Bio-Engineering or Non-Structural Techniques developed for mitigation of erosion at Majuli Island as a

Pilot Project

Presented By

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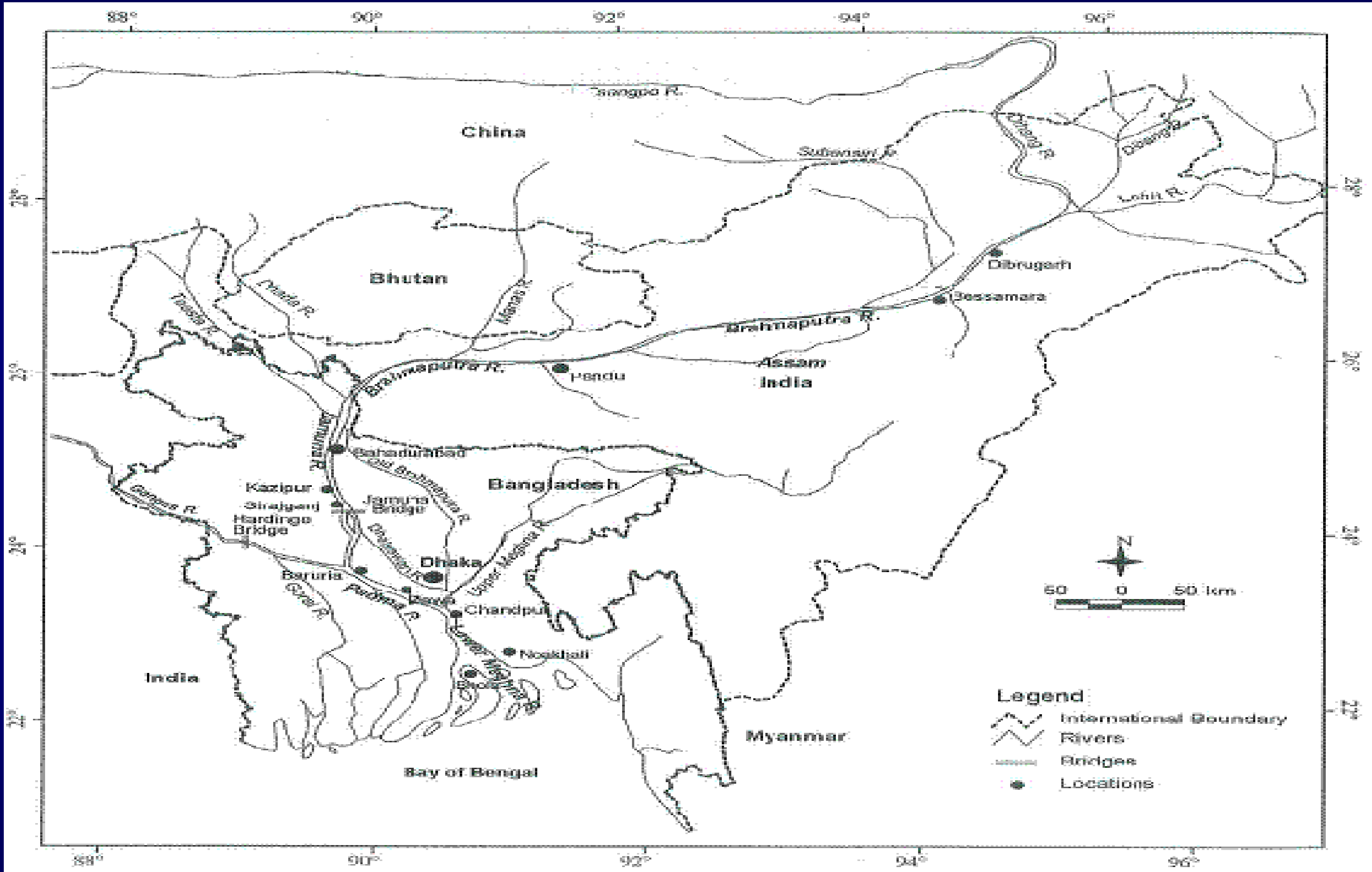
Presentation Outline

