Jagannath University Journal of Life and Earth Sciences, **6**(2): 135-146 pISSN 2414-1402

JnUJL&ES

Research Article

RIVERBANK EROSION TREND ANALYSIS AND ITS IMPACT ON SOCIO-ECONOMIC CONDITION OF THE INHABITANTS OF ISLAMPUR UPAZILA IN JAMALPUR DISTRICT

Shahana Akther*, Umme Saleh Shakira and Md. Hanif Bhuiyan

Department of Geography and Environment, Jagannath University, Dhaka 1100

Received: 22 October 2020, Accepted: 28 June 2021

ABSTRACT

The study examines the pattern of riverbank erosion and its effects on the socio-economic condition of the inhabitants of Islampur upazila in Jamalpur district. Riverbank erosion is a regular event in Jamalpur district, particularly in Islampur upazila because this area is more prone to erosion and many people have already lost their agricultural land, homesteads and other important structures to the river or face imminent erosion. The affected people displaced their place of origin and migrated to a new area where they faced a crisis of basic needs, occupation and security. Both qualitative and quantitative approaches were followed in this study. Data were accumulated from both primary and secondary sources. Primary data were collected from questionnaire survey and focus group discussion (FGD) and secondary data were collected from different sources of published and unpublished documents. Three satellite images (Landsat 5 TM, 7 ETM and 8 OLI TIRS) and ArcGIS 10 software were used to analyze the pattern of riverbank erosion. Satellite-based monitoring reveals that the deposition rate is higher than the erosion rate in this area during the 1997 to 2017 study period. The study also revealed that the multiple shifting of livelihood of affected people quickly goes under the poverty line and simultaneously their living status also changed. Therefore, this research is an attempt to identify the pattern of riverbank erosion and related problems in the study area and to draw attention of the authority for proper actions and measures.

Keywords: *River bank erosion, trend analysis, displacement, impacts, adaptation*

Introduction

Bangladesh is the most disaster-prone countries in the world. More than, 140.23 million people of Bangladesh are at significant risk to more than one form of natural hazards (Islam *et al*., 2014). Among them riverbank erosion is one of the most disturbing natural hazards in Bangladesh (Shamsuddoha and Chowdhury 2007). Since 1973, 1.6 million people become homeless due to the major rivers (Jamuna, Ganges and Padma) bank erosion (CEGIS 2015). The Jamuna is a braided downstream river regarded as unstable bank lines and rapid rates of sideways movement

***Correspondence:** *Shahana Akther, Email: shahanaakther001@gmail.com*

(Khan and Islam 2003). The annual discharge value of Jamuna River is around 60000 $m^3 s^{-1}$ which is three times greater than the Mississippi (Coleman 1969) and may exceed 100000 $m^3 s^{-1}$ in a100-year flood (Halcrow *et al*., 1992). This indicates the severe bank erosion and rapid rates of bank line change along the Jamuna River (Khan and Islam 2003). During 1973 to 2015 erosion and accretion along the Jamuna River was 88,462 ha and 16,315 ha respectively (CEGIS 2015). The imbalance between erosion and accretion is rendered to the widening of the river. According to the last few decade's data, the Jamuna River is widening and both of its banks are shifting. It has been estimated that tens of thousands of people are displaced annually by river erosion in Bangladesh, possibly up to 100,000 (Faruque 2007).The riverine people are severely affected by riverbank erosion and they become poor overnight by losing their cultivated land, home, homestead garden and also their occupation (Rabbi *et al.*, 2013). The displaced people shifted their houses neighboring rural areas (Siddik *et al*., 2017). It has disastrous socio-economic effects and increase the rate of poverty (Islam and Bhuiyan 2016). The main objectives of the study are to analyze the trend of riverbank erosion of the Jamuna River in the western part of Islampur upazila; to identify the socio-economic impacts of riverbank erosion on floodplain people; and to assess the measures taken to mitigate the erosion of Jamuna River in the study area.

Methods

The study was carried out on the eastern part of Jamuna River and riverine island people at Islampur upazila of Jamalpur District because this area is more prone to erosion and many people have already lost their agricultural land, homesteads and other important structures to the river or face imminent erosion (Fig. 1). As Jamuna is a very dynamic river in nature, every year people living in this area face severe bank erosion and flood. According to the satellite imagery, the affected area is the most unstable and usually the movement of the river Jamuna is unpredictable. It is evident from the comparative image that the trend of erosion projected increment and riverbank erosion in 1997 to 2017 is sequentially much and it's about 91.7 km. So, it is very important to identify the trend of erosion in this area and its socio-economic impact on the inhabitants of people to protect them from the erosion and devastating flood.

