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River Change Detection and Bank Erosion Identification using Topographical and Remote Sensing Data

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ABSTRACT
There are continuous changes upon earth surface by a variety of natural and anthropological agent's activities. These agents cut, carry, away and deposit the materials from land surface. River erosion is an endemic and recurrent hazard in Bangladesh and every year, millions of people are affected by erosion that destroys many kinds of resources. Now-a-days Remote Sensing and Geographic Information System widely used for assessment of change in the river caused due to river erosion by using temporal satellite data. This study related to Jamuna River in Sirajgonj which is continuously changing due to geomorphic, climatic and human activities influence in the surrounded region of Present River. This changes identification is the main objective of paper. Water index NDWI is used for the assessment of river change by erosion and accretion for the period of 2000-2016. Integration of RS and GIS was applied for the assessment by using LANDSAT satellite imagery for the year 2000, 2010 and 2016. The result explains the 16 years' changes in the river bank due to various natural and manmade activities. Due to river erosion and deposition the river channel natural course change which affect the flood plain population, growth centres, infrastructures and other resources.

Keywords: Bank Erosion, Jamuna River, GIS, Change Detection.

INTRODUCTION

Rivers and streams networks which have greater geological prominence, are natural water resources on the earth surface. There is huge spatiotemporal distinction in the forms and sizes of the rivers and they have characteristics of dynamism (Hamid Ch et. al, 2017). There are constant changes upon earth surface by a variability of natural and human activities. These changes due to these activities result in cut, carry, away and deposit the materials from land surface (Aher et al., 2012). The change in base stream and formed of rivers changes due to the erosion and erection of the rivers is one of the result of these activities (Mallick & Etzold, 2015).
The assessment of the rate of river erection and erosion known as the change in the form and shape of the river has become crucial. Remote sensing (RS) and Geographic Information System(GIS) which are now-a-days used very commonly for spatiotemporal assessment of the different Topographical, Geomorphical, Geological change (Ahmad, 2012). Satellite data have the capability to deliver comprehensive, synoptic sight of equitably huge area at regular interval by using Remote sensing (RS). For analyzing and monitoring of river bank change or erosion and erection rate integration of Remote Sensing and Geographic Information System (GIS) is suitable and idyllic. Also by integration of

Remote Sensing and Geographic Information System (GIS) changes of channel configuration and the orientations between the river channel and its embankments can be determined (Das & Talukdar, 2017). By using the RS and GIS technology, not only river profiles at definite time frame are developed and rate of erosion and accretion is computed but also the use of temporal satellite images can express the dynamics move of river and its floodplain. Also multi-temporal satellite images help to predict how the mobility of river will continue or in order to restore the stability which kind of actions will be preferable (Hamid Ch et al., 2017). The study is undertaken due to availability of remotely sensed database and benefit of remotely sensed data like large view, multi temporal etc. (Binh & Truong, 2000)

Bangladesh is mainly known as riverine country located in South Asia with a coastline of 580 km (360 mi) on the northern littoral of the Bay of Bengal. Rivers are pride of Bangladesh with one of the largest networks in the world with a total number of about 700 rivers (Banglapidia, 2013). So river erosion is an endemic and recurrent hazard in Bangladesh and every year (Uddin, Shrestha, & Alam, 2011). Various tributaries and connected distributaries of the major river networks of Bangladesh are susceptible to the riverbank erosion hazard as well as flood effects. According to a study annually around 2000-3000 kilometres of riverbank network face erosion (Hassan & Mahmud-ul-islam, 2016). As a consequence of river erosion every year millions of people are affected and it destroys many kinds of resources such as standing crops, farmland and homestead land etc. It brings massive suffering in the life of people who live along the river bank (Aher et al., 2012).

This study related to Jamuna River in Sirajgonj which channel is continuously changing due to geomorphic, climatic agents and human activities influence in the surrounded region of Present River. The study aimed at carrying comparative study/analysis of the LUC of Jamuna river in Sirajgonj using RS and GIS tools. This changes identification is the main objective of paper with constructive suggestions for control the bank erosion and shifting of Jamuna River.