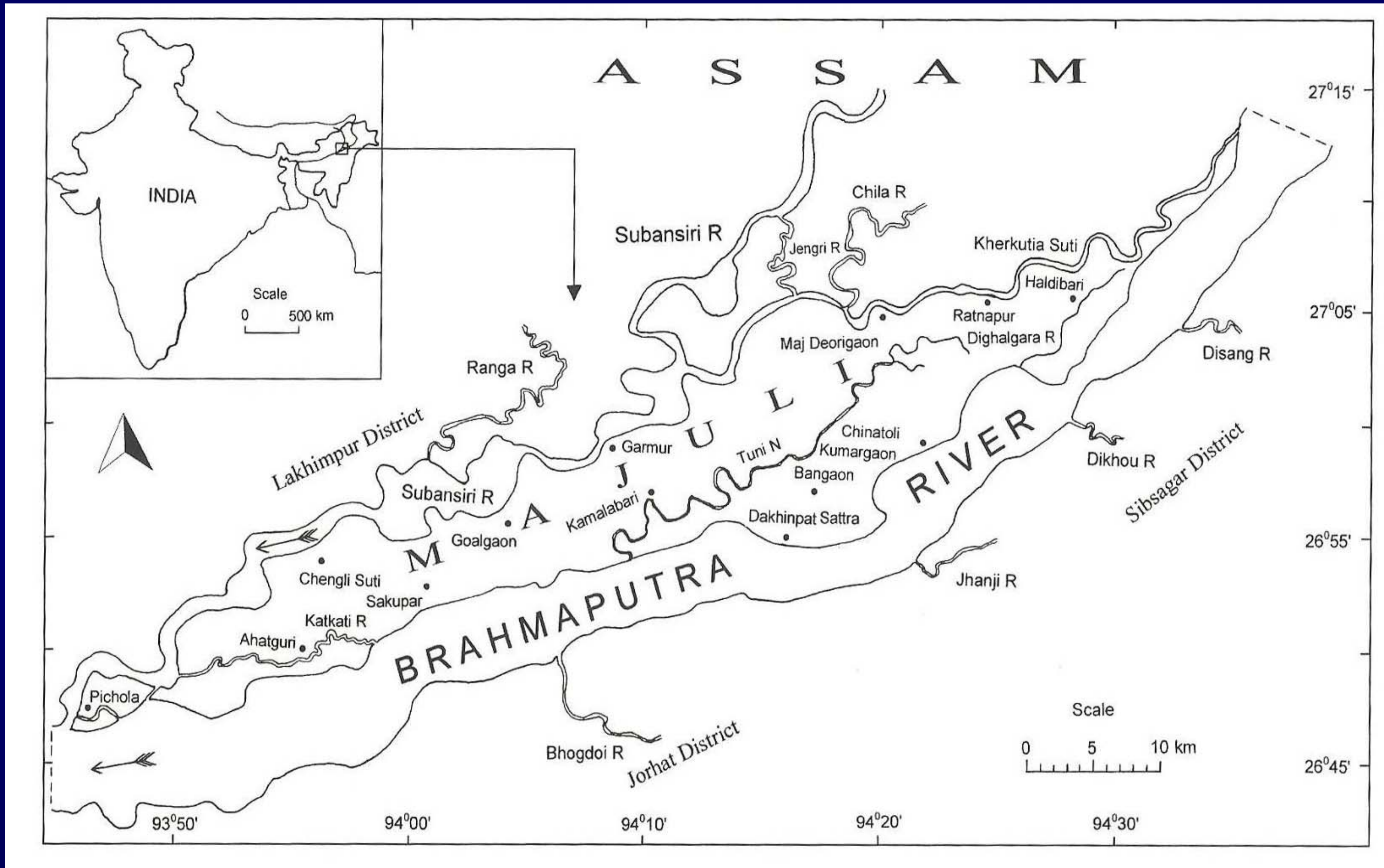
- Introduction
- Challenges of the Watershed and the River
- Flood and River Bank Erosion Characteristics
- The Majuli Problem
- Erosion Mechanism
- Review of Erosion Abaement Measures
- Bio-Engineering or Non-Sturctural Measures
- Summary and Conclusion