Interdisciplinary approach was used in this research. Mapping Tools was used for riverbank trend analysis and Participatory Rural Appraisal (PRA) was used to understand the socio-economic impact of riverbank erosion on local people. Questionnaire survey was conducted based on semi-structured and open-ended questionnaires and the information was collected from the household head. Kulkandi, Belgachha, Sapdhari and Palbandha union were selected purposely considering their river bank erosion induced vulnerability. The total population of the upazila is 289337 and 120 households were selected by using simple random sampling technique and 4 Focus Group Discussion (FGD) were conducted from four unions and the respondents were school teacher, union parishad member, aged people and NGOs worker in order to know the socio-economic impact. The collected data were compiled and analyzed by using SPSS software and data were presented with different figures.

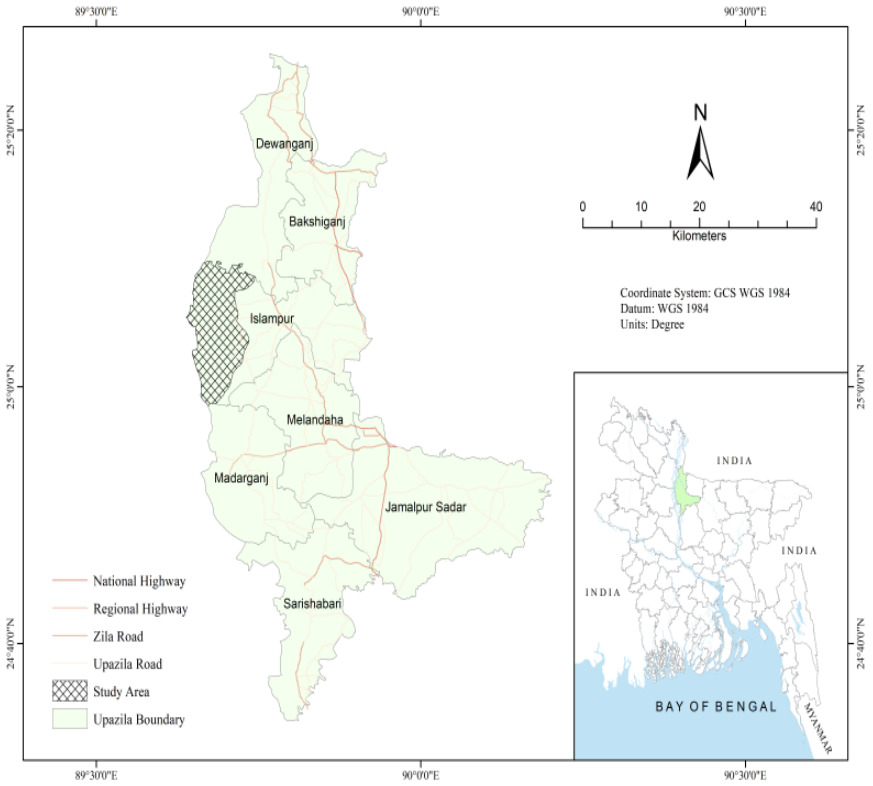

Fig. 1. Location of the study area.

For riverbank erosion trend analysis, three times satellite images (Landsat 5 TM, 7 ETM and 8 OLI TIRS) of the study area of different years during 1997 to 2017 have been collected from the United States Geographical Survey (USGS) (Tables 1 and 2). To analyze the pattern of riverbank erosion Earth explore and ArcGIS 10 software were used in this study.

Table 1. Landsat images were used for extracting the information.

Acquisition Year	Acquisition Date	Sensor	Acquisition Quality	Cloud Cover
1997	1997-11-01	Landsat_5 TM	09	1%
2007	2007-11-05	LANDSAT_7 ETM	09	5.0%
2017	2017-11-08	LANDSAT_8 OLI_TIRS	09	0.04%

Preprocessed images have been applied for several image correction processes. GCP and resampling methods were used for geometric correction. Applied radiometric correction through the processes of Digital Number (DN) convert to Top of Atmosphere (TOA) by using ENVI software. In addition, Dark Object Subtraction (DOS) methods also applied to correction of image atmospheric error (Dewan and Yamaguchi 2009). By using the ENVI software, all of these image

preprocessing processes were applied. Preprocessed image used to extract river channels through river extracting processes in ArcGIS. The river extracting process are as given below:

a) Applied 1997 satellite image into 'Iso cluster unsupervised classification' in ArcGIS with 4 classes;

b) Reclassify the Unsupervised 4 class's image into 2 classes;

c) Reclassify raster image converted into polygon applying reclassify process in GIS;

d) Finally separate the river shape from the converted polygon and export as a layer.

