Riverbank Erosion and Migration, Inter-linkage: With Special Focus on Assam, India

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Research

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Abstract

Background: River-bank erosion becomes a vulnerable phenomenon in the bank of the Brahmaputra river and its tributaries. Around 17 riverine districts of Assam are affected by riverbank erosion and lost large plots of land. Due to riverbank erosion the victims' loss their homestead and crop land as well as their survival strategy in the eroded areas. Moreover, farmers largely affected due to riverbank erosion as they loss their sources of income. This forces the farmer to migrate to another place for their survival. The paper examines the linkage between river bank erosion and migration based on secondary information. To examine the linkage, information collected from government published source 'Census of India' and 'Statistical handbook of Assam'. On the basis of the information, 10 indicators constructed from 26 variables and then factor analysis method applied to examine the linkage between riverbank erosion and migration.

Results: Four variables that are agricultural worker, industrial worker, cropped area and livestock population are loaded into the first factor, for which the first factor is labeled as the socio-economic indicator. In case of second factor the two variables i.e. MGI and urban population are loaded. On the basis of the loaded variables this factor labeled as demographic indicator. In case of third factor also two variables are loaded that is, NGI (Natural Growth Index) and Literacy rate. The loaded variables indicate that both NGI and Literacy rate are positively related. Two variables are loaded in this fourth factor i.e. river bank eroded area and the district population growth. This factor labeled as environmental indicator on the basis of the variables loaded in this factor. The factor correlation matrix indicate the opposite relation between first and fourth factor.

Conclusion: The results obtained from Factor component analysis reveals that the first and fourth factor component mainly established the linkage between riverbank erosion and migration. Besides this the component correlation matrix also reveals the inter-linkage between the variables. Thus we can say that there is positive relation between riverbank erosion and migration. However, it can be interpret that farmers mostly affected due to riverbank erosion and migrate more, because farmers mostly inhabited in floodplain areas.

Background

Movement of people from one location to other caused by various factors such as economic, social, political, environmental etc., are termed as drivers of migration (Black et al. 2004). But forced migration in recent decades becomes a common phenomenon in the world. Forced migration that caused by environmental disaster or natural disasters is termed as environmental refugee (Bates 2002; Warren 2015). The environmental events such as land degradation, soil erosion, and droughts have severe effect on farmers that leads to migration of farmers from rural agricultural area to urban industrial area for getting employment (Larson et al. 2004). There are various studies that reveals the relation between environmental degradation and migration such as land degradation and migration (Shah 2005; Gupta and Sarma 2010), river-bank soil erosion and migration (Uddin and Basak 2012; Das et al. 2013)

deforestation and migration (Ravindranath and Sukumar 1996), and common property resource degradation and migration (Chopra and Gulati 2001; Mahanta and Das 2012).

In India river-bank erosion becomes a cause of force migration as it create various types of socio-economic problem (Das et al. 2013). As per the information of National Disaster management Authority (NDMA 2014), Bihar and Assam are two highly flooded and erosion affected states in India. West Bengal state is also affected to some extent (Chatterjee and Mistri 2013). Assam, which is mostly a plain state in northeast India, has been heavily affected by river-bank erosion since 1950[1]. The state has lost 12.6 thousand hectares of land, which displaced 77.8 thousand people in 2014 (GOA 2014). There are a handful of studies which have endeavored to see the relation between river-bank erosion and migration in Assam. Till 1985, Assam lost about 7.4 % of its total area due to river-bank erosion and that leads to displacement of five thousand people (Goswami et al. 1985). Phukan et al. (2008) estimate that since 1960 to 2008, the Brahmaputra River wiped out more than 4000 sq. km of land and displaced more than 25 thousand villages. The river bank erosion caused various socio-economic problems and compels the populace to migrate in search of livelihood (Mili et al. 2013; Ahmed 2016). In this context the study examines the linkage between riverbank erosion and population migration with an analytical approach and the factors responsible behind such migration.

Review of Related Literature

The theories on internal or rural-urban migration contend that migration happen due to the factors like wage differences, differences in employment opportunities as well as health and education facilities etc. (Fei and Rannis 1962; Todaro 1970). The rural people migrate when the benefits arise in the urban areas is more than the costs (Sjaastad, 1960). In contrast, minimization of risk and maximization of joint income are the influencing factors of migration according to the New Economics of Labour Migration (NELM) theory (2001). In recent decades environmental events like flood and riverbank erosion becomes an extreme event, which forces people to migrate by affecting their income sources. These make migration a way to minimize the risk induced by environmental events (Dercon 2005; Black et al. 2011).