Introduction (contd)

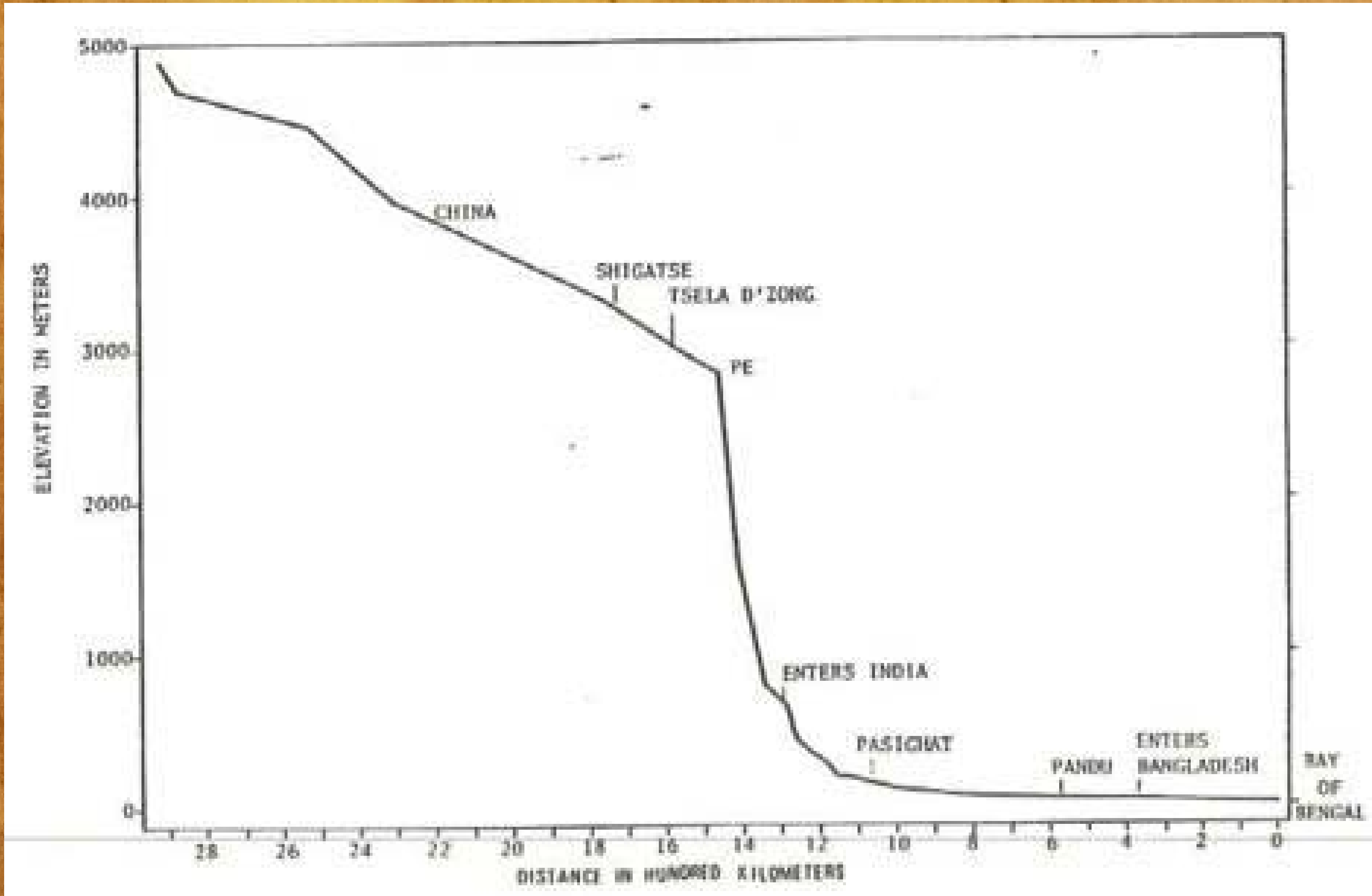
- CPGB Background
- Brahmaputra River Characteristics
- Geological Factors


