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ASSESSMENT OF BANK LINE SHIFTING OF SURMA RIVER USING GIS AND REMOTE SENSING APPROACH

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Abstract

River and Drainage System the rivers of Bangladesh are very extensive and distinguish both the physiography of the country and the life of the people. Bangladesh is called a land of rivers as it has about 700 rivers including tributaries. This study has been conducted to assess the bank line shifting of Surma River using Remote Sensing and GIS approach in light of the recent outbreak of erosion in many rivers in Bangladesh. Landsat Satellite images of 1994, 2006, and 2018 have been collected based on study area. ERDAS IMAGINE 2014 and ARC GIS 10.3.1 have been used to analyze the satellite images. A number of 23 places between Dowarabazar and Golapgonj of Sylhet district have been selected for study area to easily perceive the order of erosion of the river in those corresponding places. Kalaruka, Dowarabazar, Dakshin Kushighat have been found as the most vulnerable places and Haripur, Chatak, Mollapara have been found as the least vulnerable places due to the river bank erosion within our fixed time frame. Also, most erosion has been found at the bends of the river, the fact, which has been also emphasized in this study.

Keywords: Surma River, Remote Sensing, GIS, Landsat Satellite, River Bank Erosion.

Introduction

The Surma-Meghna system' the Meghna is the longest (669 km) river in Bangladesh. It drains one of the heaviest rainfall areas (e.g., about 1,000 cm at Cherapunji in Meghalaya) of the world. The river originates in the hills of Shillong and Meghalaya of India. The main source is the Barak River, which has a considerable catchment area in the ridge and valley terrain of the Naga-Manipur hills bordering Myanmar. The Barak-Meghna has a length of 950 km of which 340 km lie within Bangladesh. On reaching the border with Bangladesh at Amalshid in Sylhet district, the Barak bifurcates to form the steep and highly flashy rivers surma and kushiyara [Rahman, 2010]. River bank erosion is a natural disaster and takes place round the year. Impacts of river bank erosion are multifarious: social, health, education and sometimes political. Numerous studies was done in the past regarding the bank line shifting which generalizes the term “River bank erosion”. Like almost all of the rivers in Bangladesh, Surma River has also got no escape from erosion. In this study, this assessment will be done. In this regard, morphological condition of the river from 1994 to 2018 will be observed with the Landsat Satellite images. This will be conducted in three divisions. First, from 1994 to 2006, then 2006 to 2018 and finally entire time period of 1994 to 2018 will be analyzed. ERDAS IMAGINE 2014 will be used mostly throughout the study. Our study area will be selected from the satellite image and after completing some steps in the ERDAS IMAGINE, ARC GIS 10.3.1 will be used ultimately to measure the shifting of the bank line. The erosion of the Surma and Kushiara along the Sylhet border is pushing the Bangladesh border inward, already resulting in the loss of thousands of acres of land to India in last few years. Official sources said more than 3000 acres of Bangladesh territory have already gone to India due to the erosion of the two rivers only. Locals, however, estimate that the loss is no less than 4,000 acres [Rahman, 2010]. Hence, it’s very important for the community living on the bank and in the surrounding areas to assess their vulnerability to river erosion and take sustainable steps to mitigate the hazard of river bank erosion. The main objectives of this study is to find out the bankline shifting of the Surma River and analyze the current position of the Bankline and compare with previous year’s data. Also have an idea of the risks of the people living adjacent the river and suggest further studies and actions to deal with the problem.

Study Area

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Methodology

Data Used

To detect the morphological changes of the river, three Landsat satellite images were used:

1. December 13, 1994
2. December 14, 2006 and
3. November 13, 2018.

Software Used

The following software's were used throughout our study:

1. ERDAS IMAGINE 2014
2. ARC GIS 10.3.1

Methodology

Methodology of the work has been shown in the Figure 1

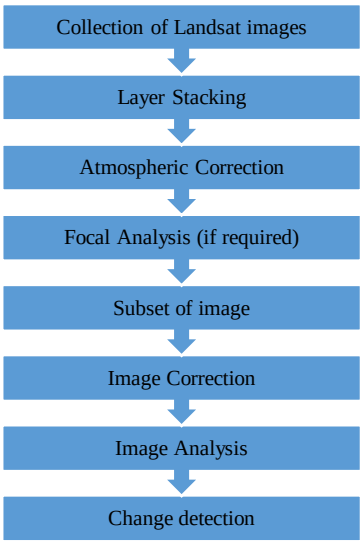

Fig 1: Process flow diagram

Collection of Images

Landsat Images were collected from this website (https://earthexplorer.usgs.gov). Path and Row was assigned for our study area and cloud cover was kept minimum. Landsat 8 image was collected for 2018, Landsat 5 image for 2006 and 1994.

