2011-2012	2012-2013
Micro	Small	Medium	Total	Micro	Small	Medium	Total				
56	6	-	62	38	4	-	42	788.08	518.47	390	245

Source: District Census Handbook – Golaghat, Assam, 2011

5. Commuting Facilities

117. The villages in the 3 development blocks have a road network covering 2,480 kms most of which are unpaved rural roads. As of 2011, only 80 villages have paved road connectivity. The distribution of roads according to hierarchy are as follow: (i) state highways, 160 km; (ii) major district roads, 157 km; (iii) rural roads 2,131 km; and (iv) urban roads, 33 km.

6. Power, Water Supply, and Sanitation facilities

118. Almost 92% of the total households in the subproject area have access to electricity. Main source of drinking water is groundwater while other use ponds and rivers. Majority of the households do not have any kind of latrine for disposal of domestic waste and instead use open areas.

Table 30: Drinking Water Facility (Bokakhat)

Total/ Urban/ Rural	Number of House hold	Tap water from Treated Source	Tap water from un Treated Source	Cov-ered well	Un covered well	Hand pump	Tube well / Bore well	Spring	River/ Canna l	Tank/ Pond/ lake	Other Sourc e
Total	34155	3618	1334	101	352	20628	6903	343	474	232	170
Urban	29946	2819	1318	92	341	18274	5894	342	473	231	162
Rural	4209	799	16	9	11	2354	1009	1	1	1	8

Source:Census of India, 2011, HH- series Tables on Houses, Household amenities and asset

Table 31: Sanitary Facility in Bokakhat

Urban/ Rural	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	1,711	6,528	2100	2,646	6,774	142	0	321	234	13,699
Rural	871	4,318	1860	2,386	6,273	138	0	233	215	13,652
Urban	840	2210	240	260	501	4	0	88	19	47

Data:Census of India, 2011

7. Medical Facilities

119. The subproject area has a functional system of medical facilities with 38 primary health care centers, 5 community health centers, 191 hospitals, and 1 sub-divisional civil hospital.

8. Land use

120. The land use distribution in the Golgahat district where subproject area is located in the succeeding Table. The most dominant landuse is agriculture accounting for almost 52% of the total area followed by forest with about 44%.

Table 32: Land use of Golaghat district (area in sq km)

Classification of area		Golaghat
Total Geographical area according to	a) Professional Survey	3,540.70
	b) Village Papers (Reported area)	3,540.70
Forest		1,569.05
Not available for Cultivation (Area under non-agricultural uses)	a) Water Logged Land	5.25
	b) Social Forestry	3.23
	c) Land under Still Water	32.58
	d) Other Land	386.50
	e) Total (a+b+c+d)	427.56
	f) Barren and Unculturable Land	84.76
	g) Total (e+f)	512.32
Other Uncultivated Land excluding Fallow Land	a) Permanent Pasture and other Grazing Land	83.14
	b) Land under Misc. Trees graves not included in Net Area Sown	82.17
	c) Culturable Waste Land	58.01
	d) Total	223.32
Fallow Land	a) Fallow Land other than Current Fallow	22.54
	b) Current Fallow	23.01
	c) Total	45.55
Total Cropped Area		1,848.85

Net Area Sown	1,190.46
Area Sown more than once	658.39

Source: Statistical Handbook Assam 2012

9. Occupational Pattern

121. The details of working population in the subproject district is presented in the succeeding Tables. Of the total population, 45% are in the workforce with the male dominating the female by almost 1:1.5. Of the total workforce, almost 35% are employed in the agricultural sector.

Table 33: Distribution of Working Population

Item		Number	%
Total Worker (main and marginal)	Person	479,928	44.98
	Male	309,104	56.91
	Female	170,824	32.62
Main Worker	Person	331,210	31.04
	Male	247,086	45.49
	Female	84,124	16.06
Marginal Worker	Person	148,718	13.94
	Male	62,018	11.42
	Female	86700	16.55
Non Worker	Person	586,960	55.02
	Male	234,057	43.09
	Female	352,903	67.38

Source: Census Report 2011

Table 34: Category of Industrial Workers in 3 Blocks

Area		Total Worker			Main worker	Cultivators	Agricultural Labour	Household Industry Workers	Other Worker
		Person	Male	Female	Person	Person	Person	Person	Person
Golaghat West	Total	108,457	67,244	41,213	74,953	24,471	3,767	1,644	45,071
	Rural	106,562	65,724	40,838	73,319	24,322	3,747	1,610	43,640
	Urban	1,895	1,520	1,634	1,634	149	20	34	1,431
Golaghat North	Total	22,511	14,319	8,195	13,456	6,678	736	584	5,458
	Rural	22511	14,319	8,195	13,456	6,678	736	584	5,458
	Urban	-	-	-	-	-	-	-	-
Kakodonga	Total	24,463	16,465	8,007	17,817	7,225	908	1,277	8,407
	Rural	24,463	16,465	8,007	17,817	7,225	908	1,277	8,407
	Urban	-	-	-	-	-	-	-	-

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

V. Anticipated Environmental Impacts and Mitigation Measures

122. Potential environmental impacts associated with the proposed Kaziranga sub-project are assessed during design, construction, and operation phases. Qualitative and quantitative techniques were applied to define the intensity, duration, and effect of identified direct and indirect impacts. Impacts are classified as either insignificant, minor, moderate, or major and concomitant mitigation measures were designed to address significant impacts.

A. Physical Environment

1. Land use

a) Land Use Change due to Project Activities and Borrow Area

Design and Construction Phase

123. **Impacts.** The estimated amount of soil material to strengthen the 6 sections of the Brahmaputra dyke is 187,997.88 m^3 compacted at least to 1.6 g/cm^3. This will require a borrow area of almost 12 hectares of land at a depth of 2.4 m with an uncompacted soil density of 1.062 g/cm^3. For the bank protection works, the sand requirements for the 1,370,000 geobags each weighing 126 kg when full will be sourced from char lands at least 1 km from the river bank. During construction phase, no change in land use is expected within the vicinity of the dyke and river bank as they will remain as built-up and riverine. However, there are potential change in the land uses off-site where borrow materials will be sourced for embankment and sand materials for the geobags.

124. During construction, hauling of materials from the quarry to the embankment poses risk of damage to public infrastructure. The access to the embankment construction site is mainly through single lane rural roads and to a limited extent PWD roads that connects to NH-37 on the southern section of the sub-project areas. These roads are not designed to handle the axle loads of a fully laden truck which could prematurely wear their surfaces.

125. Borrow areas if not rehabilitated pose risk of accident to the nearby communities and their grazing animals. Also, if the borrow areas are not rehabilitated as per the intended end use of the owner, will result to loss of income.

126. Reduction of agricultural areas could result from inappropriate site selection for construction materials storage area and construction camp.

127. **Mitigation Measures.** Majority borrow materials will be sourced from existing and approved sites like the Dolomar quarry, and quarries located in Bihori, Lakhojan, and Kakochang, which are about 20 km to 40 km from the reach. No materials will be borrowed within the KNP or near the embankment as this will induce seepage and weaken the structure. To minimize the need for soils, the contractor will maximize the use of sand as filler and soil as outer cover of the embankment. In case borrow earth must be sourced from privately-owned lands, preference will be given to lands which farmers want to either convert into a fishpond or lowering the agriculture field level to increase its water retention capacity. All efforts shall be made to avoid or minimize tree loss due to borrowing.

128. While borrowing earth, top soil shall be preserved. All borrow pits shall be rehabilitated based on 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 civil works contractor shall submit the borrow area identification details along with borrow area rehabilitation plan in advance.

129. 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 any 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.
(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 water-logged areas (bandhis) shall be cut and interconnected to permit ordinary drainage. These shall be connected to the nearest drainage channel 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.

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

(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 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 30cm in depth;
(viii) The haulage distance from site shall not be too far.

131. All sand materials for filling of geobags will be sourced from char lands at least 1 km away from the riverbanks as practiced in the Palasbari subproject. No permits or clearances are required for sand extraction in the char lands or sandbars.

132. All haul trucks shall be covered while transporting the earth. The contractor will coordinate with the jurisdictional panchayat, PMGY or PWD of haul roads that will used. All roads used shall

be maintained by the contractor during their use and restored to its original if not better condition after.

133. No agricultural lands will be used for storage and/or handling of construction materials. Construction camps shall be located on uncultivated areas. All requisite facilities like drinking water supply, sanitation, domestic solid waste collection and disposal, and fuel supply shall be provided at these camps. The land used for construction camp shall be made reusable/cultivable after closure of construction camp. No construction debris shall be deposited on agricultural land. In addition, where the construction activities are undertaken along the KNP boundary, no land use conversion will be undertaken.

134. In addition to strict implementation of the WRD borrow area location, no borrow pit, workers camp, quarrying, and discharge of any wastes along the side of the parks boundary and the embankment. These restrictions shall form part of the contract documents for construction. Under the project, no land within the KNP shall be used for any temporary or permanent works.

Operation Phase[27]

135. **Impacts.** Potential encroachment on the embankment for habitation and cultivation purpose will affect structural stability. As observed on the existing embankment, nearby communities have created cuts to serve as footpaths to allow grazing of domesticated animals and for people to access the river waters.

136. 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 3 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.

2. Land use Change due to Construction Material Sourcing (Quarrying)

a) Soil

1. Soil Erosion

Design and Construction Phase

137. **Impacts.** Soil erosion potential is a function of topography, geological structure, rainfall, soil type and land use/land cover. Erosion of the 6 strengthened sections of the Brahmaputra dyke as proposed in this subproject will be prone to erosion along their side slope while bioengineering has not taken adequately established. Erosion will reduce the strength of the embankment against inundation and eroded materials will contaminate agricultural and grazing lands and silt natural channels reducing water conveyance capacities.

138. Mitigation Measures. Following mitigation measures can prevent embankment slope 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

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

also be covered by straw or mulch to avoid soil loss in the intervening period.

(iii) 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) The embankment and road design shall incorporate adequate engineering measures so that the construction could withstand the earthquake magnitude of more than 6 Mb.

(vi) 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.

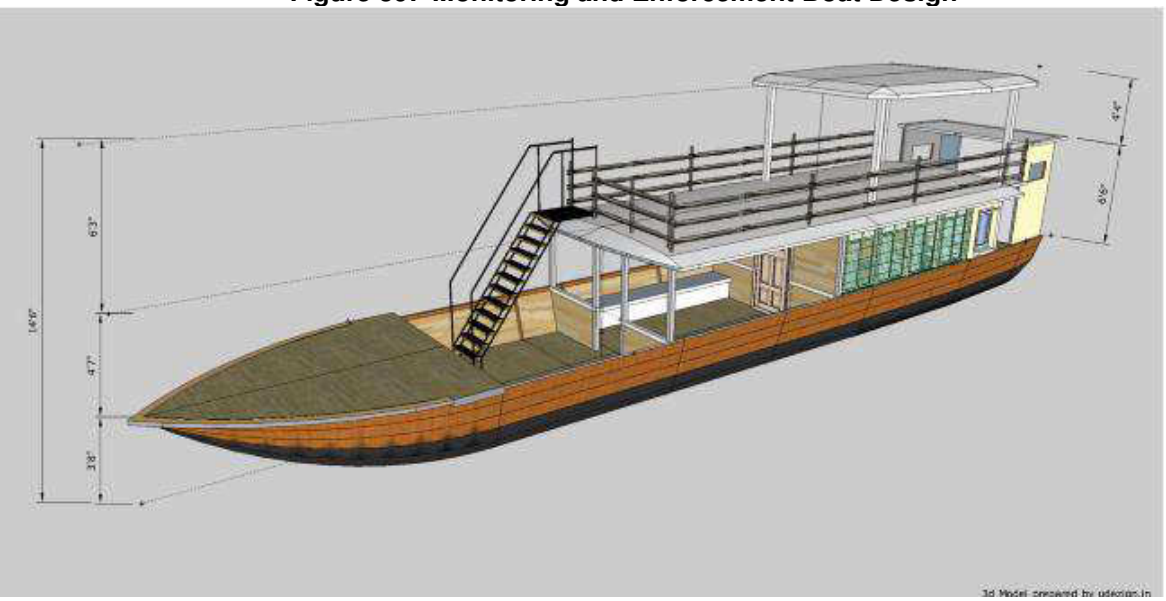
Operation Phase

139. **Impacts.** Due to river bank erosion, the bank line at various sections throughout the reach has shifted by as much as 4.3 km during from 1973-1990. A total of 7,336.42 ha land was eroded between year 1967-2008 in the Kaziranga sub-project and KNP areas. Strengthening the bends near the Dhansirimukh and the launching of porcupine screens just upstream the KNP-Brahmaputra river boundary might shift the tributary channels which could increase erosion downstream where the KNP boundary is located.

140. **Mitigation Measures.** In the Morphology Study for the Kaziranga Sub-Project Area by Gerrit J. Klaassen, Sarat Phukan & Jorgen N. Sarma (2012) concluded "Bank protection of the upstream reach of the KNP should be done in such a way that the natural character of the banks is maintained." The proposed porcupine screens are pro-siltation measures and the risks of morpohological changes to the KNP that is immediately downstream of Kaziranga reach are limited and very difficult to establish that there is either more or less erosion. The proposed pro-sitation works are limited in scope compared to the width of the Brahmaputra rier and will not result to a general rearrangement of the channel pattern. In the other subproject reaches where porcupine screens have been established under Tranche-1, there was no observable changes in bankline erosion downstream after almost 5 years of completion. The impacts in Kaziranga reach might be less as the bankline channel is dominated by relative low sediment load originating from the Dhansiri River.

141. To ensure any morphological changes that will occur along the KNP are detected early and remedial measures are designed and implemented, under the sub-project FREMAA and KNP management have agreed to purchase 2 monitoring boats to allow continuous monitoring for erosion downstream along the KNP banks. These boats will have a low draft of 2.5 ft with dimensions of 56'x12'x3.8' made of wood powered by a 2956cc, TATA 407SP turbo, inter-cooled direct injection diesel engine. Findings on the status of erosion along the KNP banklines will be reported to FREMAA to formulate and implement joint actions based on river training and erosion control techniques and lessons drawn from the project implementation. These monitoring boats will follow the KNP design and construction as provided in the succeeding Figure. This will also be used to monitor and protect wildlife animals that crosses the channels to reach the charlands just north of the revetment works.

Figure 39: Monitoring and Enforcement Boat Design



2. Soil Compaction and Contamination

Design and Construction Phase

142. **Impacts**. Soil around construction site, haul road, construction camp, and workshop will get compacted and contaminated by waste or spilled oil due to the transportation of man, machine, and materials. Considering majority of the land surrounding the embankment construction sites are dominantly agriculture, there is a risk of disruption farming activities on affected area.

143. **Mitigation Measures**. The movement of construction vehicles, machinery, and equipment shall be restricted on 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. All wastes shall be disposed only to approved sites.

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

(i) The construction vehicle 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)/ MoEFCC authorized vendors.

3. Hydrology and Morphology

Design and Construction Phase

145. No impact is envisaged 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 post-construction (operation) stage are presented under various sub-sections below:

4. Flood

Operation Phase

146. **Impacts**. The proposed project will have little to no-impact on the flood duration and intensity in the sub-project area. The civil works involved in the Brahmaputra dyke can be considered as "emergency" in nature, addressing 6 sections that have already incurred damages and severely deteriorated posing great risk to the benefitted area of Bokhahat circle and KNP. These sections will be rehabilitated to perform its regular intended functions. To minimize the existing drainage congestion[28] in the southern part of the reach, construction and operation of 3 sluice gates in the existing embankment will implemented under the subproject. The operation will have little impacts on the duration and depth of flood in the future due to the following:

147. The proposed civil works involved in the Brahmaputra dyke is to restore its original function, no new embankment will be constructed

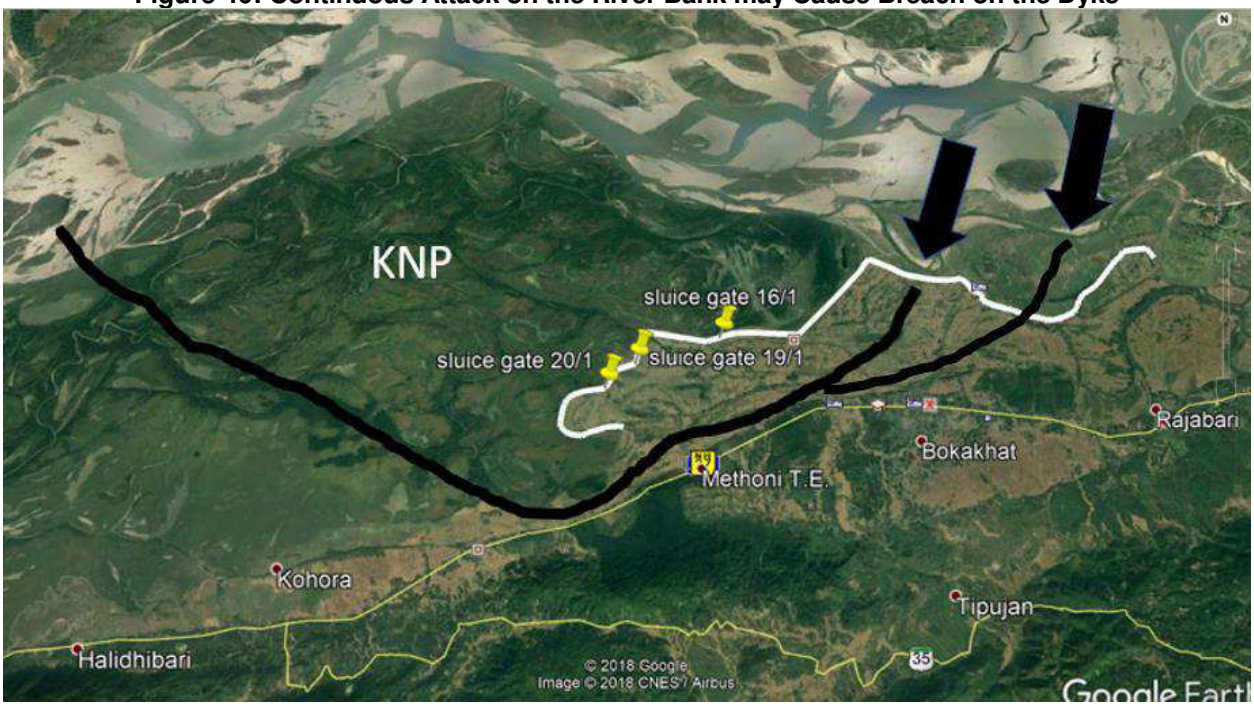
148. The operation of the sluice gate is to alleviate flood congestion in the southwestern section of the project area to avoid convergence of flood waters coming from the Geelabeel River, surface runoff from the Bokakhat villages and surface runoff from KNP. When flood levels are higher inside the dyke, the sluice gate will allow waters to exit towards the KNP and drain around dyke towards NH-37 and Goshanibar and finally rejoining the Brahmaputra west. When flood levels are higher on the KNP side of the embankment due to high rainfall, the sluice gate will be operated to drain waters towards the Geelabeel River.

149. **Impacts:** Active bank erosion in the Dhansirimuk-Agartoli Reach may results to a breach in the Brahmaputra Dyke. A breach of this magnitude will have catastrophic result which could result to human and wildlife mortalities. The succeeding Figure illustrates this risk from the continuous erosion along the saddles of the Kaziranga reach that could cut across Bokakhat community and agricultural areas and joins a channel in between the KNP and NH-37 to rejoin the Brahmaputra downstream. This scenario will cut-off the KNP from the KKL which can result to detrimental loss in wildlife.

150. **Mitigation**. The subproject actually mitigates this risk through riverbank protection measures as described in the section above. Further, the subproject will review the various elements of flood forecasting and warning (FFW) process, paying special attention to warning needs at the village level and possible improvements at the community level and flood emergency management level. It is anticipated that an important element of an improved FFW system will be the provision of local forecasts by WRD, i.e. the translation of regional forecasts by CWC into clear and easily understandable warnings at the village level. Local communities will be centrally involved in this process. The Project will work with CWC and IMD regarding FFW.

[28] The drainage of floodwaters from the area protected by the West Brahmaputra Bund is currently impeded by the lack of sluices through the embankment. The proposed sluices will improve post-flood drainage.

Figure 40: Continuous Attack on the River Bank may Cause Breach on the Dyke



5. Changes in Water Levels

Operation Phase

151. **Impacts.** The proposed works will have no significant effect on flood levels in the Brahmaputra River considering the scale of the proposed riverbank protection and porcupine screens against the total width of river channels including the chars near Bokunwal, which in total is about 12 km. The hydraulic conveyance of this section is so great that the loss in additional flood storage associated due to the proposed works, will have no significant effect on flood levels.

6. Effect on Flow Velocity/Discharge Intensities

Operation Phase

152. **Impacts**. Recognizing instability and unpredictability of the Brahmaputra River, clearly two different scales need to be distinguished in studying effects of flow velocity and discharge changes: (i) the total river cross section, several kilometers in width, and (ii) the cross section of the near bank channel, typically below one kilometer in width. Limited interventions along the bank will not change the cross section's average flow velocities in alluvial rivers. Areas of faster flow are compensated through areas of slower flow and lower discharges, which on average cancels 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.

153. However, a different case is when flow concentrates on the channel along the protected bank due to revetment with apron and slope pitching made geobags. Revetments lead to a moderate local increase in near bank flow velocities, as the river is guided along a fixed boundary. This is commonly reflected in local scouring along the bank and deepening of the channel after construction of riverbank protection. The present level of understanding does not allow quantifying this increase in general terms. Experience with the lower Brahmaputra indicates that there is no

significant increase and flow velocities are in general well below the depth averaged design velocity of 3 m/s, even though in some cases spikes surpassing 4 m/s at the surface could be measured. As the same order of magnitude of flow velocities also occurs at natural nodal points, no negative effects on wildlife, especially fish are expected. Locally, in the immediate vicinity of the bank, riverbank protection provides a more favorable environment to fish than unprotected banks. While the smooth eroding underwater slopes do not provide any shelter, voids between the larger riverbank protection elements have a demonstrated positive effect on the number of fish.

154. In case of porcupines, the flow velocities are retarded and sedimentation is encouraged. Slow flow velocities do not have a negative effect, as the areas of low velocity are comparable to areas of active creation of in-stream channel bars (chars or chaporis). This happens regularly all over the river.

155. **Impacts from Upstream Development Works.** 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 Kaziranga 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 Brahmaputra River. The impact of this reduction in sediment inflows on main stream channel cross-sections and flood behavior in the Kaziranga Reach is difficult to predict, but any effects are likely to lead to a reduction in flood levels.