China
Sangpo R.
Subansiri R.
Dibang R.
Lohit R.
Bhutan
Dibrugarh
Bessamara
Brahmaputra R.
Pandu
Assam
India
Jamuna R.
Bahadurabad
Old Brahmaputra R.
Bangladesh
Kazipur
Sirajganj
Jamuna Bridge
Ganges R.
Hardinge Bridge
Dhaka
Baruria
Gorai R.
Padma R.
Upper Meghna R.
Chandpur
Noakhali
Lower Meghna R.
India
Myanmar
Bay of Bengal
50 0 50 km
Legend
International Boundary
Rivers
Bridges
Locations

Majuli Island in Assam



Background & Problem Statement



Channel Behavior with Flow and River Stage

- Geomorphology, sediment yield and transport mechanisms of the Brahmaputra are unique, and have led to:

  - Multi-channel Character (Three to six channels separated by islands and mid-channel bars under low flow conditions)

  - Shifting or channel migration under flood conditions

  -Severe bank erosion.

Geological Factors

- Due to location in a seismic zone, major earthquakes like that of 1950 cause numerous landslides and rock falls in the mountains and foothills generating large quantities of sediment to enter the river system as a slug.
- Resulting disturbance to the normal flow regime over a long period of several decades as the extra sediment load works its way downstream.

Challenges

- Based on the satellite image estimation of area eroded in Brahmaputra for the recent years of 1997 to 2007-08 (Sarma, 2009), the total land loss per year (excluding avulsion) is reported to be 72.5 Sq.km/year. The erosion wiped out more than 2500 villages, 18 towns, croplands, sites of cultural heritage and tea gardens affecting lives of over 500,000 people.

Challenges (Continued)

- Based on records, the average suspended sediment (Bed-sediments and wash load) transport rate (June to September) is reported as approximately as 2 million tons/day at Pandu. The average discharge of the Brahmaputra through Assam is 8,500 to 17,000 cubic meter/sec. Average annual flow rate at Pandu is about 16,000 cubic meter/sec.

Challenges (Continued)

- Based on records from 1954 to 2004, high flood occurs on average once every 5 years. But the frequency and magnitude of floods have increased in recent years. The average area flooded for the 9 years of highest flood is 2 million ha or 20,000 square km (Say 400 Km x 50 km) or about 25% of area of Assam. The social disruption and costs associated with flooding have been rising.

Challeges (Continued)

Embankments built to prevent floods are only partially effective for numerous reasons:

- Inadequate Design with low freeboard. They can contain only floods up to a certain magnitude.
- They are non-continuous in many areas, have gaps where tributary streams enter the embanked river
- Susceptible to failure from continued river bank erosion, geotechnical instability, improperly designed or lack of seepage control measures.
- Inadequate regular maintenance and repair.

River Bank Materials & Erosion Mechanism

- Suspended sediments and River Bank materials of the Brahmaputra river consists of generally fine sand-0.06 to 0.09 mm, respectively.
- Bank Materials consist of generally varying proportion of fine sand, silt with occasional presence of minor amount of clay
- Bank formation and rate of recession are controlled by the Fluvial processes, whereas the mechanism of bank failure is determined by the Engineering Properties of the Soils.

