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Exploring the Socioeconomic Impact of Riverbank Erosion in the Brahmaputra Valley of Assam, India: A Case Study of Two Districts

Abstract

This paper explores the socioeconomic impact of riverbank erosion and measures the incidence and severity of poverty among the riverbank inhabitants of Assam, India. Primary data from two erosion effected districts of Assam have been collected using multistage random sampling technique. To measure the incidence of Poverty among the riverbank inhabitants, Head Count Ratio (HCR) method has been used. Severity of poverty is measured using Poverty Gap Index (PGI). The results reveal that the level of poverty and the severity of poverty are related with the degree of erosion. Similarly, the migration (both short-term and long-term) also related with the degree of erosion. It has also found that various types of socioeconomic issues arise due to riverbank erosion, such as loss of cropland and livestock, education and transportation problem, social displacement, etc. An important fact observed is that the problem of migration and poverty also exist in the non-eroded villages. For which, it cannot be say that migration issue arise only because of riverbank erosion. But, riverbank erosion pushes the other problems to more vulnerable situation which compels the affected people to take their decision. Therefore, riverbank erosion may be considered as a cause of migration and poverty in the study areas. In this context, the paper recommends that with the erosion control measures, the policies such as resettlement, financial support and social safety nets should be implemented in the erosion affected areas to reduce poverty as well as to reduce outmigration.

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1 Introduction

Assam is situated in the northeastern part of India and it is the only state, which has highest plain area among the Northeastern states. Out of total geographical area, 98.4% is rural (GOA, 2020). It occupied 2.4% of the total geographical area of the country and 2.6% population of the country lives in this state. Decadal growth rate of population is 17.07% with a density of 340 persons per sq. km and sex ratio is 958 females against 1000 males (Census, 2011). The state is affected by flood and riverbank erosion since 1914 (GOA, 2014). This is because the major river Brahmaputra flows through the middle of Assam. Thus, flood and erosion in the Brahmaputra River become a recurrent process and affects almost 21 districts (GOA, 2021). Not only the Brahmaputra, the Barak River also affect some districts in the Barak Valley region (GOA, 2021). As per the information of the report of National Disaster Management Authority Commission (NDMA, 2013), severe erosion in the Brahmaputra River led to loss of large plots of land during the period from 1990 to 2007-08. The length of total erosion during the period 1990 to 2007-08 in Assam was 742.98 km, out of which, 353.85 km. was in the north-bank and 389.13 km. was in the south bank of the Brahmaputra River. In terms of sq. km., the total land lose to erosion during the same period (1990 to 2007-08) was 538.80 in the north-bank and 914.62 in the south-bank of the Brahmaputra. While in the Dhubri district, the total length eroded was 40.19 km in the north-bank (124.461sq km.) and 7.05 km in the south-bank (194.983 sq km.). Thus, due to this severe erosion, a large number of villages and families were displaced from the Brahmaputra river basin (GOA, 2014). Owing to flood and riverbank erosion, Assam has lost more than12 million ha of land (GOA, 2014). Along the Jiadhal River in Dhemaji district, many socioeconomic problems arise due to flood such as Displacement, loss of agriculture and home, psychological effects, poor transportation system, problems of education, medical problems etc. (Burhagohain & Bhuyan, 2015). In Golaghat district flood and erosion has displaced and created various types of socioeconomic problems such as loss of agricultural land, homestead land and forest land, social and family relations broke etc. (Mili et al., 2013). In this way severe and continuous flood related erosion forces the poor people to fall into the trap of poverty as they lost farm and homestead land, as well as livelihood in Dhemaji and Dhubri district (Dekaraja and Mahanta, 2018). Apart from that, the riverbank erosion destroys the process of production and livelihood, the family and community relations breaks, as well as threatened cultural identity of the people. As a result, the affected people compel to migrate for seeking livelihood and resettlement (Das et al., 2014). In Hajo and Barpeta district of Assam, also people lost large plot of land and displaced from their home (Baishya, 2013; Ahmed, 2016). The displaced people migrate to nearby villages and towns. Those who migrated to town engaged in unskilled jobs like pulling *thela* and rickshaw, building construction, security guard etc. In this context, the study wants to examine the various socioeconomic impact of riverbank erosion in Dhemaji and Dhubri district of Assam. Moreover, the study focuses on to measure the incidence and severity of poverty among the riverbank inhabitants and to find out whether the migration happens because of riverbank erosion. Thus, the objectives of the paper are formulated as

1. To explore the various socioeconomic problems arise due to riverbank erosion.
2. To estimate the rate of poverty and incidence of poverty in the erosion affected areas.
3. To examine whether the migration happen because of riverbank erosion.

The paper has been divided into five broad sections. Following introduction, the second section presents a brief review of literatures. Section three discusses the methodology applied to study the impact of riverbank erosion. The fourth section presents the results and discussion. Finally, the paper concluded with summary of findings and recommendations in the fifth section.