These extracting processes had applied sequentially for 2007 and 2017 images respectfully. Water-body and sand-bed of the study area was separated in ArcGIS by erase tools. These tools were used for measuring river channel shifting pattern, deposition and erosion pattern. Changing patterns of river area, sedimentation pattern and river migration have been measured as a 10 years gap, from 1997 to 2017. In addition, a separate area was calculated in ArcGIS geometric analysis and the calculated area analyzed in MS Excel and present it graphically.

Table 2. Accuracy assessment of classified images of the study area (1997, 2007 and 2017).

Classes	1997		2007		2017	
	Producer Accuracy (%)	User Accuracy (%)	Producer Accuracy (%)	User Accuracy (%)	Producer Accuracy (%)	User Accuracy (%)
Others (Land/veg/bare Soil/grass and so on)	97.30	94.74	92.00	95.83	98.77	98.77
River	93.55	96.67	97.14	94.44	90.00	90.00
Overall Accuracy	95.59		95.00		97.81	
Kappa Coefficient	0.9108		0.8966		0.8877	

Results and Discussion

Trend of Riverbank Erosion in the Study Area

By the analysis of a series of different Landsat images from 1997 to 2017, the yearly rates of erosion and deposition and their differences with different time are shown in Figs. 2 and 3. Though the time, erosion and deposition are varied at different periods. The summation of total land loss due to bank erosion was 43.8 km^2 and the highest rate of erosion occurred during the period of 1997-2007 and the amount was 29.1 km^2 (Fig. 2).

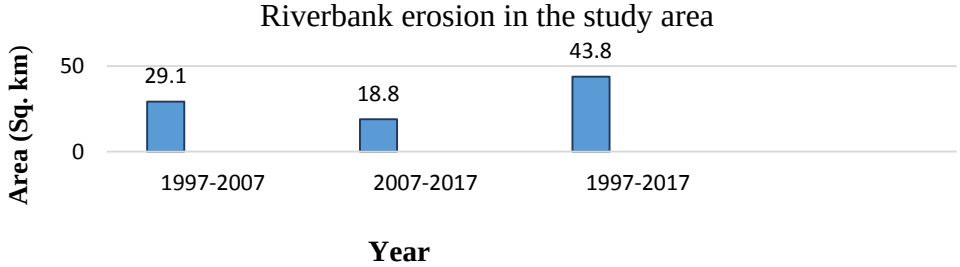

Fig. 2. Riverbank erosion during 1997-2017 in the study area.

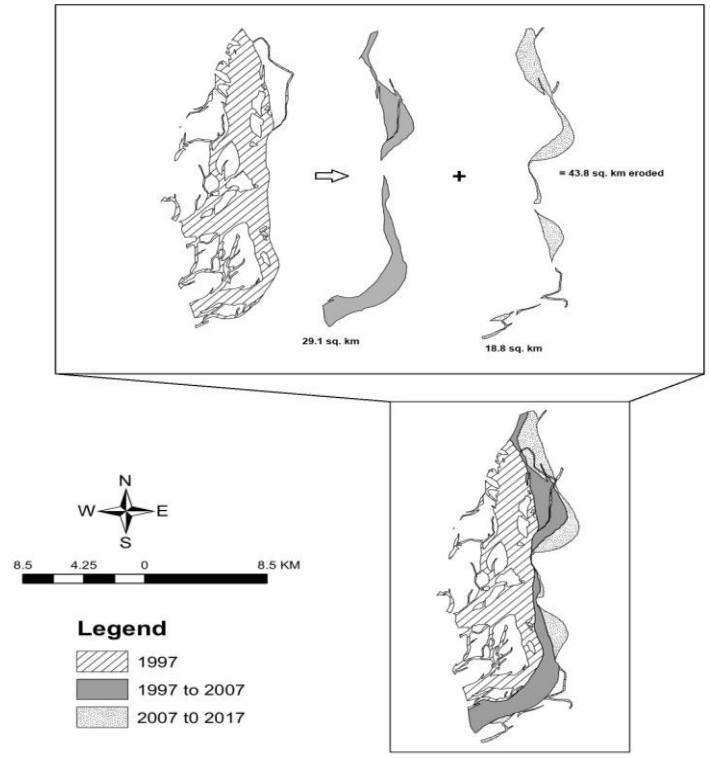

Fig. 3. Shifting pattern of Jamuna River during 1997-2017 in the study area.