Erosion Mechanism (Continued)

- Hydraulic Factors responsible for bank erosion of the river system are:

i) Rate of Rise and fall of river water level,

ii) Number and position of major channel active during the flood stage,

iii) Angle at which the thalweg approaches the bank line.

iv) Amount of scour and deposition that occurs during the flood,

v) Variability of cohesive soil in bank material.

Erosion Mechanism (Cond.)

- vi) formation and movement of large bed form,
- vii) intensity of bank slumping and
- viii) progression of abandoned river courses to present –day channel.

Braided Channels of Brahmaputra near Majuli

Braided Channels of Brahmaputra near Tezpur

Braided Channels of Brahmaputra near Kaziranga

Braided Channels of Brahmaputra near Guwahati

Braided Channels of Brahmaputra near Goalpara

Erosion at Molual Kalita Gaon

Erosion at Molual Kalita Gaon

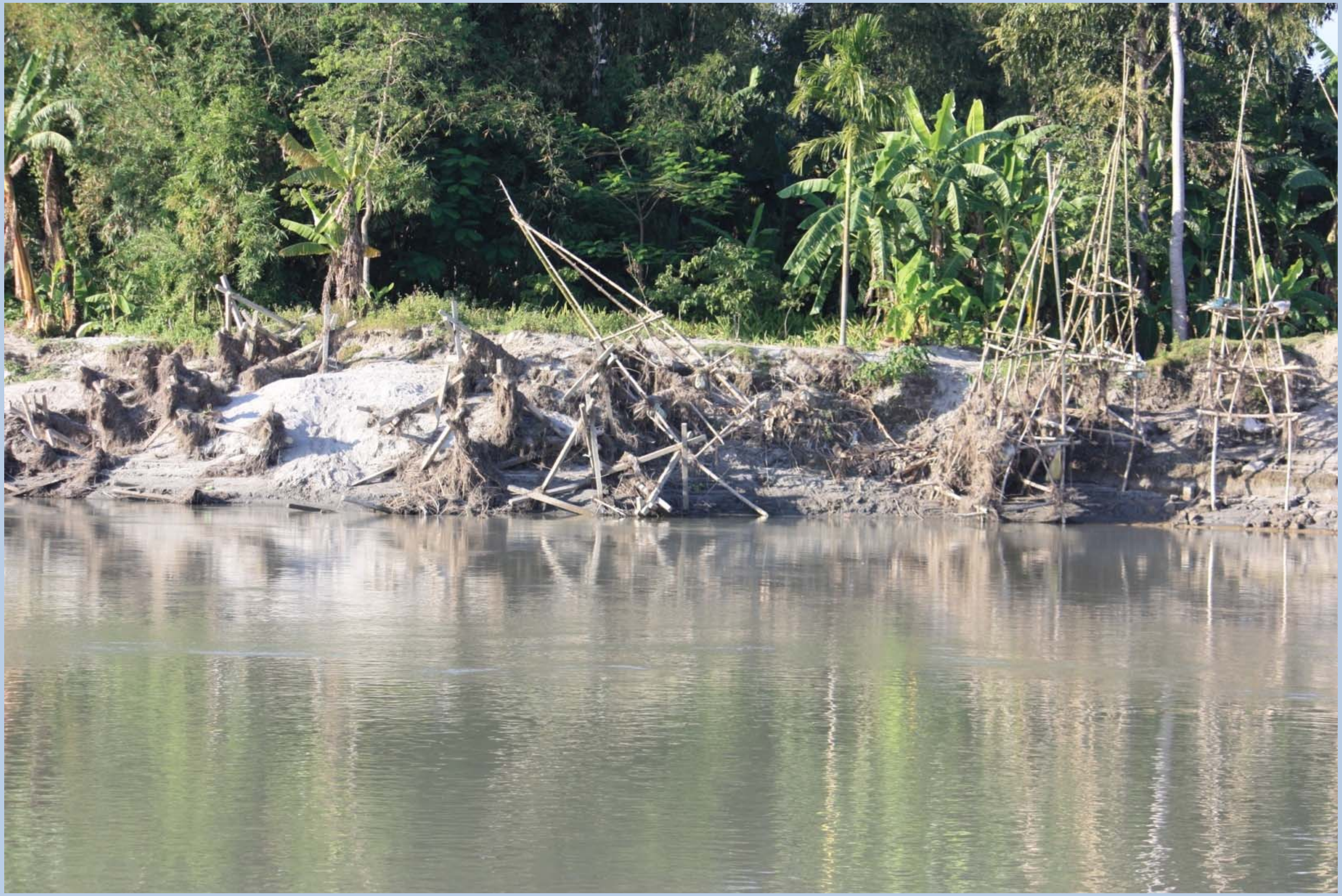
Brahmaputra River Bank Erosion Majuli

Majuli

Majuli

Majuli

Majuli



Majuli (Continued)

Majuli (Continued)

Majuli

Majuli-Mid area

Progression of Bank Erosion

Observed recently on March 14, 2016.

River bank erosion /Failure at Neematighat

Photograph of Bank Erosion (Contd.)

River Bank Revetment Failure at Neematighat

Photograph of Bank Erosion (Contd.)

Bank Erosion/Failure at Majuli Island

Photograph of Erosion(Contd.)

View of the eroded River Bank downstream of Spur No.1

Bio-Engineering or Non-structural Measures

The application falls into three categories:

1. Areas on the Island where stream bank erosion has not yet occurred but has the physical characteristics that indicate a potential for future erosion

2. Areas on the Island where stream bank erosion is evident and that require immediate application of structural control measures, in some cases including backup non-structural applications.

3. Areas on the Island where stream bank erosion is on-going and active. Reliance will be on recommending specific structural mitigation design measures.

Plant Establishment and implementation of best management practices that include the following measures:

1. Seeding of native plants and shrubs such as tall grasses and herbaceous species

2. Direct planting of hardwood cuttings into the soil.

3. Direct planting of small, easily transportable seedlings.

4. Securing natural fiber matting to secure slopes and reduce erosion