METHODOLOGY

Sirajgonj district which is known as is the gateway to the North Bengal of Bangladesh, is one of the most susceptible regions of Bangladesh in terms of riverbank erosion. The people of the district affected due to the river erosion for a long period (Hassan & Mahmud-ul-islam, 2016). As a result, there is substantial change in the river streams and the land use of the surrounding area of the Jamuna river in Sirajgonj district.

For the study a sequential methodology has been embraced. the study of change analysis of land cover has been done in several places. For carrying the study TM of Landsat imagery is collected for three different years 2000, 2010 and 2016 for the month march and the cloud cover of the data is less than 4%. After data collection data is processed in several steps for further analysis. Change detection is a process which has been adopted to estimate the change in land use in a time period such as 5 years or 10 years. After supervised classification this compared the resulting maps on a pixel-by-pixel basis using a change detection matrix to estimate the land use change and change in the rate of the river erection and erosion of the study area in sixteen years 2000-2016.

For the assessment and determining change in the rate of the river erection and erosion of the study area water indices named Normalized Difference Water Index (NDWI)) is adopted. The indices for the study for year 2000, 2010 and 2016 were calculated on based on different spectral response off vegetation over red and near infrared spectrum. After calculation of data for year 2000,2010 and 2016 using NDWI change detection matrix is developed with the integration of the 3d analyst tool of the GIS for assessing the change in rate of erection and erosion of Jamuna river in Sirajgonj district.

The equations use for calculation of vegetation indices are

$$NDWI = (NIR-GREEN) / (NIR+GREEN)$$ (McFeeters, 2013)

RESULTS AND DISCUSSIONS

Being situated by the river Jamuna, Sirajganj district covers a major portion of river erosion and deposition area. After construction of the Jamuna Bridge, more people living nearby of Jamuna River are being displaced. In the last 10 years the Jamuna river eroded nearly 30 villages, one third of the city and 400,000 people became homeless. In the last 3 years, huge chars (islands) have been forms in the middle of the river causing more sufferings to the people (The Daily Star, 2011), (Shetu et al., 2016).

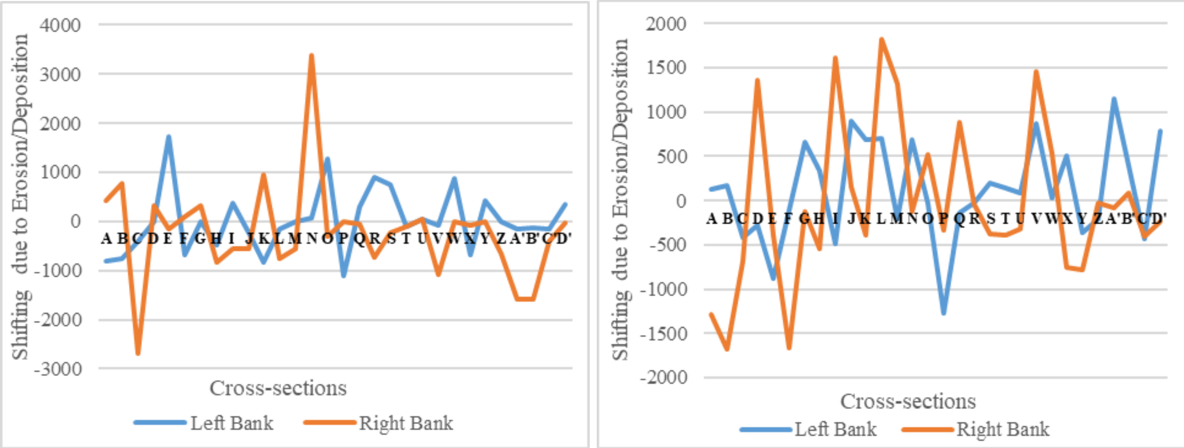
The shifting of the channel of Jamuna River in Sirajganj districts from 2000 to 2010 and 2010-1016 along both the banks was measured in 30 cross- sections each along the river and the results are presented in table1. The negative values (-) indicate the shifting due to erosion and the positive values (+) indicate the shifting due to deposition. The highest erosion in the that took place in the right bank was along the section C (2678m) and in the left bank along the section P (1110m) in the time period 2000-2010 and also erosion is dominant in sections V, A' & B' in right bank and sections A, B & K in left bank. Erosion is more dominant along the right bank of the river which indicates shifting of the channel towards western side. In the section N highest amount of sedimentation (3378m) indicate the shifting of the right bank towards eastern side. Along the left bank, except a fewer sections erosion sedimentation is more dominant which indicates shifting of the channel towards western side. In the time period 2010-2016 The highest erosion in the that took place in the right bank was along the section B (1674m) and in the left bank along the section P (1275m). Similarly, as earlier time period 2000-2010 erosion is more dominant along the right bank of the river which indicates shifting of the channel towards western side. In the section L highest amount of sedimentation (1824m) and also dominant sedimentation in sections D, I, M & V indicate the shifting of the right bank towards eastern side. Along the left bank, except a fewer sections erosion sedimentation is more dominant which indicates shifting of the channel towards western side bank shifted towards the western side.

