Forum geografic. Studii și cercetări de geografie și protecția mediului
Volume **XXII**, Issue **1** (**June 2023**), pp. **16-27;** DOI: **10.5775/fg.2023.066.i**

The changing river course and its impact on riverine society: A case study on the Padma River, Murshidabad District, West Bengal (India)

Dr. Sanatan GHOSH[1*]

[1] Associate Professor, Department of Geography, Krishnath College & Coordinator (Ad hoc) Department of Geography, Murshidabad University, Berhampore, Murshidabad, West Bengal, India.
* *Corresponding author*: sghosh2871972@gmail.com

Received on 20-01-2023, reviewed on 22-02-2023, accepted on 20-03-2023

Abstract

River bank erosion within Murshidabad district is a tragedy, which happens haphazardly along the bank of the Padma River system. The main objective of the study is to analyze the changing river course and its impact on society. By comparing the toposheet and Landsat (5 and 8) images of the Padma River of the Murshidabad district from the years 1924, 1990, and 2020, it is clearly observed that there have been significant changes on the southern portion of the river since 1924 (Bhagawangola II, Raninagar II, and Jalangi Block), while less changes occur on the central part of the river, which is near the Lalgola block. But in the year 2020 significant changes have been found in the northern and middle portion of the district near Samserganj and Lalgola block. Those parts belong to a highly vulnerable zone of bank erosion. This study analyzed some factors, such as soil stratification of the river bank and human encroachment as an obstruction to the natural river flow, also responsible for bank failure. The river has been consuming the vast portions of the right bank every year due to its increasing sinuosity. The victims are mostly in the Samserganj, Lalgola, Bhagawangola II, Raninagar II and Jalangi blocks, who suffered greatly from 1924 to 2020 due to moving of river course by 27% on the right side, which is notified from cross sectional analysis. Additionally, the predicted erosional impact of the region highlights the socio-economic perspective of the research area.
Keywords: *dynamic river course, cross section, lateral erosion, Landsat, Padma River, socio-economic perspective*

Introduction

Murshidabad district is situated in the moribund deltaic region of the lower Ganga plain in India. The deltaic rivers have the tendency to oscillate within a wide limit. The alteration of river channels is almost a universal occurrence. Murshidabad district's people have probably been affected by the river for a long time. Murshidabad was the capital and important Business centre of Bengal, Bihar and Orissa in the British period. Murshidabad has lost its earlier glory due to historical and geographical reasons. Another historic town that perished naturally was Karnasubarna. The probable cause may be the severe erosion of the Bhagirathi River or the lack of a sufficient water supply when the main flow of the Ganga was diverted through Padma. Researchers have been studying the geomorphological phenomenon of river bank erosion and channel shifting for the past few years (Mukhopadhyay & Das Gupta 2010; Parua, 2006, 2009, 2010; Rudra, 2005, 2010; Ghosh 2015; Islam et al., 2019; Rahman, 2010; Raman et al., 1986). The changing river courses also led to river bank erosion, devastating floods, extensive silt deposition along river beds, meandering cut-off which are the serious threat to human habitation as well as environment. The river system is made up of mainly the Ganges, the Padma, the Bhagirathi, Jalangi, and Bhairab. These river systems are constantly altering their paths, and deltaic rivers do so in a wide range. The river systems of the district are generally meandering and braided in nature. Rivers help the systems in dynamic equilibrium. When river channels are altered due to naturally dynamic hydrologic conditions, the river readjusts itself in terms of size, profile, and pattern to re-establish its previous balance or equilibrium (Couture, 2008). The free-flowing river is always adjusting the equilibrium condition through erosion, transportation, and deposition processes. When the deposition process is underway on one side, the erosion process is underway on the other bank side. Mid channel bar or char formation is restricted to mid channel flow pattern and flow concentrated to bank side, as result of severe bank erosion. The erosion and deposition of a meandering river are continuously characterized by the processes of emergence, submergence, and re-emergence. This phenomenon has been explained as follows: "accumulated silt leads to the rise of a sand-bed in the interfluves (the region of higher land between channels); being obstructed by this bed of the river then divides into two channels with the sand-bed in between. This makes the flow oblique. The flow gets obstructed with the river-bank eventually causing river bank erosion. The eroded silt and sediment are carried by the river which again

accumulates to form a new sand-bed and cycle continues" (Mukherjee, 2011).