In Bangladesh, Yamuna River affect and displaces large number of people by eroding its bank areas and forces people to migrate somewhere else for sustaining their livelihood (Uddin and Rahman 2011;Uddin and Basak 2012). The erosion severely affects the socio-economic livelihood of the riverbank inhabitants. People affected by erosion lose 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[2] in Bangladesh to adjust with the erosion problem (Karim 2014). In Bangladesh, the loss of agricultural land and landlessness due to erosion is considered as the major contributory factor behind poverty (Rana and Nessa 2017). Adopting the origin and destination survey method in Bangladesh, Rana and Nessa (2017) observes that two-third populace of the surveyed villages migrates permanently from one union to another union by getting support from their neighbors, relatives, friends and they stayed in the destination place at lower living cost in comparison to the origin.

In the context of India, Das et al. (2014) reveals the impact of riverbank erosion in their study. The study finds that impacts of riverbank erosion are multifarious: social, economic, health, education and sometimes political, which creates forced migration. The socio-economic 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). The forced migrants faces different form 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. (2017) 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). 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 (Chatterjee and Mistri 2013).

Assam in the north-east India largely affected by flood and riverbank erosion in the lower reaches of Brahmaputra valley (WRD). Reviewing the population redistribution problem in Majuli sub-division of Assam, Nayak and Das (Undated) reveals that shrinkage in land area of the island over the years due to soil erosion by the mighty Brahmaputra is the main problem[3]. Due to loss of farm and homestead land, the poor people fall into poverty trap. The river bank erosion destroys the existing modes of production and ways of life, breaks the family and community relations, as well as threatens cultural identity of the people. Mili et al. (2013) in their study on Golaghat district of Assam, India, mention about various problems that arise due to flood and erosion such as displacement, loss of agricultural land and home, psychological effect, poor transportation system and problems in education. Such various forms of socio-economic problems induced by riverbank erosion compel victims to move to nearby area in search of livelihood (Baishya 2013). In another study, Ahmed (2016) finds that the impact of riverbank erosion is too severe in Barpeta district of Assam, India. Most of the affected people migrate from the eroded areas as they lose the income source. Agriculture being the main source of income, loss of crop land due to riverbank erosion they actually lose everything. In addition to that, as they don't have any other coping strategy they are forced to migrate to nearby towns and cities to stabilize their income fluctuation. They mostly get employment in informal sector like pulling *thela*, rickshaws, unskill construction works of buildings, roads, etc.

Methodology

Study Area:

Assam is the only plain state (except two hill districts) of the north-eastern region, which is geographically located between $24^0 8'$ N to $28^0\ 2'$ N latitude and $89^0\ 42'$ E to 96^0 E longitude. It consists of

three valleys: Brahmaputra valley, Barak valley and North Cachar Hills with the total geographical area of 78,438 sq. km[1]. Total area eroded due to erosion in Assam in 2014 was 12.58 million ha, which is 0.16 percent of the total area of Assam. Total population of Assam in 2011 is 31.21 million, which forms 2.58 percent of total population of India. Decadal population growth rate is 17.07 percent with a density of 340 persons per sq. km. and sex ratio is 958 female against 1000 male. The economy of the state mostly depends on agricultural sector where 86 percent of the total population lived in rural areas. About 63 percent population depends on agriculture for their livelihood. Out of total main workers in the state 36 percent are cultivators and 10.4 percent are agricultural labors. The total cropped area in Assam in 2012-13 is 4.07 million ha, which is 51.96 percent of total geographical area and the average size of operational holdings is 1.10 hectare. The marginal category farmer occupied more than 67.3 percent of total operational holdings of land in the state. In 2011-12, 31.98 percent of total population is below poverty line of which 33.89 percent are in rural and 20.49 percent in urban areas.

Income from livestock and poultry farming contributes a significant share in the rural economy of Assam. As per 2012 livestock census, the livestock population of the state is 19.08 million. During 2014-15, only 2629 nos. of Micro Small and Medium Entrepreneurs (MSME) units registered in the state. The small size of industries led the state and the districts into far backwardness.

Data source and selection of variables:

Only secondary data are used in this study. Secondary data are collected from census report of 2001 and 2011, Govt. of Assam, Statistical Handbook of Assam, Revenue and Disaster Management Department, Govt. of Assam. Information regarding villages is collected from the Circle Office of each selected Development Block. Primary data are collected through field survey.