Table 1: Shifting along both banks of the river from 2000 to 2010 & 2010-2016 (in meter)

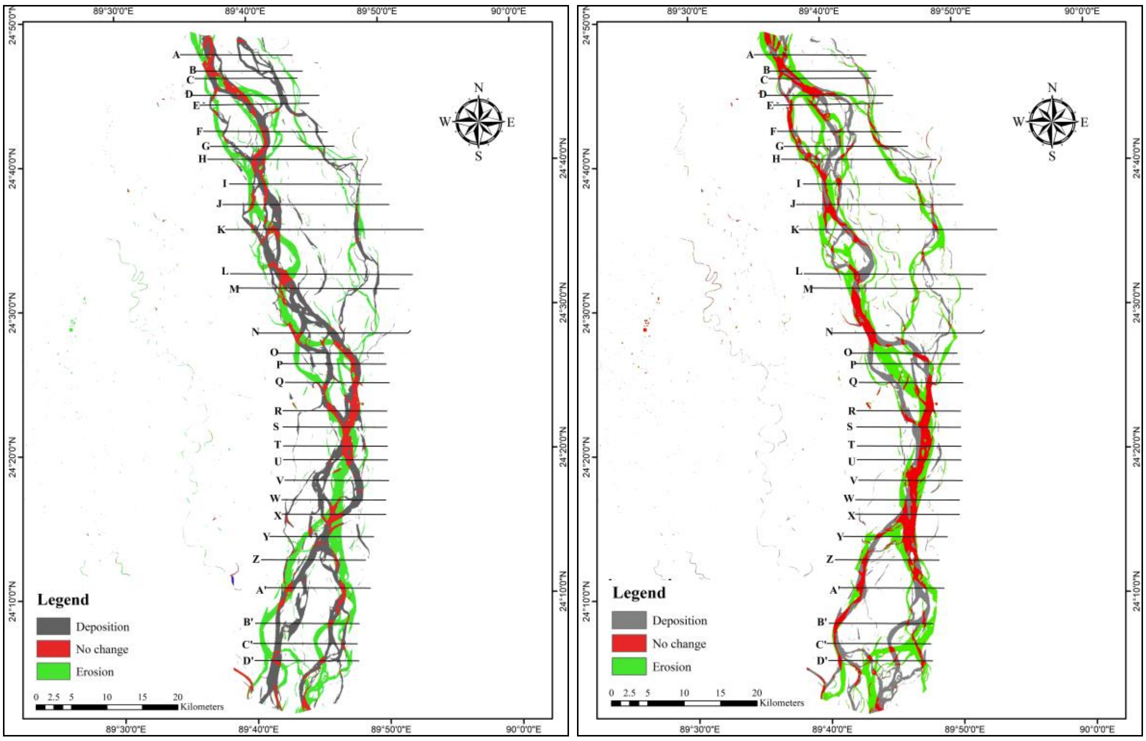
Section	2000-2010 (in meter)		2010-2016 (in meter)	
	Left Bank	Right Bank	Left Bank	Right Bank
A	-808	416	122	-1292
B	-765	777	177	**-1674**
C	-410	**-2678**	-417	-679
D	5	326	-275	**1362**
E	**1740**	-142	-883	-389
F	-683	97	-104	**-1663**
G	0	316	656	-120
H	-476	-841	343	-540
I	381	-544	-494	**1617**
J	-230	-566	**894**	154
K	-838	960	687	-390
L	-150	-752	709	**1824**
M	0	-551	-214	**1314**
N	80	**3378**	695	-130
O	**1274**	-294	-27	522
P	**-1110**	0	**-1275**	-340
Q	301	-58	-132	882
R	**900**	-725	-19	-33
S	746	-229	197	-381
T	-113	-92	149	-384
U	59	53	80	-318
V	-73	**-1077**	875	**1453**
W	872	0	35	539
X	-683	-82	510	-750
Y	422	0	-366	-780
Z	0	-650	-210	-21
A'	-150	**-1595**	**1154**	-85
B'	-127	**-1589**	398	85