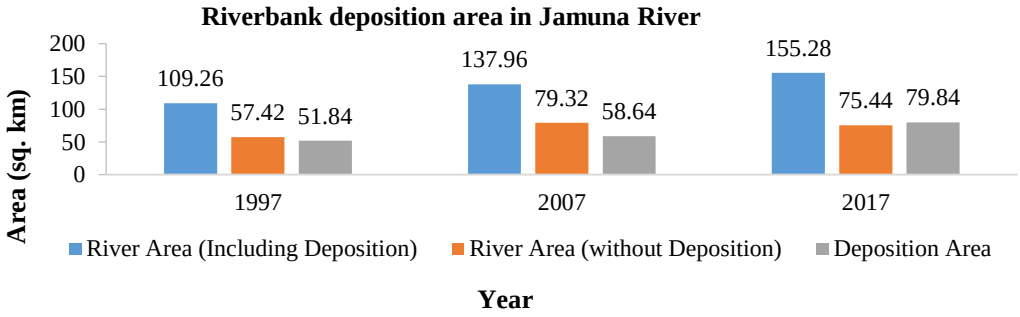

Fig. 4. River bank deposition area of Jamuna River during 1997-2017 in the study area.

Fig. 4 revealed that the highest deposition occurred in 2017 which was 155.28 km whereas it was 137.96 km^2 in 2007 and 109.26 km^2 in 1997 respectively. On the other hand, river area without deposition was 75.44 km^2 in 2017. Interestingly, the river area without deposition was 57.42 km^2 in 1997 than it raised at 79.32 km^2 in 2007 and again it declined at 75.44 km^2 in 2017. The total land gained by accretion was 79.84 km^2 and erosion was 43.8 km during the period of 1997-2017 (Table 3).

Table 3. Deposition area of the eastern part of Jamuna river during 1997-2017.

Year	Deposition km^2	Erosion km^2	Difference km^2
1997	51.84	29.1	+ 22.74
2007	58.64	18.8	+ 39.84
2017	79.84	43.8	+ 36.04