Result and Discussion

The following figures depict the corresponding shifting of bank line from year 1994 to 2018. In this regard, shape file of only river land of year 1994, 2006, 2018 were used. In figure: 24 shape file of year 1994 assigned as red and 2006 as green. In figure: 26 shape file of year 2006 as sky blue and 2018 as brown. In case of graphs, the diagram shows degree of bank line shifting toward right and left. Values above zero indicates shifting of banks toward right and values below zero indicates shifting toward left [Joseph, 2005]. From the analysis Kalaruka has suffered most severe bank erosion. In Chatak area there is no erosion.

Shifting of Bank line from 1994 to 2006

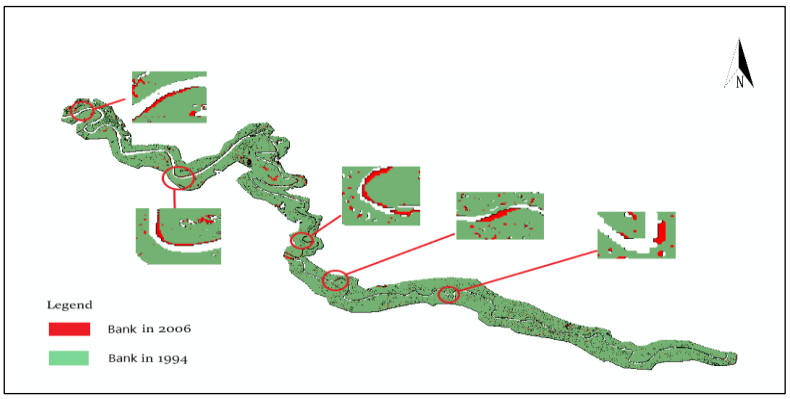

Fig. 2: Severely bank line shifted places (1994-2006)

Merging of two shape file of 1994 and 2006 was done in fig. 2 places were selected to measure the shifting. But of all places, most severely shifted places were identified in this figure. In the following table, names of different location, shifting of right and left bank and direction of shifting are shown. For example at Dowarabazar left bank of the river has shifted 84.85 meters leftward and right bank has shifted 42.42 meters rightward.

Table 1: Data of Bank line shifting in (1996-2006)

Location	Left Bank shift (m)	Direction	Right Bank shift(m)	Direction
	84.85	Right	42.42	Right
Dowarabazar 2	47.43	left	60	left
Haripur 1	81	Right	75	Right
Haripur 2	47.43	Right	41.97	Left
Betura 1	61.17	Right	30.01	Right
Betura 2	63.63	Left	84.85	Left
Chatak 1	No shifting		No shifting	
Chatak 2	60	Right	30	Right
Chatak 3	61.84	left	45	Left
Chatak 4	60	Right	75	Right
Kalaruka 1	54.08	left	67.08	left
Kalaruka 2	30	left	30	left
Kalaruka 3	60.57	left	96.04	left
Kalaruka 4	66.41	Right	30	Right
Kalaruka 5	117.15	Right	127.27	Right
Kalaruka 6	61.85	left	32.39	Right
Lamakazi 1	60.78	left	60.32	left
Lamakazi 2	30.07	left	75	Right
Gopall	90.014	left	30	Right
Mollapara	60	left	63.63	Right
Dakshin Kushighat	30.91	left	63.63	Right
Maijbag	30	left	77.81	Right
Hajipur	37.18	left	42.42	Right

In the figure below the downward gradient means shifting to left and upward gradient means shifting toward right. The numbers indicates the location.

