Assessing the Hydro-Morphological Change Due to the Confliction of Old Brahmaputra and Dasani rivers

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Abstract. The old Brahmaputra, Dasani, Jinjiram, Alaikhal, and some other distributary channels of Jamuna flow through Jamalpur. Old Brahmaputra and Dasani rivers are hydro-morphologically dynamic, erodible, and meandering. There is a precedent of two rivers meeting in the Jamalpur district. In 2009 near Sherpur Sadar, Old Brahmaputra and Dasani rivers were conflicted**.** After that conflict in 2009, about 4 km length of the Old Brahmaputra River and 14km length of a branch channel of the Old Brahmaputra River name Jhinai lost their existence. Generally, one river will pass more flow than the other after meeting two rivers. More flow rivers will face bank erosion, shifting, and hydro-morphological change. On the other hand, less flow of the river will be silted on the river bed. There will be a probability of conflict between the Old Brahmaputra River and Dasani River again near Baksiganj upazila in Jamalpur district. Because the present distance between the two rivers bank is only 340m and they are getting closer day by day. Landsat Satellite images for the years 1985, 1990, 1995, 2000, 2005, 2010, 2015, 2020 and 2023 have been collected based on the study area from USGS Earth (earthexplorer.usgs.gov). ERDAS IMAGINE 2014 and ARC GIS 10.3.1 have been used to analyze the satellite images to understand the morphology and planform of the river. This study has assessed the probability of future conflict between the Old Brahmaputra and Dasani rivers using past morphology, planform change and present trend of river bank shifting. The effect of to merging of rivers on people's life, livelihood, and the river system in Jamalpur district has also been assessed. Remedial measures have been recommended to sustain Jamalpur's people's life, livelihoods, and river system.

Keywords: Bank erosion, hydro-morphology, conflict, Silt up, GIS, remedial measures.

1 Introduction

Bangladesh, mainly formed by alluvial deposits, faces riverbank erosion often due to the regular shifting of river channels. Riverbank erosion and shifting are standard geomorphological processes of alluvial floodplain rivers. The old Brahmaputra, Dasani, Jinjiram, Alaikhal, and some other distributary channels of Jamuna flow through Jamalpur. The approximate total length of those rivers within the Jamalpur district is about 250 km (google earth measuring tool). During the monsoon period,

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river bank erosion seriously affects all those rivers. Every year a large number of people in the Jamalpur district face bank erosion. The Old Brahmaputra is one of the main distributaries of the Jamuna (Brahmaputra) that distributes a part of the Jamuna discharge over a huge area of the North Central area of Bangladesh. The old course of the Brahmaputra River, presently named as the Old Brahmaputra, takes off at Horichondi bazar, approximately 5.0km upstream from Bahadurabad in Jamalpur. Near Jhalur Char at Dewanganj upazila in Jamalpur district, the Old Brahmaputra River is divided into two channels one flow east-south direction named Dasani River and another flow south direction called Old Brahmaputra River. Old Brahmaputra River and Dasani River are flowing more or less parallel to downstream. Near Jamalpur sadar upazila Dasani River meet with Old Brahmaputra and the combined flow of the two rivers is called Old Brahmaputra which flow through Mymensingh and finally meet with Meghna River near at 1km downstream of Bhairab Bazar. Old Brahmaputra, Jinjiram, and Dasani are interconnected rivers. So, any change in one river is influenced by other rivers. Figure 1 shows river planform of the Jamalpur district. Observing Landsat Satellite images of 2008, 2009, 2015, and 2023, shown a merge between Old Brahmaputra and Dasani Rivers near Sherpur Sadar in 2009 (Figure 4). Due to this merge between two rivers, there have occurred many changes in hydro-morphology of rivers. About 4.10 km length of the Old Brahmaputra River and 22km length of a branch channel of the Old Brahmaputra River named Jhinai have lost flow and silted up the river bed due to this merge. Dasani River changed its geometric shape to balance the excess flow that came from Old Brahmaputra River, on the other hand Old Brahmaputra River lost his geometric shape due to the lack of flow. At present the gap between of two rivers bank is only 350m near at Modonairchar in Bakshiganj upazila, which located 35 km north from Jamalpur town shown in Figure 2. Day by day, they are approaching to each other. At this location during the period 1985 to 2022 Old Brahmaputra River has shifted about 1223m towards the Dasani River and Dasani River also shifted 99m towards the Old Brahmaputra River within the same period. If the shifting of the Old Brahmaputra River may continue within a few years, there have a strong probability of conflict between the two rivers again. The main focus of this study is to assess the probability of the conflict between the two rivers, the effect on the river after this conflict and remedial measures.