Source: Field Study, 2018

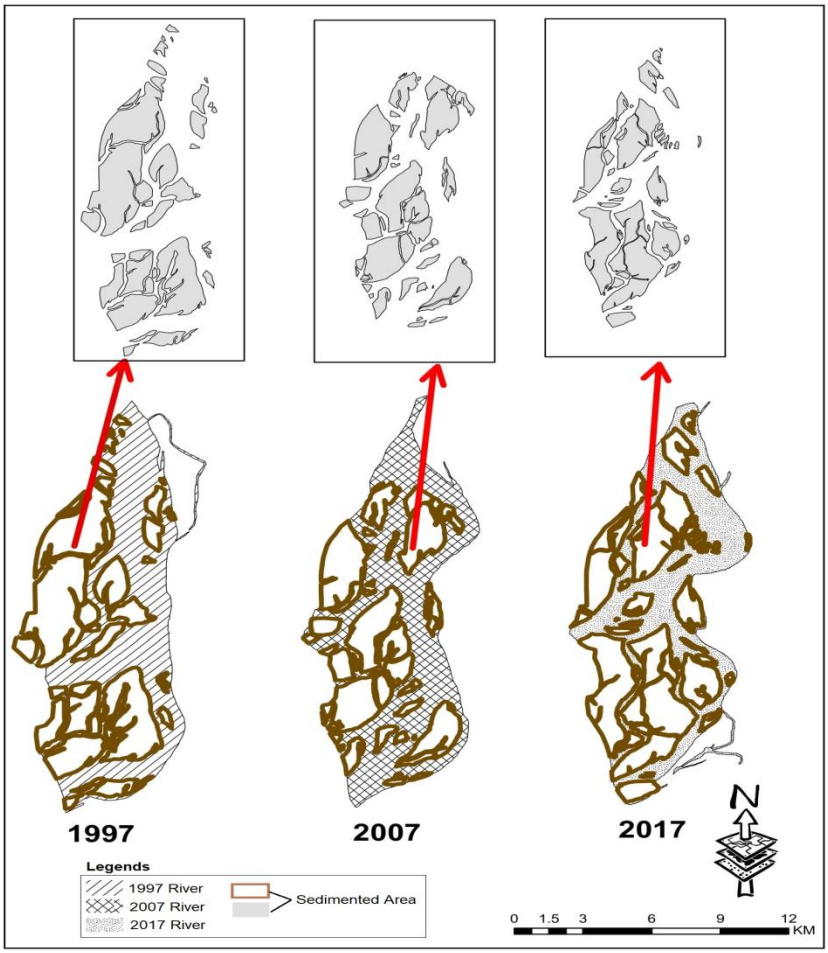

Fig. 5. Sedimentation pattern of Jamuna River during 1997-2017 in the study area.

It is clear that accretion and erosion were vigorous during this period. The total land change was about 36.04 km^2 (Fig. 5). Pointing out the overall gained of land was the dominant features for the same period.

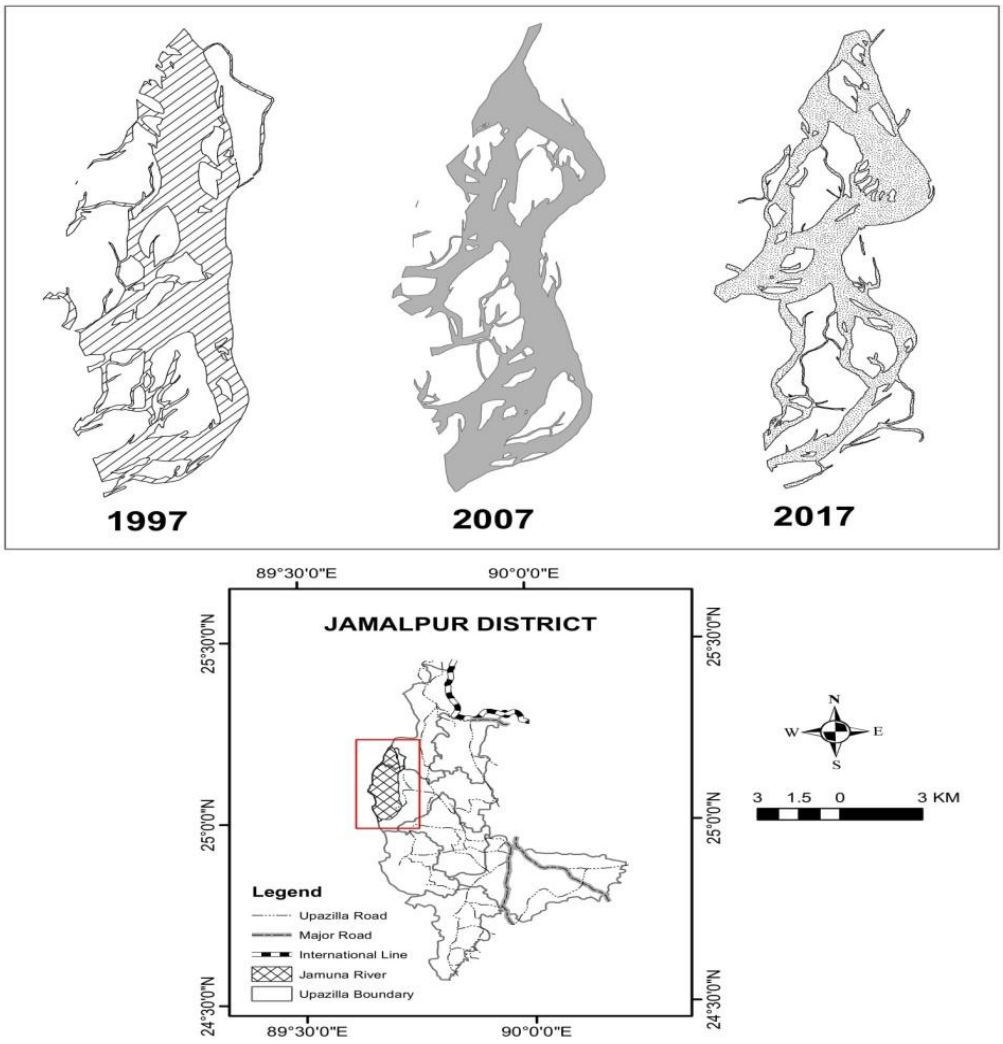

Fig. 6. Spatio-temporal change of the eastern part of Jamuna River in the study area.

