Assessment and Prediction of River Bank Shifting Using Automated GIS and Remote Sensing Approaches: A Case Study of the Jamuna River in Bangladesh

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1. Introduction

Being the biggest delta in the world, Bangladesh is home to Jamuna river, one of the largest sand-bed braided and dynamically evolving rivers globally. With its incessant morphological changes and perpetual rise & disappearance of bars & dunes, Jamuna takes a new form every few years. Hence, understanding the river bank shift with erosion-accretion patters of Jamuna is salient in assessing the river's impact on its floodplain and surrounding landscape.

This study assesses the spatio-temporal changes of the Jamuna river banks for last 4 decades (Jan,1984 - Jan,2024) & predict changes in 2034 & 2044. **GEE** was employed to extract **NDVI maps with 5 years interval** to digitize bank lines which were used in **Digital Shoreline Analysis System (DSAS), ArcGIS.** The rate of changes was analyzed based on **Linear Regression Rate (LRR), End Point Rate (EPR)** & **Net Shoreline Movement (NSM).** Predictions were obtained by **simple extrapolation** using **Kalman Filter Model.**

The quantitative nature and results of this study can be utilized to assess the extend of erosion control measures needed for the river. The historical trends and contemporary predictions of the study can be useful in further studies on the impacts that drastic river bank shifting can have on natural and anthropogenic factors surrounding the river channels.

2. Study Area

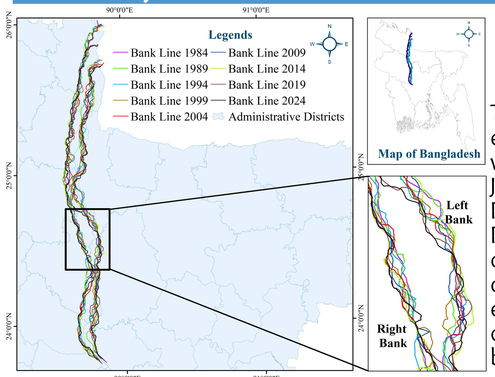


Figure 01: Study Area & Digitized Bank Lines

The study encompasses the whole length of Jamuna river in Rajshahi and Rangpur Divisions of Bangladesh to calculate the erosion & deposition of both banks.

1083 & 1465 transects were taken for left and right banks respectively with an interval of 200m. A specific portion of the transects for Left Bank Lines are depicted in **Figure 02.**

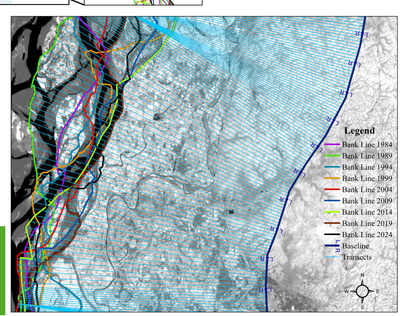


Figure 02: Transect Lines from Baseline to River Bank Lines

3. Methodology

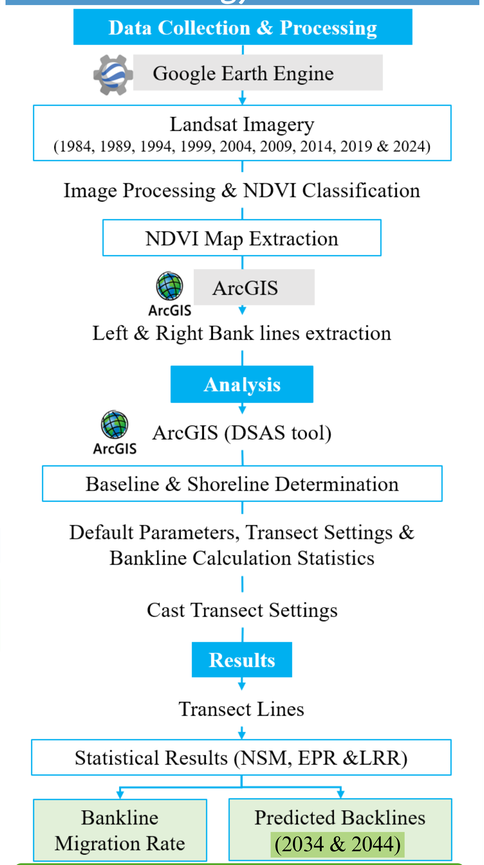


Figure 03: Methodology of the Study

4. Bankline Analysis

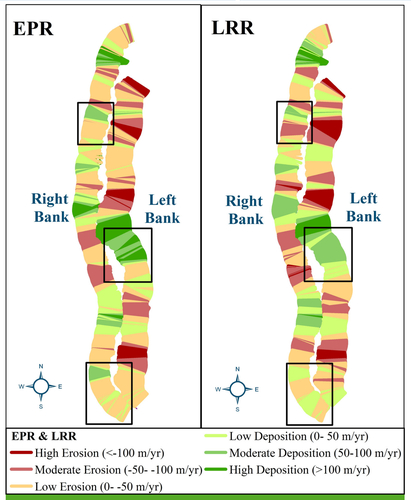


Figure 04: Spatial Distribution of Erosion & Deposition for Bankline Migration Rate during 1984 - 2024