To examine the linkage between riverbank erosion and migration, 26 relevant variables have been considered to represent different demographic, riverbank erosion and livestock related variables at two points of time 2005 and 2014 (see appendix). In 2004 a severe flood occurred in Assam. The information of the effect of 2004 flood was available in 2005. Therefore, data for 2005 and latest information available till 2014 are taken for consideration. Data's related to census are observed in two periods such as 2001 and 2011. That is why variables related to riverbank erosion and livestock also taken at two periods. With the help of these 26 variables, 10 indicators have been constructed to represent demography related indicators, riverbank erosion indicators and livestock indicators as follows:

1. ***Demography related Indicators***: Migration is not only influenced by economic factors, it is also influenced by socio-demographic and environmental factors (Henry et al. 2003). Therefore, estimation of migration to see environmental migration Natural Growth Index (NGI) and Migrational Growth Index (MGI) have been constructed (Chopra and Gulati 2001). To calculate NGI, Variables that taken are Crude birth rate, percentage of married females in the age group 15-19, population density, sex ratio, literacy rate. All these variables indicate the growth of population in a specific area. Increase in crude birth rate and increase in percentage of married females in the age group 15-19 leads to a high population growth (Frajeka 1968). Lutz and Qiang (2002) argued that fertility rate

and population density also influence population growth. NGI is calculated on the basis of factor scores of the above variables.

MGI is constructed to represent rural-urban migration. The variables that are considered for calculating MGI are rural and urban population growth, agricultural workers and industrial workers. Due to migration from rural to urban area, population in urban area increases (Bhagat 2011). Similarly, reduction in agricultural labor (increase in industrial workers) also indicates migration from agricultural to industrial areas (migration from rural to urban areas). All these variables simultaneously indicate the growth of migrated people. Taking the factor scores of all these variables MGI is calculated. The factor scores have been calculated using factor reduction method.

1. ***River-bank Erosion Indicator:*** River-bank eroded area has been considered as the main variable for this indicator. However change in cropped area is also taken as another variable as river-bank erosion leads to decrease in cropped area as well as effect on the production of food-grains (Gray and Muller 2012; Uddin and Basak 2012). Due to bank erosion victims are compelled to migrate in search of livelihood.
2. ***Livestock Indicators:*** Among livestock population cattle, buffaloes, and goat or sheep are taken as main variables. Loss of these livestock assets directly affect on the farmers income and livelihood, which influence farmer's decision to migrate. These losses mainly occur because of unavailability of fodders for the livestock population (Mahanta and Das 2012), which in turn affect livestock farming. Therefore, change in population of cattle, buffaloes and goats are taken as important livestock indicators. Here population of cattle, buffaloes and goat are added and taken as total livestock population and then the difference of the population in the two period of time 2005 and 2015 has been used to see the changes in livestock population.

Method:

Factor analysis (FA) is a statistical method used to describe variability among observed correlated variables in terms of the potentially lower number of unobserved variables called factors. Hence, this method is useful to establish the link between concerned variable and the correlated variables in terms of the factors. In this study factor analysis method is used to examine the linkage between riverbank erosion and migration with the variables and indicators mentioned below. The rural-urban migration related information is not available to establish the linkage between riverbank erosion and migration. That is why, some correlated variables that relate to migration is taken into consideration and then applied the factor analysis technique to see the linkage. The factor analysis technique used in this study is based on the studies of Chopra and Gulati (2001) and Mahanta and Das (2012).

Results And Discussion

The factor loading table or the rotated pattern matrix indicates four important factors based on Eigen values (*Table 1*). These four factors covered more than 86 percent variance among the variables. The

factors also represent very high correlation among the observed variables. Each factor in the table represents different relations among the indicators and indicate different category of indicators.

First factor: Four variables are loaded into the first factor, such as agricultural worker, industrial worker, cropped area and livestock population. On the basis of the variables the first factor is labeled as the socio-economic indicator. The variables indicate strong relationship among them. With the loaded variables, the first factor also represents its link with the second factor.

Second Factor: In case of second factor the two variables i.e. MGI and urban population are loaded. On the basis of the loaded variables this factor labeled as demographic indicator. Urban population increases due to migration from rural areas as the agricultural land could not provide adequate employment opportunity in the rural areas. Behind this rural-urban migration the first factor, which represent socio-economic indicators also have positive effect. Various Studies and theories on migration reveals that in the rural areas employment as well as other facilities related to standard of living, health and education, etc. are not available according to needs of the people (Todaro 1970; Schultz 1971; Ledent 1982). Besides, these people also face the natural disasters like drought (Shah, 2005), riverbank erosion by the inhabitants of riverbank areas, floods, volcanic eruptions etc. (Uddin and Basak 2012). These all the factors often influence the decision to move to urban or any advanced location for better livelihood.