156. **Mitigation Measures**. Flow velocity changes along the bankline 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.

7. Effects on River Morphology

Post- Construction / Operation Phase

157. **Impacts.** 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 revetment made of geobags and anti-erosion porcupines along the Dhansirimukh to Agaratoli will reduce bankline erosion. In addition, porcupines tend to store sediment and re-mobilized during higher discharges. This storage and release follows the normal river regime where sediment gets mobilized mainly during the higher discharges of the flood season, with little transport during the drier months. Both measures further reduce turbulences and the impact on the currents as opposed to spurs, which actively deflect the currents, and consequently 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.

158. **Mitigation Measures.** To avoid downstream riverbank erosion, the subproject places 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 unstable pattern of constantly changing in-stream channel bars, locally called, chars or chaporis. Fluent and adaptive land use patterns of char land will continue in future. The subproject will continue to implement systematic annual platform analysis and prediction, 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.

159. In case unexpected downstream effects are observed, the subproject concept allows later rectification within the concept of adaptive approach through FREMAA.

8. Impact on Silt Deposition

Post construction/Operation Phase

160. **Impacts.** Brahmaputra river is one of the most heavily sediment charged river carrying an average annual suspended load of 400 million metric tons. During flood events the inundated area gets heavily silted due to this high sedimentation load in the river. In the past flooding scenarios, such as in 2004, it was observed that there were sand depositions on good agricultural lands associated with embankment breaches. The deposition of sand with low organic content leads to reduction in soil productivity. Breaches in embankments during flood constitute the major factor in large-scale deposition of sand-sized coarse sediments i.e. sand-casting in the riverine tracts of Assam. The bank stabilization and strengthening of the embankment system in the Kaziranga Reach would prevent deposition of silt over the land which used to get flooded, leading to improvement in productivity of soils. This will help in supporting the agriculture land as about 26.2% of land in 8 km buffer around the embankment is used for agricultural activities.

161. On the other hand, there will be induced silt deposition along the riverbanks induced by pro-siltation measures such as porcupines in selected areas depending on the local flow and channel conditions. However, this does not alter the unstable pattern of constantly changing in- stream channel bars within the river area.

162. **Mitigation Measures.** The pattern of silt deposition in the river and areas adjacent to the bank especially near anti-erosion and river training works will be monitored at regular intervals and necessary changes regarding the mitigation measures taken accordingly. The risk of breach is reduced from the sub-project intervention.

9. Effect on Drainage System

Post construction/Operation Phase

163. **Impacts.** Effect on the natural drainage system cannot 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.

164. **Mitigation Measures.** Provision shall be made to the extent possible not to obstruct the natural drainage lines from discharging into the Brahmaputra. 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. The operation of the sluice gates are intended to alleviate drainage congestion in the sub-project area.

10. Effect on Wetlands/ Beels

Post construction/ Operation Phase

165. **Impacts.** The Shohola beel is one of the important wetlands of Kaziranga Subproject area located between Moriaholla and Dhansirimukh. This beel is located towards the riverside of the embankment. No direct impact is anticipated on this beel due to the Kaziranga sub- project activities. There are many other wetlands in the study area, but most of them are on the riverside or in Kaziranga National Park area and are not likely to be affected by the project activities.

11. Water Quality

Design and Construction Phase

166. **Impacts.** The construction of sluice gate 16/1 at Ch 16080 and upgrading of the embankment between Ch 14600 to 16000 will affect the water quality of the nearby beel and downstream river that drains the beel (see succeeding Figure). The water quality of these water bodies will deteriorate due to siltation from the re-formation of the embankment and the construction of the RCC sluice gate. Threat from oil and grease contamination is also possible from earth moving and other construction equipment. Field observations during the environmental impact assessment and discussions with the KNP officials indicated this beel is not being used by wildlife for wallowing or drinking due to the installed electric fence along the park side. Increase in suspended solids downstream of the sluice gate and embankment construction site will affect water users downstream that included irrigation and to a certain extent fishing activities.

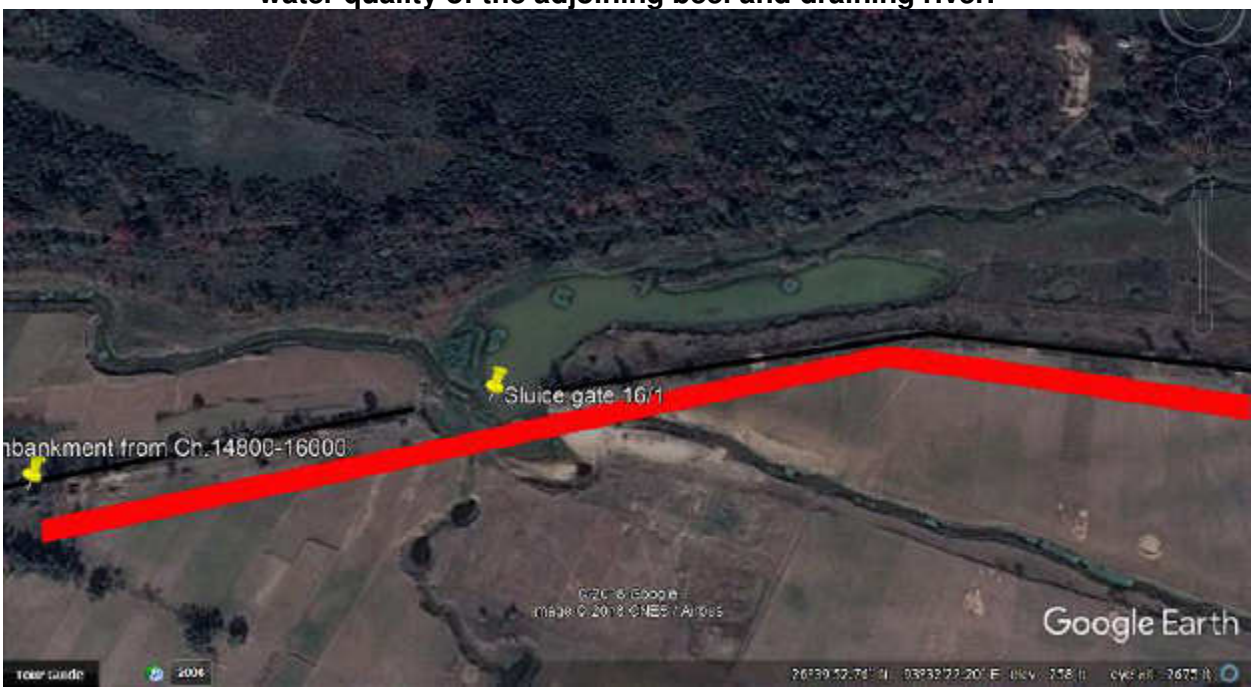
167. Another source of water pollution during project construction phase will be sewage and wastewater generated from labor camp. The project will last for 2 years to complete the aggregated 3.775km embankment works, 3 new sluice gates construction, 4 kms bank protection works, and porcupine guide screens of different lengths on a 10 kms river reach. These will not require a large construction and labor camp and at most 75 persons maximum at any given time. Wastewater is expected around $7m^3$/day, although this is small volume the risk of surface and groundwater contamination from improper management exist.

168. 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. Ground water is easily available in 5 m BGL even during the lean periods. 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.

169. **Mitigation Measures**. To minimize the potential water quality impacts on the adjoining beel and downstream river, construction activities in this location shall be limited during dry season only when the beel is dry or at its minimum level. Siltation screens will be installed along the construction site and immediately downstream of the beel to minimize impacts. Coordination with the KNP officials to monitor the impacts on wildlife due to construction activities and immediately inform the contractors and the FREMAA to implement additional mitigations measures when needed.

170. To minimize the need for construction camps, preference shall be made hire local labor and used several yet small existing houses as temporary labor camps. 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 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.

Figure 41: Construction of the Sluice Gate 16/1 creates potential adverse impacts on the water quality of the adjoining beel and draining river.



Post Construction/ Operation Phase

171. After completing the construction works, the facilities will be handed over to the local communities. For facilities that will not be used by the communities, the contractor will have to dismantle and rehabilitate the areas.

12. Climate

Design and Construction Phase

172. **Impacts.** Climate models[29] agree that there is a potential for intensifying "hydrological cycle, leading to more intense precipitation with associated changes in the intensity, frequency and severity of floods." Empirical relationships between the basin averaged rainfall wet spell (storm) properties and the characteristics of the floods are formulated for storms which lead to significant short-term flood response and concluded an increase in the number of spells with higher rainfall and longer duration which can lead to increase in peak flood and the total flood volume in the Brahmaputra Basin.[30]

173. The Brahmaputra, being the highest specific discharge river system in the world, experiences several annual long-duration flood waves during the monsoon season. Using a macro-scale distributed hydrological model (DHM) calibrated and validated for 9 wet years to assess the flood characteristics of the basin, indicated a significant increase in both peak discharge and flood duration is expected for both the pre-monsoonal and monsoonal seasons in the basin, but the number of flood waves per season would be reduced. Based on the projected climate change scenario, it is expected that there will be more catastrophic floods in the basin.

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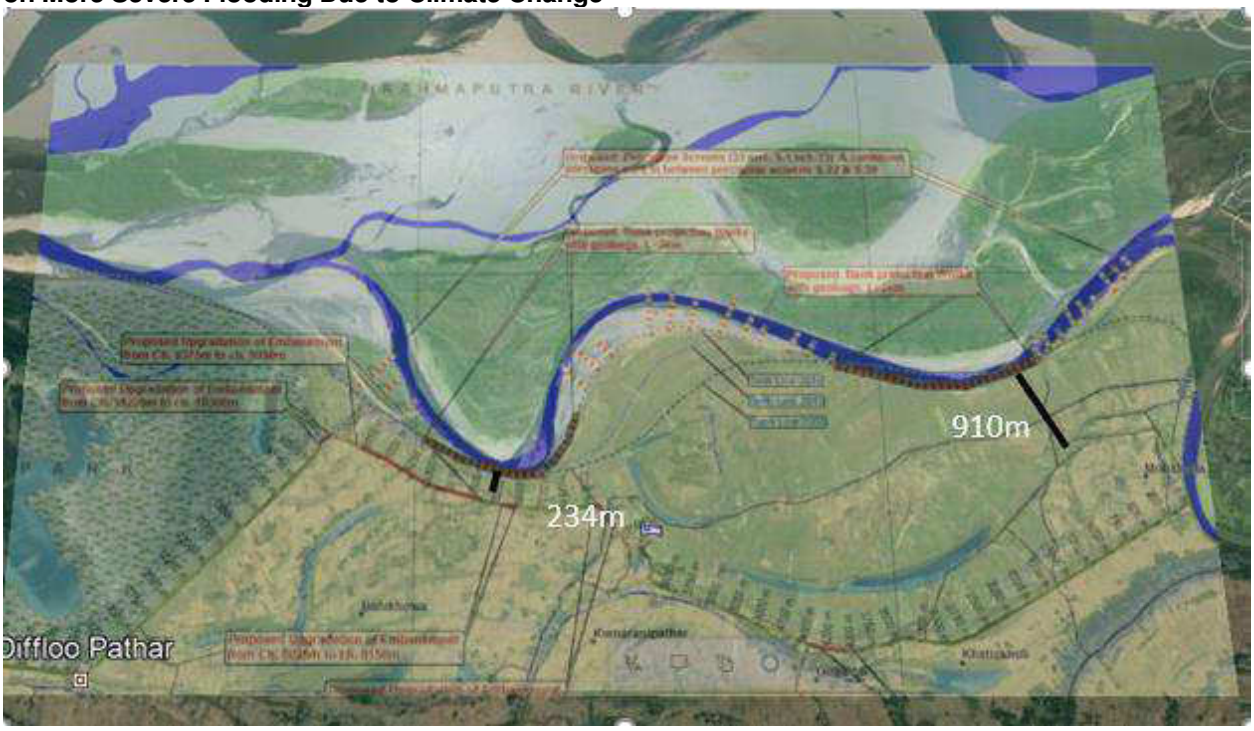
[29] Coupled Model Intercomparison Project (CMIP5), for the first time, provides 10–30 years predictions obtained from the General Circulation Models (GCMs). https://www.sciencedirect.com/science/article/pii/S0022169415003157

[30] Impact of climate change on floods in the Brahmaputra basin using CMIP5 decadal predictions.

174. The increase in frequency of extreme flooding exposes the sub-project area to higher risk of damage resulting to loss in life and property. Increase risk of embankment breaching and more intense attack on the river bends in the Dhansirimukh could have devastating effect on the KNP wildlife if they are caught in these floods as the highland corridor with the Karbi hills are inundated.

175. **Mitigation**: The civil works proposed under the subproject specifically address these climate change vulnerabilities of the subproject area including the KNP. The revetments in two areas along the Dhansirimukh-Agaratoli reach fortifies the river bends under erosion from the Brahmaputra river while the porcupine screens intend to promote sedimentation along this bank to increase the separation distance between the bank and the Brahmaputra river channel as provided in the succeeding Figure which overlays the proposed works with the existing riverbank situation. The most vulnerable sections of the embankment are along the river bends that are only 234 m and 910 m from the Brahmaputra river. The predicted increase in flood severity may increase erosion and therefore the vulnerable bends need to be reinforced while gaps and weakness in the existing dyke will be addressed in this project.

Figure 42: Existing Riverbank Erosion May Increase Threat to the Existing Embankment System Based on More Severe Flooding Due to Climate Change



Operation Phase

176. **Mitigation.** The civil works proposed under the project are considered as climate change adaptation measures. Although these adaptation measures will reduce vulnerabilities to climate change, they have inherent limits and are not designed to resist all future floods. The embankments, designed to survived 1:200 flood return periods, will be overtopped if designed high flood levels are exceed. The sub-project will pursue non-structural flood and river bank erosion measures that will enhance the ecosystem and human resilience to predicted impacts of climate change. These non-structural measures include: Land Use Guidelines, Building and Development Guidelines, Flood

Forecasting and Warning, Flood Emergency Planning and Management, Community-Based Flood Risk Management (CBFRM), and Flood Education.

13. Air Environment

Design and Construction Phase

177. **Impacts.** The ambient air quality of the area is good with baseline levels of SPM, RSPM, NOx, SO2, Pb, and CO are lower than prescribed NAAQS for rural areas. While various construction activities will deteriorate the ambient air quality within the immediate vicinity of the construction sites, these are short term and co-terminus with the construction activities.

178. 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. Dust emissions become crucial on embankment segments where many residents have established their residents along or on the embankment.

179. 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 12.

180. **Mitigation Measures.** Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing road. Water will 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.

181. The following mitigation measures will also be taken to mitigate the dust entrainment and fugitive emissions from the various sources in Kaziranga 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 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 will be carried out in all sensitive receptors should to include schools, health centers, government institutions, and residential areas within 300 meters from all construction sites. Weekly monitoring of PM10 and PM2.5 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. Fabrics and plastics for covering piles of soils and debris is an effective means to reduce fugitive dust from the material stores/ warehouses.
(viii) Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled materials do not become a source of fugitive emission.
(ix) 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.

(x) All slopes and embankments will be turfed as per best engineering practices to help minimize the dust generation during operation of the road.
(xi) Plantation along the embankment should be maintained.

Post construction/ Operation Phase

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

183. **Mitigation Measures**. Emissions from motor vehicles is under the jurisdiction of the Assam Transportation Department which requires Pollution Under Control certificates prior to registration. These certificates are issued based, among others, the ability to meet tail pipe emission standards.

14. Noise

Design and Construction Phase

184. **Impacts.** During construction phase, noise will be generated from various activities such as site clearing, excavation, and ground shaping. The general noise levels during construction phase from heavy earth moving equipment and machineries may reach 100 dB(A) at the work sites.[31] This is higher than the prescribed World Bank Environment Health and Safety guidelines that no worker should be exposed to a noise level greater than 85 dB(A) for more than 8 hours without hearing protection.

185. As a worst-case scenario considered for prediction of noise levels during construction phase, noise energy levels coming from various sources were added in a single point and estimated to reach 100.3 dB(A) at a distance of 1 m and attenuates to 52.4 dB(A) at a distance of 250 m from the sources. The predicted levels are presented in the succeeding Table.

Table 35: Increase in Noise Levels due to Operation of various Construction Equipment

Distance (m)	Ambient Noise Levels dB (A)	Increase in Noise Level dB (A)	Increase in Ambient Noise Level 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

186. Predicted ambient noise levels are above the WB EHS daytime guideline value of 55 dB(A) within 200 meters distance from the construction site. In addition to the above, 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,

[31] 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/Trucks (82-94), Concrete mixers (75-83), Concrete pumps (75-83), Concrete pumps (81-83), Cranes (movable) (75-86), Vehicular Traffic (construction material &plant & 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).

the increase in vehicular movement is expected to increase up to a maximum of 40 to 50 trucks/ hour.

187. 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 provided in the succeeding Table.

Table 36: Increase in Noise Levels due to Increased Vehicular Movement

Distance (m)	Ambient Noise Levels 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**

188. During construction phase, increase is expected to be between 25 to 30%. However, the increase in noise levels will be localized, temporary in nature and will occur during daytime only. Utmost care to be taken to reduce noise during the construction of sluice gate the wetland and works to be executed under the monitoring of park management. Good practices are shown in Appendix 21.

189. **Mitigation Measures.** Following noise control measures shall be adopted, and included in the civil work contracts:

(i) Site Controls: Stationary equipment shall be placed along un-inhabited stretches
(ii) 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 150m (Category C) and 250m (Category D), to minimize objectionable noise impacts.
(iii) If the natural attenuation is not adequate to meet National and WB EHS guidelines, the contractor will modify construction equipment schedule and installation of enclosures around the noise generating equipment and activities.
(iv) 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.
(v) Protection devices (ear plugs or ear muffs) will be provided to the workers operating near high noise generating machines.
(vi) Construction equipment and machinery shall be fitted with silencers and maintained properly.
(vii) Noise measurements shall be carried out along the reach as well as in nearby villages, to ensure the effectiveness of mitigation measures.
(viii) Use of manual labor will be promoted.

Post construction/Operation Phase

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

191. **Mitigation Measures.** Adequate signage shall be provided restricting use of pressure horn particularly in noise sensitive locations particularly near schools, hospitals and populated areas etc.

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 in air environment mitigation measures.

15. Terrestrial Ecology

a) Disturbance to Vegetation

Design and Construction Phase

192. **Impacts.** A total of 1,480 trees on both sides may be affected. Final number of trees will be determined by the District Forest Office.

193. The areas between coordination of N: 26°07'58" E: 91°01'04" and N: 26°07'58" E: 91°20'52" supports comparatively very good vegetation along the riverbank of the proposed project area which may be cleared due to construction activities.

194. **Mitigation Measures.** Efforts shall be made to minimize the tree loss. Provision shall be made for planting 3 trees for every tree cut. Plantation program will be implemented in tandem with the construction schedule and in coordination with the KNP officials. The plantation program will use only the local species. The native and existing vegetation profile shall be maintained during plantation program, so that local inhabitants can utilize their resources. The indigenous plants shall be preferred.

195. Part of the contractor's responsibility is to minimize vegetation clearing along the river bank stretches where the revetment and porcupine screens will be constructed.

Post construction/Operation Phase

196. No direct impact is anticipated during operation stage.

b) Habitat Fragmentation and Destruction

Design and Construction Phase

197. No habitat fragmentation is envisaged due to the project activities in this reach. No new embankment will be constructed under the subproject. The construction of the 3 new sluice gates will be built across existing channels and depressions. The nearest wildlife wallowing sites to the embankment where works will be undertaken are located near Agoratali and Mahkhuti area with coordinates 26° 36' 48 N-93° 27' 26 E, which is about 600m away from the 100m stretch embankment upgrading and will not be affected.

Figure 43: The Nearest Wildlife Wallowing and Drinking Beel to the Project Area

16. Animal Distribution/Migratory Route

Design and Construction Phase

198. **Impacts.** At Bankoal Bali Sapori with coordinates: 26° 41' 56" N-93° 44' 23" E, and 26° 42'N, 93° 41'E; 26° 42'N, 93° 35'E dolphins were observed surfacing particularly during rainy seasons and tend to converge in the deeper channels during low flow season. The construction of geobag revetment and launching of porcupine screens may affect movement of dolphins.

199. The rhino and wild buffalo wallow in the Mahkhuti Beel is about 600 meters away from the construction site and beyond the noise and dust impact areas, where predicted levels may be higher than baseline. No adverse impacts on the wildlife movement expected.

200. **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.

Post construction/Operation Phase

201. No impact is anticipated during operation stage with regards to animal distribution and migration.

17. Endangered Species

Design, Construction, and Operation

202. **Impacts.** Due to the sub-project's proximity to the KNP, potential impacts may be attributed during the construction phase with the parks more than 40 globally threatened species, and 31 endangered mammals. Impacts include disturbance of wildlife movement due to noise and dust, siltation of water bodies that serves as wallowing and source of drinking water, and the exacerbation of flood levels and duration during the construction and operation of the sluice gates.

203. During construction laborers may poach wildlife near the construction site despite of strict prohibition by KNP authorities.

204. During sub-project operation, providing improved flood security in the Bokhakat area will induce in-migration and could increase human-wildlife conflict. This is particularly significant as the sub-project is near the Kaziranga Tiger Reserve and discussions with the Forest Officials that several poachers caught resides or gains access through the Bokhakat area. The operation of the sluice gates may prolong the flood duration on the KNP if the surface runoff is not allowed to pass through

205. **Mitigation**. There will be no works or physical activities of the subproject located inside the KNP. The emergency works on six locations and the construction of 3 sluice gates along the Brahmaputra Dyke will confined within 20 meters from embankment toes and anticipated impacts will be short-term and coterminous with the construction phase of 2-years, and site-specific. No aniticipated impacts are considered significant adverse or unprecedented. No potential loss of threatened and vulnerable species due to increased risk of flooding on the KNP side with the operation of the 3 sluice gates was identified. The Kaziranga Reach, including the KNP is subjected to periodic flooding. Annual flooding is important to KNP as it rejuvenates the unique eco-system of grassland, swamps and ponds which in turn sustain large population of rhinos, elephants, deer, wild buffaloes, tigers, and leopards. The KNP is the largest undisturbed and representative area in the Brahmaputra valley floodplain. It was declared a heritage site because of its unique habitat shaped by the flood pattern that is covered by wet alluvial tall grassland interspersed with numerous broad shallow pools fringed with reeds and patches of deciduous to semi-evergreen woodlands. However, extreme floods have resulted to wildlife drownings and in 2017 the KNP lost 361 animals, including 31 rhinos. Between 2002-2017, 130 rhinos drowned and perished. Wildlife lost was not limited to rhinos, the 2017 floods also killed 9 elephants, 282 hog deer, 1 tiger, 16 sambar deer, and 8 buffaloes. The same flooding affected more than 1 million individuals in 1,700 villages of Golaghat District. The construction and operation of the sluice gates will have insignificant impact on the animal movement towards higher grounds of the Karbi Anglong hills to take refuge during flood season. The sluice gates are not located in known wildlife corridor that connects the KNP with the Karbi Anglong Landscape. The operation of the sluice gate will be able to alleviate floods on both sides of the embankment, i.e. when flood levels are higher inside the dyke, the sluice gate will allow waters to exit towards the KNP and drain around dyke towards NH-37 and Goshanibar and finally rejoining the Brahmaputra west. When flood levels are higher on the KNP side of the embankment due to high rainfall, the sluice gate will be operated to drain waters towards the Geelabeel River. The joint operation of the sluice gates by WRD and KNP will be crucial. These agencies have partnered to establish three watch towers to monitor among others, the flood level and advice the WRD on the operation of the sluice gates. The construction of sluice gate 16/1 could pose impacts on the water quality of the adjoining beel and draining channel. Deterioration of water quality due to increase in suspended solids are easily mitigated through the timing of construction activities to coincide with dry or low flows and installation of silt screens.