One of the few morphological systems, meandering streams, provide a rich historical record of changes in channel design and related erosion and deposition of flood plains (Panda & Bandyopadhyay, 2010). The changes of river courses have been contributing to many international problems such as boundary dispute, land reallocation problems, identity problems for the people of charland etc. in the border areas between Bangladesh and Murshidabad (India). Smuggling is also another social problem in the border area. Many people are displaced from their homeland, lost their agricultural land and property etc. A description of the uses of space-based remote sensing data for river research was presented by various researchers. This study has emphasized the most recent applications of satellite remote sensing data to studies of river systems. All sorts of these data are presently available. Malda and Murshidabad, two districts in West Bengal, are the worst affected and experiencing a long-term natural disaster as a result of the Padma river's altered route and ensuing river bank failure. The present study is significant in the context of an alarming situation in the district due to changing of river courses which is aggravated due to human interferences. Many people lost their homeland, agricultural land, domestic animals and even their lives. In such alarming situations people are shifted to other places as environmental neo-refugees without permanent houses and proper sanitation and drinking water. People are forced to migrate to other states for work or are engaged in illegal activities. Both Central and State Governments spend huge amounts of money to tackle these problems. So, this study is significant both internationally and nationally.

Objectives

The main objectives of this study are:

i. To analyze the changes of river course from early 1920 to present time.

ii. To identify and analyze the impact of changing river courses on socio-economic and environmental conditions on the riverine people.

iii. To identify the predicted erosion impact areas.

iv. Planning and mapping to give suggestions and remedy measures to tackle these problems.

Data and Methodology

Data and information are collected from primary and secondary sources. The major sources of primary data include observation, questionnaire survey and interviews of the selected displaced households settled in new areas. The secondary sources of information are satellite images, old records, published reports and articles (Table1).

The following methodology is taken for study work:

• Changes of river channels in early times have been documented from reports, documents when map is not available.

• Extensive field investigation was undertaken to places of river bank erosion areas with the help of Garmin GPS survey.

• Lateral dynamics of the river channel was established and mapped from earlier maps which are available such as SOI Topographical Map (1924), other thematic maps and LANDSAT Satellite Imagery1990 and 2020, with help of ArcGIS software.

• The questionnaire survey and interview method has been done in the displaced household settled in new areas in the district such as – Muradpur (Jalangi), Hasanpur, Mithipur (Raghunathganj -II), Hasanpur and Nirmalchar (Bhagawangola II), Maya and Khandua (Lalgola), Bamnabad (Raninagar II) and Dhusaripara and Dhuliyan (Samerganj). 600 household samples were collected using the stratified random sampling approach. Basically, they belong to a low economic group and a minority (Muslim) community.

Table1: Data source of this Study

DATA TYPE		SOURCE	SCALE
SPATIAL DATA	GEOMORPHOLOGY	National Remote Sensing Centre, Hyderabad	1:50,000
	SOIL	FAO & UNESCO 1972	1:5000
	RAINFALL	Center for Hydrometeorology and Remote Sensing	4km x 4km
	SLOPE	CARTO DEM	PAN(2.5m) Stereo Data
	TOPOSHEET	US ARMY TOPOSHEET NG 45 -15 & NG 45 -16	1:250000
	LANDSAT 5	PATH 138 ROW 43 & DATE 05.06.1990	30m
		PATH 139 ROW 43 & DATE 01.06.1990	30m
	LANDSAT 8	PATH 138 ROW 43 & DATE 04.06.2020	30m
		PATH 139 ROW 43 & DATE 28.05.2020	30m
NON SPATIAL DATA		Primary field survey data	

Study area

The research samples were drawn from the affected villages in the Jangipur, Lalbagh, and Domkal sub-divisions of the Murshidabad district of West Bengal (Figure 1). The Padma and its tributaries are the primary rivers of the research area. The research area is located quite near the Bangladesh-India border region. Nine cadastral units along with the banks of the Padma River which are prone to erosion were chosen as study units to satisfy the needs of the study.