By the analysis of satellite images, it is clear that erosion rate is lower than deposition rate and the river is narrowing in the western part of Islampur upazila (Fig. 6).

Socio-economic Impact of River bank Erosion on the Local People

It is very important to understand the socio-economic impact of riverbank erosion in the study area. The socio-economic profile of the respondents is shown in Table 4.

Table 4. Socio-economic profile of the respondents.

Socio-economic Indicators of the Respondents		Frequency	Percentage
Sex Ratio	Male	90	75
	Female	30	25
	Total	120	100
Duration of Living (Years)	0-1	17	14.2
	2-5	46	38.3
	6-10	58	48.3
	11-15	06	5
	15+	03	2.5
	Total	120	100
Level of Education	Illiterate	86	71.6
	Primary	15	12.5
	High school	13	10.8
	Higher secondary	05	4.7
	Graduate	01	0.83
	Total	120	100
Marital Status	Married	95	79.7
	Unmarried	21	17.5
	Widowed	03	2.5
	Celibate	01	0.83
	Total	120	100
Types of Occupation	Farmer	40	33.3
	Fisherman	28	23.3
	Day labor	27	22.5
	Small Business	10	8.3
	Medium Business	05	4.7
	Unemployment	10	8.3
	Total	120	100
Monthly Income (Taka)	<5000	28	31.7
	5000-10,000	40	33.3
	10,000-15,000	38	23.3
	15,000+	14	11.7
	Total	120	100
Housing Condition	Kacha	84	70
	Semi-pacca	25	20.8
	Pacca	05	4.7
	Others	04	3.3
	Total	120	100
Source of Drinking Water	Tube well	95	66.7
	Ponds	15	29.7
	Others	05	4.7
	Total	120	100
Sanitation	Kacha	75	62.5
	Semi-pacca	30	25
	Sanitary Latrine	10	7.5
	Others	0	0.83
	Total	120	100

Source: *Field survey, 2018*

In the study area, most of the respondents (58%) have been migrated to the place of present residence in between 6-10 years and 46% people have been displaced from their origin 2-5 years.

Migration Pattern of the Respondents

Due to riverbank erosion landless people do not want to migrate permanently from their place of origin but they are forced to move permanently. According to the respondent's perception about migration routes, it can be stated that they mostly preferred short distance for permanent migration whereas they preferred long distance for temporary migration. Around 43% respondents permanently migrated to the same mouza whereas only 4% respondents migrated to another district. On the other hand, around 45% respondents temporarily migrated to another district and only 3% respondents temporarily migrated within the same mouza (Fig. 7).

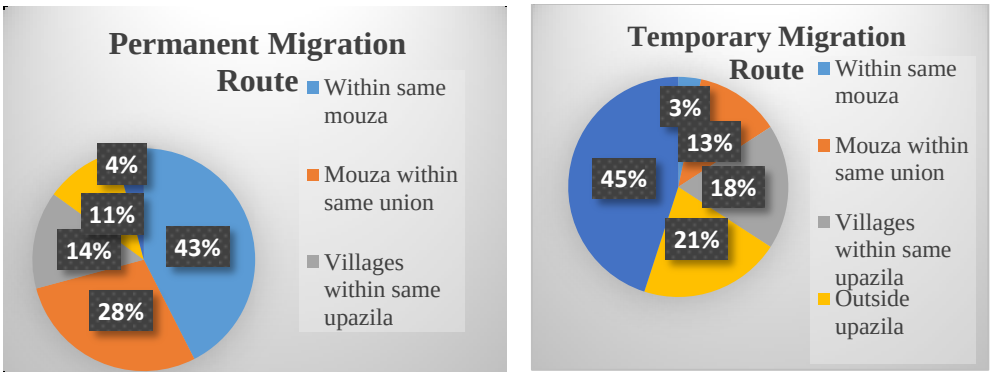

Fig. 7. Migration pattern of the respondents.

Riverbank Erosion Impacts on Livelihood

Generally, the inhabitants of this upazila have not sufficient and fixed employment opportunities to meet their own needs. According to the study due to riverbank erosion 55.79% farmers change their occupation among them18.90% respondents change it 5-6 times in their lifetime. Moreover, 13.89% of day labor and 9.10% of rickshaw pullers have changed their occupation at different times (Table 5). It is evident that multiple shifting of livelihood of affected people quickly goes under the poverty line and simultaneously their living status also changed.