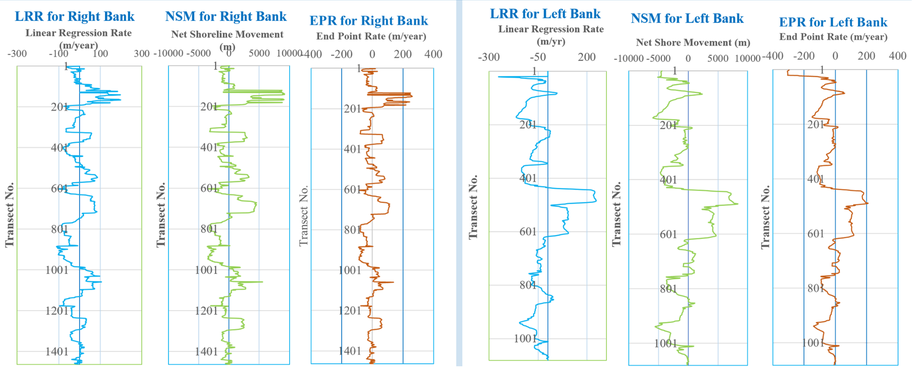


Figure 05: Bank lines Movements along Each Transect, based on LRR, NSM & EPR

Right Bank
Average Erosion Rate: **-35.18 m/year**
Average Deposition Rate: **54.34 m/year**
Erosion along the length of **171.4 km (857 Transects)**
Deposition along the lengths of **121.6 km (608 Transects)**

Left Bank
Average Erosion Rate: **-63.5 m/year**
Average Deposition Rate: **76.17 m/year**
Erosion along the length of **153.4 km (767 Transects)**
Deposition along the lengths of **63 km (315 Transects)**

5. Bankline Prediction

The Kalman filter is initiated by using LRR calculated by DSAS.

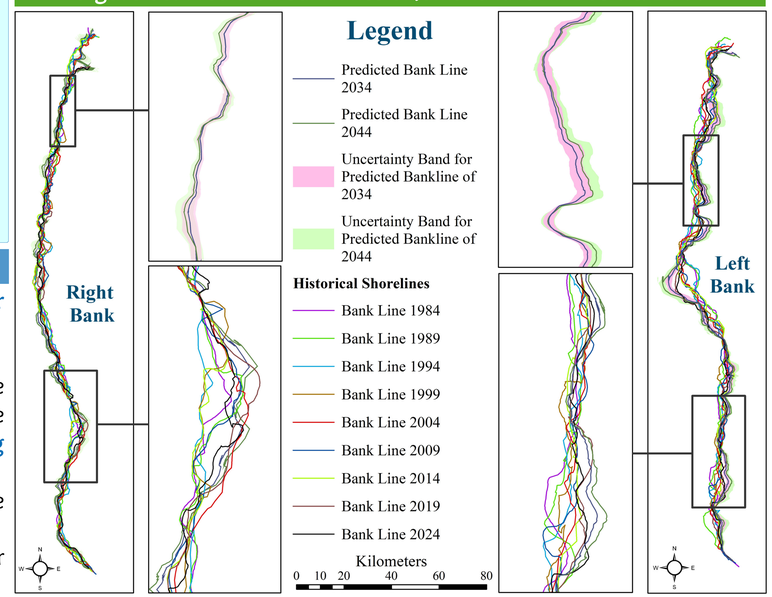
Right Bank Predictions (2034)
Erosion Rate: **-45.78 m/year**
Deposition Rate: **48 m/year**
Erosion Lengths **152.6 km**
Deposition Lengths **113.4 km**

Right Bank Predictions (2044)
Erosion Rate: **-45.25 m/year**
Deposition Rate: **46.94 m/year**
Erosion Lengths **161.8 km**
Deposition Lenghts **119.6 km**

Left Bank Predictions (2034)
Erosion Rate: **-70.8 m/year**
Deposition Rate: **113.2 m/year**
Erosion Lengths **183.4 km**
Deposition Lengths **49.2 km**

Left Bank Predictions (2044)
Erosion Rate: **-72 m/year**
Deposition Rate: **109.8 m/year**
Erosion Lengths **185 km**
Deposition Lengths **51.4 km**

Figure 06: Predicted Bank lines of Jamuna River in 2034 & 2044



6. Results & Conclusion

- Present **erosion rates are lower than deposition rates** for both banks. However, **erosion occurs for greater lengths** than deposition and **net area of erosion is greater than net area of deposition.**
- EPR & LRR show similar high, mid & low migration rates in most places with occasional discrepancies.
- The **left bank has more high-erosion & high-deposition zones** compared to the right bank, meaning the **left bank is more unstable for** the last 4 decades. Prediction for 2034 and 2044 indicates the **continuation of greater deposition rates along smaller lengths with smaller erosion rates along greater lengths.**
- The **forecasting model may not be accurate** for the entire length of Jamuna because of its unstable nature and other compounding anthropogenic factors which were not considered in the predictions.
- These results suggest that Jamuna river is subjected to **alarming morphological changes**. Hence, further research should be done on its floodplains, land uses, settlements, other anthopogenic changes.