5. Soil preparation including scarification and applying soil nutrients and fiber to enhance the establishment of native plants and seed dispersal from adjacent undisturbed plant cover.

6. Improve and enhance agriculture stewardship of soils and upland land management to reduce runoff and soil erosion.

Methodology For Non-Structural Approach

A three-phase approach has been designed by the CPGB Group toward making very specifically formulated non-structural design.

- Phase One: Empirical Field Data:

i) Assessment of current land management practices within the river floodplain as well as outside as adjacent lands that are identified as significant contributors of soil and sediment carried by surface water runoff.

Methodology (Contd.)

- ii) Assessment of the role of the existing wetlands (riverine and in-island) and bogs of the Majuli Island in attenuation of flood peaks and control of sediments. These marshes and wetlands mend the unique landscape of the island, support the habitats for fish and wildlife and are a very important part of the culture of the recreational and commercial fishery culture of the island inhabitants.

Methodology (Contd.)

III) Assessment of native plant communities that have functioned as flood and riverbank erosion mitigation within the river floodplain. Plant communities that function in soil and slope stabilization will be identified. The natural strategies of plant and plant communities to re-establish after flood events will also be studied

IV) Assessment of Land Management practices that contribute to soil erosion within the river floodplain.

Methodology (Contd.)

- Phase two: Planning and Design in coordination with the CPGB design and modeling teams

i) Specific strategies will include methods of deployment of native plant species in providing short- term erosion control during construction and construction-related infrastructure (borrow pits, excavation, etc.) as well as long-term erosion control

Methodology (Contd.)

ii) Planning activities will include identification of methods of obtaining native plant species (seeds, hardwood cuttings, or field grown) together with a time frame, identifying potential contractors, suppliers, and equipment sources. This phase will also identify permitting and governmental considerations and will begin the process for obtaining critical permits and approvals.