2 Review of literature

Various studies revealed the issues of flood and riverbank erosion in together manner, as riverbank erosion is simultaneously occurred with flood (Rahman, 2010). However, the impacts are different in

both the cases: impact of flood is short-term while the impact of riverbank erosion is long-term (Das et al., 2013). Flood temporarily displaces the people, but riverbank erosion permanently displaces the people and therefore livelihood becomes vulnerable (Uddin and Basak, 2012; Das et al., 2017). There are various studies, which discuss the flood, and riverbank erosion induced socioeconomic problems in Assam. In a study made by Mili et al., (2013) in Golaghat district of Assam, India, found various problems that arise due to flooding and erosion, such as "*displacement, loss of agricultural land and home, psychological effect, poor transportation system and problems in education*[1]". These types of socioeconomic problems induced by riverbank erosion push the victims to migrate to any nearby area in search of livelihood (Baishya, 2013). Another study conducted by Ahmed (2016), finds that Barpeta district of Assam is severely affected by riverbank erosion. Ahmed on the basis of field survey also finds that the affected people migrate from the eroded areas as they lost the primary source of livelihood. It has also argued that agriculture is the main source of income for those riverbank inhabitants that depend on cropland; hence, loss of cropland in riverbank erosion means they lose everything. Further, it has argued that the erosion affected people do not have any other coping strategy; therefore they migrate to nearby towns and cities to earn their livelihood. The migrated people normally get employment in informal sectors like pulling *thela*, rickshaws, unskilled construction works of buildings, roads, etc. During, 2015 a study also conducted by **Nayak and Panda** published in 2016, to examine the socioeconomic life and livelihood of the people of riverbank areas of Brahmaputra River. The authors conducted a field survey to study the problem in depth. Authors have estimated that on an average a family in surveyed villages lost an asset worth Rs. 60,533 in the year 2014-15 due to floods. The study also finds that the Brahmaputra River is giving life support (in the form of agriculture, fishing, transportation etc.) to those households of riverine areas apart from its negative effects like flood and erosion.

The state government report reveals that the severity of erosion is very high in Dhemaji and Dhubri district of Assam in comparison to the other districts (GOA, 2014 and 2018). Within the two districts, during 2007-08, people living below poverty line in the rural areas of Dhemaji district is higher (i.e. 69.53%) than the Dhubri district (i.e. 28.66%) [NSSO]. However, as per Human Development Report of Assam, 2014 the poverty Ratio in rural areas of Dhemaji district was 37.5% and in Dhubri district it was 43.5%. Overall poverty ratio in Dhemaji district is 36.5% and in Dhubri district is 41.5%. In case of the state, it is 37% (GOA, 2014). As per 2018-19 ASI (Annual Survey of Industries), 2.38 million persons are engaged in industries in the state. Industrially, both the sample districts are backward. During 2018-19, only 1976 units of the Micro Small and Medium Enterprises (MSME) were registered (which is 7.23% of the registered MSMEs in the state) in the districts with 746 (3.72% of the state total) workers involved in these MSME units (GOA, 2020).

Studies conducted in West Bengal and Bangladesh also pointed the issues of riverbank erosion and its socio-economic impacts. The Yamuna River in Bangladesh affects and displaces a large number of riverbank inhabitants through the erosion process and therefore affected people migrate to other places for sustaining their livelihood (Uddin and Basak 2012; Bhuyan et al., 2017). The displaced People lost their agricultural land as well as properties that affect their sources of income and lead to entrapped poverty. Although erosion displaces many families, but in low eroded areas victims adopt some coping strategies like sale of land and livestock, shifting to new char land to adjust with the erosion problem (Fakhruddding and Rahman, 2015). Therefore, in Bangladesh, erosion induced considered as the major contributory factor of high rate of poverty (Rana and Nessa, 2017). Adopting the origin and destination survey method in Bangladesh, the study conducted by Rana and Nessa (2017) observed that two-third populace of the surveyed villages migrates permanently from one union to another union by getting support from their neighbours, relatives, friends and they stayed in the destination place at lower living cost in comparison to the origin[2]. In the context of India, Das et al., (2014) finds that impacts of riverbank erosion are "*multi farious: social, economic, health, education and sometimes political*", which creates forced mi-

1 District is the sub-union of a state that comes under the jurisdiction of District magistrate.

2 Union indicates the provinces or states.

gration. The socioeconomic impacts categorized as short-term (loss of home, agricultural land, jobs and assets) and long-term (*direct effects on the living conditions of affected populations and indirect effects on human health and development, also referred to as the accumulation of human capital, which includes schooling of children and health status of mothers and children*) impacts (Das et al., 2017; Dekaraja & Mahanta, 2021). The forced migrants face various types of risk of insecurities due to erosion, such as economic insecurity due to unemployment, erosion of capital and indebtedness, social insecurity due to deprivation of civic rights, health insecurity due to lack of basic infrastructure, etc. Therefore Das et al. (2014) suggest that there should be specific policies to protect civic rights of those migrants and it would have been better to introduce gender specific policy (especially for female protection) (Uddin and Basak, 2012). Among various impacts, loss of property in the form of cropland, cattle, and houses made the households more vulnerable to poverty and forces to migrate (Karim, 2014).