Table 5. Frequency of occupational change in a lifetime by riverbank erosion in the study area.

Occupation	1-2 times	3-4 times	5-6 times	7-8 times	>8 times	Total
Farmer	7.45	12.60	18.90	10.90	5.94	55.79
Day Labor	2.94	3.61	4.39	1.91	1.04	13.89
Rickshaw puller	2.35	3.23	2.51	1.01	-	9.10
Fisherman	2.62	4.01	1.45	-	-	8.08
Small Business	2.01	1.86	1.32	1.30	1.42	7.91
Medium Business	1.05	0.78	-	-	-	1.83
Housewife	1.89	1.33	.18	-	-	3.4
Total						100

Source: *Field survey, 2018*

Effects on Education

The literacy rate of Islampur upazila is 23.6% whereas the national literacy rate is 72.9% (BBS, 2018). Moreover, 86% people are still illiterate and only 1% people is able to complete their graduation level. Riverbank erosion has adverse effects on the educational system in the study area (Felderman 2012). According to the study, 42.1% students have lost their books and 38.15% students have experienced loss of educational institutions by the riverbank erosion. Due to the loss of educational institutions and books 36.84% students were unwilling to study after erosion. Consequently, 69% affected people become unable to expend more money on education like before erosion. For the poverty, students are engaged in different types of work to meet their basic needs.

Effects of Property

Maximum people in the study area have bitter experience of losing their property such as settlement, agriculture land, homestead etc. due to riverbank erosion. According to the study 82% respondents have lost their cultivable land, 71% lost their homestead and 57.34% lost their settlement. The loss of property badly affects their living status and livelihood pattern.

Effects on the Quality of Life

Generally, the maximum upazilas of Jamalpur district are more underprivileged in health care facilities than that of any parts of the country (Baki 2014). Consequently, the average infant and child mortality rate of this area is also higher than the national level (Das 2014). According to the study, 78% respondents were unable to expend more money to buy food and health care facilities like before erosion. Moreover, the health care facilities in the study area are not sufficient. Only one upazila health complex, three satellite clinic and some community clinics cannot provide essential health care facilities to the inhabitants (Rahman 2010). Around 80% respondents thought that these medical facilities are not adequate to provide required health services to the people. In addition, during the monsoon season, the communication system was disrupted and the health care facilities is totally collapsed (Sewnet 2015).

Effects on Utility Services

In this study safe drinking water and sanitation are considered as the utility services. About 95% respondents rely on tube wells for safe drinking water. During the monsoon period most of the tube wells are inundated and people are suffered from unavailability of safe drinking water. On the other hand, 75% people use *kacha* latrine and only 10% people have sanitary latrine. As a result, they have to suffer different types of water-borne diseases (Uddin *et al*., 2015).

Adaptation Process

Riverbank erosion is the most devastating natural hazard in the study area but people try to adjust with erosion. When the erosion begins 87% respondents of the affected areas start shifting their belongings to safe places, 53.2% make bamboo shelves to keep daily necessaries and 71% keep their domestic animals on the highland such as embankment and unfaceted relative house. Around 52.1% people transfer domestic animals to their relatives, 32.63% transfer seeds and crops and 18.87% transfer useful household materials to their unaffected neighbors. Moreover, only 8.4% people transfer their cash money to their relatives. Around 56% respondents mentioned that they

ensure community nightguards to keep safe their domestic animals and assets from thieves and robbers.

From the findings of the study, it is clear that both structural and non-structural measures should take in the western part of Islampur upazila to protect river bank erosion and improve the quality of affected people. Some measures and actions needed to mitigate the bank erosion and its effect on local people. The respondents identified some measures to mitigate the impact of river bank erosion such as construction of embankment, provide shelter and security, create alternative livelihood, provide handicraft training for women, establish adequate medical facilities, provide low interest financial support for rehabilitation to adjust with erosion.

Conclusion

Jamuna River historically plays a significant role in the lives and livelihood of people in the study area. Though the accretion rate is higher than erosion rate but it has a significant bad effect on local people. The study revealed that around 56% farmers changed their occupation and they preferred short distance for permanent migration and long distance for temporary migration. It not only forces people to displace or leave their place of origin, but also destroys their lives and livelihood. Every year huge numbers of people become homeless and jobless and they migrate to neighboring areas or big cities and create unstable conditions in the place of destination. Moreover, multiple changes of livelihood of affected people quickly goes under the poverty line and their living status also hampered. So, it is a high time to take proper sustainable measures and actions to mitigate the erosion and rehabilitate the erosion affected people.