Third factor: In the third factor also two variables that is, NGI (Natural Growth Index) and Literacy rate are highly loaded. The loaded variables indicate that both NGI and Literacy rate are positively related. Behind this natural growth of population the first factor or socio-economic indicator as well as the second factor which represent the demographic indicator have strong influence. However, both the second and third factors are part of demographic indicators.

Fourth factor: Two variables are loaded in this fourth factor i.e. river bank eroded area and the district population growth. This factor labeled as environmental indicator on the basis of the variables loaded in this factor. The negative factor loading for riverbank erosion area and positive factor loading for district population growth placed an opposite relation between the variables. This indicates increase riverbank erosion will decrease the population growth and vice versa. Besides this, the changes in population growth also influence by the previous first, second and third factor. However, the opposite relation indicates the positive effect on migration decision.

Thus from the above discussions it has found that all the four factors which represents different category are theoretically interlinked with each others, from which we can interpret the linkage between riverbank erosion and migration. In this context, the component correlation matrix indicates the correlation among those factors (table 2). Mainly the first and second factor negatively related with the fourth factor, which indicate the opposite relation between socio-economic factor with riverbank erosion as well as the rural urban migration and riverbank erosion. Thus the inter-linkage between the factors represents the linkage between riverbank erosion and migration. This indicates that there is a positive relation between riverbank erosion and migration.

Conclusion And Recommendations

The factor analysis results reveal that there is a close link between riverbank erosion and migration. Riverbank erosion creates different forms of socio-economic and demographic problems that ultimately force the victims to migrate. Factor analysis results show the relation between river bank erosion and migration. The component correlation matrix mainly indicates that rural-urban migration is related to the environmental degradation i.e. riverbank erosion.

Although the above analysis revealed that there is a close linkage between riverbank erosion and human migration; it don't want to claim that the nature is the main reason behind the population migration. There are various causes as mentioned by the migration theories, among which nature (Riverbank erosion) may be a cause. However, further in-depth study needed to see the problem in depth that is what are the various impacts of riverbank erosion? What are the coping measures adopted by the erosion displaces?

Declarations

Ethics approval and consent to participate: We the author(s) of the manuscript entitled "Riverbank Erosion and Migration Inter-Linkage: with special focus on Assam, India", hereby declare that the paper is our original work and results of this paper did not published or waiting for publication in any other source. The data and information used in this paper is collected by ourselves from various government sources like, Census of India, Statistical handbook of Assam, India, and from the Circle office of each development block.

Consent for publication: We also like to assure that there is no any conflicting issue in my research work, since it is a part of doctoral research done first author at the University of Gauhati, Assam, India. So, we would like to contribute our research work for review and publication in your journal.

Availability of Data and materials: The data used in this study are from published source of government of India, hence it may be available in another study also. But, the analysis is different from other research works. Since the method of analysis is different from other.

Competing Interest: However, we would like to inform that the method of analysis mainly borrowed from two research work, one done by Chopra and Gulati on "Land degration and migration" and the other done by Ratul Mahanta and Daisy Das on "Common Property resource degradation and Migration". Hence there may be some similarity in the method. But, the data and analysis are completely different.

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Authors' Contribution: The first author has the major contribution in this research. All the data analysis and discussion of results has been done by the first author. The second author mainly helped in reviewing the analysis and discussion and also helped in preparing the paper in a required format.

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Tables

Table-1: Obliquely rotated component loadings

	Factor Component				*Communality*
Variables	***First***	***Second***	***Third***	***Fourth***	
	Socio-Economic	***Demographic***	***Socio-Demographic***	***Environmental***	
Agri_work	*.935*	*.046*	*-.038*	*-.057*	*.893*
Ind_work	*.924*	*.011*	*.033*	*-.137*	*.869*
Cr_area	*.843*	*.131*	*.134*	*-.112*	*.798*
Liv_ pop	*.843*	*-.100*	*.184*	*.227*	*.731*
MGI	*.028*	*.997*	*-.078*	*-.002*	*.996*
U_ Pop	*-.003*	*.995*	*-.102*	*-.028*	*.993*
NGI	*.290*	*-.059*	*.948*	*.011*	*.954*
L_ rate	*-.161*	*-.150*	*.938*	*.042*	*.939*
Pop_Gr	*.099*	*.093*	*.314*	*.820*	*.789*
R_Area	*.184*	*.119*	*.356*	*-.721*	*.682*
Eigen Values	*3.323*	*2.251*	*1.801*	*1.268*	
% of Variance	*33.232*	*22.513*	*18.014*	*12.676*	
Total Variance				*86.435%*	

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Source: Calculated by Author