Figure 1: Location of the study area

The study units are – Dhulian, Dhusaripara, Bamnabad, Nirmal char, Khandua, Maya, Mithipur, Hasanpur and Muradpur. According to the district statistics handbook for Murshidabad published in 2011, the district was split into two essentially equal-sized geographic sections by the river Bhagirathi. But there is a geological distinction between them. The Western part of the Bhagirathi River is known as the Rarh region. It is a sequence of lateritic clay from the Sub-Vindhyan period characterized by nodular ghuting. Bagri area is located along the eastern portion of the Bhagirathi River and it is made of Gangetic alluvial sediments of the Quaternary period. The slope of the entire research area ranges from 0 to 15 degrees. Monsoonal climates have been found in the area and a huge amount of rainfall (approx. 1500 mm) occurs due to the south west monsoon. The bulk of the population is employed in agricultural sectors, while just a tiny fraction is involved in industrial activities, according to the district statistics handbook, Murshidabad (2011).

Results and discussion

Lateral dynamics of Padma River course

Most of the dams in India are constructed due to irrigation and generation of hydroelectric power, but the construction of Farakka Barrage served different purposes. The Farakka Barrage (2.64 km long) was designed to divert 40,000 cubic feet per second (1133 cubic metre per second) of the Ganga water towards the Bhagirathi river through a feeder canal (38 km long) to save the Kolkata port. The interface of the Ganga regime by construction of Farakka Barrage gives many hydrological and morphological changes of water level, discharge, sediment movement, bed slope characteristics etc. (Ghosh, 2015). Such changes of river course have been analyzed within two temporal windows from 1924 to 1990 and 1990 to 2020 (Figure 2).

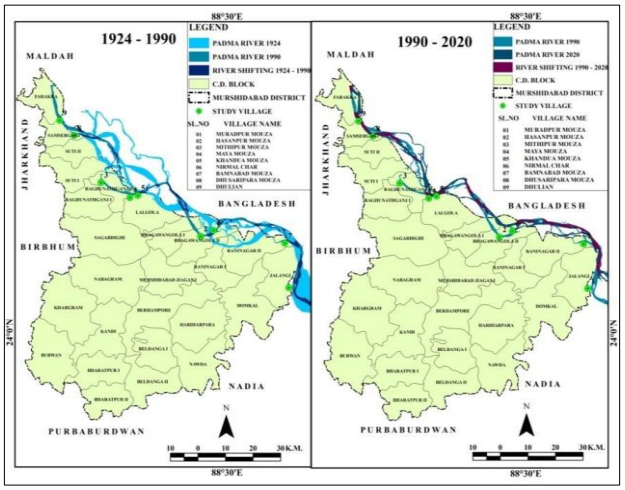


Figure 2: Lateral dynamics of the Padma River (1924 to 2020)

Table 2: Changing point of Padma River

SL.	LATITUDINAL &	VILLAGE	COMMUNITY	SHIFTING OF RIVER WITHIN STUDY PERIOD

NO.	LONGITUDINAL VALUE	NAME	DEVELOPMENT BLOCK (C.D. BLOCK)	1924 - 1990 (k.m.)	REAMRKS	1990 - 2020 (k.m.)	REMARKS
1	88°42′00′′ E, 24°08′24′′ N	MURADPUR	JALANGI	3.41	**Right side**	6.31	**Left side**
2	88°24′36′′ E, 24°18′36′′ N	HASANPUR	BHAGAWANGOLA II	5.11	**Right side**	3.87	**Left side**
3	88°04′48′′ E, 24°28′48′′ N	MITHIPUR	RAGHUNATHGANJ II	3.67	**Right side**	5.21	**Leftside**
4	88°10′48′′ E, 24°25′48′′ N	MAYA	LALGOLA	2.3	**Right side**	1.5	**Right side**
5	88°12′00′′ E, 24°26′24′′ N	KHANDUA	LALGOLA	1.8	**Right side**	1.05	**Right side**
6	88°27′18′′ E, 24°19′48′′ N	NIRMALCHAR	BHAGAWANGOLA II	1.3	**Left side**	1.41	**Left side**
7	88°41′06′′ E, 24°17′06′′ N	BAMNABAD	RANINAGAR II	1.85	**Right side**	2.11	**Left side**
8	88°00′00′′ E, 24°37′48′′ N	DHUSARIPARA	SAMSERGANJ	1.6	**Right side**	1.71	**Rightside**
9	88°57′00′′ E, 24°40′48′′ N	DHULIAN	SAMSERGANJ	2.24	**Right side**	1.46	**Right side**