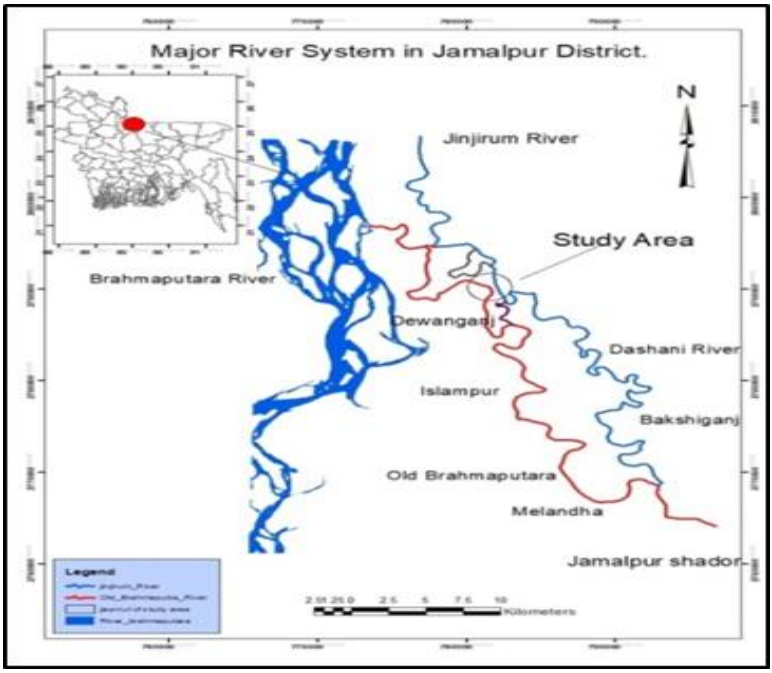

Fig. 1. Planform of the rivers system in Jamalpur district (Google image 2023).

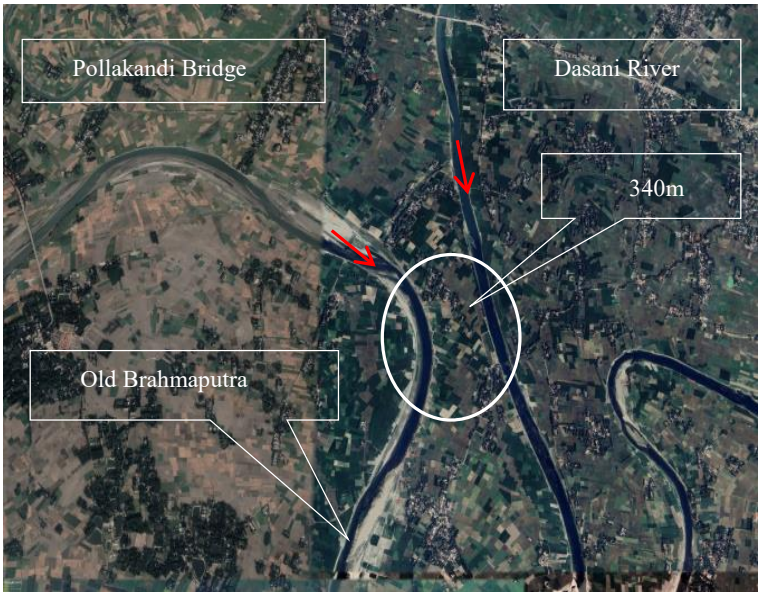

Fig. 2. Plan form of rivers near at Modonairchara Bakshiganj in Jamalpur district (Google image 17/11/2022)

2 Methodology

2.1 Study Area

Jamalpur District (Mymensingh division) is located between 24°34' and 25°06' north latitudes and in between 89°38' and 89°47' east longitudes (www.jamalpur.gov.bd). Bakshiganj Upazila is situated in the district. For this study, 4km downstream from Pollakandi Bridge along the river Old Brahmaputra near Modonairchar at Bakshiganj upazila in Jamalpur district was considered. That location was also 3km downstream from Dasani Bridge along the river Dasani. **Fig. 3** shows the map of the study area.