206. No wallowing areas inside the PA will be affected by the sub-project.

207. FREMAA has partnered with the KNP authorities to install 3 watch towers and a camp near the sub-project boundary to deter future encroachment and poaching. Under the sub-project these structures will be constructed complete with needed monitoring cameras and communication while the KNP will provide the necessary staff. These watch towers will also allow the KNP and FREMAA to monitor animal movement during flood conditions and ensure proper operation of the sluice gates. Figure 46 and Figure 47 provide the photographs of the watch tower and camp.

208. Working hours will be limited during daytime only and under the supervision of KNP officers to deter poaching and ensure proper conduct of laborers. Any laborer caught poaching or gathering protected species inside the KNP will be penalized in accordance with the Wildlife Act and on conviction, the penalty for hunting is imprisonment for a period ranging from a minimum of three to a maximum of seven years with fines not less than 10,000 rupees.

Figure 44: Photographs of the Sluice 16/1 Site Showing the Beel and the Neighboring Agricultural Land Use

18. Aquatic Ecology

a) Effect on Fishing Activities/productivity

Design and Construction Phase

209. Impacts. Temporary flushing of fish towards the deeper part of the river may occur during construction of bank line protection measures. The construction of spurs and deflectors 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 in the area has adapted to the high turbidity of the Brahmaputra River and no impacts are expected. Special care should be taken to keep the identified breeding areas of Dolphins undisturbed. There are three dolphin sites located at Moriaholla and Dhansirimukh area as identified in the succeeding Figure. Two are located upstream the project area and therefore no impacts from the project are expected.

210. Fish landing areas will be temporarily disturbed during the installation of porcupine screens which can result to loss in income to the fisherfolks.

Figure 45: Locations of Dolphin Sightings along the Kaziranga Reach

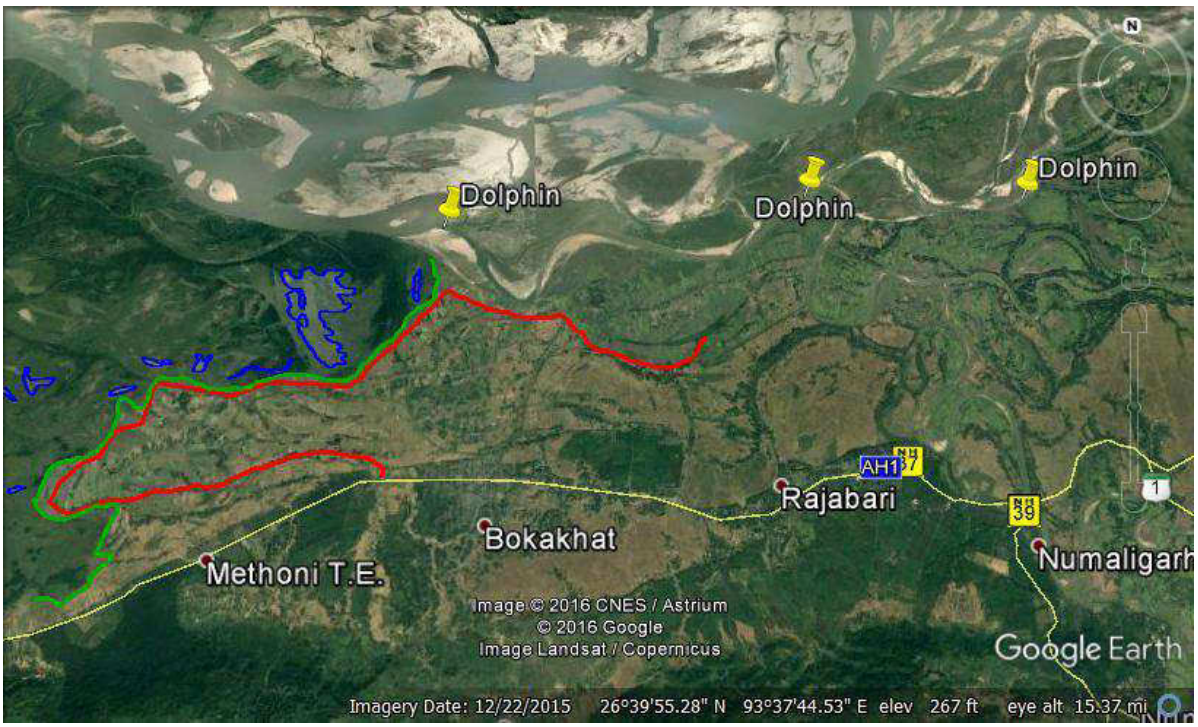


Figure 46: Photograph of a Watch Tower Designed by the KNP to be Constructed under the Sub-Project

Figure 47: Photograph of a Camp Designed by the KNP to be Constructed under the Sub-Project

211. **Mitigation Measures.** Adequate provision shall be made in the design to ensure access to the fish landing site/Boatghat. Adequate requisite facilities shall be restored or maintained for undisturbed movement of the fishermen. The provision of sanitary facilities with grease trap to collect waste oil shall be provided at fish landing site/ boatghat to prevent contamination of river water especially at boatghat which is also the fish breeding site.

212. As dolphins were seen in 3 sites along the Kaziranga reach and one may be affected by the sub-project. Construction activities shall not be allowed during breeding seasons which spans from May to August. About 2km section around the identified Dolphin site will be designated as sensitive area. 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 that channel is not obstructed in any way. Civil work contract documents will specify these requirements, including the regular monitoring by an environment expert from the subproject implementation office.

Post construction/Operation Phase

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

b) Animal Distribution/Migratory Route

Design and Construction Phase

214. **Impacts.** The migratory fish species like Tor and Anguilla were encountered in the Kaziranga reach which show anadromous and catadromous migratory behavior, respectively, migrating through the main channel of the river through the deeper zones of the river. The construction of the dyke will not have any negative effect on the migratory route. Other fish species like *Crossocheilius, Tor* show only local migration from upper to lower reaches of the river and will not be affected. Dolphin breed during monsoon between May to August may be affected as it is sensitive to polluted water and any obstruction of the channels at this stage may disturb the breeding activities. They move in to the deeper channels in winter.

215. **Mitigation Measures**. The construction activity should be restricted during the breeding period of May to August at Dolphin movement sites. 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 that channel is not obstructed in any way. Civil work contract documents will specify these requirements, including the regular monitoring by an environment expert from the subproject implementation office.

19. Effect on Spawning and Breeding Grounds

Design and Construction Phase

216. **Impacts**. The breeding habitat on the riparian zones must not be disturbed. Heavy silting because of construction activities which would result in high turbidity should be avoided. During monsoon particularly at high flood level, fish and other vertebrates breed in the shallow marginal areas of the river bank and may be disturbed during project construction particularly the free migration of fish brooders and juveniles from the river to the beel and vice-versa.

217. **Mitigation Measures.** The construction activity should be restricted during the breeding period of April to August particular near the Bankoal Bali Sapori area. All care shall be taken to ensure that construction waste does not find its way to water in this area and pollute it.

Post construction/Operation Phase

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

20. Socio Economic

c) Demography

Design and Construction Phase

219. **Impacts.** The establishment of construction camps that will add to the population of the sub-project temporarily. 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.

220. **Mitigation Measures.** 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.

221. All water, electricity, transport, and waste disposal requirements of the camps will be provided by the contractor and ensure existing supplies and utilities are not affected. Prior clearances and permissions from the panchayats will be secured by the contractor.

21. Archaeological Sites to be Impacted

222. No archaeological sites will be impacted due to the proposed construction of river embankment along the Kaziranga reach

22. Places of Pilgrimage and Tourism to be Impacted

223. There is no pilgrimage spot along the Kaziranga reach. KNP is a world famous tourist area however, the location of the subproject activities and structures are located along the boundary and therefore no adverse impacts are expected to affect tourist activities. A beneficial impact of the project to the tourism industry is the reduction of flood and erosion risks which can drastically affect the subsector if a breach takes place resulting to inundation.

23. Sanitation

Design and Construction Phase

224. **Impacts.** Most of the residents do not have sealed latrines to dispose human excreta. A number of people uses the river and its banks as open toilets and the upgradation of the embankments particularly during construction phase will disturb this practice.

225. **Mitigation Measures**. The contractors shall construct public latrines on areas where the community practices open defecation particularly along the river.

24. Socio-Economic Impact - Land Use

226. Unplanned development, encroachment of the embankment, tree plantation on the embankment may affect the stability of the embankment. This will be mitigation by preventing

uncontrolled and unplanned development. Awareness will be created amongst the people for the upkeep of the embankment.

25. Accidents and Safety

Design and Construction Phase

227. 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. This can be mitigated by adequate lighting and signage shall be provided at the construction sites. Signage shall be made in local language. The 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 checkup camps shall also be organized every year.

Operation Phase

228. Due to improved road condition, drivers may have tendency to drive fast on embankment road resulting in accidents. To mitigate the impacts, 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.

26. Navigation

Design and Construction Phase

229. **Impacts.** This river section is navigated by people for moving to one place to another located at river bank and moving to char lands for fishing and farming. They use small motor boats and fish landing sites or boat Ghats for these movements. There are various fish landing sites in this sub project area. These landing sites could be temporarily disturbed due to project activities. No impacts are expected on the general navigability of the river due to the project since project activities are limited mostly on river bank and immediate reach.

230. **Mitigation Measures**. During construction, contractors will 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.

VI. Information Disclosure, Consultation, and Participation

A. Public Consultation nd Participation

231. Meaningful consultation with affected people were carried out, and the consultation processes are appropriately documented in thi report. The study team ensured 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.

232. 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, 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 Kaziranga reach.

233. During the 2007-2009 environmental impact assessment, two 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 on 4 villages in Sept 2007. This was followed by more detailed surveys in 12 villages out of 119 villages in the subproject area. The survey included one village in char land and another village outside of the subproject area using focus group meetings (FGMs) and participatory rural appraisal techniques. Furthermore, surveys on most vulnerable people were conducted in 13 villages through focus group meetings. 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.

234. The second state workshop was conducted in February 4, 2009 at the Brahmaputra Hotel in Guwajati organized by the WRD, Government of Assam and the 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.

235. In the preparation of this IEE, 5 public consultations were carried out on: 13thFebruary 2015, 9thNovember 2015, 8th February 2016 (2 nos) and on 10th November, 2016. The consultations with villagers in the fringes of Kaziranga reach discussed the 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 consultations, several visits were made in the fringe villages to assess the implication of program on social and environment aspects in July 2015. Official public consultation were carried out in the affected villages of Japoripothar, in Kaziranga Sub Project Reach on 9th November 2015 and on 8th February, 2016 in another schools in Tamulipathar. List of consulted persons with their signature and contact number in Appendix 14. Again on 9th November 2016 people along the embankment and Range Officer of Eastern Range of Kaziranga National Park, Agoratoli were consulted.

236. As part of the subproject implementation, future public consultations are also envisaged. 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.

B. Information Disclosed

237. The EIA report 2009 and this IEE report are disclosed in ADB and FREMAA websites. Hard copies of these repors are available to interested parties at the FREMAA and SIO Kaziranga offices upon request. The 2009 EIA report was submitted to the MoEF&CC to obtain the environmental clearance.

238. The information disclose during public consultations serves to initiate discussions and receive key inputs from the participants on their concerns about the potential environmental impacts of the subproject. Issues were discussed in depth with the government officials, NGOs, and concerned villagers. Information shared included 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.

239. The information provided during the public consultation with the stake-holders were focused on the following points:

(i) Problem(s) related to environment due to 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 and Redressal Mechanism
(vi) Cooperation during execution of the work

240. Impacts on flora and fauna were discussed in detail with the officers of the forest department including air and noise pollution due.

241. The consultations covered key aspects of the environmental assessment to include 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.

242. The state-level workshop were summative in nature focused on study findings and key recommendations. The first workshop discussed 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 FIREARM Assam, social impact assessment and safeguards, and environmental impact assessment. After the workshops, press briefings were organized with the circulation of the executive summaries. The presented materials at the workshops are posted in the ADB website.

C. Major Comments Received

243. A wide range of stakeholders from different administrative, social and economic backgrounds were consulted and these are summarized in the succeeding section.

1. The Concerns of Local Stakeholders

244. The project received unanimous support and consent from all local people. The dominant 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.

245. People welcomed the initiative of the Government of Assam for strengthening the embankment and providing revetment on the riverbank as many of them were inundated during 2004 flood and recently in 2015, 2016. 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.

246. The local stakeholders were especially supportive of the subproject and its objective reduce the flood damage and protect land from erosion and ultimately socio-economic development of the region. The local people did not perceive any adverse impact resulting from the implementation of the proposed civil works. A few people expressed concerns on the weakness of the present embankment and are prone to overtopping and breach causing inundation of their houses and paddy fields.

247. Local people also highlighted the erosion due to Dhansiri flood and emphasized on protection of Bankoal - Moriahola area along with KNP. They also highlighted that it will have beneficial impact on their agriculture land. Cropland depredation was one of the concern of the villages by the elephants and buffalo and pigs

2. NGOs' Concerns

248. There are limited NGOs' active in the project area that focuses on environmental concerns. Most of the NGOs deals with flood relief works. All the NGOs' consulted welcome the flood control project and its potential of protecting agricultural land, domestic animals, and fishermen communities. They also mentioned the importance of maintaining the natural drainage system and increasing forest cover through afforestation program. Dr Sanjay Hazarika of CE-NES also indicated the need of enhancing institutional capacity and strengthening review mechanism:

(i) 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.

3. Local Officers' Concerns

249. Dr. Baruwa from Environmental Council of Assam raised his concern of arsenic leaching into groundwater 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 ground water samples taken in Kaziranga reach revealed very low

arsenic content in river water as well as ground water and the water quality were found well within the desirable standards as per IS 10500:1991.

250. Mr. BirenThukuria (EE, WRD) highlighted need to study the impacts 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.

251. 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.

252. 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 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,

253. The interaction with Chief Conservator of Forests, Forest Development Department and Head Assistant of the CCF office provided useful suggestions on possible intervention of proposed project on Forest and Wildlife. No specific suggestion or comment was made with respect to Kaziranga reach as no protected area inside the subproject 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. Afforestation is needed if there is any loss of tree species during project intervention and at least three plants must be planted in place of one such tree cut during project intervention. For afforestation program, bamboo, simul trees and banana plants must be planted along the side of embankment. These trees have no side roots to destroy the embankments. In the borrowing sites, water resistant plants such as Salix tetrasperma, Buwal and Panihizol should be planted.

254. Range Officer suggested the details of the labors used under construction to be submitted to Range Office to monitor against illegal hunting and gathering of wildlife. He suggested the issuance of identity cards to the workers for spot checking and verification. Patrolling the embankment will be regularly conducted by the Forest Department to deter human-wildlife conflict. All the wallowing areas are inside the park boundary but the installation of CC cameras will be helpful. No invasive species will be introduced in the park.

255. The details of formal and informal consultation held with various stakeholders with outcome is summarized at Appendix 14.

D. State Level Workshops

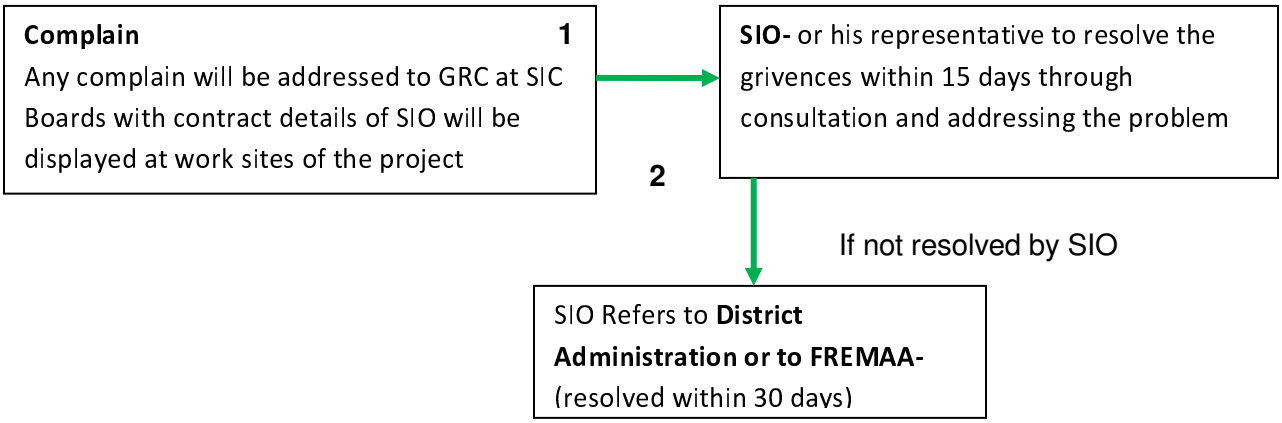
256. Public consultations were conducted with the stakeholders during the two state workshops, which were held in the months of December 2007 and June 2008 in Guwahati. Taking into consideration the environmental importance of the subproject, several environmental NGOs were invited during these state workshop but limited participation was noted. The list of delegates and invitees of the workshops held during December 2007 and June 2008 have been kept with the Water Resources Department.

257. During the workshops most of the delegates and NGOs present in the workshops expressed support to the project. Similar issues were raised that included: (i) wider implications beyond the subproject areas should be assessed including downstream hydrology and sediment transport, impacts of global climate change; (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.

VII. Grievance Redress Mechanism

258. A grievance redressal mechanism initially developed under the PPTA was further enhanced through discussions with affected communities resulted to the proposed set-up as presented in the succeeding Figure. A Grievance and Redress Committee (GRC) will be constituted at SEIU level composed of the SIO, representatives from the panchayat/ municipality, local NGO, and affected people including women and vulnerable groups. The GRC will continue to function after the implementation of the sub-project. Disputes and complaints relating to the sub-project implementation will be resolved at SIO level within two to four weeks from the date of lodging the complaint. Outstanding issues not resolved will be referred to District Administration or to FREMAA for final decision.

Figure 48: Working principle of GRC



VIII. Environmental Management and Monitoring Plans

259. The aim of the Environmental Management Plan (EMP) is to ensure the effective implementation of mitigations and enhancements measures. The EMP describes specific measures that will be implemented by the contractors during project construction stage under the supervision of FREMAA. Measures to be undertaken during operation phase will rely on existing institutions like the FREMAA and WRD. A companion of the EMP is the environmental monitoring plan that allows the implementing agency calibrates the EMP to ensure impacts are properly mitigated. The EMP also ensures that the positive impacts are conserved and enhanced.

A. Environmantal Management Plan

260. 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.

261. The major components of the Environmental Management Plan 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

262. The Environmental Management Plan is detailed at Appendix 15.

B. EMP Implementation Timetable

263. The different sets of mitigation and enhancement measures were designed during construction and operation stages. The implementation schedule has been prepared considering 24 months of construction phase starting from year 2018-2020 and operating phase of 30 years.

C. Contingency Response Plan

264. Two contingent events were identified the sub-project needs to prepare response plans; road crashes along the embankment during and a breach and/or overtopping of embankment that will cause catastrophic inundation. Emergency response to road crashes along the road embankment are already in place with the local police and health centers taking responsibilities.

265. Improved flood forecasting and warning by the WRD to communities is one of the components of this Project to be developed during Year 1 of implementation. A variety of national (CWC, IMD), State (WRD, Revenue and Disaster Management Department) and local government (deputy commissioners of district administration) agencies participate in the flood forecasting-warning process in Assam. The crucial element of this process is the provision of timely and accurate warning of villagers about an impending flood. Discussions to date indicate that most villagers receive no formal flood warnings. They generate their own warning by watching the river during the flood season and intensity of local rainfalls. Currently, the WRD assigns officers at 5 km intervals to patrol the embankments, measure flood levels and report back to the flood control center. These front-line observers are trained to provide effective and accurate local flood warnings with levels meaningful to villages along their respective 5-km sections of embankment.

D. Partnership with the KNP Authorities

266. Three potentially adverse impacts of the subproject. First is the unanticipated downstream river morphological effect of the of the revetment and porcupine screens needs to be monitored. Second, the operation of the sluice gates to alleviate flood congestion, particularly under extreme climate events, could cause longer flood duration on the KNP. This condition may occur particularly when the Bokhakat settlement area is flooded with runoff waters from the higher elevation area if the KNP will be restricted to flow towards the Geelabeel River on the east towards the other side of the Brahmaputra Dyke. This situation could, to a certain extent, affect wildlife migration towards the Karbi-Anglong Hills to avoid floods. Third, the indirect impact from the potential increase in human settlement behind the strengthened embankment that may intensify the human-wildlife conflict including poaching inside the KNP. To address these potential significant impacts, FREMAA and KNP have partnered to improve monitoring and enforcement. Under the subproject, FREMAA will construct 3 watch towers and a camp near the existing embankments on the KNP side to act as deterrent to poachers, monitor wildlife movement, and oversee the sluicegate operation. Further, 2 monitoring boats will be provided by the project to bolster KNP's capability of monitoring bankline erosion and advice FREMAA and WRD on the effectivity of the pro-siltation works.

E. Authorities and Their Responsibilities for Implementation of the EMP

267. 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 Figure 49.

268. All the policy decisions, including incorporation of the EMP requirements in compliance to loan covenants shall be the responsibility of the recommended Assam Integrated Flood Control and Riverbank Erosion Risk Management (AIFRERM) Society as the executing authority and will be registered under the Societies Act. The AIFRERM Society will be 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.