The Ganges River split into two major streams once it reached the northern part of Murshidabad district near Dhulian before the construction of Farakka Barrage. Following the construction of Farakka Barrage and feeder canal (dedicated to Nation 1975), only a small amount of water flows from the Bhagirathi River through a very small channel and reaches the Padma River at Mithipur, although natural flow of the Bhagirathi was started after crossing the Jangipur Barrage. The northern and eastern boundaries of the Murshidabad district are defined by the Padma branch of the river Ganga, which flows towards the south-east. On the other hand, the Bhagirathi River branch flows southwards. This section of the Padma River discharges a large amount of water. The main channel is constantly shifting except the high bank. As a result, shoal or island or charland is continually rising in the channel. The people of the islands such as Nirmalchar of Bhagawangola -II block and Bamnabad char of Raninagar –II block live in temporary huts due to the annual bank flooding. Within this study area, nine different locations have been identified where the Padma River has shifted its course in different directions, on a distance exceeding one kilometer (Table 2 and Fig. 3).

Lateral dynamics of the Padma River from 1924 to 1990

From Table 2, Figure 2 and Figure 3 it is observed that the Padma River has been shifted on a maximum distance of 3 to 5.11 km towards the right side, near Bhagawangola-II, Raghunathganj-II and Jalangi block, while the minimum distance can be found near Lalgola, Raninagar, and Samserganj block, while the river shifted towards east direction or left-hand direction about 1.3 km near Nirmal char of Bhagawangola II block. During this time period, significant river bank erosion has been registered in Bhagawangola II and Jalangi blocks.

Lateral dynamics of Padma River from 1990 to 2020

The Padma has been shifted on a maximum distance from 3 to 7 km towards its left side near Bhagwangola-II, Raghunathganj-II and Jalangi block; the minimum distance where it shifted was registered near Raninagar II block, while the river shifted towards west direction or right hand about 2 km near Samserganj (Dhulian & Dhusaripara) and Lalgola (Maya & Khandua) block. During this time period, Samserganj and Lalgola blocks have seen significant river bank erosion due to right side sifting of river courses. Figure 4 basically shows the vulnerable river bank erosion zone after the average weight analysis of data. The vulnerable river bank erosion zone along the Padma River bank are Zone I, which consists of Farakka, Samserganj and Suti-II block, Zone-II consists of border area of Raghunathganj and Lalgola block, Zone-III consists of Bhagawangola –I and Bhagawangola-II block, Zone-IV consists of small area of Raninagar-II and Jalangi block. Currently, Samserganj and Lalgola blocks are the most vulnerable river bank erosion zone.

It has been observed that average changes of the Padma River course from 1924 to 1990 is 76.580 metre/year and after the construction of Farakka Barrage, the river bank erosion is 79.2187 metre/year from 1990 to 2020. River bank erosion has increased since the Farakka barrage was constructed. Figure 5 & 6 basically show cross-sections of the minor bed-major bed along the Padma in 1990 and 2020 which identified the thalweg shifting of the river. At the block level, the average changes in river course are greatest (98.75 metre/year) in the Jalangi block following the construction of the barrage, while river bank erosion is 57.24 metre/year, which is less than the previous phase. Overall, the highest river course change after the completion of the dam took place at Suti II block, 67.5 metre/year (1990 to current years), although river course

change before dam construction was 38.44 metre/year. Besides, it is also observed that river course changes have gradually decreased after the construction of dam at Bhagawangola II, Bhagawangola I and Raninagar I block.