All the studies mentioned that flood and riverbank erosion are complementary disaster, both occurred together manner. Therefore, impact of flood and riverbank erosion is almost similar. All the studies above discussed the various problems occurred due to flood and riverbank erosion. Our current study also looks similar to the above studies to some extent as it wants to explore the socioeconomic problems arise due of riverbank erosion. However, our study is different from others on the ground that it wants to detect the problem of migration that occurred because of riverbank erosion with the other socioeconomic problems. Apart from that our study

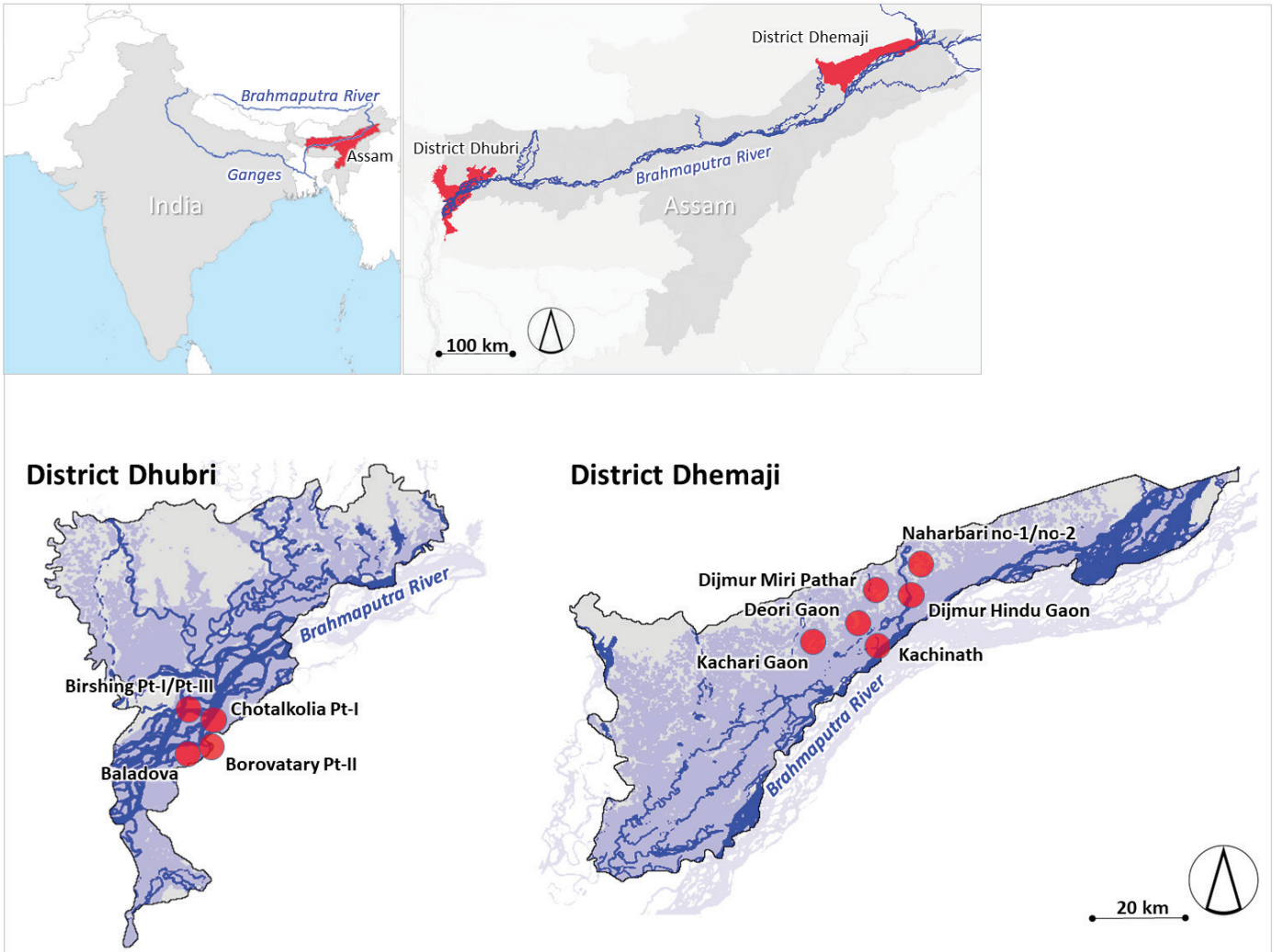

Figure 1. Location of study areas, villages in Dhubri and Dhemaji District with flood risk areas along Brahmaputra River in light blue shading (Own map based on Bhuvan Data, GCS WGS - World Geodetic System 1984)

estimated the rate of poverty and extent of poverty among those erosion affected households which is a tremendous work.