269. A Program Management Unit (PMU) was established in AIFRERM Society that have multi-disciplinary structure. One of the units in the PMU is 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 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) as that functioned in tranche 1. 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.

270. In each subproject, there will be subproject implementation unit (SIU) comprising technical team (SIU-T) and disaster risk management and coordination team (SIU-DRMC) like Tranche 1. The SIU-DRMC will have experts engaged from the market on environmental management and social safeguards, who will implement or cause the implementation of the monitoring and mitigation measures under the supervision of the PMU-SEU. The head of the SIU-DRMC, a nodal officer of the district administration in disaster risk management, will be assigned as chief safeguards officer.

F. Mechanisms for Feedback and Adjustment

271. The SIU with the help of contractors will submit monthly progress report on implementation status of EMP to the SIU and PMU. Any deviation from the contract requirements with respect to proposed EMP should be corrected within a fortnight and records maintained for the same. As part of the feedback mechanism, the SIU shall monitor project compliance with respect to the EMP and Applicable laws, rules and regulations.

272. Public involvement shall be encouraged and ensured throughout the lifecycle of the subproject. The SIU shall gather and maintain information on any damage or public concern that may be raised by the local people, NGOs and local authorities. While immediate solutions are to be worked out with the help of contractor, a detailed report will be submitted to the SIU for information. The SIU will be responsible to bring it to the notice of the PMU. Resulting decisions shall be communicated back to SIU and contractor for correction and future implementation. An operation-period workshop may be required for effective implementation of the EMP.

G. Environmental Monitoring Plan (EMoP)

273. The objectives of environmental monitoring during the construction and operation are to ensure the mitigation measures are being implemented, gauge their effectives to allow corrective actions, and ensure unanticipated impacts are identified and mitigated appropriately. A monitoring schedule was prepared 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, fisheries, cropping pattern, soil erosion, drainage congestion, tree plantation, air quality, noise and vibration are provided in Appendix 16. 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.

H. Monitoring Schedule

274. A monitoring schedule was developed based on the possible occurrence of adverse impacts and required mitigation actions. This schedule is subject to change depending on the analysis results obtained.

1. River Hydrology, Morphology, and Sediment Transport

275. No significant external negative impacts on river hydrology, morphology, and sediment transport is expected due to the nature of the subproject to support the strengthening of the existing embankment systems that will maintain or restore the intended functions of those systems and thus formalize the existing flooding behavior that has persisted since these embankments were first 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, the project will put into operation a systematic monitoring of river hydrology, morphology, and sediment transport and build sound knowledge base as an important component of the overall investment. This will facilitate the identification of any localized impacts in the subproject areas.

2. Terrestrial and Aquatic Fauna including Fisheries

276. The fish productivity monitoring are important and sensitive issues. In case, any significant decline in terms of fish productivity in the beels/wetlands or pond is noticed the monitoring frequency be increased till the effectiveness of mitigation measures are established.

3. Soil Erosion and Drainage Congestion

277. No significant soil erosion problem is anticipated due to the project either during construction or operation phase. Nonetheless, during construction phase some localized soil erosion take place along the embankment and borrow areas. Regular spot checks will be conducted under the subproject.

278. The performance and impacts of existing and strengthened embankment systems on the natural drainage including the wetlands within the systems will be closely monitored to facilitate appropriate mitigation measures such as provision of sluice gates and their proper operation to reduce post-monsoon drainage congestion and allow water level management in wetlands.

4. Air and Noise Quality

279. Short-term episodes of air pollution in terms of increase particulate matter and noise may occur within 300 meters from the embankment construction site. Weekly monitoring is required on all sensitive receptors within this distance.

5. Water Quality

280. No significant change in water quality is perceived due to the project in the operation phase. During construction phase, Suspended Solids, DO, and Oil & Grease will be monitored every 2 weeks along on the receiving water body.

6. Tree Plantation

281. The 75% survival rate of re-plantation shall be monitored on the first year of the operation phase. If the survival rate is found below 70%, survival rate monitoring shall be again taken up after 2 years. This cycle should continue until the 70% survival rate is achieved.

I. Authorities and their Responsibilities for Implementation of EMoP

282. The SIU-DMCT will be responsible for timely monitoring of various parameters and compliance with the mitigation measure proposed. A resultant data base will be maintained as part of FREMAA's Management Information System (MIS).

J. Institutional Capacity

283. The proposed organization structure to implement the AIFRERMIP and the environmental management plan is shown in the succeeding Figure. To enhance the capacity of the SIU for effective implementation of proposed mitigation measures and monitoring the resultant effect, a training program is provided at Appendix 18.

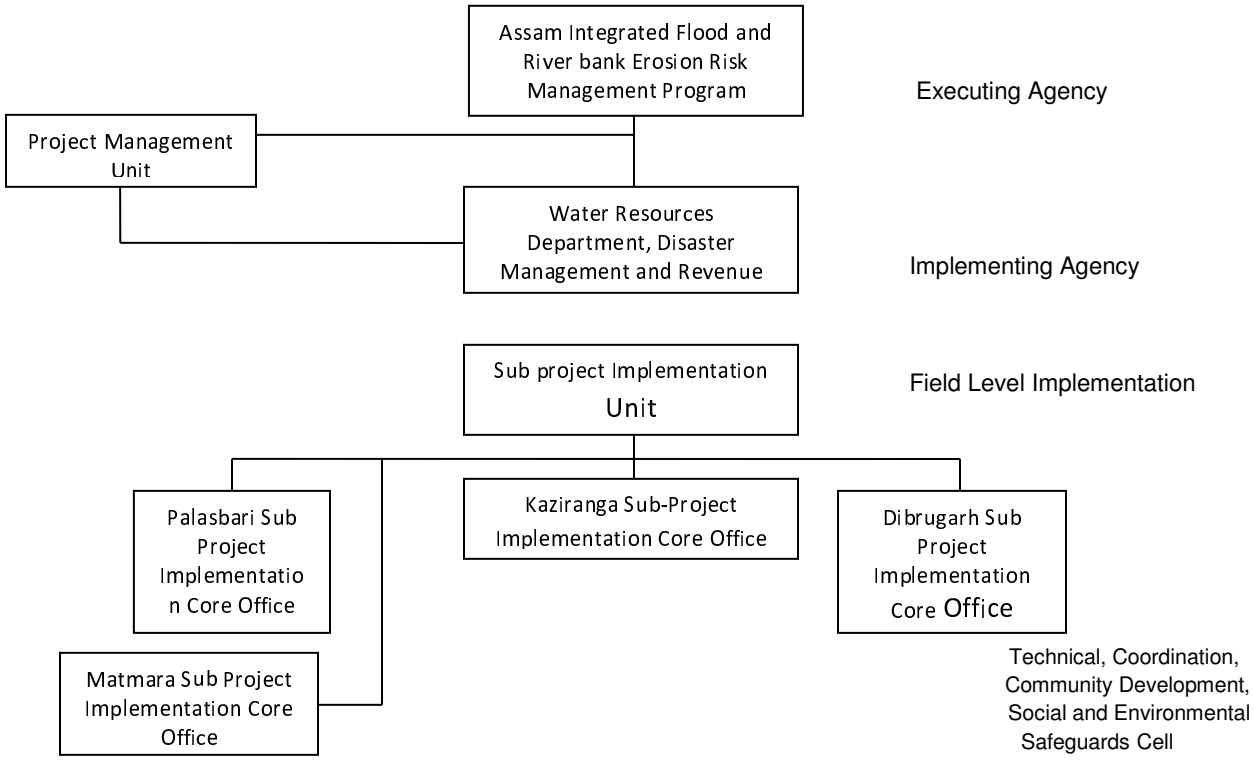


Figure 49: Proposed Organization Structure

K. Mitigation, Monitoring and Institution Strengthening Cost

284. Appendix 19 presents the estimated budget to implement the EMP. Of the total cost of INR10.662 million of which INR3.982M is to enhance the KNP's enforcement and monitoring capability through the construction of 3 watch towers and 1 camp. This is followed by the mandatory compensatory tree plantation with INR2.716M or 26% of the total. To monitor erosion pattern along the reach and most importantly the KNP, the procurement of 2 monitoring boats amounting to INR1.529M accounts for 14% of the total. Environmental monitoring and capacity building each accounts for about 11%.

IX. Conclusion and Recommendation

A. Conclusion

285. The proposed subproject is the Kaziranga reach located upstream of Kaziranga National Park. The sub-project is part of a three-reach focus areas identified as the most vulnerable to flood and erosion of the Brahmaputra River, under the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (IFRERM-Assam). The subproject is needed to safeguard the people, property, and wildlife habitat from the risk of devastating floods.

286. The project involves upgrading of vulnerable sections of the existing embankment, construction of sluice gates, bank protection, and launching of porcupine screens. In 2008, the ADB classified the subproject as environmental category A due to this proximity of key suproject components and activities to the Kaziranga National Park, namely: the construction of a new 7.25km embankment from Diffalupathar to NH37, and the raising of the existing 19.88 kms Brahmaputra Dyke crest. The KNP is considered a critical habitat of that supports numerous critically endangered mammals including Tiger, Asian elephant, Asiatic wild buffalo, Capped langur, Hoolock gibbon, and River dolphin. KNP support 2/3rd of the entire world's One-horned rhinoceros; birds like the White bellied heron, Greater adjutant, Bengal Florican, and Spottted greenshark. KNP is a UNESCO World Heritage Site representing one of the last unmodified natural areas in north-eaastern India, the single largest undisturbed representative area in the Brahmaputra Valley Floodplain, and one of the finest wildlife refuge in the world. KNP is also classified as an Important Bird Area and a Tiger Reserve.

287. An environmental clearance was issued by the MoEF&CC to the project during the 31st Meeting of the Standing Committee of National Board for Wildlife held on 12-12 August 2014 at Indian Paryavaran Bhawan, Jor Bag Road, New Delhi. An environmental impact assessment was conducted in 2008 and the report approved by the ADB and publicly disclosed in 2009.

288. In 2009, the Kaziranga subproject was classified as environmental category A as some of its activities are adjacent to the KNP boundary. Originally proposed under Tranche 1 of the MFF, the subproject was not implmemented as scheduled due to delays in securing the environment clearance from the Ministry of Environmnet, Forest, and Climate Change that took 7 years. FREMAA and ADB decided to move its implementation during Tranche-II. However, the MFF ends on October 2020 leaving the Kaziranga subproject with 2 years implementation period. This constraint necessitated FREMAA to redesign and truncate the initial structural works. The reduction in project scope was significant both from the investment and environmental safeguard perspectives. The truncated design cancelled the construction of a new 7.25k embankment from Diffalupathar to NH-37 to envelop the Bokhakat. The proposed raising and strengthening of the entire 19.850 kms Brahmaputra Dyke was scaled down to the rehabilitation of 6 sections vulnerable with a total length of 3.075kms. The installation of multilayer pre-stressed concrete (PSC) Porcupine screens was reduced to maintenance of the works previously made by the Water Resources Department along the northern bank of the Brahmaputra River starting immediately downstream of the Dhansiri River confluence towards the Kaziranga National Park (KNP) boundary. In contrast to the previous proposal, two sections of the river that are currently subjected to extreme river erosion will receive upgraded bank protection works in the form revetments with apron and slope pitching made of geotextile bags. Construction of 3 sluice gates remains the same.

289. The truncated subproject design for Tranche-II was re-categorized to Category B based on the following: i) removal of environmentally critical activities that may pose significant adverse environmental risk to the KNP, considered a critical habitat, namely the construction of the 7.25 km long new embankment and upgrading/increasing the height of the existing Brahmaputra Dyke; and ii) scale down of the works in the existing Bhrahmaputra Dyke to rehabilitation rather than upgrading

that focuses on 6 vulnerable sections with a total length of 3.825km. No works will be undertaken by the subproject inside or along the KNP boundary.

290. All environmental impacts from the implementation of truncated subproject are less than than than previously anticipate, site-specific, most to occur during the costruction phase, and readily mitigated. No unprecedented impacts are expected from the rehabilitation of the existing Brahmaputra Dyke and the maintenance and extension of the Water Resources Department's porcupine screens.

291. Construction activities during the pre-, during-, and and post-construction and operation stages were identified. An analysis of the interactions between the construction activities and the environment revealed impacts are are low, site-specific, readily mitigated, and none are unprecedented. No significant adverse 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. 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. The proposed bank protection of the upstream reach of the KNP will be done in such a way that the natural character of the banks is maintained. The proposed porcupine screens are pro-siltation measures and the risks of morpohological changes to the KNP that is immediately downstream of Kaziranga reach are limited and very difficult to establish that there is either more or less erosion. The proposed pro-sitation works are limited in scope compared to the width of the Brahmaputra rier and will not result to a general rearrangement of the channel pattern. In the other subproject reaches where porcupine screens have been established under Tranche-1, there was no observable changes in bankline erosion downstream after almost 5 years of completion. The impacts in Kaziranga reach might be less as the bankline channel is dominated by relative low sediment load originating from the Dhansiri River.

292. Nonetheless, continuous and 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. Further, to ensure any morphological changes that will occur along the KNP are detected early and remedial measures are designed and implemented, under the sub-project FREMAA and KNP management have agreed to purchase 2 monitoring boats to allow continuous monitoring for erosion downstream along the KNP banks. These boats will have a low draft of 2.5 ft with dimensions of 56'x12'x3.8' made of wood powered by a 2956cc, TATA 407SP turbo, inter-cooled direct injection diesel engine. Findings on the status of erosion along the KNP banklines will be reported to FREMAA to formulate and implement joint actions based on river training and erosion control techniques and lessons drawn from the project implementation. These monitoring boats will follow the KNP design and construction as provided in the succeeding Figure. This will also be used to monitor and protect wildlife animals that crosses the channels to reach the charlands just north of the revetment works.

293. The strengthening of the existing embankment and the construction of the sluice gates adjacent to the KNP will generate low and localize impacts. The subproject intervention simply formalizes the existing flooding behaviour that has persisted since these embankments were constructed. The limited scale and scope of the works, confined within the existing embankment will have no anticipated impacts on the wildlife. Typical impacts related to land clearing, earthmoving, and ground shaping during they embankment upgrading like noise, dust, and silt-laden runoff are easily mitigated through good engineering practices. For mitigating and minimizing impacts of dust and fugitive emissions mitigation measures such as water sprinkling, maintenance of minimum distances from existing communities, proper maintenance of construction equipment and vehicles are proposed.

294. To address impacts on biodiversity and the protected species several measures have been recommended for avoidance; mitigation, minimization and enhancement. These measures partners with the KNP managers to strengthen their monitoring and anti-poaching activities through the construction of 3 watchtowers near the sub-project boundary, 1 ranger camp, and procurement of 2 monitoring boats.

295. During the construction stage, some trees along the embankment are likely to be cleared and a corresponding compensatory afforestation will be implemented.

296. **Conclusion**. Considering the technical, institutional and budgetary measures recommended it is expected that the subproject will not result to significant adverse impacts. There will be subproject structures and activities inside the KNP. Tremendous social and economic benefits will be generated in the Golaghat district and the KNP by providing protection against flooding and river bank erosion.

Appendix 1: Clearance from National Wildlife Board, MOEF&CC

Excerpts from the minutes of the 31st meeting.

Minutes of 31st meeting of SC NBWL dated 12th & 13th Aug 2014

Ministry of Environment and Forests
Wildlife Division
Minutes of the 31st Meeting of the Standing Committee of National Board for Wildlife held on 12-12 August 2014 at Indian Paryavaran Bhawan, Jor Bag Road, New Delhi.

The 31st Meeting of the Standing Committee of National Board for Wildlife (NBWL) was held on 12-13 August 2014 in the Ministry of Environment and Forest (MoEF), New Delhi. The meeting was convened under the chairmanship of Hon'ble Minister of State (Independent Charge) for Environment, forest and Climate change. The list of participants is at Annexure-1.

At the outset, Hon'ble Chairman while welcoming all participants to the 31st Meeting of Standing Committee of NBWL mentioned that this meeting was being held after a long gap, due to the proce4ss of re-constitution of the National Board for Wildlife and its Standing Committee. He urged the participants that there was a need to take conservation alongside developmental activities and therefore, all the proposals that have been included in the agenda need to be looked into very carefully and judiciously. He also clarified that in case the Committee prescribes any conditions while recommending projects, care should be taken that the conditions are feasible for implementation and at the same time compliance of the conditions should also be closely monitored. The Chairman also pointed out that each case be discussed as per its merits. He then requested the Member Secretary to initiate the discussions on the agenda items.

The agenda items were then opened for discussion.

PROPOSALS WITHIN 10 KMS FROM BOUNDARY OF NATIONAL PARKS ANDSANCTUARIES

4. Proposal for strengthening the existing (embankment) from Moriaholla toDiffalupathar to avoid any beach resulting flash flood in eastern range of Kaziranga NP, Assam.

The Member Secretary briefed the Committee regarding the proposal. The Chief Wildlife Warden, Assam mentioned that the proposal was for strengthening the existing embankment from Moriaholla to Diffalupathar to avoid any breach resulting flash flood in eastern range of Kaziranga National Park and also in order to control flash floods inside the Park.
After discussion, the Standing Committee decided to recommend the proposal as it would help in controlling flash floods inside Kaziranga National Park. The Committee also decided that the following conditions, as stipulated by the State Chief Wildlife Warden be also complied with:

i. Entire work shall be executed under close supervision of park authorities.
ii. Top of the dyke shall be graveled.
iii. Three new sluice gates shall be constructed in order to regulate flow of water across the dyke.
iv. All the sluice gates shall be operated during high flood as well lean season jointly by the water Resources Department and Kaziranga National Park officials.
v. Material for porcupine works shall be transported through river route only

LIST OF PARTICIPANTS OF THE 31ST MEETING OF STANDING COMMITTEE OF NBWL HELD ON 12TH- 13TH AUGUST 2014.

***

1	Shri Prakash Javadekat Hon'ble Minister of State (Independent Charge) for Environment & Forest	Chairmen
2	Dr. V. Rajagopalan, Secretary, Environment & Forests	invitee
3	Dr S. S. Garbeyal Director General of Forests & Special Secretary	Member
4	Shri A. K. Srivastava Addl. Director General of Forests (FC)	Member
5	Dr V. B. Mathur Director, Wildlife Institute of India, Dehradun	Member
6	Professor Raman Sukumar	Member
7	Shri Bharat Pathak, Director, GEER Foundation, Gujarat	Member
8	Dr H. S. Singh	Member
9	Shri Rajendra P Agarwalla, PCCF(WL) & Chief Wildlife Warden Assam	Invitee
10	Shri Pradeep Vyas, Addl. PCCF(WL), West Bengal	Invitee
11	Dr Atul K. Gupta, Pr. Chief Conservator of Forests & Chief Wildlife Warden, Tripura	Invitee
12	Shri S.S. Sharma. Pr. Chief Conservator of Forests, Uttarakhand	Invitee
13	Shri D. K. Pnadey, Addl. Pr. Chief Conservator of forests, Andhra Pradesh	Invitee
14	Shri Pramod Krishnan, Conservator of Forests (WL), Palakkad, Kerala	Invitee
15	Shri Praveen Pandey, Pr. Secretary (Forests)	Invitee
16	Shri Amit Mallick, CCF&FD(PT), Kerala	
17	Shri Rupak De, PCCF cum Chief Willife Warden, Uttar Pradesh	Invitee
18	Shri S. N. Singh, Addl. PCCF & Chief Wildlife Warden, Rajasthan	Invitee
19	Shri A. K. Singh, Pr.CCF(WL) & Chief Wildlife Warden, Jammu and Kashmir	Invitee
20	Shri P.L. Chauhan, CCF(WL) South Shimla, Himachal Pradesh	Invitee
21	Shri Kailash Ch Bebarta, Addl.PCCF(WL)	Invitee
22	Shri Dhirendra Singh, Addl.PCCF & Chief Wildlife Warden, Punjab	Invitee
23	Shri C.N. Pandey, Pr.CCF(WL) & Chief Wildlife Warden Warden. Gujarat	Invitee
24	Shri Narendra Kumar, Chief Wildlife Warden, Madhya Pradesh	Invitee
25	Dr Vivek Saxena, OSD (Forests), Haryana Bhawan, New Delhi	Invitee
26	Shri Vinod Kumar, CF(WL), Gurgaon, Haryana	Invitee
27	Dr Rajesh Gopal, Member Secretary, NTCA	Invitee
28	Dr S. K. Khanduri, Inspector General of Forests (WL)	Invitee
29	Shri M.L. Srivastava, Deputy Inspector General of Forests(WL)	Invitee

Appendix 2: Use of Geotextile Bags For Rivebank Erosion Mitigation

1. The use of geo textile 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. Geo textiles were first introduced in the market in 1950ies 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 revetment.

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

(i) **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.

(ii) **Reinforcement**: The geo textile 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.

(iii) The gradual natural changes to environment may not have much impact as it occurs slowly and fish may get opportunity to adapt. However, any man made 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. So 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 cr eate 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).

(iv) 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.

(v) 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 fabric are widely accepted. It is assumed that restrictions in these industries are much tighter. So it can be postulated that PP fabric 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 3: 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 (organised)	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 4: National Ambient Air Quality Standards

Pollutants	Time-weighted average	Concentration ambient air			Method of measurement
		Industrial Areas	Residential, Rural & other Areas	Sensitive Areas	
Sulphur Dioxide (SO2)	Annual Average*	80 µg/m3	60 µg/m3	15 µg/m3	Improved West and Geake Method Ultraviolet Fluorescence
	24 hours**	120 µg/m3	80 µg/m3	30 µg/m3	
Oxides of Nitrogen as (NO2)	Annual Average*	80 µg/m3	60 µg/m3	15 µg/m3	Jacob & Hochheiser Modified (Na-Arsenite) Method
	24 hours**	120 µg/m3	80 µg/m3	30 µg/m3	Gas Phase Chemiluminescence
Suspended Particulate Matter (SPM)	Annual Average*	360 µg/m3	140 µg/m3	70 µg/m3	High Volume Sampling, (Average flow rate not less than 1.1 m3/minute).
	24 hours**	500 µg/m3	200 µg/m3	100 µg/m3	
Respirable Particulate Matter (RPM) (size less than 10 microns)	Annual Average*	120 µg/m3	60 µg/m3	50 µg/m3	Respirable particulate matter sampler
	24 hours**	150 µg/m3	100 µg/m3	75 µg/m3	
Lead (Pb)	Annual Average*	1.0 µg/m3	0.75 µg/m3	0.50 µg/m3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 µg/m3	1.00 µg/m3	0.75 µg/m3	
Ammonia1	Annual Average*	0.1 mg/m3	0.1 mg/m3	0.1 mg/m3	
	24 hours**	0.4 mg/m3	0.4 mg/m3	0.4 mg/m3	
Carbon Monoxide (CO)	8 hour**	5.0 mg/m3	2.0 mg/m3	1.0 mg/m3	- Non Dispersive Infra Red (NDIR)
	1 hour	10.0 mg/m3	4.0 mg/m3	2.0 mg/m3	Spectroscopy
*	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 5: 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	46 40
(C)	Residential area	55	
(D)	Silence Zone	50	

Note:-

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 metres 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 —decibelll is a unit in which noise is measured.