C'	-152	-399	-425	-409
D'	354	-20	782	-232

Minus sign (-) indicates shifting due to erosion and plus sign (+) indicates shifting due to deposition

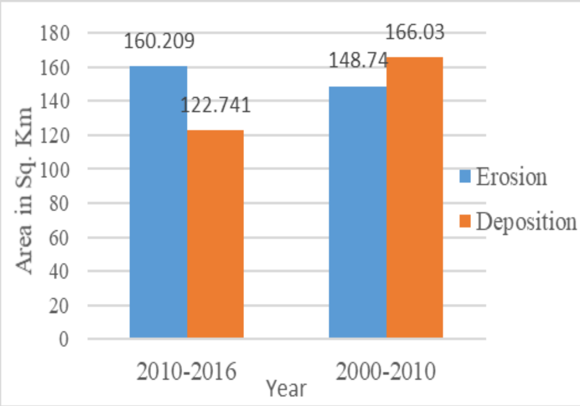


[Fig1]: Shifting along both banks of the Jamuna river from 2000 to 2010 & 2010 to 2016 respectively due to erosion and deposition

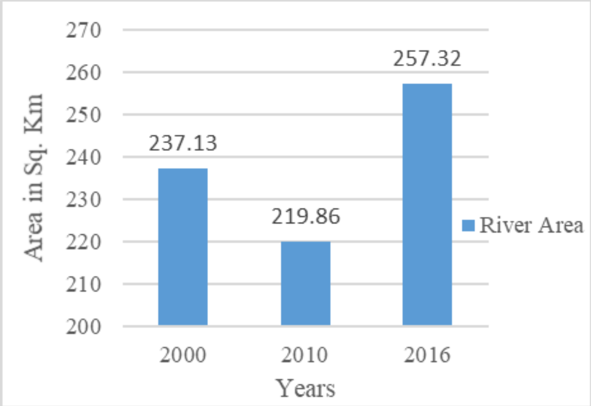


[Fig 2]: River Bank Change of the Jamuna River from 2000 to 2010 & 2010 to 2016 respectively