3 Methodology

3.1 Study Area

The study covers Dhubri and Dhemaji district of Assam, which are largely affected by riverbank erosion (Figure 1). Geographical location of Dhuburi district is- $90^0$15' E to $90^0$20' E longitude and $26^0$15' N to $26^0$26' N latitude, which is 30 m above the mean sea level, while Dhemaji is located between $94^0$12' 18'' E and $95^0$41' 32'' E longitudes and $27^0$05' 27'' N and $27^0$57' 16'' N latitudes, 104 m above the mean sea level. Total geographical areas of Dhubri and Dhemaji districts are 2176 sq. km and 3237 sq. km respectively as per the information of Revenue and Disaster Management Department, GOA, 2014. Dhemaji and Dhubri districts are highly erosion affected districts, where total area eroded in 2014 was 8.64 million ha (2.67% of district area) and 1.61 million ha (0.74% of district area) respectively. Population displaced due to flood and erosion was 9.92 million (11.82% of the state population displaced) and 12.86 million (35.95% of the state population displaced) in Dhubri and Dhemaji district respectively (Revenue and Disaster Management, GOA, 2014).

Total population of the study districts is 2.63 million, of which 1.35 million are male and 1.29 million are female and sex ratio is 953 females per 1000 males. The average literacy rate is 65.52 and the density of population is 485 per sq. km (combining both the districts) (Census, 2011).

The economy of the state as well as the districts is mostly depending on the agricultural sector where 86% of the total population lived in rural areas. About 63% population depends on agriculture for their livelihood. In comparison to the state more than 80% population in the sample districts lives in rural areas and agriculture is the main occupation for their livelihood. Out of total main workers in the state 46% are cultivators and 15.89% are agricultural labours. Total cropped area of Assam in 2019-20 is 3.97 million ha, which is 50.67% of total geographical area and the average size of operational holdings is 1.49 ha. As against this, total cropped area in the districts is 0.32 million ha out of 0.67 (7.35% of the state) million ha in 2019-20 (Statistical Handbook of Assam, 2021). The area under high yielding varieties in the districts is only 8.3% of the state during 2019-20. The marginal category farmer occupied more than 65% of the total operational holdings of land in the state. In 2011-12, 31.98% of total population is below the poverty line of which 33.89% in rural and 20.49% in urban areas (HDR, 2014). If compare to the state, the cultivators are very high among the marginal workers in Dhemaji district, while in the Dhubri district it is very low. But the case is opposite for the agricultural labourers among marginal workers (Table 1).

3.2 Data Source and Sampling Design

The problems have been examined using both primary and secondary data. Secondary data have been collected to get an idea of the riverbank erosion induced problems in the study area. The secondary data have been collected from the published sources of Government of Assam. Secondary data related to cropland, livestock, industries are collected from Statistical Handbook of Assam (2014 & 2021). Sec-

Table 1. Distribution of main and marginal workers.

	Category	Cultivators	Agri lab	HH Ind	Others	Total
Dhubri	Main worker	35.62	21.27	3.17	39.94	100
	Marginal worker	15.43	38.64	7.16	38.77	100
Dhemaji	Main worker	72.45	2.38	1.54	23.63	100
	Marginal worker	74.54	12.47	3.56	9.43	100
Assam	Main worker	46.12	15.89	2.70	35.29	100
	Marginal worker	39.78	27.86	5.68	26.68	100

Note: All the values are percentages of the total main and marginal workers. Agri lab means Agricultural labours, HH Ind means Household industries. Source: Census of India, 2011

ondary data on population, gender, caste are collected from Census of India, Assam (2011). Secondary data related to status of riverbank erosion and population affected district wise are collected from the Revenue and Disaster Management Department of Government of Assam in 2014. Some of the village level information on riverbank erosion and families affected are collected from Circle Offices of each selected district. Then primary data have been collected through field survey using a semi-structured schedule (2016).

To examine the problem in depth primary data have been collected using a multi stage random sampling technique. Under this technique, one Revenue Circle (RC) has been selected from each of the two districts on the basis of high erosion criteria (Table 2). Then six revenue villages selected from each RC on the basis of high, medium, low erosion criteria and two non-eroded villages from each RC also selected to examine the distinction between the eroded and non-eroded villages. From each village 10% sample households selected for interview. In this way, 194 households from Dhemaji district and 242 households from Dhubri district were interviewed. During household interview, a semi-structured schedule has been used and the information supplied by the households are marked in the schedule. The authors conducted the survey with the help of a local enumerator during the month of January and March of 2016.