Fig. 3: Bank line shifting of the River (1994-2006)

Shifting of Bank line from 2006 to 2018

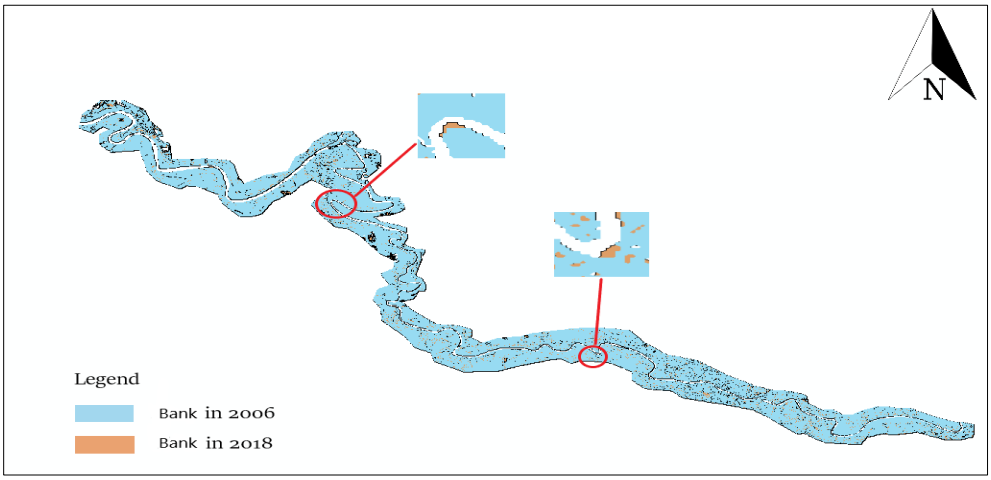

Fig. 4: Severely bank line shifted places (2006-2018)

Table 2: Bankline shifting in (2006-2018)

Location	Left Bank shift(m)	Direction	Right Bank shift (m)	Direction
Dowarabazar 1	31.66	Right	57	Right
Dowarabazar 2	47.43	Right	75	Left
Haripur 1	33.54	Right	30	Left
Haripur 2	30	Left	60.33	Left
Betura 1	60	Right	65	Right
Betura 2	53.87	Left	42.42	Left
Chatak 1	No shifting		54.07	Right
Chatak 2	30.02	Right	30	Right
Chatak 3	60	Left	30.07	Left
Chatak 4	30	Right	60.01	Left
Kalaruka 1	107.39	Left	69.06	Left
Kalaruka 2	30	Right	23.31	Right
Kalaruka 3	30	Right	60	Right
Kalaruka 4	63.63	Right	30	Right
Kalaruka 5	42.42	Right	33.17	Right
Kalaruka 6	30.04	Right	30.018	Left
Lamakazi 1	30.04	Right	45.93	Right
Lamakazi 2	21.21	Right	30	Left
Gopall	84.94	Right	73.76	Right
Mollapara	31.97	Right	31.54	Left
Dakshin Kushighat	26.46	Right	78.79	Right
Maijbag	28.09	Right	30	Left
Hajipur	31.82	Right	30	Left

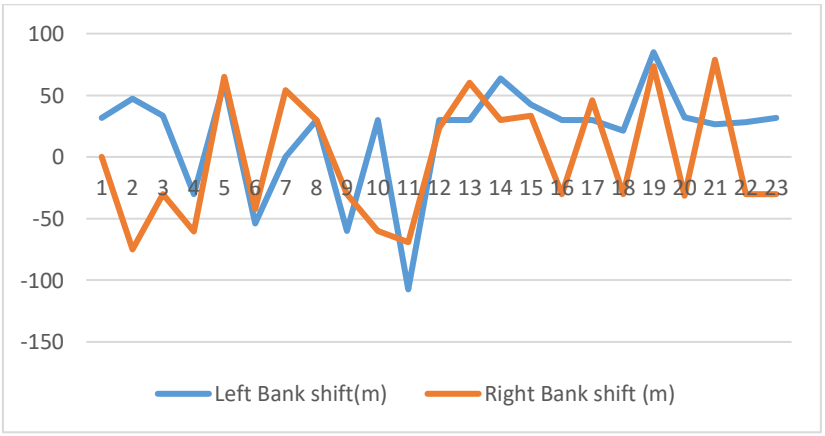

Fig. 5: Bank line shifting of the river (2006-2018)

Error! Bookmark not defined.The table shows total aggradation and degradation for entire time period of our selected timeframe 1994 – 2018.