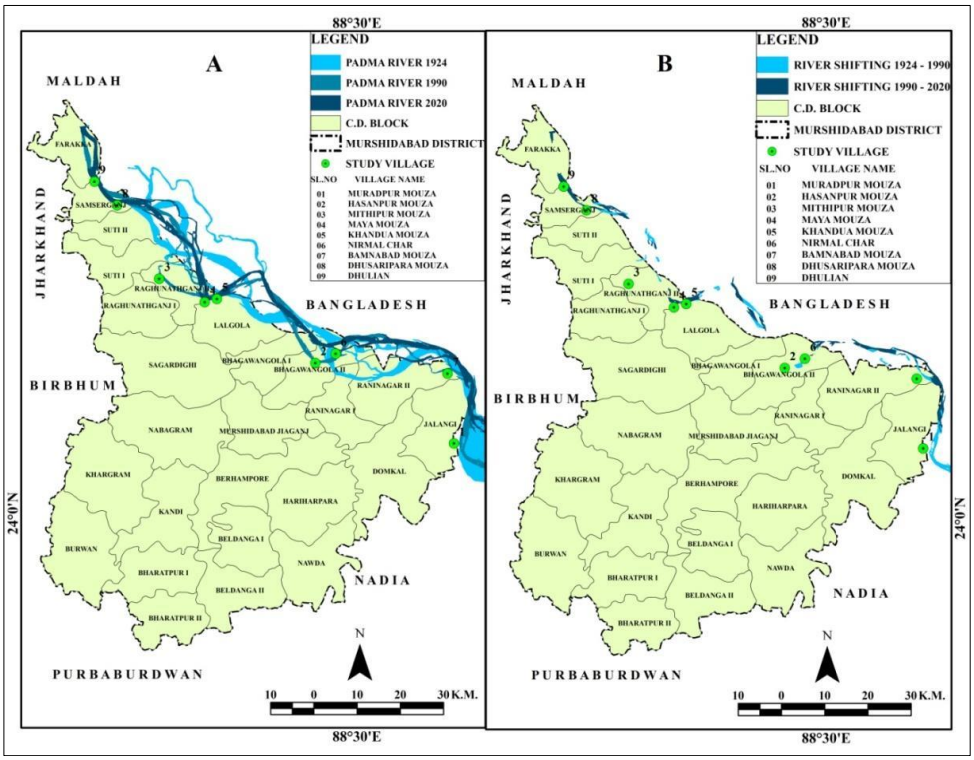


Figure 3: Major shifting points of the Padma River (1924 to 2020)