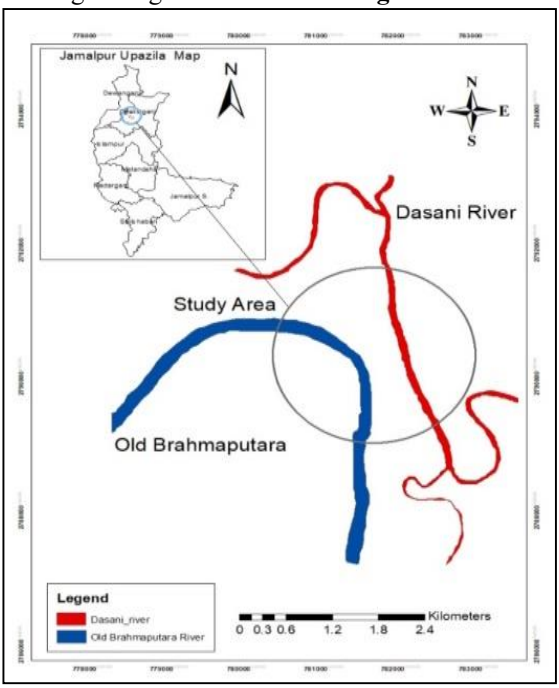

Fig. 3. Study area showing Old Brahmaputra River and Dasani River

2.2 Collection of Satellite Images

Landsat imageries of 30m resolution were collected from USGS Earth (earthexplorer.usgs.gov) to proceed with the study. Path and Row were assigned for our study area, and cloud cover was less than10% kept minimum. The dry season image data for the twelve years (1985, 1990, 1995, 2000, 2005, 2008, 2009, 2010, 2015, 2020, 2022 and 2023) were selected because such data were free of cloud cover and topographic seasonal variations. After collecting the river bank images from USGS, ArcGIS 10.4 software was castoff to analyses the amount of erosion or deposition as well as river shifting. The properties of the collected images are given in the Table 1.

Table 1. Description of Landsat imageries

Satellite	Satellite Sensor	Spectral Bands	Scale/resolution(m)	Acquisition date	Path/Row	Source
Landsat	Landsat 7	ETM+	30	19/02/1985 06/05/1990 24/11/1995 19/12/2000 15/11/2005 16/01/2008 18/01/2009 28/10/2010 21/12/2015 02/02/2020 30/11/2022 02/12/023	138/43	USGS Earth

2.3 Procedure for Analyzing Images

Open Arc GIS software, add Landsat image, brand composite, Clip study area, classification – supervised classification, land data marge, raster to polygon, river shape extraction and using measuring tool.

2.4 Sinuosity Calculation

For single-channel Rivers has been used to divide rivers into straight versus meandering. The ratio of river length to valley length or ratio of river slope to valley gradient is called sinuosity. By using GIS measuring tool river length and valley length are calculated for the years 2022 in Fig. 2, 2009 in Fig. 4. Sinuosity index is measured for Old Brahmaputra and Dasani River

Table 2. Description of Sinuosity index

River	Location	Duration	Sinuosity index
Old Brahmaputra	Sherpur Sadar	2009	1.61
Dasani			1.04
Old Brahmaputra	Bakshigonj Upazila	2022	1.23
Dasani			1.00

3 Result and Discussions

3.1 The Merge Effect of Old Brahmaputra and Dasani near Sherpur Sadar

The GIS data are commonly used to form the historical bank shifting map of the river (Falkowski et al. 2018). Several studies have considered the river's bank erosion, shifting, and deposit using GIS (Billah, 2018; Saleem et al., 2020; Best et al., 2007; Pal et al., 2017). We have used the interactive tracing digitization method in GIS to digitize the images. At 1985 the distance between Old Brahmaputra and Dasani River was 565m near at Sherpur Sadar. In 2008 that distance became 170m (Fig. 5A). Confliction was occurred between Old Brahmaputra and Dasani River in 2009 (Fig. 5 B). The sinuosity was 1.60, 1.12 and average width 120m, 50m respectively for the Old Brahmaputra and Dasani River in 2009. Due to high sinuosity meandering bend of Old Brahmaputra the water moved from the convex side (RB) toward the concave (LB) to maintain water level. For this reason, after merging of the rivers flow of Old Brahmaputra diverted toward Dasani River. Dasani River changed it geometry for adjusting the excess flow which came from Old Brahmaputra and had become wider. At present width of Dasani River is varied 100m to 230m from downstream of the confliction. Although the combined flow of Old Brahmaputra and Dasani River is named as Old Brahmaputra. After conflict due to lack of sufficient flow about 4.10 km length of Old Brahmaputra River and 22km length of a branch channel of Old Brahmaputra River name Jhinai river silted and lost river existence within 2008 to 2022 (Fig. 5D). Some pictures of dead Old Brahmaputra and Jhinai river are given in Fig. 6. At present Jhinai River and Old Brahmaputra have no flow, only some portion store rain water from adjacent area during monsoon (Fig. 6).