"*Focus group discussions (FGD) are also conducted in the villages to get some village level information and to study the problem in-depth. In this method, a meeting has been conducted with the village headman and 10 to 20 erosion affected people. The researchers worked as moderator during the discussion meeting. Before starting the FGD session, the researcher introduced the participants and clearly addresses the purpose of the session. The FGD session has been conducted in an open field with the help of the other two persons viz., a note taker and a record keeper. During FGD's the erosion affected people have given chances to reveal their views and asked them about the various problems faced by the people*." (Dekaraja & Mahanta, 2018).

Table 2. District wise villages selected for field survey.

District	Revenue circle affected by erosion	No of Villages affected by erosion	Name of Villages (Selected)
Dhubri	South Salmara (Selected)	62 villages	1. Baladova 2. Borovatary Pt-II 3. Birshing Pt-III 4. Birshing Pt-I 5. Chotalkolia Pt-I 6. Chotalkolia Pt-II 7. Balatari (Non-eroded) 8. Birshing Sialmari (Non-eroded)
	Dhubri	32 villages	
	Golakganj	30 villages	
	Gauripur	37 villages	
Dhemaji	Sissiborgaon (Selected)	45 villages	9. Dijmur Hindu Gaon 10. Dijmur Miri Pathar 11. Naharbari no-1 12. Deori Gaon 13. Kachinath 14. Kachari Gaon 15. Naharbari no-2 (Non-eroded) 16. Dimow Hindu Gaon (Non-eroded)
	Dhemaji	38 villages	
	Jonai	30 villages	

Source: Revenue and disaster management (2014) and selected revenue circles, GOA, 2016.

3.3 Methods of Analysis

Basic statistical tools such as mean, standard deviation, percentages and tabular method have been used to analyse the results. SPSS version 16.0 has been used to analyse the information. The qualitative variables are taken as a dummy variable, which takes the value 0 and 1.

Besides these, "*Head Count Ratio (HCR) and Poverty Gap index (PGI) have been used to check the incidence of poverty and severity of poverty in the eroded villages*" (Das et al, 2017). The HCR method is helpful to check the incidence of poverty as well as to measure the rate of poverty. In this method, the number of poor household is counted whose household income is less than the government specified limit (for a poor household). "*Since HCR does not reflect the severity, hence, the PGI method is used to measure severity. To measure poverty, income from various sources has been calculated such as daily wage labour, agricultural farming, private job, business, selling of home-produced goods etc. The incidence of poverty or the percentage of population*

living below the poverty line is calculated using the following equation". (Das et al., 2017).

$$P_h = \frac{1}{N}\sum_{i=1}^{N} I(y < z) = \frac{n}{N} = HCR, \text{ where, } n = \sum_{i=1}^{N} I(y_i < z) \quad (1)$$

In equation (1), '*n*' represents the number of poor households and '*N*' represents the total population, '*z*' is the poverty line or state specific minimum expenditure for a household and '*y*' is the income of an individual or household. $I(\cdot)$ takes on a value of 1 if Income Y_i, called the welfare indicator, is less than the poverty line *z*. Otherwise it takes on a value of 0.

However, the *HCR* does not represent the extent to which individuals fall below the poverty line. Therefore, to see the extent of poverty among the poor people Poverty Gap Index (PGI) has been calculated (Dekaraja and Mahanta, 2021). For policy implication, the PGI is helpful as it shows the extent and severity of poverty. On the basis of above methods, HCR the PGI are calculated using the following equation (2).

$$PGI = P_h = \frac{1}{N}\sum_{i=1}^{N}\left\{\frac{z - y_i}{z}\right\} I(y<z) = \frac{1}{N}\sum_{i=1}^{N}\left\{\frac{z - y_i}{z}\right\} = HCR.R \quad (2)$$

The above equation also called the depth of poverty. HCR and R calculated as in equation (3),

$$HCR = \frac{n}{N}, \text{ and } R = \left[\frac{z - y_p}{z}\right] \quad (3)$$

In the above method the state specific poverty line is set as per the Tendulkar's committee report in 2011-12 has been used (GOI)". The poverty line was ₹. 829 per month for an individual of rural areas. This poverty line has been updated to ₹. 1137 for the year 2016 using the consumer's price index for agricultural and rural labours.

3.4 Basic statistics of surveyed household

Table 3 presents the information of the households surveyed and their demographic characters. The table shows that most of the respondents are male, the average age of the respondents also found similar in all the villages. The education level also found similar in all the villages. But, the variation observed in case of religious distribution; this is because, majority of the respondent in Dhemaji district belongs to Hindu community, while the majority of respondents in Dhubri district belong to Muslim community. However, the average statistics revealed that household's characteristics are similar in all the category of villages.