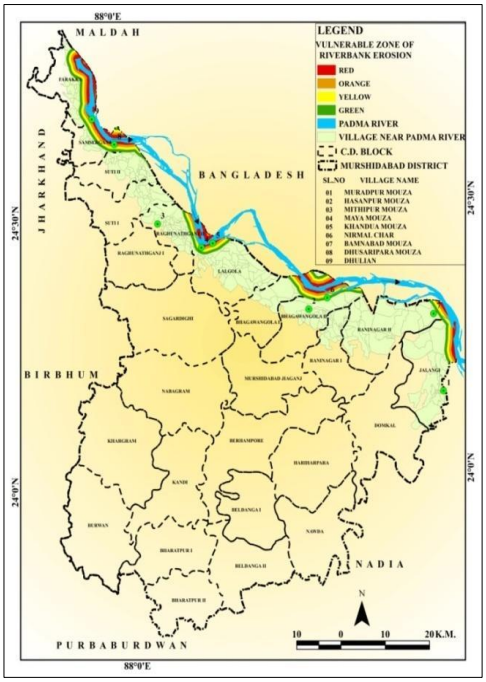


Figure 4: Vulnerable zone to erosion along the Padma River, 2020

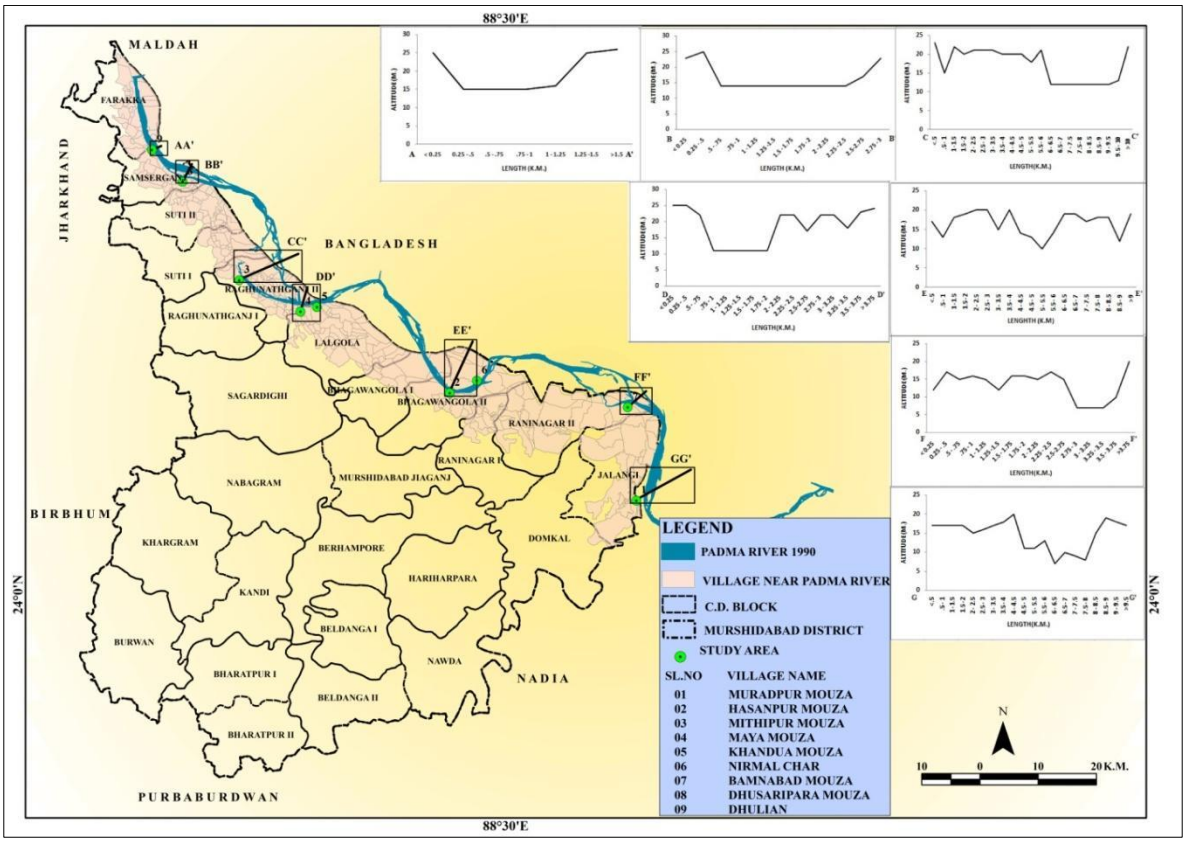


Figure 5: Analysis of cross-sections of the minor bed-major bed along the Padma River, 1990