Fig. 4. Planform of merging of Old Brahmaputra and Dasani River near at Sherpur Sadar (Google image 2009).

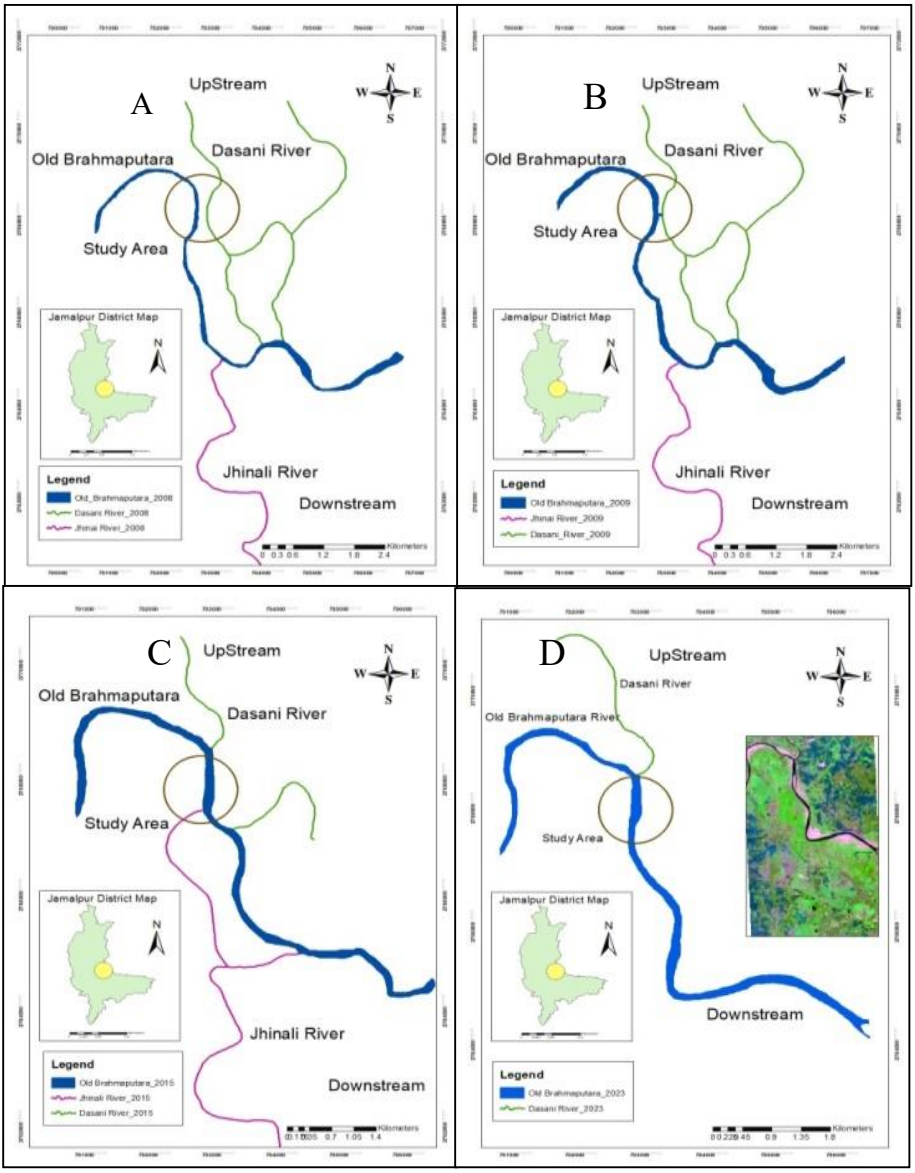

Fig. 5. Plan form change Old Brahmaputra and Dasani Rivers near at Jamalpur Sadar during the years 2008(A), 2009(B), 2015(C) and 2022(D).

Fig. 6. Pictures for dead Jhinai River and Old Brahmaputra near Jamalpur Sadar (4/08/2023).