—All, 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 6: Sampling Locations for Terrestrial Ecology Of Bankoal - Diffalupathar Sub-Project Site

Sl. No.	Sampled Location	Lat/Long	Remarks
Spot 1	Bankual Bali Sapori	26°41'56"N93°44'23"E	Dolphin comes here during rainy season, Common Shelduck (2), Yellow wagtall (7), White Wagtail (2) and Lesser whistling teal (50+) recorded
Spot2	Bankual Barali Muwa	26°41'39"N93°44'23"E	62m
Spot3 Ch. 10 km	bhalukaguri	26°42'42"N93°45'49"E	In Bhalukaguri, the original embankment was break down during 2004 flood and to protect the rice fields Bankual Krishi bundh was made by Panchayat during 2004-2005 between the land of Bhalukaguri and Riri Goan.
Spot4	Kathonibari	26°41'41"N93°43'53"E	57m
Ch. 11	Bankuwal	26°42'31"N93°45'08"E	Redwattled Lapwing (2), Ruddy shelduck(5), Yellow Wagtail(6), Cattle Egret(10+), Paddyfield pipit(6+) recorded
Spot5 Ch11.0km	Majdulupa	26°42'31"N93°45'08"E	
Spot6 Ch. 13km	Riri Goan	26°41'36"N93°43'01"E	
Spot7 Ch. 25 km	Dhansirimukh	26°40'19"N93°37'39"E	
Ch 26	Inside	26°40'37"N93°36'44"E	Hoopoe(3), Green Bee-eatre(2)
Spot 8 Ch. 21	Alengi	26°40'12"N93°39'31"E	
Spot 9 Ch. 6	Alami	26°42'58"N93°46'26"E	
Spot 10 Ch.0.0 km	Afala	26°42'56"N93°46'27"E	
Spot 11 Ch. 18	Kuruabahi	26°40'18"N93°41'31"E	
Spot 12 Ch. 19	Nikori Ghat	26°40'55"N93°40'59"E	
Spot 13 Ch.21	Jugonia	26°40'12"N93°39'31"E	
Ch.23	no	26°39'49"N93°38'44"E	1 Pied hrrier foun
Spot14 Ch.24	Jugania Ati	26°39'59"N93°38'13"E	
Spot 15 Ch. 28	Kharu Goan	26°40'45"N93°36'14"E	
Spot 16 Ch.29	Mohkhuti camp (inside)	26°40'50"N93°35'35"E	Indian Roller(3)
Spot 17 Ch. 30	Agoratali Shalabeel	26°36'48"N93°27'26"E	Rhino mother calf and buffalos were found
Ch. 31	Tamul pathar		

Appendix 7: Mammals of Kaziranga

Sl. No	Family	Scientific Name	Common Name	IUCN Status
1.	Loridae	Nycticebus bengalensis	Slow Loris	DD
2.	Hylobatidae	Bunopithecus hoolock	Hoolock gibbon	End.
3.	cercopithecidae	Macaca mulata	Rhesus macaque	LR
4.		Macaca assamensis	Assamese macaque	VUL
5.		Trachypithecus pileatus	Capped langur	End
6.	Cervidae	Cervus unicolor	Sambar	LR
7.		Cervus duvaucelii	Swamp deer	VUL
8.		Muntiacus muntjak	Indian Muntjac	LR
9.		Axis porcinus	Hog deer	LR
10.	Boviae	Bubalus amee	Asistic wild buffalo	End
11.		Bos gaurus	Gaur	VUL
12.	Suidae	Sus scrofa	Wild pig	LR
13.	Elephantidae	Elephas maximus	Asian elephant	End
14.	Rhinocerotodae	Rhinoceros unicomis	Greater one-horned rhir Oceros	End
15.	Ursidae	Ursus thibetanus	Asiatic black bear	VUL
16.		Helarctos malayanus	Sun bear	DD
17.		Melursus ursinus	Sloth bear	VUL
18.	Canidae	Canis aureus	Jackal	LR
19.		Cuon alpinus	Wild dog	VUL
20.		Vulpes bengalensis	Indian fox	LR
21.	Felidae	Panthera tigris	Tiger	End
22.		Pantera patdus	Common leopard	LR
23.		Neofelis nebulosa	Clouded leopard	VUL
24.		Pardofelis marmorata	Marbled cat	VUL
25.		Catopuma temmincki	Golden cat	VUL
26.		Felis chaus	Jungle cat	LR
27.		Prionailurus bengalensis	Leopard cat	LR
28.		Prionailurus viverrinus	Fishing cat	VUL
29.	Mustelidae	Melogale moschata	Small-toothed ferret bac Ger	VUL
30.		Melogale personata	Large-toothed ferret bac Ger	VUL
31.		Arctonyx collaris	Hog badger	Unlisted
32.		Amblonyx cinereus	Small-clawed otter	
33.		Martes flavigula	Yellow-throated marten	

Appendix 8: Globally Endangered, and Endemic Avian Fauna in Study Zone of Kaziranga National Park and Subproject Area

Common Name	*Scientific Name*	*Status as per WPA,1972*
Oriental white baked vulture	*Gyps bengalensis*	CR
Slender billed vulture	*Gyps tenuirostris*	CR
White bellied heron	Ardea insignis	En
Greater adjutant	*Leptoptilos dubius*	En
Bengal Florican	*Houbaropsis bengalensis*	En
Spotted greenshank	*Tringa guttifer*	En
Spot billed pelican	*Pelecanus philipensis*	V
Lesser adjutant	*Leptoptilos javanicus*	V
Lesser white fronted goose	*Anser erythropus*	V
Marbled teal	*Marmaronetta angustirostris*	V
Baer's Poachard	*Aythya baeri*	V
Pallas's sea eagle	*Haliaeetus leucoryphus*	V
Greater spotted eagle	*Aquila clanga*	V
Eastern imperial eagle	*Aquila heliacal*	V
Lesser kestrel	*Falco naumanni*	V
Swamp francolin	*Francolinus gularis*	V
Indian skimmer	*Rynchops albicollis*	V
Purple wood pigeon	*Columba punicea*	V
Hodgson's Bushchat	*Saxicola insignis*	V
Marsh babbler	*Pellorneumpalustre*	V
Jerdon's babbler	*Chrysomma altirostre*	V
Slender billed babbler	*Turdoides longirostris*	V
Black breasted parrotbill	*Paradoxornis flavirostris*	V
Finn's weaver	*Ploceus megarhynchus*	V
Darter	*Anhinga melanogaster*	NT
Black necked stork	*Ephippiorhynchus asiaticus*	NT
Oriental white ibis	*Threskiornis melanocephalus*	NT
Ferruginous Poachard	*Aythya nyroca*	NT
White tailed sea eagle	*Haliaeetus albicilla*	NT
Greater Grey headed fish eagle	*Ichthyophaga ichthyaetus*	NT
Cinereous vulture	*Aegypius monachus*	NT
Red headed vulture	*Sarcogyps calvus*	NT
White cheeked hill Patridge	*Arborophila atrogularis*	NT
Black bellied tern	*Sterna acuticauda*	NT
Blyth's kingfisher	*Alcedo herculis*	NT
Great pied hornbill	*Buceros bicornis*	NT
Long tailed Prinia	*Prinia burnesii*	NT
Rufous rumped grass warbler	*Graminicola bengalensis*	NT
Marsh babbler	*Pellorneum palustre*	Endemic
Black breasted Parrotbill	*Paradoxornis flavirostris*	Endemic

*(En: Endangered; CR: Critically endangered; V: vulnerable; NT: Near threatened)

Appendix 9: Endangered Mammalian Fauna in Kaziranga Sub Project Area

Scientific Name	Common Name	IUCN,1972 Status
Pletinista gengeticus	River Dolphin	En
Macaca mulata	Rhesus macaque	LR
Macaca assamensis	Assamese macaque	V
Bubalus amee	Asiatic wild buffalo	En
Sus scrofa	Wild pi	LR
Elephas maximus	Asian elephant	En
Rhinoceros unicornis	Greater one-homed rhinoceros	En
Canis aureus	Jackal	LR
Vulpes bengalensis	Indian fox	LR
Panthera tigis	Tiger	En
Panthera pardus	Common leopard	LR
Pardofelis marmorata	Marbled cat	V
Catopuma temmincki	Golden cat	V
Felis chaus	Jungle cat	LR
Prionailurus bengalensis	Leopard cat	LR
Prionailurus viverrinus	Fishing cat	V
Melogale moschata	Small-toothed ferret bad-ger	En
Melogale personata	Large-toothed ferret bad-ger	V

(En: Endangered; CR: Critically endangered; V: vulnerable; NT: Near threatened)

Appendix 10: Sampling Locations of Aquatic Ecology

Sl. No.	Survey Point	GPS Position	Sl. No.	Survey Point	GPS Position
1	Alami	N: 26°42'30"	2	Afola (0 pt.)	N: 26°42'56"
		E:93°48'04"			E:93°46'39"
3	Bholukaguri	N: 26°42'42"	4	Bongkuwal	N: 26°42'33"
		E:93°45'49"			E:93°45'05"
5	Bongkuwal Bali-chapari	N: 26°41'43"	6	Ririgaon	N: 26°41'37"
		E:93°44'04"			E:93°43'26"
7	Dhansirimukh	N: 26°41'41"	8	Kurabahi	N: 26°40'18"
		E:93°42'58"			E:93°48'56"
9	Nikorihat	N: 26°40'55"	10	Jugonia	N: 26°40'12"
		E:93°40'59"			E:93°39'31"
11	Jugonia Ati	N: 26°39'59"	12	Dhanisrimukh	N: 26°05'48"
		E:93°38'13"			E:93°37'39"
13	Kharugaon	N: 26°40'45"	14	Mohkuti camp	N: 26°40'58"
		E:93°36'14"			E:93°35'36"
15	Aageratoli	N: 26°36'48"	16	Tamulipathar	N: 26°28'48"
		E:93°27'26"			E:93°18'38"

Appendix 11: Endangered Mammalian Fauna in Study Zone Kaziranga National Park

Scientific Name	Common Name	IUCN,192 Status
Nycticebus bengalensis	Slow Loris	DD
Pletinista gengeticus	River Dolphin	En
Bunopithecus hoolock	Hoolock gibbon	En.LR
Macaca mulata	Rhesus macaque	V
Macaca assamensis	Assamese macaque	En. LR
Trachypithecus pileatus	Capped langur	V
Cervus unicolor	Sambar	LR
Cervus duvaucelii	Swamp deer	LR
Muntiacus muntjak	Indian Muntjac	En
Axis porcinus	Hog deer	V
Bubalus arnee	Asiatic wild buffalo	LR
Bos gaurus Sus	Gaur	En. En
scrofa	Wild pig	V
Elephas maximus	Asian elephant	DD
Rhinoceros unicornis	Greater one-horned rhinoceros	V
Ursus thibetanus	Asiatic black bear	LR
Helarctos malayanus	Sun bear	V
Melursus ursinus	Sloth bear	LR
Canis aureus	Jackal	En.
Cuon alpinus	Wild dog	LR
Vulpes bengalensis	Indian fox	V
Panthera tigris	Tiger	V
Panthera pardus	Common leopard	V
Neofelis nebulosa	Clouded leopard	LR
Pardofelis marmorata	Marbled cat	LR
Catopuma temmincki	Golden cat	V
Felis chaus	Jungle cat	En.
Prionailurus bengalensis	Leopard cat	V
Prionailurus viverrinus	Fishing cat	
Melogale moschata	Small-toothed ferret bad-ger	
Melogale personata	Large-toothed ferret bad-ger	

(En: Endangered; CR: Critically endangered; V: vulnerable; NT: Near threatened)

*

Appendix 12: 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 13: Aquatic Ecology

Fishes are listed based on all available published information as shown in table. Current status of nomenclature and systematic are done based on Catalog of Fishes (Eschmeyer, 2006, online version, updated April 16, 2006). Tentative IUCN criteria (EW=extinct in wild, CR=critically endangered, EN=endangered; VU=vulnerable, LR=lower risk (-nt -near threatened, lc=least concern and cd=least concern), DD=data deficient) of fishes are based on CAMP (1998). For
fishes which are not assessed, it is marked NA. (Not available)

Sl. No.		Stations												Cons. Stat.
	Fish Sp.	1	2	3	4	5	6	7	8	9	10	11	12	
1.	*Hilsa ilisha*	-	-	-	-	+	+	-	-	-	-	-	-	Vu
2.	*Cirrhinus reba*	-	+	-	-	+	-	-	-	-	-	-	-	Vu
3.	*Labeo calbasu*	-	+	-	-	-	+	-	-	-	-	+	+	LRnt
4.	*Labeo gonius*	-	-	+	+	+	+	-	-	+	+	+	+	LRnt
5.	*Osteobrama cotio*	+	-	-	-	-	+	-	-	-	-	-	-	LRnt
6.	*Puntius sarana*	-	+	+	-	-	-	-	-	-	-	-	-	Vu
7.	*Puntius ticto*	-	-	-	+	+	+	-	-	-	-	+	-	LRnt
8.	*Puntius sophore*	-	-	+	+	+	-	-	-	-	-	-	-	LRnt
9.	*Salmophasia bacaila*	-	-	-	-	-	-	-	-	-	-	+	+	LRlc
10.	*Barilius barna*	-	+	+	+	-	-	+	+	+	-	-	-	LRnt
11.	*Barilius barials*	+	+	+	-	-	-	+	+	+	-	-	-	LRnt
12.	*Notopterus notopterus*	+	+	+	+	+	+	+	+	+	+	+	+	LRnt
13.	*Notopterus chitala*	+			+	+	+	+	+		+	+	+	
14.	*Mystus cavasious*		+	+	+			+	+	+	+	+		
15.	*Mystus vitattus*	+	+	+	+	+	+							
16.	*Devario aequipinnatus*	-	-	+	+	+	+	-	-	-	+	+	+	LRnt
17.	*Devario devario*	-	+	+	-	+	+	-	-	-	-	+	+	LRnt
18.	*Raiamas bola*	-	+	+	-	-	-	-	-	-	-	-	-	Vu 23.
19.	*Crossocheilus latius*	-	+	-	-	-	-	+	+	-	-	-	-	DD 24.
20.	*Garra gotyla*	+	+	-	-	-	-	+	-	-	-	-	-	Vu 25.
21.	*Garra gotyla*	-	+	-	-	-	-	-	-	-	-	-	-	EN
22.	*stenorhynchus*													
23.	*Garra nasuta*	+	+	-	-	-	-	-	-	-	-	-	-	NE
24.	*Psilorhynchus balitora*	-	+	+	+	-	-	+	+	-	-	-	-	NE
25.	*Acanthocobitis botia*	-	+	+	+	+	-	-	+	+	+	-	-	LRnt
26.	*Lepidocephalichthys*	-	+	+	+	+	-	-	+	+	+	+	+	NE

27.	*guntea*										(Hamilton-Buchanan)			
28.	*Cantophrys gongota*	+	-	-	-	-	-	-	+	-	-	-	-	LRnt
29.	*Botia Dario*	-	-	-	-	+	+	-	-	-	-	+	+	NE
30.	*Batasio batasio*	-	+	+	-	-	-	-	-	-	-	-	-	NE
31.	*Clupisoma garua*	-	-	-	-	-	-	-	-	-	-	+	+	Vu
32.	*Eutropichthys vacha*	-	-	-	-	-	-	-	-	-	-	+	+	NE
33.	*Pseudeutropius*	-	-	-	-	-	-	-	-	-	-	+	+	NE
34.	*atherinoides*													
35.	*Bagarius bagarius*	-	-	-	-	-	-	-	-	-	+	-	+	Vu
36.	*Erethistes pussilus*	+	+	-	-	-	-	+	+	-	-	+	+	NE
37.	*Erethistoides montana*	-	-	+	+	-	-	-	-	-	-	-	-	CR
38.	*Gagata cenia*	-	-	-	-	-	+	-	-	-	+	+	+	NE
39.	*Gagata gagata*	-	-	-	-	-	-	-	-	-	-	+	+	NE
40.	*Glyptothorax telchitta*	-	-	-	-	-	+	-	-	-	-	-	+	LRnt
41.	*Glyptothorax trilineatus*	-	+	-	-	-	+	-	-	+	-	+	-	NE 46.
42.	*Hara hara*	-	+	-	-	+	+	+	-	-	+	-	+	NE 47.
43.	*Pseudochenesis*	-	-	-	-	-	+	-	-	-	-	+	+	Vu
44.	*Laguvia shawi*	-	-	-	-	+	-	-	-	-	-	-	+	EN
45.	*Clarias batrachus*	-	-	-	-	-	-	-	-	+	+	-	-	Vu
46.	*Heteropneustes fossillis*	-	-	-	-	-	-	-	-	-	+	-	+	Vu
47.	*Olyra longicaudata*	-	+	+	-	-	-	+	-	-	-	-	-	NE
48.	*Xenentodon cancila*	-	-	-	-	+	-	-	-	-	+	-	+	LRnt
49.	*Macrognathus pancalus*	-	-	-	-	-	-	-	-	-	+	-	+	NE
50.	*Mastacembelus amatus*	-	-	+	-	+	-	-	-	-	+	-	+	NE
51.	*Chanda name*	-	+	+	+	+	+	-	+	+	+	+	+	NE
52.	*Parambassis ranga*	-	+	+	+	+	+	-	+	+	+	+	+	NE
53.	*Catia catia*	-	-	-	-	-	-	-	-	-	-	+	+	NE
54.	*Badis badis*	-	+	+	-	+	+	-	-	-	+	+	+	NE
55.	*Glossogobius giuris*	-	-	-	-	-	-	-	-	-	+	+	+	LRnt
56.	*Channa gachua*	-	+	-	-	+	-	-	-	+	+	+	-	Vu
56.	*Channa punctatus*	-	-	-	-	-	-	-	-	-	+	+	-	LRnt
57.	*Channa striatus*	-	-	+	+	+	-	-	-	-	-	-	-	LRnt
58.	*Channa orientails*	+	-	-	+	+	+	+	+		+	+	+	
59.	*Walago attu*	-	+	+	+	-	-	+	+	+	+	+	-	
60.	*Anabas testudineus*	+	+	+	+	+	+	-	-	-	+	+	-	
61.	*Tetradon cutcutia*	-	-	-	+	+	-	+	+	+	-	-	-	
Marco-Invertebrates														

Gastropods														
62.	*Pila globosa*	-	-	+	+	+	+	-	-	-	+	+	+	
63.	*Pila scutata*	-	+	+	-	+	+	-	-	-	-	+	+	
64.	*Brotia costuta*	-	+	+	-	-	-	-	-	-	-	-	-	
65.	*Paludomus pustulosa*	-	+	-	-	-	-	+	+	-	-	-	-	
Bivalves														
66.	*Lamelidens cirrianus*	+	+	-	+	-	-	-	+	+	+	-	-	
Oligochaeta														
67.	*Tublifex*	-	-	+	+	+	+	-	-	-	+	+	+	
Prawn														
68.	*Marcobrachium malcomsori*	+	+	+	+	+	-	+	+	-	+	-	+	
69.	*M . lanchesteri*	-	-	+	+	+	+	-	-	-	+	+	+	
Crabs														
70.	*Sterteriane spingera*	+	+	+	-	-	-	+	+	+	-	-	-	
71.	*Peratelphusa eduntula*	-	+	+	-	-	-	-	-	-	-	-	-	
72.	*P . spingera*	+	+	+	+	+	+	+	+	+	+	+	+	
73.	*Potaman woodmansoni*	-	-	+	+	+	+	-	-	-	+	+	+	
Amphibians														
74.	*Chinxalus simus*	-	+	+	-	-	-	-	-	-	-	-	-	
75.	*Buto melanostictus*	-	+	-	-	-	-	+	+	-	-	-	-	
76.	*Hoplobat rachus tigerinus*	+	+	-	-	-	-	+	-	-	-	-	-	
77.	*Chinxalus sp.*	-	-	+	+	+	+	-	-	-	+	+	+	
Turtles and Tortoises														
78.	*Aspideretes gangeticus*	-	+	+	+	-	-	+	+	-	-	-	-	
79.	*Kachuga tecta*	-	+	+	+	+	-	-	+	+	+	-	-	
80.	*Kachuga smithii*	-	+	+	+	+	-	-	+	+	+	+	+	
81.	*Kachuga sylhetensis*	+	+	-	-	-	-	+	-	-	-	-	-	
Lizards														
82.	*Gecko gecko*		+		+	+			+	+	+	+	+	
83.	*Hemidactylus frenatus*	+			+	+	+	+	+		+	+	+	
84.	*Varanus bengalensis*		+	+	+			+	+	+	+	+		
85.	*Varanus salvator*	+	+	+	+	+	+							
86.	*Calotes emma*		+				+	+	+				+	
Snakes														
87.	*Ophiophagus hannah*	+	+		+		+	+	+				+	
88.	*Naja naja*			+	+	+	+	+		+	+	+	+	
89.	*Trimeresurus spp.*	+		+		+	+	+		+	+	+	+	