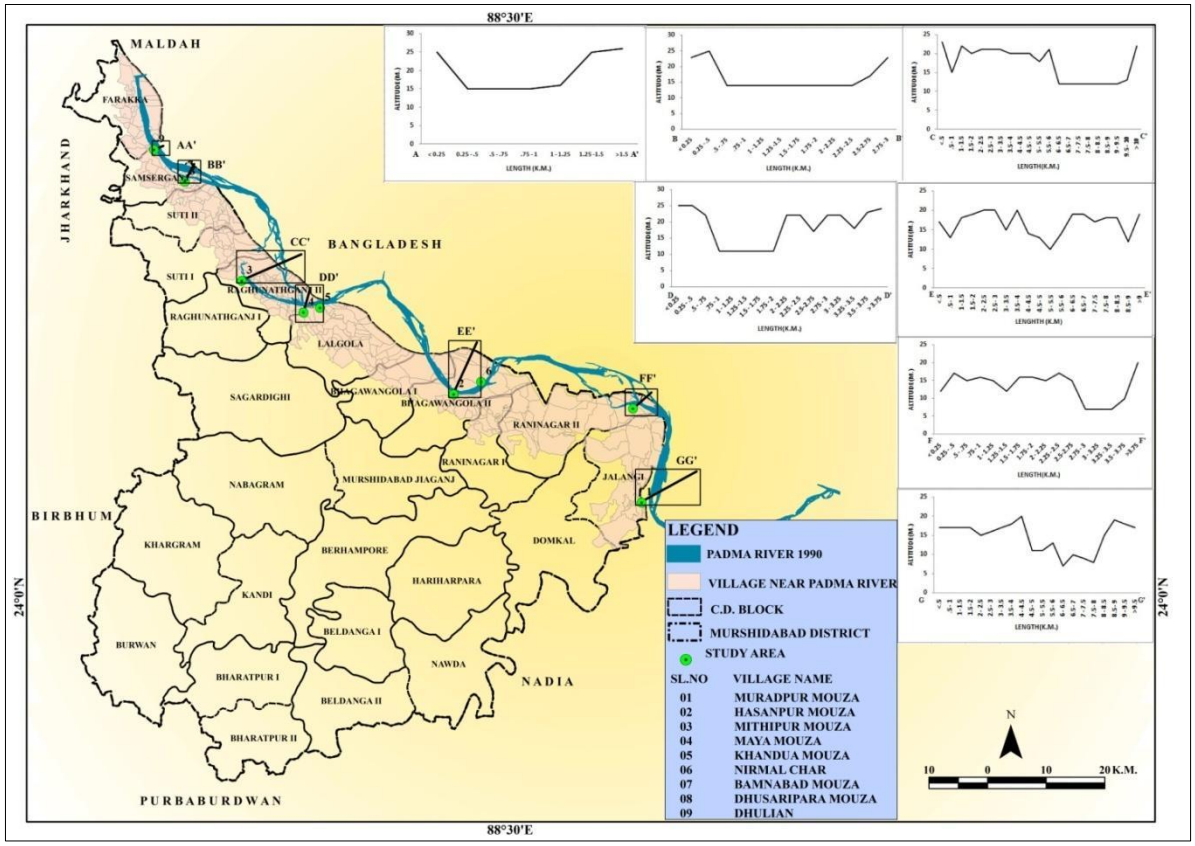


Figure 6: Analysis of cross-sections of the minor bed-major bed along the Padma River, 2020

Trigger factors of lateral erosion

i. The river channel in moribund deltaic region varies from braided to meander with limited straight channel. Within the meandering reach, the river course is sinuous and deep banks.

ii. Stratigraphy of a bank composed of micaceous unconsolidated sand at bottom and thin silt clay at top causes severe bank erosion (Figure 7).

iii. Fluctuation of river water discharge of the Ganga (from 1,100 a cubic metre per second to 76,000 a cubic metre per second) as well as fluctuation of water level (10 to 12 metres) causes alternately drying and wetting of the river bed. As a result, bank materials are dislodged and bank erosion accelerated.

iv. Seepage of groundwater towards the river leads to liquefaction and flowage of basal development of cracks ultimately accelerated bank erosion in early post monsoon period.

v. Sediment load of the river water also plays an important role in bank erosion. Fine sediment in river water will increase the viscosity of flow, increase the force, decrease the bed irregularities and bed form roughness and thus enhance the instability of river bank resulting in bank erosion.

vi. Current and wave action are also important factors in bank erosion. River current is turbulent in nature and acts along the bank obliquely and undercut the lower portion of the river bank. As a result, unconsolidated bank materials of the upper part have collapsed. If the velocity, discharge and depth of river water will increase, the current and wave action are more concentrated along the river bank. That is why river bank erosion is more in the rainy season.

vii. Anthropogenic activities along the bank side such as digging of the land for preparation of brick, furrowing of land for cultivation, construction for habitation etc. also accelerate the process of river bank erosion. Brick fields are concentrated in different parts of Murshidabad district along the bank side of the Padma and Bhagirathi River. Digging of land on the river bank also causes bank erosion at Dhulian and Maya and other places by land mafia. Apart from the 2.64 km. the long Farakka Dam which was built across the river during 1962-1971, bank revetment with boulders, construction of the spurs to deflect the impinging current, the flood control embankment, excessive withdrawal of groundwater are all combined causes for river bank failure.

Figure 7: Trigger factors of lateral erosion - ***A. Unconsolidated Sand at bottom and thin silt clay soil at top at Maya, Lalgola; B. Human interference (Brick field) along the river bank at Maya; C. River bank characteristics near Dhulian; D. Construction of Bank Protection Wall at Dhulian; E. Illegal digging along the river bank at Maya***

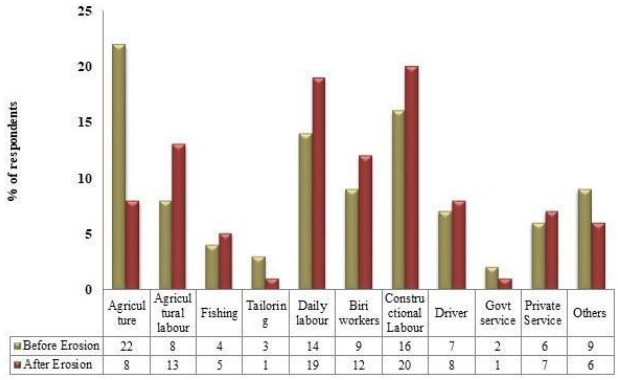
Socio-economic impact of the river bank erosion

A serious environmental risk caused by river bank erosion also contributes to social and economic inequality. Loss of nutrients of soil required for plant development, harm to downstream ecosystems by erosion-generated sediments, and reduction of water storage capacity are the three main impacts of erosion. Flood plains are heavily populated since they are fertile and easily accessible and riverine locations have always attracted human settlements. Each and every year the

Padma riverine societies are highly affected by river bank erosion during the post monsoonal phase. In the eastern portion of the Murshidabad district, nine severely affected human settlement areas have been chosen in order to better understand the extent and degree of river bank erosion as well as the nature of people's adjustment with the erosion. Out of these selected areas, two blocks, namely Samserganj block (Dhusaripara and Dhulian) and Lalgola block (Khandua and Maya) were severely affected from 1990 to present and rest of the villages (Muradpur, Hasanpur, Mithipur, Nirmal char and Bamnabad) were affected from 1924 to 1990.