3.2 River Shifting Analysis for Study Area

In 1985 the distance between two rivers was 1736m with respect reference line AB. This distance is become 411m in 2023. Analyzing the images from 1985 to 2023 based on reference line AB we observed that the Old Brahmaputra River shifted 1226m towards the east, and the Dasani River shifted 99m towards the west shown in Fig. 7.

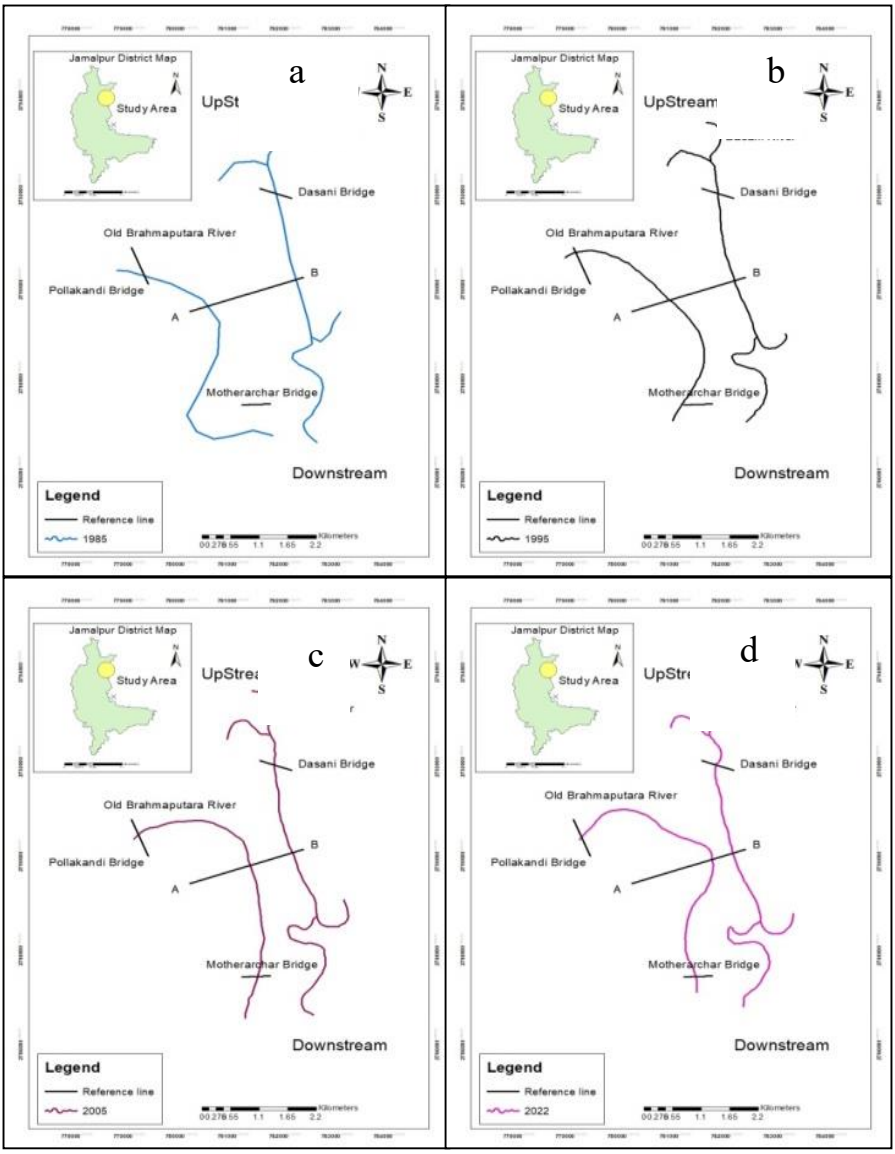

Fig. 7. Plan form change of Old Brahmaputra and Dasani at study area during 1985 to 2022.

Based on the above analysis, the left bank of the Old Brahmaputra River is an erosion-prone bank and shiftable due to its curvilinear shape. On the other hand, the right bank of the Old Brahmaputra River is deposit-prone and shift able due to its convex edge. Both banks of Dasani River are so far stable due to being straight in shape.

Table 3. Shifting of Old Brahmaputra River concerning reference line AB

Years	1985	1990	1995	2000	2005	2010	2015	2020	2022
Distance from reference line AB (meter)	0	178	367	654	818	1020	1151	1191	1226

From table 3 shifting of Old Brahmaputra River was slow down during the years 2015 to 2022 years as compared than 1985 to 2015 because of some bamboo bundle works was done around reference line AB in 2018 show in Fig. 8.