4 Results and Discussion

4.1 Loss of Agricultural Land and Livestock

A household in the eroded areas loses various types of assets and faces various types of problems due to erosion. Among the assets, land and livestock are the primary one. A household in the rural areas can generate income by cultivating in the agricultural land as well as keeping livestock at home. The livestock includes cow, buffalo, duck, hen, pig etc. Selling these various livestock, many households in the rural areas manage their household expenditures. Land and livestock considered as the primary assets of the rural household and loss of these assets means they lose their livelihood. Table 4 presents the loss of assets in terms of total eroded land and livestock. Here the total eroded area includes all the category of lands, such as, homestead land, cropland and forest land, leased-in and leased-out land. The table also shows that, the affected people in the high eroded

Table 3. Basic statistics of the households interviewed.

Category		Sex (1=male, 0=female)	Age of the respondent (in years)	Education (years of schooling)	Religion (1=Hindu, 0=Others)	Community (1=ST, 0=Others)	Family Size (in numbers)	Adult Members (in numbers)
Eroded	High	0.99	44.09	5.12	0.46	0.30	5.32	3.21
	Medium	0.95	48.70	5.29	0.77	0.71	5.89	3.80
	Low	0.99	45.96	6.00	0.60	0.45	5.76	3.46
	All Types	0.98	46.25	5.45	0.61	0.47	5.65	3.47
Non-eroded	No Erosion	0.93	44.09	5.80	0.56	0.58	5.80	3.51

Source: Field survey, 2016.

Table 4. Agricultural land and livestock loss.

Category of Villages	Total Eroded Area (in ha)	Loss of Livestock (in Rs)
High Eroded	0.38(0.25)	12992.6
Medium Eroded	0.21(0.12)	10443.8
Low Eroded	0.14(0.09)	7916.91
Eroded (Overall)	0.24(0.20)	10351.4

Source: Calculated from field survey data
N.B.: 1. Values represents per household
2. Values in bracket indicate the (standard deviation)

Table 6. Changes in livelihood from farming to non-farming.

Sl. No.	Category of Village	Percentage of household
1	High Eroded	78.00
2	Medium Eroded	75.00
3	Low Eroded	66.00
4	Eroded (Overall)	74.00
5	Non Eroded	Nil

Source: Field survey.

Table 5. Status of land loss (in ha.) of various categories of land among the surveyed households.

Category of villages	Homestead land	Crop land	Forest land	Leased in land	Leased out land	Total area eroded
High Eroded	7.78	34.46	3.71	0.2	0.52	46.44
Medium Eroded	5.11	22.57	2.33	0	0	34.90
Low Eroded	4.05	12.55	2.02	0	0	18.52
Eroded (Overall)	7.78	34.46	3.71	0.2	0.52	85.49

Source: Calculated from field survey data.

villages lost a large area of land as compared to the other category of villages (medium and low). Among the various categories of land, it has seen that cropland eroded is very high among the erosion affected household (Table 5). Moreover, loss of livestock also measured in terms of monetary loses (Table 4). Here, livestock includes all the categories of livestock such as cow, buffalo, goat, duck, and hen.

4.2 Changes in Livelihood Pattern

It has been observed from the above sections that the erosion affected households face various types of problems owing to riverbank erosion, such as, loss of land and livestock, transportation and education problem, loss of livelihood, etc. As a result of these problems, mainly the loss of assets, most of the farmers changed their occupation from farming to non-farming and they reported as non-farmers during the time of survey; but they also reported their asset lose which occurred before occupation change[3]. In this context, while interviewing Adbul Hussain of Baladoba village of Dhubri district, he said

"*Due to erosion, I have lost 1 ha. of cropland on which I was previously depend and also taking land in lease for cultivation from others. After erosion, I shifted to the Fulbari side with my family. Now I daily go to Fulbari town of Meghalaya and working as a rickshaw puller and somehow I could manage daily family expenditure.*"

Table 6 reveals that a large number of households in the erosion affected villages forced to change their livelihood from farming to non-farming. It has also seen that the status of change in livelihood in high eroded villages is more than the less eroded villages. While, an interesting fact observed is that change in occupation in both the high and medium eroded villages almost similar. This is due to the fact that the farmers in those areas are small and marginal farmers, and they shifted to nearby areas in fear of further loss of land and involved in non-agricultural activities.

4.3 Destruction of Infrastructure

During the survey, we have observed that most of roads and educational institutions were destroyed in the surveyed villages. But the monetary value of those assets unable to measure, for which infrastructural problems faced by the affected households have been mentioned. Since, the data on number of destruction of educational institutions and destruction of roads due to riverbank erosion unable to collect; hence the infrastructural lose have been mentioned in terms of education and transportation problems. The education problems indicate the students' dropout, shifting to other institutions and no enrolment. These educational problems faced by

3 Non-farmers indicate those persons who engaged other activities like daily wage labour, small business, or any other activities except the agricultural activities.