Table 3: Data of Bank line shifting in (1996-2006)

Location	Left Bank shift (m	Direction	Degradation/Aggradatio	Right Bank shift(n	Direction	Degradation/Aggradatio
Dowarabazar 1	87.09	Right	Aggradation	114.59	Right	Degradation
Dowarabazar 2	75	Right	Aggradation	87.46	Right	Degradation
Haripur 1	42.42	Right	Aggradation	30	Left	Aggradation
Haripur 2	63.07	Left	Degradation	60	Left	Aggradation
Betura 1	90	Right	Aggradation	73.77	Right	Degradation
Betura 2	75	Left	Degradation	108.17	Left	Aggradation
Chatak 1	No shifting			41.83	Right	Degradation
Chatak 2	60	Right	Aggradation	60	Right	Degradation
Chatak 3	90	Left	Degradation	60	Left	Aggradation
Chatak 4	114.23	Right	Aggradation	75	Left	Aggradation
Kalaruka 1	127.27	Left	Degradation	116.19	Left	Aggradation
Kalaruka 2	42.37	Left	Degradation	30	Left	Aggradation
Kalaruka 3	78.51	Left	Degradation	64.02	Left	Aggradation
Kalaruka 4	63.63	Right	Aggradation	83.61	Right	Degradation
Kalaruka 5	100.62	Left	Degradation	128.16	Right	Degradation
Kalaruka 6	53.5	Left	Degradation	30	Right	Degradation
Lamakazi 1	90	Left	Degradation	60	Left	Aggradation
Lamakazi 2	30	Left	Degradation	30	Left	Aggradation
Gopall	75	Right	Aggradation	60	Right	Degradation
Mollapara	No shifting			41.45	Right	Degradation
Dakshin Kushigha	No shifting			114.1	Right	Degradation
Maijbag	No shifting			30	Right	Degradation
Hajipur	42.42	Left	Degradation	42	Right	Degradation

Discussion

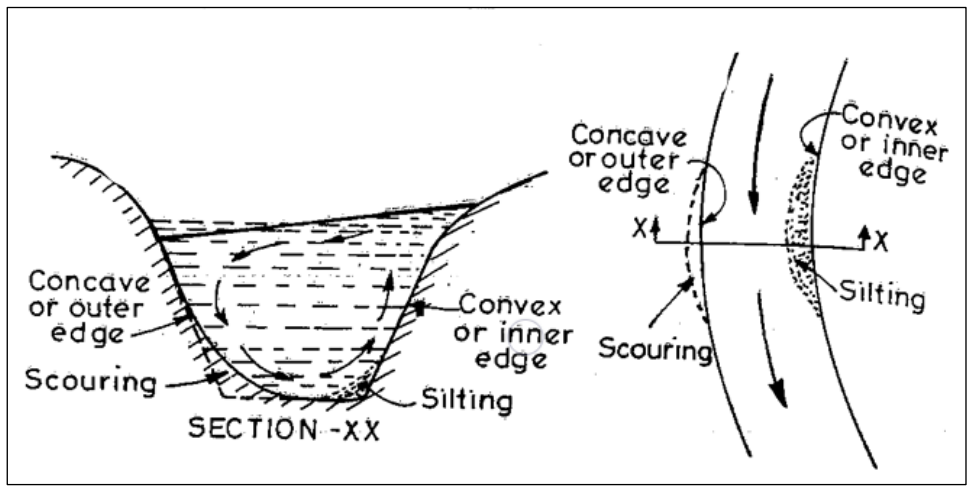

Fig. 6: Scouring and siting mechanism of river

When the flow moves round the bend, a centrifugal force is exerted upon the water, which results in the formation of traverse slope of water surface from the convex edge to the concave edge, creating greater pressure near the convex side. To keep its own level, water tends to move from the convex side towards the concave. However, the topmost water surface movement is prevented by the centrifugal force. Moreover, towards the bottom, the velocities are much less than towards the top and enough centrifugal force is not available to counteract the tendency of water at the top to move inwards. Hence, the water dives in, from the top at the concave end and moves at the bottom toward the convex end. These rotary currents cause the erosion of concave edge and deposition on convex side. When once a bend is formed, the flow tends to make the curvature larger and larger.

Analyzing the above theory, maximum shifting is supposed to be occur at the bending of the river. And we also found that. In 1994-2006 maximum shifting was found at kalaruka 1 that was situated at the bend of the river. Same evidence was also found for 2006-2018.

Conclusion

- In light of the bank line shifting data that have been shown aforesaid, in 1994-2006 maximum shifting was found at kalaruka 5, in 2006-2018 maximum shifting was found at kalaruka 1.
- In 1994-2006 no shifting was found at chatak 1 and also in 2006-2018 there was no shifting at chatak 1 left bank despite of having some in right bank.
- It is evident from the data that most shifting occurs at the point where the river changes its direction which is also known as meandering characteristics. For example, maximum shifting was found for the entire time period of 1994-2018 at kalaruka 5 point where the river changes its direction.

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