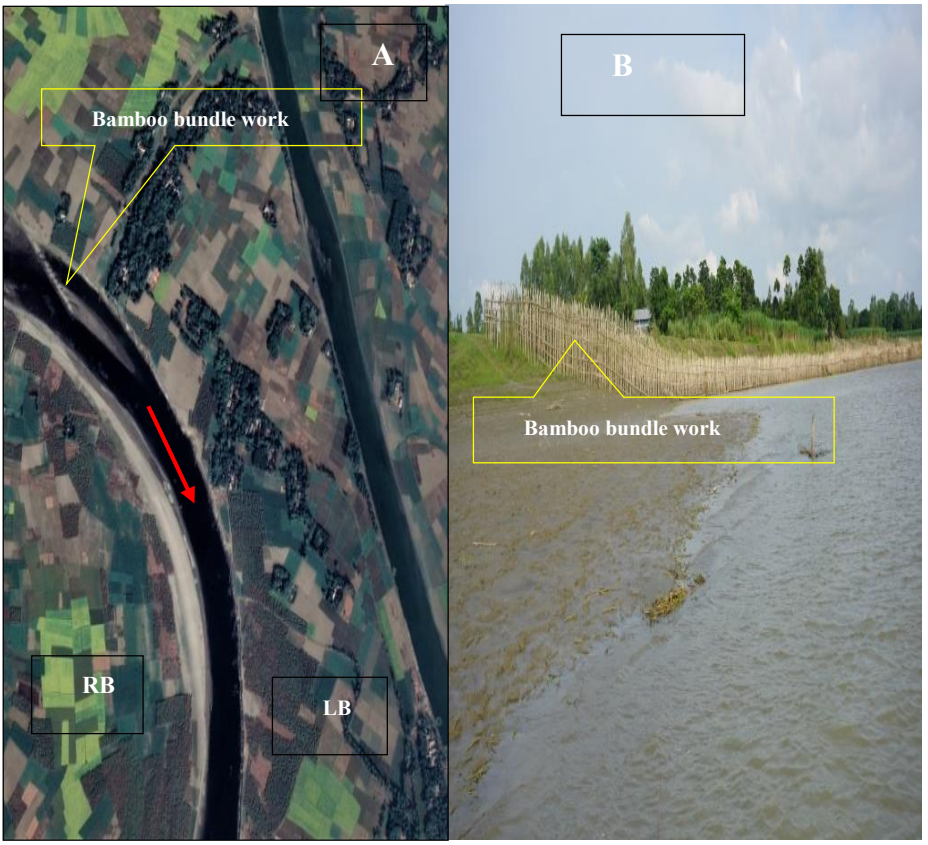

Fig. 8. Picture (A) planform view of bamboo bundle work Google image 2018 work and picture (B) field image of bamboo bundle work along left bank of Old Brahmaputra River**.**

Table 4. Shifting of Dasani River concerning reference line AB.

Years	1985	1995	2005	2015	2022
Distance from reference line AB (meter)	1736	1678	1674	1648	1637