Table 7. Percentages of households face the education and transportation problem.

Category of villages	Education Problems	Transportation Problem
High	78.00	98.00
Medium	76.00	96.00
Low	76.00	95.00
All Eroded	76.00	95.00
No Erosion	21.00	00.00

Source: Field survey (2016).

Table 8. Percentages of households whose family members migrated outside.

Category of villages	Short-term migration	Long-term migration	Overall migration
High	45.00	30.00	75.00
Medium	45.00	21.00	66.00
Low	37.00	18.00	55.00
All Eroded	44.00	24.00	68.00
No Erosion	24.00	13.00	37.00

Source: Calculated from field survey data. (2016).

the affected households due to displacement and destruction of educational institutions. The transportation problems indicate the disruption in road connectivity. Table 7 presents the status of educational and transportation problems, where it has observed that percentage people faced the problems almost same in all the category of villages except the non-eroded villages. People in the non-eroded villages also faced the education problems. In the non-eroded village students' dropout occurred due to poverty and non-availability of higher educational institutions. Therefore, it can be argued that, although education is a problem in the eroded villages; but education and transportation problem exist there before erosion also. However, erosion leads those problems to more vulnerable in the erosion affected villages as it leads to dropout more number of students.

4.4 Population Migration:

Loss of livelihood and other coping strategies in the eroded areas forces the victims to migrate in search of livelihood or source of income and thus population redistribution becomes a problem among the displaced people. In case of migration, it is observed that although the mean size is different, people migrate (both short-term and long-term) from both the eroded and non-eroded areas (table 8). It is because, the migrants from non-eroded areas moved to smoothen income fluctuation which is caused by differences in various opportunities such as, employment, education facilities, transport and communication facilities etc. (Todaro, 1971). That means, migration is common behavior among the rural people (Byerlee, 1974). Although the migration is common behaviour in both the categories of villages but it is more in eroded than non-eroded villages. Another fact is that, short-term migration is high in all the category of eroded villages, while long-term migration is low. This is because; most of long-term migrants were not present during the surveyed period; only their relatives have reported about their migration. Moreover, most of the long-term migrants are permanent migrants. Therefore, all accurate information related to the long-term migrants unable to collect during the field survey. In case of farmers and non-farmers similar kind of results are found; because farmers are those, who have cropland and still engaged in agricultural activities, hence they migrate for short period to smoothen their fluctuating income. In the non-eroded villages, also similar patterns are found where short-term migration is higher than long-term migration (Table 9). It has already mentioned that shot-term migration occurred in the non-eroded villages to smoothen their income, while the long-term migrants are the migrants who migrate for government services, and educational purpose from non-eroded areas. Therefore, long-term migration in non-eroded villages although exist, but it is low.

To see the rate of migration differences among the high and other category of erosion, chi-square test is conducted. Pearson chi- square test (χ^2 = 8.39, DF=1, p< 0.01) for the mean differences of migration among high eroded and other categories of villages indicates that there is significant difference between the villages. Similarly, the short-term and long-term migration also varies among the high and other categories of eroded villages. The Pearson chi-square test for short-term (χ^2 = 4.75, DF=1, p< 0.05) and long-term (χ^2 = 4.84, DF=1, p< 0.05) migration also revealed a significant difference. Thus, it has observed that migration is related to the degree of erosion. Although the degree of erosion is significant in the above cases, but we cannot say that riverbank

Table 9. Migration among farmers and non-farmers.

Category	Farmers (percentages)				Non-farmers (percentages)			
	Short migration	Long migration	All migration	Total HH	Short term migration	Long term migration	All migration	Total HH
High	32.61	4.35	36.96	100	69.74	28.95	98.68	100
Medium	19.51	2.44	21.95	100	81.82	16.36	98.18	100
Low	18.18	7.79	25.97	100	67.80	25.42	93.22	100
Eroded (All types)	22.56	5.49	28.05	100	74.21	24.21	96.84	100
Non-eroded	13.33	3.33	16.66	100	42.11	20.95	63.05	100

Source: Field survey/primary data (2016).

erosion is a primary cause of migration. This is because migration also occurred from the non-eroded villages.

4.5 Impact on the Environment or Environmental Degradation

Besides the impacts mentioned above, the environment (forest area, soil fertility, and aesthetic beauty) also badly affected owing to riverbank erosion. Based on the focus group discussion conducted among the erosion affected people, it has observed that homestead trees and forest trees have been lost by those households. Before erosion, there were a large number of betel nuts and leaf trees in the homestead lands of the surveyed households, which disappear after the erosion. Apart from this, they also loss various types of trees that were planted in their homestead land.