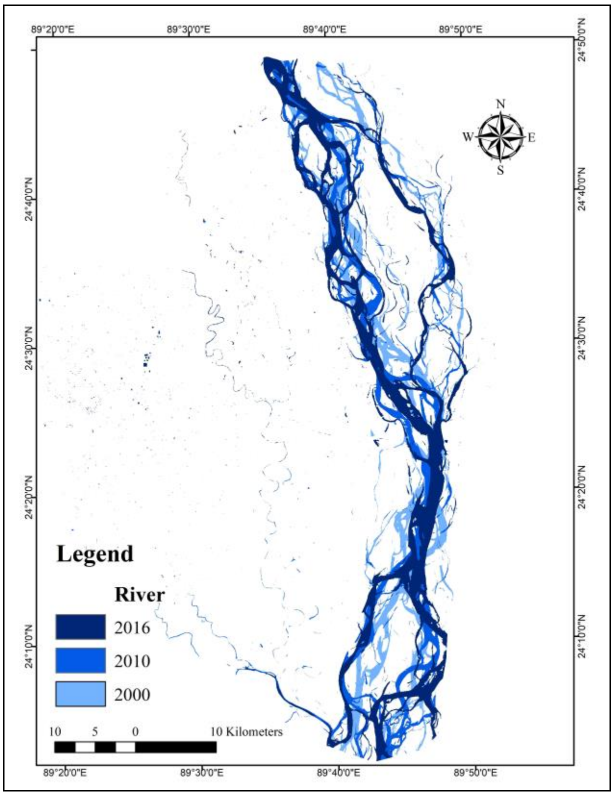
The figure 2 & 3 represents the total area of erosion and deposition of the Jamuna river from 2000 to 2010 and 2010 to 2016. In the time period 2000- 2010, deposition is more dominant than erosion. Total area of erosion is about 1448.74 Sq. km and deposited area is about 166.03 Sq. km. On the contrary in the time period 2010- 2016, erosion is higher than deposition and total eroded area is about 160.209 Sq. km and deposited area is about 122.741 km. In comparison to the two-time period erosion is higher in 2010-2016 than 2000-2010-time period and deposition is higher in 2000-2010-time period. In the time period 2000-2016 change of river channel due to erosion is greater than deposition.



[Fig 3]: Erosion & Deposition of the Jamuna River from 2000 to 2010 & 2010 to 2016



[Fig 4]: Change of the Area of Jamuna River in Different Year



[Fig 5]: Change of the Area of Jamuna River in Different Years

Figure 4 & 5 representing the change of the area of Jamuna river in the year 2000,2010 & 2016. In the year 2000 the total area covering the Jamuna river in Sirajgonj district was 237.13 Sq. Km. From 2000 to 2010-time period as deposited area is higher than eroded area, so in the year 2010 the total area of Jamuna river reduced to 219.86 Sq. Km. On the contrary in the year 2016 the total area of river increased to 257.32 Sq. Km as from 2010 t0 2016 erosion rate is higher than deposition.

CONCLUSIONS

Due to various natural and manmade activities like flood, water velocity, sand excavation, removal the vegetation covers, fertile soil excavation for the various proposes of local surrounded region's people, deposition and erosion lead to shifting of the channel of Jamuna River in Sirajganj districts. Erosion is more pronounced in right banks and deposition is more dominant in left bank in the both 2000-2010 and 2010-2016-time period. than the sedimentation. In the time period 2000- 2010, in both bank total erosion is more dominant than deposition whereas in 2010- 2016-time period, erosion is higher than deposition. Total erosion is greater in 2010-2016-time period than 2000-2010-time period. Total area of erosion is about 308.949 Sq. km and deposition is 288.771 Sq. km from 2000 to 2016. Erosion is higher than deposition in Jamuna river. The total area covering the Jamuna river in Sirajgonj district increased to 257.32 Sq. km which was 237.13 Sq. km in the year 2000. A large section of flood plain population, growth centers, infrastructures and other resources are affected by erosion every year. Numerous measures for flood and erosion protection such as earthen embankments, spurs, porcupines etc. are undertaken to protect the area. But they are not enough as a long term measure. To guard the river bank area from erosion and severe scouring using environmentally friendly constituents and methods, a wide-range of systematic study of the bank materials as well as morphology of the river is needed for construction of embankments.

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