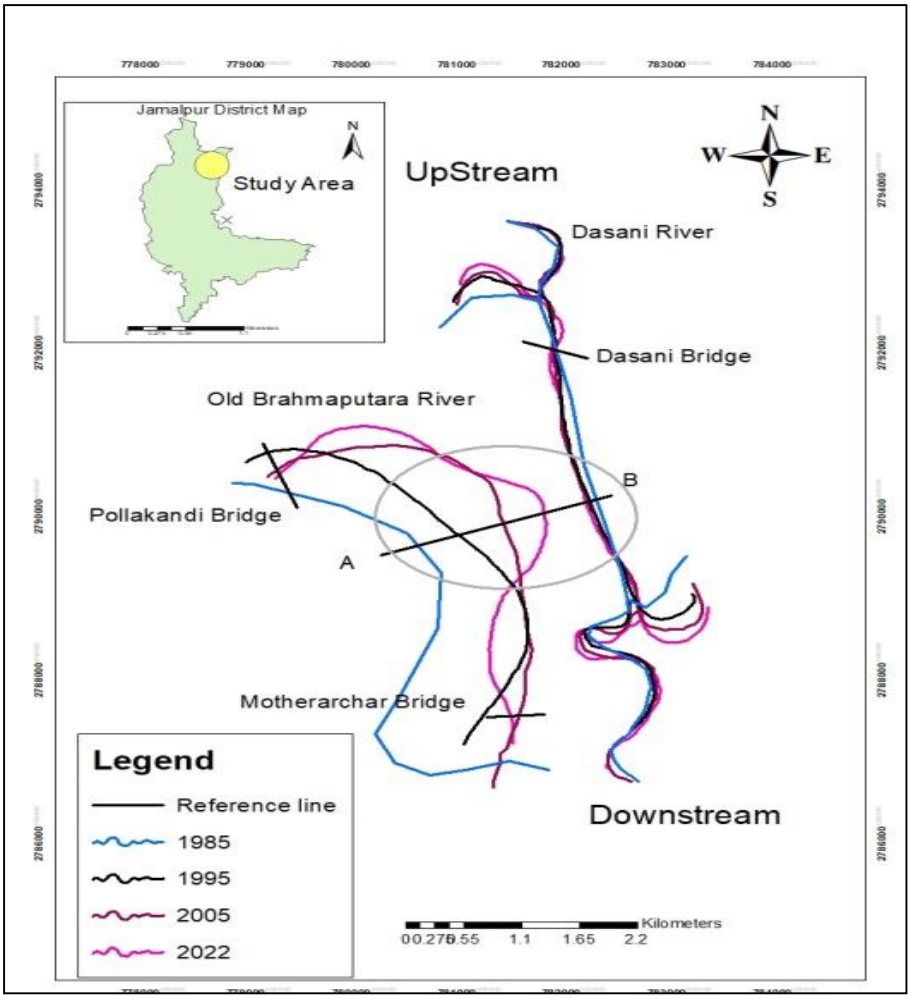

Fig. 9. Plan form change of Old Brahmaputra and Dasani at study area during 1985 to 2022

3.3 Reasons for River Shifting and Bank Erosion

After analyzing the images in GIS, we observed that the average shifting of the Dasani River was 2.67m per year. In study reach the Dasani River almost straight and sinuosity was 1.01 (Article 2.4). In a straight portion of a river, the cross-section is shaped like a trough, with high-velocity flow in the mid of the section. Since the velocity is higher in the middle, the water level will be lower in the middle and higher at the edges, (SK Garg – 1991, Irrigation Engineering and Hydraulic Structures: For Civil Engineering). Therefore, Dasani River bank line shifting and bank erosion are very slight. Figure 10(B) shows the bank erosion for Dasani River. Analyzing the images, we observed that the Old Brahmaputra River shifted 1226m, an average of 33.13m per year. Study reach the Old Brahmaputra River is a curvilinear bend of about 3.6 km and 1.61 (Article

2.4). Every alluvial river tends to develop curves, which are characterized by scouring on the concave side and sitting on the convex side, when the flow moves around the bend, a centrifugal force is applied upon the water, which results in the development of traverse slope of the water surface from the convex edge to the concave cutter. Water moves from the convex side toward the concave to keep its level. These rotary currents cause erosion of the concave edge and deposition on the convex side. When a bend is formed, the flow tends to make the curvature larger (SK Garg – 1991, Irrigation Engineering and Hydraulic Structures: For Civil Engineering). This mechanism continued along our study reach 3.6 km curvilinear bend of the Old Brahmaputra River from 1985 to 2022. Erosion occurs on at left bank due to the convex edge and deposition on the right bank's convex edge. Amount of erosion and deposition are more or less same. The variation of width of rivers is slight during last 37 years. Fig. 10 (A) shows the bank erosion for Old Brahmaputra River

Fig. 10. Pictures of Old Brahmaputra (A) and Dasani (B) River bank erosion near at Bakshiganj upazila in jamalpur district (20/10/2023).

3.4 Conflict Prediction of two Rivers

The average shifting of Old Brahmaputra and Dasani River is about 33.13m and 2.67m respectively per year (Table 1, Table 2). Gap between the two river banks is 340m at present along reference line AB (Figure 2. According to average shifting rate of two rivers the conflict may be occurred within 9 to 10 years. Plotting a graph Shift of rivers against years respect with reference line AB. From logarithmic graph Figure 11, we see

there have a probability of confliction of Old Brahmaputra's left bank (concave edge) with the right bank of Dasani River within 2030 and the gap will be zero.