Methodology (Contd.)

iii) Members of the CPGB will work with the appropriate government agency to identify multiple review of work in progress. It is critical that input i.e., certainly design review input, is obtained from the government to ensure the non-structural, sustainable recommendations are well integrated in the overall design package.

Methodoly (Contd.)

- Phase three: Design Development

i) This phase of design will consist of identifying specific technical specifications and contract documents needed to implement this aspect of the erosion control and mitigation aspects of the project. In subsequent phases, this work will include the preparation of technical drawings and specifications that will be incorporated in the larger engineering package of the project.

Methodoloy (Contd.)

ii) In addition to the erosion reduction strategies, the project team will identify land management policies that the Government entity may employ to encourage improved soil and water runoff management practices in upland areas and agricultural lands. These Best Management Practices not only reduce soil erosion, but improve soil productivity and conservation for the benefit of agricultural and forestry sectors.

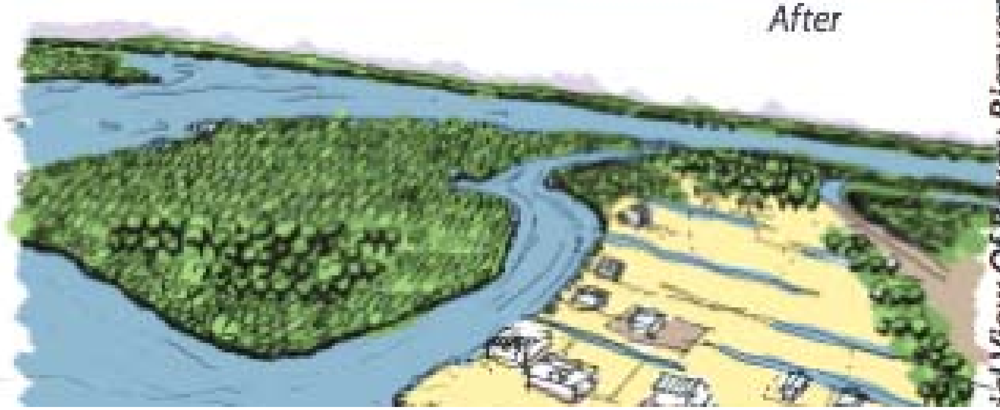
Methodolgy (Contd.)

Iii) Field personnel will be required to guide all aspects of plant restoration activities associated with this aspect of flood mitigation and control construction. Technical personnel will be available to trouble-shoot and resolve field construction, assess contractor performance, and represent the client by providing professional consultation to make sure the intents of the project are appropriately met.

Examples of Non-structural Measures Designed by the CPGB Team Members: Floodplain Ecosystem restoration in the Lake Borgne area of Mississippi River outlet