{Note: Variables used in this study are indicated as NGI (Natural Growth Index), MGI (Migrational Growth Index), L_Rate (Literacy rate), U_Pop (Urban Population growth), Pop_Gr (District Population Growth), Ind_Work (Industrial Workers), Agr_Work (Agricultural Worker), Cr_area (Cropped Area), R_Area (Riverbank Eroded Area), Liv_pop (Livestock Population)}

Table- 2: Component Correlation Matrix				
Component	1	2	3	4
1	1.000	.037	.099	-.031
2	.037	1.000	-.048	-.037
3	.099	-.048	1.000	.016
4	-.031	-.037	.016	1.000
Extraction Method: Principal Component Analysis.				
Rotation Method: Oblimin with Kaiser Normalization.				

Figures

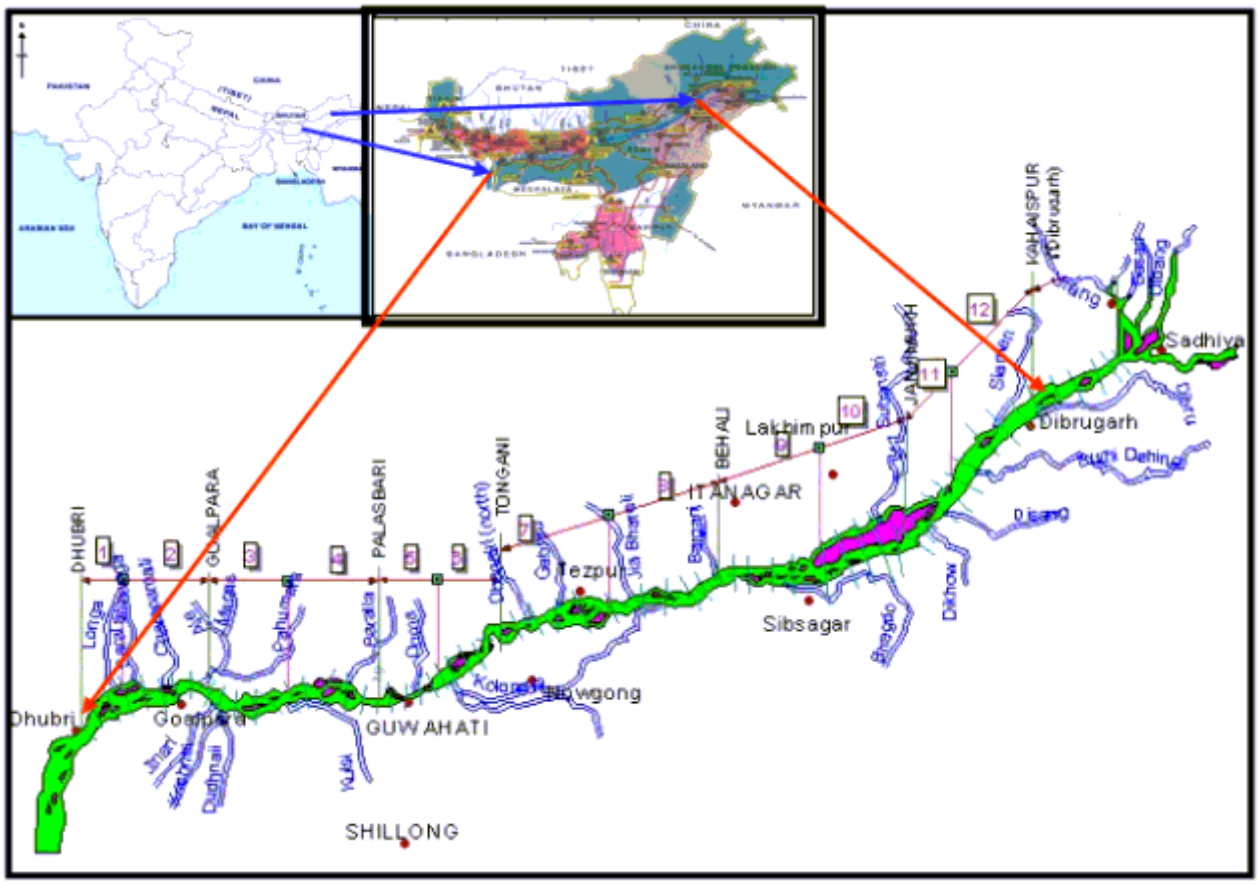

Figure 1

Riverbank erosion Map of Brahmaputra River Source: NDMA Commissioned IIT Roorkee Study on Brahmaputra River Erosion: A Biased and Structural Solution Oriented Report, 2013.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Data.xlsx
- Appendix.docx