90.	*Amphiesma stolata*	+		+	+	+		+	+	+			+	
Mammals														
91.	*River Dolphin*	-	+	-	-	-	-	+	+	-	-	-	-	
92.	*otter*	+	+	-	-	-	-	+	-	-	-	-	-	
Plankton														
Bacillariophyceae														
93.	*Fragilaria*	-	+	+	+	+	+	-	+	+	+	+	+	
94.	*Synedra*	-	+	+	+	+	+	-	+	+	+	+	+	
95.	*Cocconeis*	+	-	-	-	-	-	+	-	-	-	+	+	
96.	*Achnanthes*	-	+	+	-	+	+	-	-	-	+	+	+	
97.	*Eucoconeis*	+	-	-	-	-	-	+	+	-	+	+	+	
98.	*Navicula*	-	+	-	-	+	-	-	-	+	+	+	-	
99.	*Gyrosigma*	+	-	-	-	-	-	-	-	-	+	+	-	
100	*Frustulia*	-	-	+	+	+	-	-	-	-	-	-	-	
101	*Gomphonema*	+	+	-	-	-	-	-	-	-	-	-	-	
102	*Cymbelia*	-	+	+	+	-	-	+	+	-	-	-	-	
103	*Sunrella*	-	+	+	+	+	-	-	+	+	+	-	-	
104	*Melosira*	-	+	+	+	+	-	-	+	+	+	+	+	
Chlorophyceae														
105	*Ulothrix*		+	+	+			+	+	+	+	+		
106	*Microspora*	+	+	+	+	+	+							
107	*Cladophora*	+	+	+			+	+	+		+	+	+	
108	*Closterium*	+			+	+			+	+	+	+	+	
109	*Cosmarium*	+			+	+	+	+	+		+	+	+	
110	*Spirogyra*		+	+	+			+	+	+	+	+		
Myxophyceae														
111	*Oscillatoria*	-	-	+	+	+	-	+		+	+	+	+	
112	*Rivularia*	+	+	-	+		+	+	+				+	
113	*Anabaena*	-	-	+	+	+	+	+		+	+	+	+	
Zooplankton														
114	*Vorticella*	+			+	+			+	+	+	+	+	
115	*Cyclops*	+			+	+	+	+	+		+	+	+	
116	*Daphnia*		+	+	+			+	+	+	+	+		
117	*Keratella*	+	+	+	+	+	+							
118	*Macrobrachium*	+	+	+			+	+	+		+	+	+	
119	*Chironomous*	+			+	+			+	+	+	+	+	
120	*Gomphus*	+			+	+	+	+	+		+	+	+	

121	*Bosmina*		+	+	+			+	+	+	+	+		
122	*Ceriodaphnia*	+	+	+	+	+	+							
123	*Chydorus*	+	+	+			+	+	+		+	+	+	
124	*Nauplis*	+			+	+	+	+	+		+	+	+	
125	*Diaptomus*	+			+	+	+	+	+		+	+	+	
126	*Canthocamptus*		+	+	+			+	+	+	+	+		
127	*Aspianchna*	+	+	+	+	+	+							
128	*Kellicotia*		+				+	+	+				+	
129	*Arcelia*	+		+		+	+	+		+	+	+	+	
130	*Paramecium*			+	+	+	-	+		+	+	+	+	
131	*Brachionus*	+	+		+		+	+	+				+	
132	*Asplanchna*			+	+	+	+	+		+	+	+	+	
133	*Filinia*	+		+		+	+	+		+	+	+	+	
134	*Semiocephalus*			+	+	+				+				
135	*Moinodaphnia*		+	+	+		+	+	+		+	+	+	
136	*Sida*	+	+	-	+		+	+	+			+		
137	*Macrothrix*	+		+	+	+				+	+		+	
138	*Epistilis*	+	+	+	+		+	+	+			+	+	
139	*Rotifer eggs*		+				+	+	+				+	
140	*Gomphus*	-	+	-	+	+	-	+	-	-	-	+	+	
Benthos														
141	*Tubifex*	-	+	+	+	-	+	+	-	-	+	+	+	
142	*Chironomus*	+	+	-	+	-	+	+	+	-	-	+	-	
143	*Viviparous*	+	-	+	+	+	-	-	-	+	+	-	+	
144	*Gyraulus*	+	+	+	+	-	+	+	+	-	-	+	+	
145	*Pisidium*	-	+	-	-	-	+	+	+	-	-	-	+	

Appendix 14: Summary of Public Consultation

Date	Name and address of Persons Consulted	Topics of Discussion	Important Outcome
2/12/2007	Dr. A. K. Baruwa, Director Assam Science, Technology &Environment Council And Assam Energy Development Agency	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	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 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.
19/5/2008	Chief Conservatory of Forests	Related to tree cutting, afore station 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. ○ For afforestration 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 Pani hizol 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 & erosion of the Brahmaputra. 2. If the proposed project	○ 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.
5/3/2008	Mr. Mintu Handique & Mr. Gaurav Borgohain, Carrier Care Group		

Date	Name and address of Persons Consulted	Topics of Discussion	Important Outcome
10/3/2008	Mr. Sanjay Hazarika CE-NES	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 isssues other than those discussed so far	○ They also suggested increasing forest cover through afferoestation 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.
27/03/2008	Kula Chetri Bohikhowa Gaon, Dhansirimukh Bokakhat,Golaghat Padma Nath Doley Branch Post Master Golaghat Sanki Doley Palasguri Dhansirimukh Hari Chandra Pegu IWD Casual Employee Pradip Talukdar Vill-Palasguri P.O.-Dhansirimukh Rakesh Chinte President, Polasbari Village Defence Party Pradip Deka WRD Employee Bokakhat Pradip Pujari Bankoal, Bokakhat Bipul Das Bokakhat Dist.- Golagha	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 isssues other than those discussed so far	○ Project is very much necessary. Erosion is a major problem. Dhansiri flood is also severe. ○ The Bankoal-Moriahola area needs to be protected. Kaziranga NP should be saved from erosion and flood. ○ Project will benefit the entire area including KNP. Should start early. All project affected people should get compensation before starting of the project. ○ The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the KNP. Should be properly done. Benefits will be there. The KNP needs urgent protection. ○ The govt. should take up the project. If properly done it will benefit people and KNP. ○ No adverse impact visualized. Will help to protect the area from erosion and flood. ○ Our agriculture productivity will improve. ○ Land will be protected. KNP will be secured from erosion. ○ This is a good project initiated by the Government and local people will be benefited.
2/03/2008	Hemen Doley Bankual Bali Chapori **Profession**: farmer Rabison Kamar Bholukaguri **Profession**: farmer Dangor Pegu Bankual Goan Profession: Fisherman Kishore Doley Riri Goan Prof: farmer	Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra If the proposed project will help in providing safety to the people , their property and environment of the area Any significant negative	○ The present embankment is very weak; hence the proposed embankment is very essential for them. Every year floodwater entered the houses and paddy field of the person. His land is situated inside the embankment. He seeks compensation from the Govt. ○ Embankment will benefit the people inhabited there, because of the regular flood. This embankment also protect the human life and as well as their livelihood. ○ People who reside inside the embankment had asked for compensation. ○ Government must be compensated for their land or alternative land should be allotted in nearby safe place.

Date	Name and address of Persons Consulted	Topics of Discussion	Important Outcome
		impact of the project on the overall environment of the area Possible impacts of the Project on Agriculture, Wetlands, Drinking Water & Local Economy Suggestion or comment on isssues other than those discussed so far	○ 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 loss their land during this project.

Consultations Organized for the IEE

Date	Area	Topic of Discussion	Important Outcome
13.02.15	Kaziranga Reach, WRD office, Circle Office	1.Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra If the proposed project will help in providing safety to the people , their property and environment of the area Any significant negative impact of the project on the overall environment of the area 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 KNP. Should be properly done. Benefits will be there.
Month of February, 2015	Different villages under Kaziranga Reach on the south Bank	1.Regarding any specific problem(s) related to environment as a result of flood & erosion of theBrahmaputra If the proposed project will help in providing safety to the people , their property and environment of the area Any significant negative impact of the project on the overall environment of the area 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 KNP. Should be properly done. Benefits will be there both for peoples life and agrarian economy.
July 2015	Effected villages within the benefited area of Kaziranga Reach on the south Bank	Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra If the proposed project will help in providing safety to the people , their property and environment of the area	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

		Any significant negative impact of the project on the overall environment of the area Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy Suggestion or comment on isssues other than those discussed so far	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 loss their land during this project.
9th November, 2015	People from different villages came to Japoripathar 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)	Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra If the proposed project will help in providing safety to the people , their property and environment of the area Any significant negative impact of the project on the overall environment of the area Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy Suggestion or comment on isssues other than those discussed so far Mitigation measures proposed by WRD were discussed Grievence redressal Mechanism	- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the KNP. 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. KNP will be secured from erosion. - So far local prople were satisfied with the plan of the mitigation measures - They also supported the grevence redressal mechanism.
8th February, 2016	People from different villages came to Tamulipatharina School for public Hearing and in Dhansirimukh, Agoratoli. Attended by School teachers, officers from the WRD, Bokakhat; FREMAA, PMC, Village headman, etc. (List of the participants with their signature is attached below)	Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra If the proposed project will help in providing safety to the people , their property and environment of the area Any significant negative impact of the project on the overall environment of the area Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy Suggestion or comment on isssues other than those discussed so far Mitigation measures proposed by WRD were discussed Grievence redressal Mechanism	- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the KNP. Should be properly done. Benefits will be there. - all the drainages to be maintained - Increase of forest cover by plantation - No adverse impact visualized. Will help to protect the area from erosion and flood. -Our agriculture productivity will improve. - Land will be protected. KNP will be secured from erosion. - So far local prople were satisfied with the plan of the mitigation measures - They suggested to collect the earth from outside the locality -They also supported the grevence redressal mechanism.

9th November, 2016	Mani Doley, Babu Doley, Bihuram Singthe, Rupa Kardong	Dransirimukh	- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the KNP. Should be properly done. Benefits will be there.
	Hireswar Doley, Monding Pasung, Bogiram Doley	Dhansirimukh Bamungaon	-No adverse impact visualized. Will help to protect the area from erosion and flood. -Elephant deprade their crops.
	Jallal Pegu, Surya Kumar Pegu		Embankment will benefit the people inhabited there, because of the regular flood. This embankment also protect the human life and as well as their livelihood. - Elephant, wild buffalo and pig destry their crops.
	Mani Kumar Sazo, Sarpanti Kutum	Bamungaon , Near Mohkhuti camp	Land will be protected. KNP will be secured from erosion.
	Gunajit Talukder, Range Office Imdad Hussain, FGD Tapanjyoti Gogoi, FRI	Eastern Range, Agoratoli	- Details of the labours used under construction to be submitted to Range Office so that they can also monitor wherether any of one is involved in any illegal activities. -He also suggested to issue identity cards to the workers, so that they can be checked/ verified any time. -For patrolling the embankment will be very useful for the Forest Department. -To reduce human wildlife conflict in the form of depredation can be minimized with the support like crackers, rubber bullets, Search lights, etc from the project. -All the wallowing areas are inside the park boundary. -For constrant monitoring of the works CC cameras will be helpful. -In certain areas of the park there are invasive species like Mimosa. During February they are cut and burned alongwith the grassland management practice. -There is no invasive species outside the Park along the embankment.

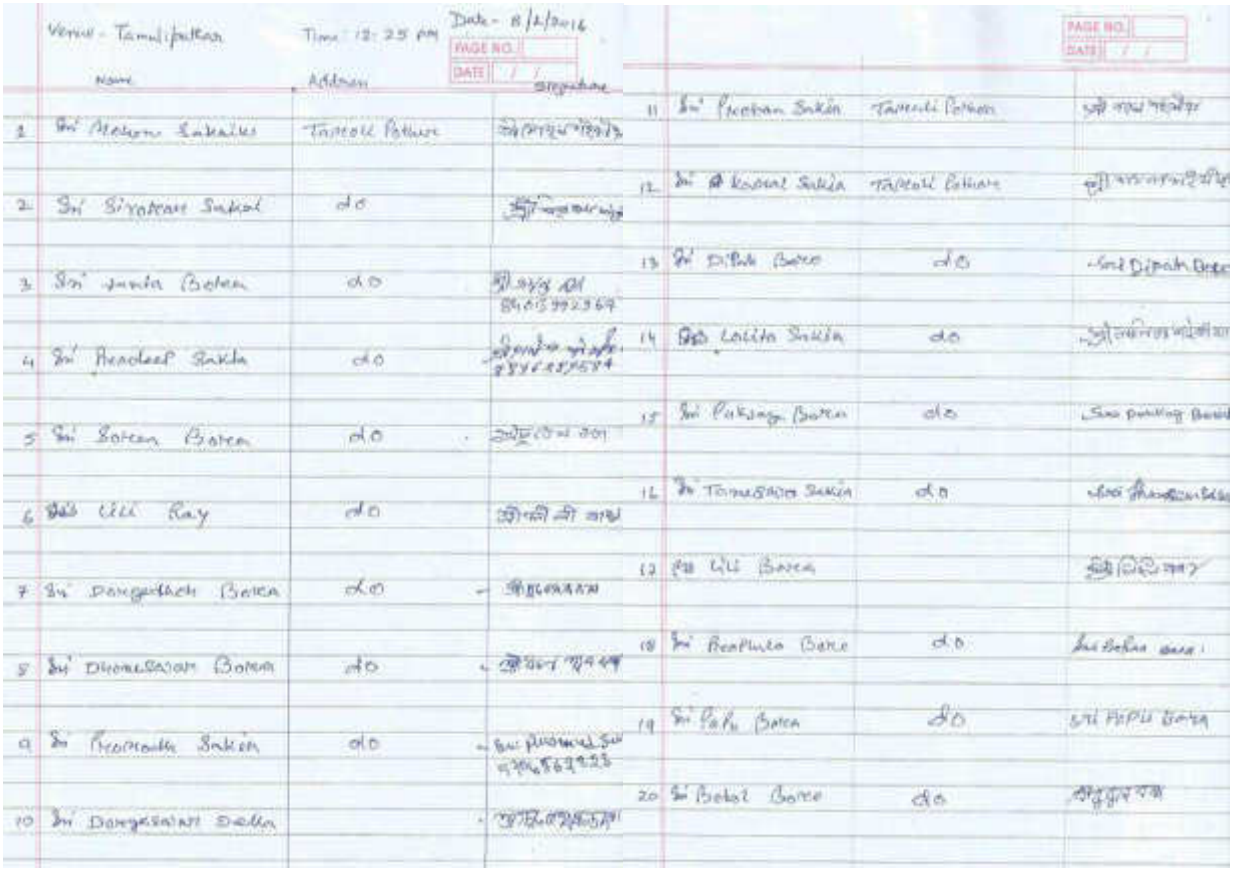
Attendance sheet of the recent public hearing at Japoripathar School, Kaziranga Sub project area.

9th November, 2015

Meeting: KAZIRANGA SUB PROJECT Venue · Dibbdubpathar School Date: 09/11/15

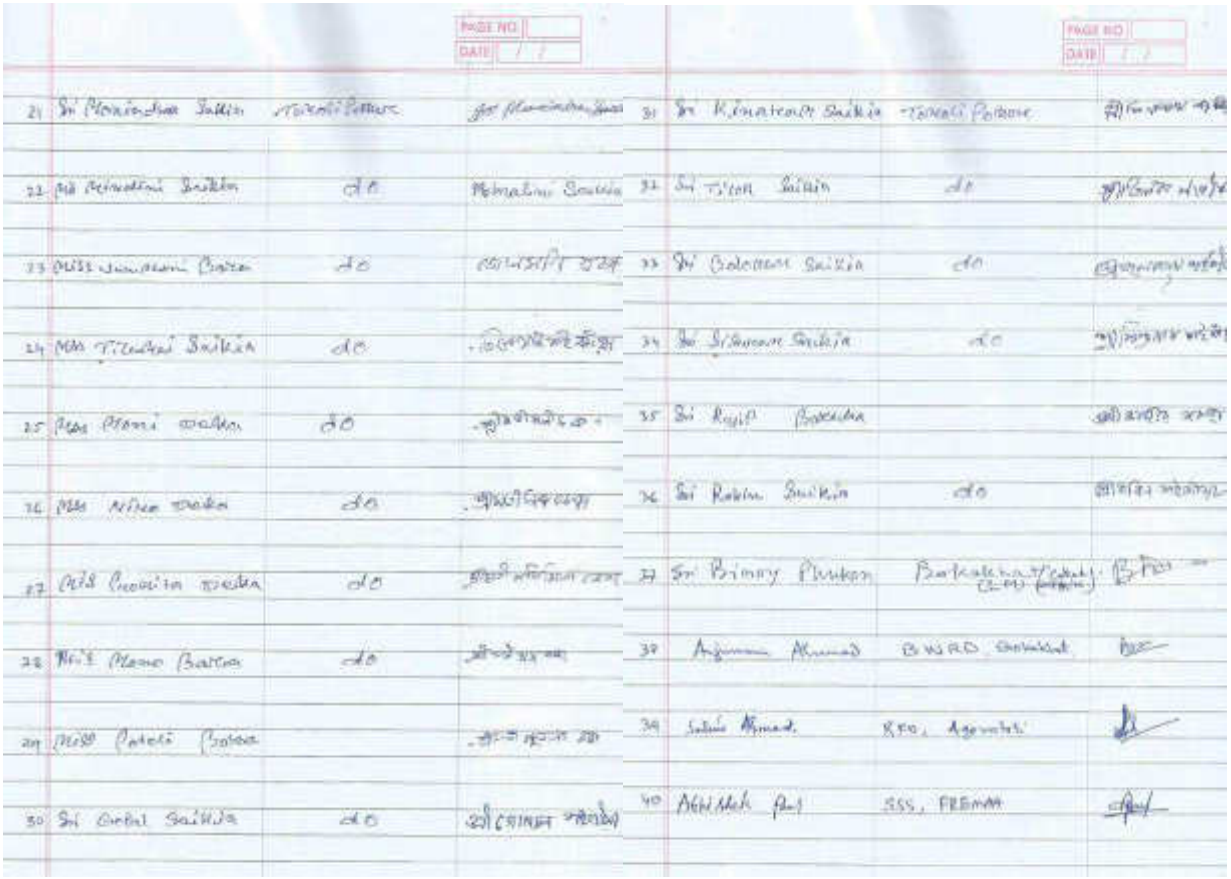
Sl No	Name	Designation	Address (with contact no)	signature
1	P. Konwar	DEO (PM)	9435036074	9.11.15
2	A.J. Chetia	DEO (T)	8011240936.	A.J. Chetia
3	Dipak Baborno.	Sub-Engr	9954247138	
4	Dr Jayanta Das	NES, PMC	9435406966	
6	Anjuman Ahmed.	J.E.	Bokakhat W.R. Sub-Div.	
7	Lokhan Ch. Das	Teacher	8011573193	
8			9706791238	
9	NARJAHAN	Teacher	9954646762	
10				
11	Om PRATYUSH Sonar			
12	Bipul Das	Sub-Engg.	W.R. Sub-Divn. BKT. 99540-26393	
13	Dwijen Bora	"	7086464273	
14	Reshu Das	See Assistant	Bokakhat WR Sub division	
15	Golap Hazarika.	F.E.H.W	9859689228	
16	Shri Ranjeet Bhumij		- Dibbloo pathar	
17	Shyamlal Pokhrel	teacher	Japoripathar NE. 9854673656	
18				
19		G.S.D.C.C	9954424547	
20			9435766402.	
21				

Attendance sheet of the recent public hearing at Tamulipathar & Dhansirimukh 8th Feb, 2016



Venue - Tamulipathar Time: 12:25 PM Date - 8/2/2016

	Name	Address	Signature
1	Sri Mohan Sakalia	Tamuli Pathar	
2	Sri Sivaram Sakal	do	
3	Sri Jamla Boken	do	
4	Sri Headleaf Sakia	do	
5	Sri Boken Boken	do	
6	Deb Ull Ray	do	
7	Sri Dangarbach Boken	do	
8	Sri Dhoneswar Boken	do	
9	Sri Promoda Sakia	do	
10	Sri Dangeswari Dalla		
11	Sri Pradan Sakia	Tamuli Pathar	
12	Sri Kanwal Sakia	Tamuli Pathar	
13	Sri Dipak Boro	do	
14	Lalita Sakia	do	
15	Sri Pakiaj Boken	do	
16	Sri Tonneswar Sakia	do	
17	Deb Ull Boken		
18	Sri Beaplata Boro	do	
19	Sri Papu Boken	do	
20	Sri Bekal Boro	do	



63	Sri Haresawar Gam	Bahikhowa gaon	[illegible]
64	Sri Tarun Kutum	Bahikhowa gaon	[illegible]
65	Sri Naram Pegu	Bahikhowa gaon	[illegible]
66	Sri Lalit Patgiri	Badoguri	[illegible]
67	Sri Bolen Gam		[illegible]
68	Sri Kamala Gam	Barman gaon	[illegible]
69	Sri Debasen Gam	Barman gaon	[illegible]
70	Sri Dalo Pan Patgiri	Badoguri	[illegible]
71	Sri Ganesh Kutum		[illegible]
72	Sri Durbajoty Hazarika		[illegible]
73	Sri Akash Pasury		[illegible]

	Name	Address	Signature
41	Rashida Barua (A.D)	FREMAA (SHY)	[illegible]
42	Sri Ananta Patgiri	Dhunaguri Dipti 'Dagaon'	[illegible]
43	Sri Bhinde Saikia	Dibalo Pathar	[illegible]
44	Sri Khagen Gam		[illegible]
45	Sri Tiran Borah		[illegible]
46	Sri Bartan Saikia	Taranali Pathar	[illegible]
47	Chitra Saikia	Taranali Pathar	[illegible]
48	R Gam	NGO	[illegible]
49	B.N. THAKURIA	EO(?), FREMAA	[illegible]
50	P. Konwar	EO(NT), FREMAA	[illegible]
51	Mahendra Khaund	W.R. Sub Division, [illegible]	[illegible]

	Name	Address	Signature
52	[illegible]	[illegible]	[illegible]
53	Sri Bikash Kutum	Barman gaon	[illegible]
54	Sri Batram Ali Mili	do	[illegible]
55	Sri Tapan Chutia		[illegible]
56	Mahendra Gam		[illegible]
57	Sri Horeish Pegu		[illegible]
58	Sikanta Gam		[illegible]
59	Sri Lita Pegu		[illegible]
60	Sri Jayanta Kataky		[illegible]
61	Nami Mahanta		[illegible]
62	Anil Patiri		[illegible]

74	[illegible]	Barman gaon	[illegible]
75	Sri Vetty Mili	Barman gaon	[illegible]
76	Sri Sarbeswar Pegu		[illegible]
77	Sri Rasiyam Pegu		[illegible]
78	Sri Lambal Kataky		Sri Lamgui Kataky

Appendix 15: Environmental Management Plan (EMP)