Before

After



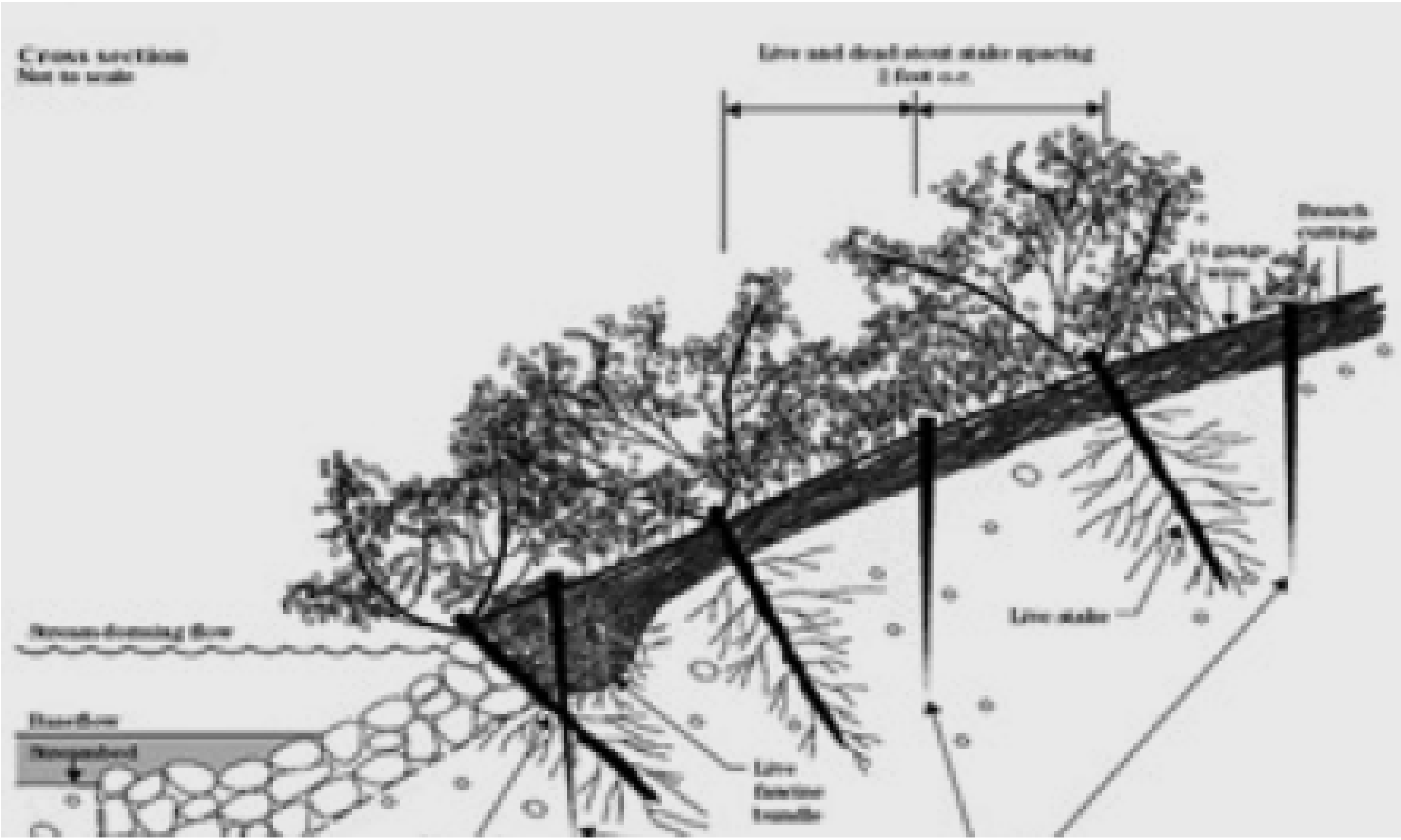
ial View Of Bayou Bienvenue Triangle And Rigolets

Examples (Contd.) Migation of river bank erosion utilizing indigenous ,deeply rooting plant species in conjunction with engineered bank stabilization (Revetments) modules

Examples (Contd.): Example of a robust river bank erosion mitigation plan (in China)

Examples (Contd.)

Illustration of a robust river bank Erosion mitigation program in China employing use of native plant species anchored or interspersed with matrix of native species with modular materials (Typical Cross-section)



Summary & Conclusions

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1. The Brahmaputra River has devoured nearly 4000 sq km of land, at a rate of 80 sq km. per year during the last 50 years, wiped out more than 2500 villages, 18 towns, affecting nearly 500,000 people.

2.. Severe erosion caused by the river at locations such as Majuli, Rohmoria, Kaziranga have reached critical stages.

3. Erosion Control and restoration of Majuli can be effectively engineered by structural and nonstructural measures, but limited progress have been achieved so far.

4. Bio-engineering /non-structural measures must be considered in many locations along the Brahmaputra River and its tributaries for cost effective mitigation and environmentally sound restoration .

5. Time is running out. An effective road map for long term solutions of riverbank erosion in the state must be developed NOW.

Acknowledgement

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Thank you