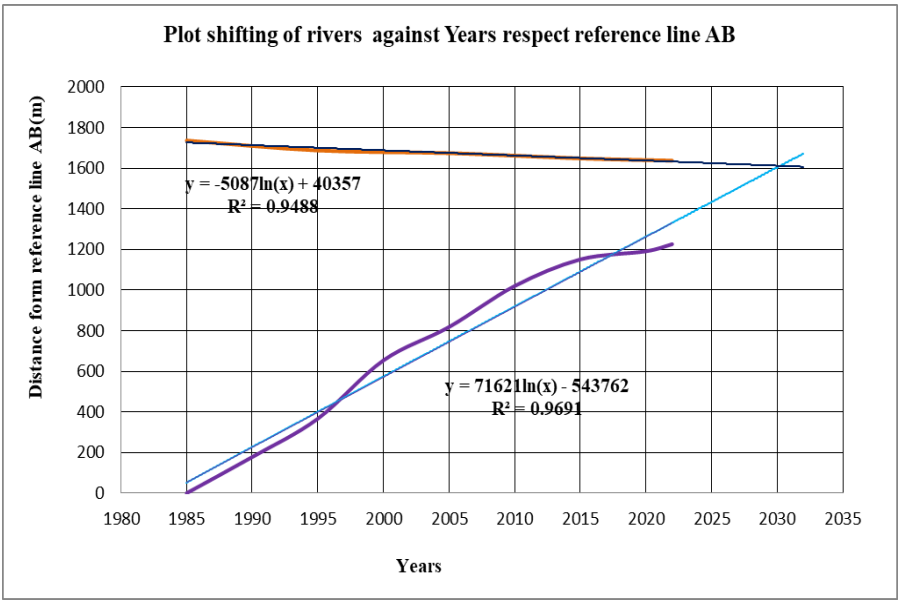

Fig. 11. Graph plot for shifting of rivers against years respect with reference line AB.

3.5. Probable Scenery after Confliction

Sinuosity of Old Brahmaputra at this bend is 1.30 on the other hand Dasani River is 1.01. Due to more sinuosity and centrifugal force at bend Old Brahmaputra River water tends to move from the convex side toward the concave side; as a result, the water of the Old Brahmaputra River will be diverted into the Dasani River. Water flow will be increased in the Dasani River and decreased in the Old Brahmaputra River. Discharge of uniform flow in a channel is given below (KG Ranga Raju, Flow through open channels)

$Q=VA$

$V = 1/n * S1/2 * R2/3$

V = Velocity (m/s)
n = Manning's co-efficient (s/m1/3)
S = Water level slope
R = Hydraulic radius (m) = A/P
A = Cross-sectional area of the channel (m2)
P = Wetted perimeter (m)
River geometry (width, depth, and cross-section) is related to discharge (BL Rhoads - 2020, University of Illinois, River dynamics: geomorphology to support management). Dasani River will change its geometry to balance the excess discharge that comes from

Old Brahmaputra. As a result, downstream of Dasani River will be subjected to more erosion, deposition, and shifting. Dasani River will be highly dynamic in terms of both hydrology and morphology. The people living beside the Dasani River bank will suffer from massive erosion problems. On the other hand, reversed effect will be occurred on the Old Brahmaputra River. After the conflict, Old Brahmaputra will have reduced flow. The reduction of Old Brahmaputra flows caused excessive siltation, increase elevation of the bed levels, and consequent reduction in the flood discharging capacity. After a period, downstream of Old Brahmaputra from that location will lose its existence. New river flow systems will develop to adjust the effect of merging of two rivers.

4 Conclusion

we notice that bank erosion is continuing during last monsoon. According to the present and past erosion, deposition conditions and data analysis, within 7-10 years, there has a strong probability that Old Brahmaputra will be merged with the Dasani River near Modonairchar at Bakshiganj upazila in the Jamalpur district. Vast study is needed to predict strongly what changes may occur in the river system due to the merging two rivers. But it's true that, this event will change the current river system and develop a new one in downstream. Due to this unique river system, people's life and livelihood changed considerably. People have to adapt to the new river system. The change of course of the rivers not only poses problems to lives but also creates environmental impacts.

5 Recommendations

The following recommendations can be drawn from this study.

(1) To sustain the present river system of Old Brahmaputra and Dasani rivers in Jamalpur district, remedial measures will be essential for preventing the conflict between those two rivers near Modonairchar at Bakshiganj upazila in Jamalpur district.
(2) To avoid the conflict of two rivers near Modonairchar at Bakshiganj upazila, based on Present erosion 1.2km bank (LB) of the Old Brahmaputra River should be protected against erosion.
(3) Protective measures may be revetment or bamboo bundle

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