References

Baki, A.T.M.A. (2014). Socio-economic Impacts of Gorai Riverbank Erosion on People: A Case Study of Kumarkhali, Kushtia. *MS Dissertation. Institute of Governance Studies (IGS).* BRAC University, Dhaka, Bangladesh.

BBS. (2018). Education and literacy in Bangladesh: an analysis from socio inclusion perspective (population monograph: volume-2). *Bangladesh Bureau of Statistics (BBS)*, Statistics and Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka

Center for Environment and Geographic Information Services (CEGIS). (2015). Prediction of River Bank Erosion along the Jamuna, the Ganges and the Padma Rivers in 2015. *CEGIS*, Gulshan, Dhaka.

Coleman, J.M. (1969). Brahmaputra River: channel processes and sedimentation. *Sedimentary Geology*, 3: 129-239.

Dewan, A.M. and Yamaguchi, Y. (2009). Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization. *Applied Geography*, 29(1): 390-401.

Das, T.K., Halder, S.K., Gupta, I.D. and Sen, S. (2014). Riverbank erosion Induced Human Displacement and its Consequences. *Living Rev. Landscape Res*, 8, doi: 10.12942/IrIr-2014-3, http://IrIr.landscapeonline.er/Articles/IrIr-2014-3/download/ IrIr- 2014-3Color.pdf (accessed 24 January 2018)

Faruque, A. (2007). Resettlement Policy Resettlement Policy Development: The Case of Development: The Case of Bangladesh. Asian Development Bank (ADB) Bangladesh, *ADB*, Resident Mission. https://pdfs.semanticscholar.org

Feldman, S. and Geisler, C. (2012). Land expropriation and displacement in Bangladesh, *Journal of Peasant Studies*, 39(3-4): 971-993

Halcrow, S.W. and Partners Ltd. (1992): River Training Studies of the Brahmaputra River, River Bank Protection Project, Brahmaputra Right Bank Priority Works: Environmental Impact Assessment, *Final Report. Prepared for the Government of the People's Republic of Bangladesh, Bangladesh Water Development Board*.

Islam, S.M.D. and Bhuihan, M.A.H. (2016). Exploring climate change adaptation in coastal communities of Bangladesh using Adaptation Capacity Index (ACI), *Jahangirnagar University Environment Bulletin*, 5: 11-23.

Islam, M., Sultana, S., Saifunnahar, M. and Miah, M. (2014). Adaptation of Char Livelihood in Flood and River Erosion Areas through Indigenous Practice: A Study on Bhuapur Riverine Area in Tangail. *Journal of Environmental Science and Natural Resources*, 7(1): 13-19.

Khan, N.I. and Islam, A. (2003). Quantification of erosion patterns in the Brahmaputra-Jamuna River using geographical information system and remote sensing techniques. *Hydrological Processes*, 17(5): 959-966.

Rabbi, H., Saifullah, A.S.M., Sheikh, M.S., Sarker, M.M.H. and Bhowmick, A.C. (2013). Recent Study on River Bank Erosion and Its Impacts on Land Displaced People in Sirajgonj Riverine Area of Bangladesh, *World Journal of Applied Environmental Chemistry*, 2(2): 36-43.

Rahman, M.R. (2010). Impact of riverbank erosion hazard in the Jamuna floodplain areas in Bangladesh. *Journal of Science Foundation*, 8(1&2): 55-65.

Shamsuddoha, M., and Chowdhury, R.K. (2007). Climate change impact and disaster vulnerabilities in the coastal areas of Bangladesh. *COAST Trust, Dhaka*, 40-48.

Siddik, M.A., Mostafa, A.K.M.Z., Islam, M.R., Hridoy, S.K. and Parvina, M.A. (2017). Socio-economic Impacts of River bank Erosion: A Case Study on Coastal Island of Bangladesh, *The Journal of NOAMI*, 34(2): 73-84.

Sewnet, A. (2015). Land use/cover change at Infraz watershed by using GIS and remote sensing techniques, northwestern Ethiopia. *International Journal of River Basin Management*, 14:1-10

Uddin, M.R., Miah, M.G.U., Afrad, M.S.I., Mehraj, H. and Mandal, M.S.H. (2015). Land use change and its impact on ecosystem services, livelihood in Tanguarhaor wetland of Bangladesh. *Sci Agric.*, 12:78-88