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
Climate change	increase frequency of devastating floods	The entire sub-project design is focused towards increasing flood resilience	Entire subproject area	Project life	Entire sub-project cost	FREMAA	WRD
Change in Landuse	Loss of agriculture land	Use of uncultivated areas near embankments only for storage and/or handling of construction materials, and construction camps	Construction sites andservice areas throughout the reach	During design and construction phase	Part of const'n cos	Contractor	FREMAA
		No dumping of construction waste on agricultural land	Entire subproject area	const'n. phase	Part of const'n cost	Contractor	FREMAA
		Land used for construction camps shall made reusable/ cultivable after closer of construction camp	Sites used as Construction camp	Post const'n.	Part of const'n cost	Contractor	FREMAA
		All efforts during the design stage shall be made to minimize the tree felling requirement.	Entire projectarea	const'n. phase	Included in design engineering cost	Engineering Team/WRD Field Officer	FREMAA
	Loss of homestead plantation	Compensatory plantation shall be started during construction phase parallel to the construction activities(1:3)	Entire project area	const'n. phase	2,716,235	WRD-SIO	FREMAA
		Monitoring of tree felling (census of trees, their numbering etc. based on engineering design)	Entire project area	const'n. phase	Part of payment to DFO	Independent agency	FREMAA
Borrow area location and rehabilitation	Loss of agricultural land and homestead plantation due to borrowing earth from country side of embankment	Borrow pits shall be preferred on river side to embankment as these can get silted in the course of time or earth from retired Embankment	Identifiedlocations for borrowing of earth	const'n. phase	Part of const'n cost	Contractor/WRD Field Officers	FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
	Permanent disfiguration of land	Use of waste land or excavation or enlargement of existing land or any hump above ground level for borrowing of	Identified locations for borrowing of earth	const'n. phase	Part of const'n cost	Contractor	WRD and FREMAA
	Seepage to the foundations of embankment	Earth borrowing away from the embankment		const'n. phase	Part of const'n cost	Contractor	FREMAA
		Strictly following WRD guidelines with respect to borrow area location and rehabilitation	Entire project area	const'n. phase	Part of const'n cost	Contractor	WRD and FREMAA
Change in Land use & Borrow Area Rehab'n.	- Encroachment on embankment for habitation and cultivation - Cutting of embankment to create approach to river side - Non-rehabilitation of borrow areas	- Provision shall be made in the embankment design for providing access to river bank close to the habitats. - Construction contractors shall ensure rehabilitation of borrow areas before handling over the project.	Entire project area and Borrow Areas	Operation Phase	Part of WRD Budget	Contractor, WRD (Field Staff)	WRD
Construction material sourcing (Quarrying)	Illegal quarrying may lead to landuse change, unstable rock formation, air and noise pollution	Aggregates required for construction of embankment and roads shall be procured from quarries approved by SPCB.	River and Hill Quarries approved by Assam Govt.	const'n. phase	Part of const'n cost	Contractor	FREMAA
		Air and noise emissions from quarries shall be well within the prescribed limits for the protection of workers health	Quarrying sites	const'n. phase	Part of const'n cost	SPCB	WRD
		Stone crushers, if required, shall be set up only after consent from SPCB and taking adequate measures for air pollution control.	Location of stone crushers	const'n. phase	Part of const'n cost	Contractor	FREMAA and SPCB
Soil erosion	Soil erosion from construction sites during monsoon season	Opening of borrow areas near the embankments shall not be done during monsoon season	Identified areas for borrowing earth	construction phase	Part of const'n cost	Contractor	FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
	Loss of topsoil	Identification of potential erosion zones during construction phase	Piling of topsoil for later use as landscaping and turfing of embankments	Especially during monsoon season	Part of const'n cost	WRD Field Officers	FREMAA
		Stabilization of soil around the approach roads/ slopes by turfing and tree plantation in ROW	Along the embankment and approach roads	Especially before monsoon starts	Part of const'n cost	Contractor	FREMAA
		Slope stabilization measures on the embankment like selection of less eroding materials	As suggested by the engineering team	const'n. phase	Part of const'n cost	Contractor	FREMAA
Soil compaction	Soil compaction round construction sites, haulage roads,construction camps,anworkshops due to transportation of man, machine, and materials	Movement of construction vehicles, machinery and equipments in embankment site and pre-defined haulage road	Construction material dumping sites and construction sites	const'n. phase	Part of const'n cost	Contractor	FREMAA
	Construction waste handling	Adequate provision for approach roads capable of handling movement and haulage of heavy vehicles and machines	Approach roads used for material handling	const'n. phase	Part of const'n costt	Contractor	FREMAA
Soil contamintn.	Soil contamination around construction sites , machine maintenance areas, fuelling stations, construction camps, hot mix plant and haulage roads	Fuelling and maintenance of construction machinery and vehicles shall be carried out at designated place with proper arrangement of waste collection and disposal.	Fuel storage and workshop areas	const'n. phase	Part of const'n cost	Contractor	FREMAA
		Fuel storage and refuelling sites to be kept away from drainage channels.	Fuel storage And workshop areas	const'n. phase	Part of const'n cost	Contractor	FREMAA
		Unusable debris to be dumped in designated places.	Identified inert material dumping sites	const'n. phase	Part of const'n cost	Contractor	FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
		Provision of oil interceptors	At fuel handling and workshop areas	const'n. phase	Part of const'n cost	Contractor	FREMAA
		Waste oil shall be sold off to recyclers authorized by SPCB/ MoEF.	At fuel handling and workshop areas	const'n. phase	Part of const'n cost	Contractor	FREMAA
Site clearing etc	Contamination of soil from construction wastes and quarry materials	All spoils to be disposed off as desired and the site to be restored back to its original conditions before handing over.	Construction material handling areas and construction sites	post construction	Part of const'n cost	Contractor	FREMAA
		Non-bituminous wastes from construction activities to be dumped in borrow pits and covered with a layer of the conserved topsoil.	Inert material dumping sites	Post cponstruction	Part of const'n cost	Contractor	FREMAA
		Bituminous wastes to be disposed off in identified dumping sites.	Identified dumping sites	After completion of construction phase	Part of const'n costt	Contractor	FREMAA
Flood	Inundation during heavy flood	Adequate provisions of sluice gates shall be made.	In proposed embankment	During the construction phase	Part of const'n costt	Engineering team and contractor/WRD Field Officer	WRD
	Clogging of channels towards country side due to siltation	Natural drainage systems shall not be disturbed.	Country side of embankment in the buffer zone	Construction and operation phases	Part of const'n costt d WRD Budget during operation	Engineering team and contractor/WRD Field Officer	WRD and FREMAA
		Adequate provisions shall be made in engineering design to withstand extreme meteorological and geo-physical events	Southern part of the reach	During the construction phase as well as operation phase	Included in construction cost	WRD (Environmental Officers)	WRD and FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
Drainage system	Embankment acts like a barrier for the drainage of accumulating country side water into the Brahmaputra during monsoon season.	Provision shall be made to the extent possible not to obstruct the natural drainage.	Entire project area	During the detailed engineering design stage	Included in engineering design cost	Engineering Team	WRD and FREMAA
Upstream and downstream effects on river morphology	Reduction of flood absorption due to the flood plains of the reach Impact on charlands near to bank line	Erosion monitoring shall be carried out downstream as well. In case of impact on fringe areas of char, passive type of measures like porcupine screens shall be used.	Entire project area	Operation Phase	KNP operation cost, boats provided by FREMAA	KNP and FREMAA	WRD A
Effect on flow velocity/ discharge intensities	No significant change due to project intervention	Monitoring of flow shall be carried out at regular intervals using field data as well as satellite remote sensing data.	At upstream and in between the reach	Operation Phase	WRD Budget	WRD	WRD
Silt deposition and bed level change	Prevention in silt deposition on agricultural land due to breach of embankments	Monitoring of anti- erosion and river training works at regular intervals	At upstream and in between the reach	Operation phase	WRD Budget	WRD	WRD
Impacts from external factors such as climate change, upstream dam construction, and watershed devt.	Design parameters may need to be changed over the years Impacts may include reduced discharge, artificial change in discharge volumes, reduced sediments	Systematic monitoring of hydrology, morphology, and sediment transport with acquisition of data Establishment of information network of discharges from upstream reservoirs Developing capacities in WRD to cope with changes in environment	Subproject reach in particular, but also include basin wide information and tributaries	Operation phase	Included in data and knowledge development component of IFRERM ASSAM	WRD	WRD
Impacts of morphological changes to subproject areas	Upstream and downstream erosion process may affect the sustainability of subproject structures	Systematic monitoring of morphology and sediment transport, with establishment of short term prediction models. Preparation and implementation of protection measures to prevent outflanking of structures	Subproject reach in particular, but also include basin wide information and tributaries	Operation phase	Included in data and knowledge development component of IFRERM ASSAM	WRD	WRD
Water quality	Impact on surface and ground water quality as it affects the adequate supply of drinking water to workers at construction camps and construction	Adequate supply of drinking water to workers.	At construction camps	const'n. phase	Part of const'n costt	Contractor	FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
	Contamination of water due to construction waste	Septic tanks shall be provided to treat the domestic sewage from construction camps.	Sites At construction camps	const'n. phase	Part of const'n costt		
	Contamination of water from fuel and lubricants	Construction work close to the channels or other water bodies to be avoided.	Entire subproject area	const'n. phase	Part of const'n costt	Contractor	FREMAA
		Construction of interceptor drains and silt traps to prevent water pollution due to increased siltation and turbidity.	Fuel handling	const'n. phase	Part of const'n costt	Contractor	FREMAA
		Oil and grease traps to be provided at fuelling locations, to prevent contamination of water Slopes of embankment leading to water bodies to be modified and careened so that contaminants do not enter the water channel/water body.	workshop areas	const'n. phase	Part of const'n costt	WRD and Officer WRD Field Officer	FREMAA
		Water quality to be monitored as envisaged in the environmental monitoring plan.	As per monitoring plan	const'n. phase	Included in the monitoring costs	WRD (Environmental Division)	FREMAA
		Sanitation facilities shall be provided	Entire Project Benefit Area	Operation Phase	WRD to Initiate with concerned civic authorities	WRD (Environmental Division)	WRD
Air Environment	Change in air quality due to construction activities	Approach roads shall be paved and widened	Approach roads to construction sites	const'n. phase	Part of const'n costt	Contractor	FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
		All slopes and embankments to be turfed as per best engineering practices to minimize the dust generation	Construction area	const'n. phase	Part of const'n costt	Contractor	FREMAA
		The hot mix plants, crushers and batching plants to be sited at least 500 m in the downwind direction from the nearest human settlement.	Construction area	const'n. phase	Part of const'n costt	Contractor	FREMAA
		Hot mix plants shall comply with applicable National/State Pollution Control Board Standards fro emissions from hot mix plants.	Construction area	const'n. phase	Part of const'n costt	Contracto and SPCBr	FREMAA
		Fugitive emissions from handling of construction material, storage as well as from transportation shall be taken care.	Construction area	const'n. phase	Part of const'n costt	Contractor and SPCB	FREMAA
		Dust Suppression by water sprinkling	Construction and storage sites	const'n. phase	Part of const'n costt	Contractor and SPCB	FREMAA
		Monitoring of Ambient Air Quality	near sensitive locations/ human settlements near to construction sites, crushers and hotmix plants Approch roads	During the construction period as per environmental monitoring plan	Included in the monitoring costs	Contractor	FREMAA
		Speed restriction, surface improvement and surface treatment shall be taken as options for control of emissions from unpaved roads.	Entire Project Area	During the construction period	Part of const'n costt	Contractor	FREMAA
	Change in air quality due to traffic	Plantation along the embankment Turfing of the embankment slopes Regular maintenance of the road on the top of embankment as well as approach roads.	Entire Project Area	Operation Phase	Included as part of regular Maintenance costs	WRD (Environmental Officer)	WRD

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
Noise	Increase in sound pressure levels due to construction machineries, vehicles etc.	Options of noise control by site controls, scheduling of project activities	At all construction sites	const'n. phase	Part of const'n costt	Contractor	FREMAA
		Protection devices (ear plugs or ear muffs) to be provided to the workers operating in the vicinity of high noise generating machines.	At all construction sites of high noise intensities	const'n. phase	Part of const'n costt	Contractor	FREMAA
		Construction equipments and machinery shall be fitted with silencers and maintained accordingly.	Construction sites	const'n. phase	art of const'n cost	Contractor	FREMAA
		Construction of temporary noise barriers near the sensitive areas, e.g. schools	At identified sensitive locations near the construction sites	Before start of construction activities near sensitive locations	Included in construction cost	Contractor	FREMAA
		Noise monitoring as per monitoring plan.	As per monitoring plan	Once in every year	Included under Monitoring Costs	WRD (Environmental Division)	WRD and FREMAA
Disturbance to vegetation	Cutting of trees in core zone during project intervention	Minimization of tree cutting while designing the embankment	Entire project site	const'n. phase	Part of const'n costt	Contractor, DFO	FREMAA
		Compensatory tree plantation preferably on the basis of 3 trees plantation against each tree cut	Entire project site and nearby areas	Starting from construction phase	Already indicated above	Contractor, DFO	FREMAA
Animal distribution/ migratory route and Endangered Species	Impact on fish breeding sites No Adverse Impact of Endangered Species	Construction activities shall be restricted during fish breeding period (May to August) at breeding sites. Due to sensitivity of Dolphins with polluted water, construction waste should not dumped near the river bank	Identified breeding sites	const'n. phase	Part of const'n cost	Contractor, DFO	FREMAA
Fishig activitie/ productivit, Migratoy Route	Impact on boat ghats. No Migratory Route near the embankment	Adequate provision shall be made in the design to ensure access to the fish landing sites/ boat ghats	12 fish landing sites identified along the reach	Starting from construction phase	Already indicated above	Contractor, DFO	FREMAA

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
	Temporary flushing of fish species towards deeper parts of the river	Undisturbed movement of the fishermen shall be provided	Along the riverbank	Starting from construction phase	Already indicated above	Contractor, DFO	FREMAA
Spawning and Breedig Grounds/Pond Fisheries	Disturbance on breeding and spawning grounds. No Adverse Impact on Pond Fisheries	Restriction of construction activities near the identified breeding and spawning grounds during the breeding period of april to august Fish productivity can be improved substantial with use of better fish culture and increasing the capacity of fish ponds	At identified spawning and breeding grounds	During April to august in construction phase	-	Contractor	FREMAA
Habitat fragmentation	Inappropriate opening of the sluice gate	Appropriate management to be made for the operation of the sluice gates	Project Benefit Area	Operation Phase	WRD Budget-	WRD and KNP	WRD
Demography	Pressure on natural resources and nearby community due to establishment of construction camps	Construction camps shall be supported with all basic amenities such as drinking water, fuel, sanitation facilities etc.	Construction	const'n. phase	Part of const'n costt	Contractor,	FREMAA
Establishments		Temporary noise barriers shall be installed close to schools and places of worship	Near identified sensitive sites	const'n. phase	Part of const'n costt	Contractor,	FREMAA
Socio-economic impact	Impact on fish landing sites	Training programmes for agriculture and fish production improvement	Project buffer zone	During construction phase	FREMAA Budgetr	FREMAA	WRD
		Appropriate provisions shall be made to provide alternate fish landing stations so that economic activities of the fishermen can not disturb during project intervention	Identified fish landing sites	const'n. phase	Part of const'n costt	Contractor,	FREMAA
Anti Poaching strategy, minimize human wildlife conflict	Poaching in the park	Construction of 3 watch towers and 1 camp with thermal camera, communications, and forest rangers Procurement and operation of monitoring boats by KNP	Along the Park Boundary	During construction phase	Tower and camp part of EMP cost estimated at US$0.281M, KNP budget for operation	FREMAA and KNP	WRD

Environmental Issues/ Project Components	Environmental Impacts	Remedial Measures	Approximate Location	Time Frame	MitigationCost (Rs.)	Institutional Responsibility	
						Implemt'n	Superv'n
		Laborers caught poaching will be turned over to the KNP and upon conviction the penalty for hunting is imprisonment for a period ranging from a minimum of three to a maximum of seven years with fines not less than 10,000 rupees.					
Safety	Risk of accidents and safety due to narrow roads and encroachment of people near construction areas	Adequate lighting and fluorescent signage shall be provided at construction sites.	Construction sites and approach roads	const'n. phase	Part of const'n costt	Contractor,	FREMAA
		Signage in local language	Construction sites and approach roads	const'n. phase	Part of const'n costt	Contractor,	FREMAA
		Setting up of speed limits and speed breakers	Construction sites and approach roads	const'n. phase	Part of const'n costt	Contractor,	FREMAA
		Personal protective equipments for workers	At construction sites	const'n. phase	Part of const'n costt	Contractor,	FREMAA
		Health check up camps for workers	At construction camps	const'n. phase	Part of const'n costt	Contractor,	FREMAA

Appendix 16: Environmental Monitoring Plan (EMOP)

Environmental Component	Program phase	Parameter	Standards	location	Duration/Frequency	Cost (Rs)	Implementation	Supervision
Terrestrial and Aquatic Fauna	Construction	Surveillance audit for status of fish species, their movement and breeding grounds. Terrestial fauna assessment will cover movement, population, and mortality.	None specific	Near the identified spawning and breeding grounds along the reach	Before breeding season and during the breeding season (During construction stage)	50,000	Independent fisheries expert	WRD and FREMAA
	Operation	Terrestrial and aquatic fauna status benefit assessment of the support during the Program as a whole	None Specific	Fish landing sites, breeding grounds, and near the core zone of the embankment	2 years after construction	Part of WRD Budget	Independent terrestrial and aquatic experts	WRD and FREMAA
Fisheries	Construction	Fish productivity	None Specific	Floodplains, beeis, rivers, and ponds	Once a year throughout the construction	25,000	Survey by fisheries experts	WRD and FREMAA
	Operation	Fish productivity	None Specific	Floodplains, beeis, rivers, and ponds	Once a year throughout the construction	Part of WRD budget	Survey by fisheries experts	WRD and FREMAA
Air Quality	Construction	PM10, PM2.5, Sox, CO	National ambient air quality standards	sensitive receptors within 300 meters from active construction site	12-hr sampling, every 2 weeks during construction	300,000 7,500 x2x 4 months x 5 sites	3rd party monitor hired by CSC	WRD and FREMAA
Hydrology	All phases	Water level, discharge, river cross sections	Central W, Commission, adapted to program needs	At program-specific locations	Regularly (monthly) during the flood season, in October and April, and as per adjusted CWC guidelines	Data and knowledge component	WRD	WRD and FREMAA
Morphology	All phases	River bathymetry, bank line developments, sediment transport,	Same as above extended to program	Same as above	Same as above	Same as above	WRD	WRD and FREMAA

Environmental Component	Program phase	Parameter	Standards	location	Duration/Frequency	Cost (Rs)	Implementation	Supervision
		flow velocity (through float tracking and cross-sectional surveys)	needs at the different sites					
Surface Water Quality	Construction	TSS, DO, Oil and Grease	As per IS 10500:1991	Brahmaputra River and wetlands and ponds	2x a month during construction phase of sluice gate 16/1	150,000 7,500x2x 5monthsx 2 locations (upstream, downstream)	3rd party monitor hired by CSC	WRD and FREMAA
Ground water and Drinking Water Quality	Construction	Arsenic	As per IS 10500:1991	Construction site, rehabilitation site, service areas.	weekly during construction phase f	576,000 (3,000x48x4)	Independent environmental laboratories approved by SPCB	WRD and FREMAA
Noise and Vibration	Construction	Noise level in dBA	As per national standards for noise	Near the construction sites and sensitive locations close to embankment	weekly during construction phase	144,000 1,500 x 96	Independent monitoring agency	WRD and FREMAA
Soil Erosion (inland erosion) and siltation	Construction	Visual check for soil erosion and siltation	-	Riverbank and river training structure	After first precipitation	Part of routine action of engineering team	WRD-SIO	WRD and FREMAA
	Operation	Study of soil erosion and siltation	-	River training structure, upstream and downstream of the reach	Once during first year of operation	Part of routine action of engineering team	WRD-SIO	WRD and FREMAA
Drainage Congestion	Construction	Visual check	-	Program benefit area	After 1 year of construction	Part of routine action of engineering team	WRD-SIO	WRD and FREMAA
	Operation	Visual check	-	Program benefit area	Once during first year of operation	Part of routine action of engineering team	WRD-SIO	WRD and FREMAA
Anti Poaching strategy and reducing human-wildlife conflict	Construction	For monitoring labour/ workers behaviour		Entire stretch of the program reach	Regularly	KNP Budget	KNP	KNP

AIFRERM= Assam Integrated Flood and River Erosion Risk Management, CWC= Central Water Commission, dbA-decibel, IS=Indian Standard, SIO= subproject management office, SPCB= State Pollution Control Board, WRD=Water Resources Department.

Source: Water Resources Department, State Government of Assam.

Appendix 17: Training[30]

No.	Target group	Subject (s)	Method	Time Frame
Planning, and Construction Phase[2]				
1	All WRD program staff	**Environmental Overview**: Environmental regulations and national standards, process of impact assessment and identification of mitigation measures, importance of EMP and monitoring, and monitoring methodology(Refresher training)	Lectures (by consultants and local training institutes) 40pax @ 1 day	Before implementation of the Tranche-2
2	Environmental engineers, field officers, contractor, supervision consultants	**Implementation of EMPs:** Basic features of an EMP, planning, designing and executing of environmental mitigation and enhancement measures, monitoring and evaluation of environmental conditions during construction and operation	Workshops and seminars (b y in tranche 2 consultants and trained PMU staff) 100 pax@1day	Before the construction begins
3	Environmental engineers, field officers, contractor, supervision consultants	**Environmentally Sound Construction Practices:** Soil conservation; vegetation protection; waste management and minimization in construction; pollution control at construction camps, construction sites, hot mix plants, and material transportation; devices and methods for construction sites and equipment; environmental clauses in contract documents and their implications; environmental monitoring during construction.	Seminars, lectures and site visits (by consultants and trained 100 pax@1day	Before the construction begins in tranche 2
4	Environmental engineers, field officers, contractor, supervision consultants	**Monitoring Environmental Performance during Construction:** Monitoring air, water, soil erosion., noise, and their effect on vegetation and fisheries; evaluation and review of results; performance indicators and their applicability; possible corrective actions; reporting requirements and mechanisms	Lectures, workshop, and site visits in tranche 2 (by consultants and trained PMU and SIO staff) 100 pax @ 1 day	During initial phases of construction
5	Construction laborers	**Waste Handling and Sanitation of Construction Sites and Construction Camps:**	Workshops and signage (by in tranche 2 consultants and trained SIO staff) 150pax@1 day	During initial phases of construction

Appendix 18: Environmental Budget (Estimated Budget)

		Item	Unit Cost	Nos	Total
1. Strengthening KNP Enforcement					
	Civil Works				
	a.	Construction of 3 watchtowers along the Brahmaputra Dyke	250,000.00	3	750,000.00
	b.	Base camp	2,000,000.00	1	2,000,000.00
	Equipment				
	a.	Long Range Thermal Camera, 4 camera each set w/ DVR for watchtower	90,000.00	3	270,000.00
	b.	Base camp furnitures (tables, desk, computer)	500,000.00	1	500,000.00
	c.	Solar Energy System 1kW PV module, 4 solar panels, PCU inverter, 2 batteries, 8m2 for watchtower	93,500.00	3	280,500.00
	d	Solar Energy System 2kW PV module, 8 solar panels, PCU inverter, 4 batteries, 16m2 area for basecamp	181,500.00	1	181,500.00
2. River Bank Erosion Monitoring					
	a.	14'x72'4' wood boat, 3.8L turbocharged diesel engine, staff cabin, toilet, radar control room, upper deck, front landing with ladder	764,500.00	2	1,529,000.00
3	Compensatory tree plantation				2,716,235.29
	1480 trees @ 1:3 replacement				
	Rs. 20 per sapling, Rs.500 for 3 year maintenance,				
	80% survival				
4	Monitoring				
	a.	Surveillance status of fish species including fish productivity			75,000.00
	b.	Air Quality (PM10, PM2.5, Sox)	4000	40	160,000.00
	c.	Noise Monitoring	1500	96	144,000.00
	d.	Surface Water Quality (TSS, DO, O&G) at Sluice Gate 16/1 Beel	7500	20	150,000.00
	e.	Groundwater monitoring for arsenic	3000	192	576,000.00
	c.	Surface water quality at 2 revetments (TSS, DO, O	7500	20	150,000.00
5	Training				
	a. environmental overview, 40pax, 1 day		40	3,000	120,000.00
	b. Implementation of EMP, 100pax, 1day		100	3,000	300,000.00
	c.	Environmentally sound construction practices, 100 pax, 1 day	100	3,000	300,000.00
	d.	Monitoring Performance, 40pax, 1 day	40	3,000	120,000.00
	d.	Waste Handling, 100 pax, 1 day	100	3,000	300,000.00
		Total		INR	10,622,235.29
				US$	171,326.38

Appendix 19: Clearance from National Wildlife Board, MOEF&CC

Excerpts from the minutes of the 31st meeting.