Due to erosion, siltation also occurred in some areas. Because of siltation or sand deposition, the soil productivity lost in those agricultural lands. This case mostly found in the Dhemaji district and in the Char areas of Dhubri district. In some areas of Dhemaji district, large amount of sand is deposited in some agricultural land, which makes agricultural activities infeasible (FGD).

The aesthetic beauty of the affected areas also diminishes due to erosion. During focus-group discussion the respondents reported that the paddy fields are now becoming a sandy land as well as most of the beautiful villages are drowned in the river Brahmaputra and its tributaries. The beautiful landscape and the indigenous plants also lost in the river. Thus, changes in the platform of the river created a huge loss to the beauty of the riverside areas.

4.6 Incidence of Poverty

It has been observed that riverbank erosion becomes a cause of poverty for erosion displaced people (GOA, 2011; Rana and Nessa, 2017). The displaced households in the riverbank eroded districts are inhabited in unauthorized places such as roadsides, reserve forest lands. Some of the displaced people have been living near the riverbank areas in spite of the risk of further erosion. They are mainly depending on small business, selling of home-produced goods, and cultivating in fertile riverbank soils. The displaced people who resettled in the bank areas cultivate there on temporary basis in *Rabi season*. Moreover, some of the displaced people in the Dhubri district resettled in the char areas[4]. These char lands are most fertile in comparison to the other lands and most of the displaced people in the study districts depends on agricultural activities (FGD). While others who moved nearer to towns or market centres engaged in occupations like pulling *thela*, rickshaw/van, vending, etc.

Although the occupations or the substitute coping strategies support livelihood to the erosion displaced people, but they are not sufficient for them. Field survey data reveals that a large number of people in the riverbank areas and who resettled in the nearby areas fall below the poverty line. With the help of HCR discussed in the methodology section, the economic deprivation has been measured. The poverty level of the various categories of villages is found to vary. It has been observed that the HCR in case of highly eroded villages is higher than the low

4 Char are sandy tracts of land, which lie in the middle of a river or adjacent to it. These tracts are created by a complex process of continuous erosion and accumulation of sand and other solid materials over a period of time. To be considered a full-fledged char such tracts must support vegetation and hence make settlement and agricultural activities viable.

and non-eroded villages (Table 10). This indicates that people in the less eroded areas somewhat better off than the high and medium eroded villages.

Table 10. Estimates of poverty indices.

Category of Erosion	HCR	PGI
High eroded	0.90	0.45
Medium Eroded	0.86	0.33
Low eroded	0.80	0.29
All eroded	0.86	0.40
Non eroded	0.46	0.13

Source: Calculated by authors from primary data.

The indices also reveal that due to variation in erosion the poverty rate varies in the surveyed villages. Interestingly, the poverty rate in the non-eroded villages is not very low; which indicate that the households affected by erosion were poor before the erosion. Thus the reasons behind the poverty cannot be called as the riverbank erosion; there may be various other factors too. However, erosion can be called as one of the reasons, which pushes the other factors that push the poor people into the trap of poverty.

5 Conclusions and Recommendations

The above discussions revealed that riverbank erosion leads to multifarious impacts, such as loss of agricultural land, livestock, educational and transportation problem, environmental impact, poverty and migration. All the socioeconomic impacts simultaneously lead to more vulnerable livelihood. Thus, the affected people socially and economically displaced as a result of riverbank erosion. Although it has seen that riverbank erosion creates various problems, but the poverty rate is observed in both the eroded and non-eroded villages; hence it can be said that most of the households lived in the erosion affected areas were poor before the erosion also. Therefore, it can argued that riverbank erosion is not the major cause of poverty and migration in the rural riverbank areas, various other problems like lack of employment opportunity, lack of advanced agricultural technology are the reasons behind poverty. But, the riverbank erosion pushes the other factors, which lead to the poor to more vulnerable.

Therefore, it can be suggested that riverbank erosion control is important to overcome from the problems arise due to riverbank erosion and reduce migration from the riverbank areas. Although the Assam Government implemented the policy to construct guard-wall and embankments through State Disaster Management Authority (SDMA), more investments should be made for construction of guard walls in the districts like Dhemaji and Dhubri. With the erosion control measures, state governments also have to adopt some institutional measures to resettle the erosion victims and provide financial grants for their livelihood (Das et al. 2017). The government should provide non-fragile land to that erosion displaced for resettlement. To reduce poverty, government has to offer alternative sources of livelihood as well as relief packages. Apart from that, more penetration on social safety nets like provision of employment opportunities in MGNREGA will be helpful to reduce poverty. Up-to August, 2021, 105.06 lakh job cards issued and only 54.17 lakh are active workers, but the total population in rural area is 2.68 crore. In Dhubri district 3.7 lakh persons are registered for job cards (Data for Dhemaji district is not available) . This registration need to increase by government. With these policy measures the socioeconomic issues can be mitigated to some extent.

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Declaration of Competing Interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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