Minutes of 31st meeting of SC NBWL dated 12th & 13th Aug 2014

Ministry of Environment and Forests
Wildlife Division

Minutes of the 31st Meeting of the Standing Committee of National Board for Wildlife held on 12-13 August 2014 at Indira Paryavaran Bhawan, Jor Bag Road, New Delhi.

The 31st Meeting of the Standing Committee of National Board for Wildlife (NBWL) was held on 12-13 August 2014 in the Ministry of Environmental and Forests (MoEF), New Delhi. The meeting was convened under the chairmanship of Hon'ble Minister of State (Independent Charge) for Environmental, Forests and Climate Change. The list of participants is at Annexure-1.

At the outset, Hon'ble Chairman while welcoming all participants to the 31st Meeting of Standing Committee of NBWL mentioned that this meeting was being held after a long gap, due to the process of re-constitution of the National Board for Wildlife and its Standing Committee. He urged the participants that there was a need to take conservation alongside developmental activities and therefore, all the proposals that have been included in the agenda need to be looked into very carefully and judiciously. He also clarified that in case the Committee prescribes any conditions while recommending projects, care should be taken that the conditions are feasible for implementation and at the same time compliance of the conditions should also be closely monitored. The Chairman also pointed out that each case be discussed as per its merits. He then requested the Member Secretary to initiate the discussions on the agenda items.

The agenda items were then opened for discussion.

PROPOSALS WITHIN 10 KMS FROM BOUNDARY OF NATIONAL PARKS ANDSANCTUARIES

4. Proposal for strengthening the existing (embankment) from Moriaholla to Diffalupathar to avoid any beach resulting flash flood in eastern range of Kaziranga NP, Assam.

The Member Secretary briefed the Committee regarding the proposal. The Chief Wildlife Warden, Assam mentioned that the proposal was for strengthening the existing embankment from Moriaholla to Diffalupathar to avoid any breach resulting flash flood in eastern range of Kaziranga National Park and also in order to control flash floods inside the Park.

After discussion, the Standing Committee decided to recommend the proposal as it would help in controlling flash floods inside Kaziranga National Park. The Committee also decided that the following conditions, as stipulated by the State Chief Wildlife Warden be also complied with:

i. Entire work shall be executed under close supervision of park authorities.
ii. Top of the dyke shall be graveled.
iii. Three new sluice gates shall be constructed in order to regulate flow of water across the dyke.
iv. All the sluice gates shall be operated during high flood as well lean season jointly by the water Resources Department and Kaziranga National Park officials.
v. Material for porcupine works shall be transported through river route only

ANNEXURE-1

LIST OF PARTICIPANTS OF THE 31ST MEETING OF STANDING COMMITTEE OF NBWL HELD ON 12TH-13TH AUGUST 2014.

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1	Shri Prakash Javadekar Hon'ble Minister of State (Independent Charge) for Environment & Forests	chairman
2	Dr. V. Rajagopalan, Secretary, Environment & Forests	Invitee
3	Dr S. S. Garbeyal Director General of Forests & Special Secretary	Member
4	Shri A. K. Srivastava Addl. Director General of Forests (FC)	Member
5	Dr. V. B. Mathur Director, Wildlife Institute of India, Dehradun	Member
6.	Professor Raman Sukumar	Member
7	Shri Bharat Pathak, Director, GEER Foundation, Gujarat	Member
8	Dr. H. S. Singh	Member
9	Shri Rajendra P Agarwalla, PCCF (WL) & Chief Wildlife Warden, Tripura	Invitee
10	Shri Pradeep Vyas, Addl. PCCF (WL), West Bengal	Invitee
11	Dr. Atul K. Gupta, Pr. Chief Conservator of Forests & Chief Wildlife Warden, Tripura	invitee
12	Shri S. S. Sharma, Pr. Chief Conservator of Forests, Uttarakhand	Invitee
13	Shri D. K. Pandey, Addl. Pr. Chief Conservator of Forests, Andhra Pradesh	Invitee
14	Shri Pramod Krishnan, Conservator of Forests (WL), Palakkad, Kerala	Invitee
15	Shri Praveen Pandey, Pr. Secretary (Forests)	Invitee
16	Shri Amit Mallick, CCF&FD(PT), Kerala	
17	Shri Rupak De, PCCF cum Chief Wildlife Warden, Uttar Pradesh	Invitee
18	Shri S. N. Singh, Addl.PCCF & Chief Wildlife Warden, Rajasthan	Invitee
19	Shri A. K. Singh, Pr. CCF(WL) & Chief Wildlife Warden, Jammu and Kashmir	Invitee
20	Shri P. L. Chauhan, CCF (WL) South Shimla, Himachal Pradesh	Invitee
21	Shri Kailash Ch Bebarta, Addl.PCCF (WL)	Invitee
22	Shri Dhirendra Singh, Addl. PCCF & Chief Wildlife Warden, Punjab	Invitee
23	Shri C. N. Pandey, Pr. CCF (WL) & Chief Wildlife Warden, Gujarat	Invitee
24	Shri Narendra Kumar, Chief Wildlife Warden, Madhya Pradesh	Invitee
25	Dr Vivek Saxena OSD(Forests), Haryana Bhawan, New Delhi	Invitee
26	Shri Vinod Kumar, CF (WL), Gurgaon, Haryana	Invitee
27	Dr Rajesh Gopal, Member Secretary, NTCA	Invitee
28	Dr S. K. Khanduri, Inspector General of Forests (WL)	Invitee
29	Shri M. L. Srivastava, Deputy Inspector General of Forests (WL)	Invitee

Appendix 20: Design and Detailed Cost of the Anti-Poaching Camp

NAME OF THE WORK:- Construction of Anti-poaching camp cum Watch Tower at Eastern Assam Wild Life Division, Bokakhat for the year 2014-15.

Schedule of Rate:- **As per PWD Schedule of Rates for Building work for the year 2013-14.**
SPECIFICATION:- R.C.C. cum Assam type Building specification "A".
Estimated Amount:- Rs. 20,00,000.00 (Rupees Twenty Lakhs) only.

Sl. No.	Description of Items	Unit	Quantity	Rate	Amount
1/1.1 A (a)P-45	Earth work in excavation for foundation trenches of walls, footing of columns, steps etc. including refilling the quantity as necessary after completion of work and ramming etc. and removal of surplus earth with all lead lifts as directed and specified in following classification of soils including bailing out water where necessary as directed and specified. For Footing = 20x1.50x1.50x1.50= 67.50 m^3 For Gr. Beam= 1x(82.20-26x1.5) x0.33x0.35 = 4.99 m^3 Total = 72.49 m^3	m^3	72.49	108.82	7,888.00
2/2.1.1 (P-51)	Plain cement concrete works with agg. Sizes 13mm to 30mm in foundation bed for footing, walls, steps..... Including curing complete (shuttering where necessary shall be measured & paid specified). (a) In Prop 1:5:10 For footing of Column= 20x1.50x1.50x0.10 = 4.500 m^3 Gr Beam = 1x (82.20-26x0.25)x0.33x0.1 =2.498 m^3 Total =6.998 m^3	m^3	6.998	4,292.86	30,041.00
				C/O = Rs.	37,929.00

Sl.No	Description of Items	Unit	Quantity	Rate	Amount
				B/F Rs.	37,929.00
3/2.2.1 (P-52)	Providing and laying reinforced cement concrete works in prop. 1:1.5:3 including but excluding cost of form work and reinforcement for reinforced cement concrete work (form work & reinforcement will be measured & paid separately). a) In sub-structure. For footings = 20 x 1.40 x 1.40 x 0.20 = 7.840 m^3 20 x 0.15/3 {1.4^2+0.4^2+V1.4^2 x 0.4^2} = 2.680 m^3 For base of column=20 x 0.25 x 0.25x1.05 = 1.312 m^3 For Gr. Beam=1x(82.20-26x0.25)x0.23x0.25= 4.353 m^3 Total =16.185 m^3	m^3	16.185	6,063.65	98,140.00
	(b) In super-structure up to 1st floor. For column = 20 x 0.25 x 0.25 x 4.00 = 5.000 m^3 For Tie beam = 1x 0.20x0.25x 1.95 = 0.098 m^3 Slab Beam : 1 x 0.23 x 0.30 x 82.20 = 5.672 m^3 Slab : 1 x 7.00 x 10.50 x 0.12 = 8.820 m^3 : 1 x 3.25 x 6.25 x 0.12 = 2.438 m^3 Staircase : 22 x 1/2 x 0.36 x 0.21 x 1.15 = 0.956 m^3 Landing : 3x 1.20 x 1.20 x 0.12 = 0.518 m^3 Total =23.502 m^3	m^3	23.502	6,241.39	1,46,685.00
	c) In super-structure from 1st floor to 2nd floor. For column = 26 x 0.23 x 0.23 x 3.30 = 4.539 m^3 For Lintel= 1x 0.15x0.20x (67.50-0.23x18)= 1.901 m^3 Slab Beam : 1 x 0.23 x 0.30 x 96.50 = 6.659 m^3 Slab : 1 x 9.10 x 12.60 x 0.12 = 13.759 m^3 : 1 x 3.25 x 6.25 x 0.12 = 2.438 m^3 Staircase : 22 x 1/2 x 0.36 x 0.21 x 1.15 = 0.956 m^3 Landing : 1x 1.20 x 1.20 x 0.12 = 0.173 m^3 Total = 30.425 m^3	m^2	30.425	6,547.58	1,99,210.00
	d) In super-structure from 2nd floor to 3rd floor. For column = 8 x 0.23 x 0.23 x 3.30 = 1.397 m^3 Slab : 1 x 7.50 x 7.50 x 0.12 = 6.750 m^3 Slab Beam : 1 x 0.23 x 0.30 x 30.00 = 2.070 m^3 Staircase : 22 x 1/2 x 0.36 x 0.21 x 1.15 = 0.956 m^3 Landing : 1x 1.20 x 1.20 x 0.12 = 0.173 m^3 Total = 11.346 m^3	m^2	11.346	6,853.77	77,763.00
	e) In super-structure from 3rd floor to 4th floor. For column = 8 x 0.20 x 0.20 x 2.50 = 0.800 m^3 Slab : 4 x 2 x ½ x 3.75 x 4.10 x 0.12 = 7.380 m^3 Total = 8.180 m^3	m^2	8.18	7,159.96	58,568.00
				C/O Rs.	6,18,295.00

Sl.No	Description of Items	Unit	Quantity	Rate	Amount
				B/F Rs.	6,18,295.00
4/18.1.1/ P-297	Supplying, fitting & fixing in position reinforcement bars conforming to relevant I.S. code for R.C.C. work including bending, cutting, binding etc. complete. (b) ISI approved supper ductile TMT Bar (i) TATA/SAIL Quantity :- 16mm dia. For column : 20 x 4 x 9.105 x 1.58 = 1150.87 Kg. : 8 x 4 x 5.80 x 1.58 = 293.25 Kg. 12mm dia- : 20 x 4 x 9.105 x 0.89 = 241.37 Kg. : 8 x 4 x 5.80 x 0.89 = 165.18 Kg. 16mm dia. For Grade beam :1 x 5 x 82.20 x 1.58 = 649.38 Kg. Slab Beam :1 x 5 x 208.70 x 1.58 = 1648.73 kg. 12mm dia. Lintel : 1 x 4 x 69.45 x 0.89 = 247.24 kg. 10mm dia. Slab : 2 x 71 x 12.00 x 0.62 = 1056.48 kg. 8mm dia. : 2 x 106 x 7.00 x 0.39 = 578.76 Kg. 10mm dia. : 3 x 30 x 3.00 x 0.62 = 167.40 Kg. 8mm dia. : 3 x 30 x 5.25 x 0.39 = 184.28 Kg. 10mm dia. : 3 x 24 x 5.25 x 0.62 = 234.36 Kg. For footing jali:20x(10x2)x 1.30 x 0.62= 322.40 Kg. 8mm dia. stirrup 20 x 59 x{0.20 x 4 +4 x 9x 0.008}x 0.39= 500.70 Kg. 8 x 40 x {0.18 x 4 + 4 x 9x 0.008}x 0.39= 125.80 Kg. 548x{(0.18+0.20)x2+36x 0.008}x 0.39 = 223.98 Kg. 6mm dia. For stirrup For Lintel 464 x{(0.10+0.15)x2+36x 0.006}x 0.22 = 73.09 Kg. 8mm dia. Stirrup Slab Beam : 1x1392x{(0.18+0.25)x2+36x0.008}x0.39=623.23 Kg. 10mm dia. For Staircase 3 x 9 x 10.56 x 0.62 =176.77 Kg. Total = 8663.28 Kg. Added 5% for wastage (+) = 433.16 Kg. Grand total = 9,096.44 Kg. = 90.96 Qntl.	Qntl	90.96	6,902.86	6,27,884.00
				C/O Rs.	12,46,179.00

Sl.No	Description of Items	Unit	Quantity	Rate	Amount
				B/F Rs.	12,46,179.00
5/3.1.1 P-59	Providing form-work of ordinary timber planking so as to give a rough finish including centering, shuttering, strutting and propping etc. height of propping and centering below supporting floor to ceiling not exceeding 4.0 m and removal of the same for in situ reinforced concrete and plain concrete work in. (3.1.1.1) Foundation, footings, bases of column. (ii) Using 25 mm thick plank. Quantity :- For footing : 20 x 1.40 x 4 x 0.20 = 22.40 m^2 : 20 x 0.25 x 4 x 1.05 = 21.00 m^2 Total = 43.40 m^2	m^2	43.40	252.24	10,947.00
	(3.1.1.3) For columns (ii) Using 25 mm thick plank. Quantity :- 20 x (0.25 x 4) x 4.00 = 80.00 m^2 20 x (0.25 x 4) x 3.30 = 66.00 m^2 8 x (0.23 x 4) x 3.30 = 24.29 m^2 8 x (0.20 x 4) x 2.50 = 16.00 m^2 Total =186.29 m^2	m^2	186.29	364.01	67,811.00
	(3.1.1.2) For side of Grade beam (ii) Using 25 mm thick plank. Quantity :-1 x 2 x (82.20 - 26x0.25)x 0.250 = 37.85 m^2	m^2	37.85	341.90	12,941.00
	3.1.1.4) For side of beam and Lintel (ii) Using 25 mm thick plank. Quantity :- 1 x (0.30 x 2 + 0.23) x 208.70 = 173.22 m^2 2 x (67.50 - 0.23x18) x 0.20 = 25.34 m^2 Total = 198.56 m^2	m^2	198.56	202.44	40,196.00
	3..1.5) For Surfaces such as soffits of suspended floors.. (ii) Using 25mm thick plank Quantity :- Slab : 1 x 7.00 x 10.50 = 73.50 m^2 : 1 x 3.25 x 6.25 = 20.31 m^2 : 1 x 9.10 x 12.60 = 114.66 m^3 : 1 x 3.25 x 6.25 = 20.31 m^3 : 1 x 7.50 x 7.50 = 56.25 m^3 Total =285.03 m^2	m^2	285.03	429.93	1,22,543.00
6/4.1.7 (P-72)	112mm thick 1st class brick nogged wall in cement mortar in super structure above plinth up to 1st floor level. (a) In cement mortar in prop. 1:4 2 x (67.50 - 0.23x18)x 0.75 = 95.040 m^2 Deduction for Door : 4 x 1.00 x 0.75 =(-) 3.000 '' Parapet wall : 1 x 42.50 x 1.00 = 42.500 '' : 1 x 24.00 x 1.20 = 28.800 '' Total = 163.340 m^2	m^2	163.340	653.01	1,06,663.00
				C/O Rs.	16,07,280.00

Sl.No	Description of Items	Unit	Quantity	Rate	Amount
				B/F Rs.	16,07,280.00
7/24.1	Spilt bamboo diagonally woven wall tied with necessary bamboo kamis on both sides @300mm apart tied with galvanized wire/cane silt etc. complete as directed. 2 x (67.50 - 0.23x18)x 2.55 = 323.136 m² Deduction for Door : 4 x 1.00 x 1.35 =(-) 5.400 '' Deduction for windows:10 x 1.00 x 1.35 =(-) 13.500 '' Deduction for Ventilator:10x 1.00 x 0.45=(-) 4.500 '' Total = 299.736 m²	M²	299.736	176.07	52,775.00
8/6.2.2/P-108	15mm thick cement plaster in single coat on rough side of single or half brick wall for interior plastering up to 1st floor level including arises internal rounded angles, chamfers and rounded angles not exceeding 80mm in girth and finished even and smooth including curing complete as directed. i) In cement mortar prop. 1: 4. As per Item No. 6 = 163.340 m²	m²	163.34	147.23	24,049.00
9/6.2.3/P-108	15mm thick cement plaster in single coat on fair side of single or half brick wall for interior plastering up to 1st floor level including arises internal rounded angles, chamfers and rounded angles not exceeding 80mm in girth and finished even and smooth including curing complete as directed. i) In cement mortar prop. 1: 4. Slab : 1 x 7.00 x 10.50 = 73.50 m² : 1 x 3.25 x 6.25 = 20.31 m² : 1 x 9.10 x 12.60 = 114.66 m³ : 1 x 3.25 x 6.25 = 20.31 m³ : 1 x 7.50 x 7.50 = 56.25 m³ Total =285.03 m²	m²	285.03	145.70	41,529.00
10/9.1.2/P-175	Providing wood work in frames (chowkath) of door, windows, clerestory windows and other similar works wrought, framed and fixing in position in contact with C.C. or brick masonry walls including supplying, fitting & fixing with nails, screws, bolts & nuts complete with M.S. flat hold fast.) 1st class timber. Doors : 4 x 5.20 x 0.125 x 0.075 = 0.1950 m³ Window : 10 x 4.70 x 0.125 x 0.075 = 0.4406 m³ Ventilator :10 x 2.90 x 0.125 x 0.075 = 0.2719 m³ Total = 0.9075 m³	m³	0.9075	77474.00	70,308.00
11/9.9.2/P-181	Providing fitting and fixing full paneled doors / windows including oxidised M. S. butt hinges (100mm x 75 mm x 3.55 mm) with necessary screws. (C) with 1st class Gamari wood (35 mm thick) Doors : 4 x 2.015 x 0.850 = 6.8510 m²	m²	6.8510	2,500.00	17,128.00
				C/O Rs.	18,13,069.00

Sl.No.	Description of Items	Unit	Quantity	Rate	Amount
				B/F Rs.	18,13,069.00
12/10.2/P-199	Providing fitting and fixing M.S. gril of required pattern for Windows/openings with M.S. flats at required spacing in frame all round, square or round M.S. bars with round headed bolts and nuts or screws. II. Ornamental Grill. Quantity :- 150.00 Kg	Kg	150.00	101.34	15,201.00
13/13.2.3	Applying one coat of cement primer of approval brand and manufacture on new walls surface after thoroughly brooming the surface free from mortar droppings and other foreign matter and including repairing the surface even and sand papered smooth. Qnty:-Item No.8+ 9 = 163.34 +285.03 =448.37 m^2	m^2	448.37	40.66	18,231.00
14/13.2.3	(b) Finishing wall with water proofing cement paint of approved brand and manufacture and of required shade on new wall surface (two coats) to give an even shade after thoroughly brooming the surface to remove all dirt and remains of loose powered materials. Qnty:-Item No.8+ 9 = 163.34 +285.03 =448.37 m^2	m^2	448.37	46.75	20,961.00
15/9.9.7	Providing, fitting and fixing fully glazed windows including oxidised M.S. butt hinges (100mm x 75 mm x 3.55mm) with necessary screws b) With 1st class local wood (Hollock /Sundari) (iii) 30 mm Quantity ; 10 x 0.85 x 1.05 = 8.925 sq.m	m^2	8.925	1,689.94	15,083.00
16//5.1.1	Cement concrete works in topping 1:1:2 on R.C.C. floor finished with a floating coat of neat cement using cement slurry for bond @2.75kg. of cement per sq.m. of floor to be laid in panels including curing complete. Quantity :- : 1 x 7.00 x 10.50 = 73.50 m^2 : 1 x 3.25 x 6.25 = 20.31 m^2 : 1 x 9.10 x 12.60 = 114.66 m^3 : 1 x 3.25 x 6.25 = 20.31 m^3 : 1 x 7.50 x 7.50 = 56.25 m^3 Total =285.03 m^2	M^2	285.03	226.67	64,608.00
				Total =	Rs. 19,47,153.00
				Add. 2.72% for water supply and sanitary installation ...(+)	Rs. 52,963.00
				Grand Total =	Rs. 20,00,116.00
				Say	Rs. 20,00,000.00

(Rupees Twenty Lakhs) only.

29/09/2019
Asstt. Engineer
Bokakhat Town Committe
Bokakhat