Occupational structure

The physical environment provides natural resources, while human activities create the economic environment. The occupational structure of inhabitants is greatly affected by riverbank erosion. The main or marginal farmers work as day labourers but now their lifestyle and social status have been changed.



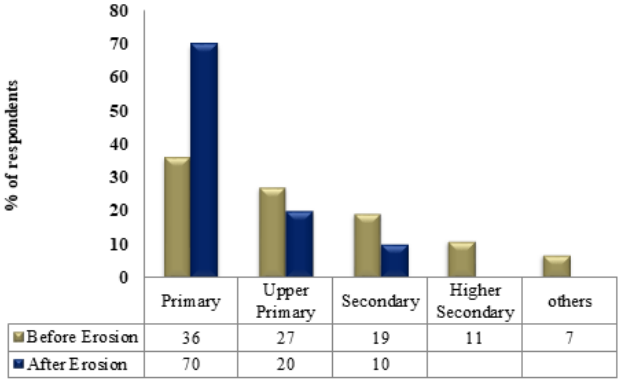
	Agriculture	Agricultural labour	Fishing	Tailoring	Daily labour	Biri workers	Constructional Labour	Driver	Govt service	Private Service	Others
Before Erosion	22	8	4	3	14	9	16	7	2	6	9
After Erosion	8	13	5	1	19	12	20	8	1	7	6

Figure 8: Occupational status of population, before and after bank erosion

From Figure 8, it is clear that 22% of respondents are engaged in agricultural activities and 14% -16% of respondents are working as daily labourers and constructional laborers. But after the river bank erosion this occupational scenario has dramatically changed. Within a very short time due to the loss of 48% of the agricultural land, people shifted their jobs from agriculture to daily labourers, construction labourers or e - rickshaw drivers. They are also forced to migrate to other states as construction labourers and other countries, mainly Saudi Arabia and Dubai as workers.

Educational status

A man can become qualified to serve his country and live a happy life by getting education. Most often, an illiterate guy is engaged in basic economic pursuits with no understanding of how to enhance or change such pursuits. The majority of them do not know what to do or how to deal with loss when a tragedy occurs. It is clear from the data that about 49% of the respondents spend Rs. 600 on schooling. Among the respondents, just 21% spend more than Rs.1000 for education. After river bank erosion there is a significant change in literacy rate. As a result, many students are not attending school. Children and young people must find employment in order to survive. It is observed from primary data, that the percentage of illiteracy has climbed from 30% to 43% and other educational levels (primary, upper primary, secondary, higher secondary and so on) show a very badly affected educational system within the study area. Education is the best option for raising income levels and improving living conditions, thus individuals should focus more on this area. Figure 9 clearly shows that 36% of family members of respondents have only primary education, 27% secondary education and the rest of 19%, 11% and 7% family members of respondents are engaged in higher education. But after river bank erosion this educational scenario has been changed due to loss of their land, destruction of school buildings and occupational changes. Currently, 90% of total members of respondents are engaged in primary education with the help of ICDS and NGOs, but there is no one with higher education.



	Primary	Upper Primary	Secondary	Higher Secondary	others
Before Erosion	36	27	19	11	7
After Erosion	70	20	10		

Figure 9: Educational status of before and after bank erosion

Housing conditions

Housing conditions are another indicator of social status. The vulnerability to river bank erosion affects the strength of the house structure. Residents in the study region are aware that they may have to leave their home at any time. Therefore, they build their houses by using materials which can quickly be moved during calamities. According to our study, 82% of the homes are *kacha houses* (a type of houses which is made of bamboo, mud, grass, leaves etc.), while 16% houses are *semi- pucca* (a house that has fixed walls but roofs are generally made of hay) and the rest 2% are pucca (a pucca house is one which has walls and roofs are made of burnt brick and stones. Losing homesteads makes the population more vulnerable to leading a good life, which is the serious consequence of bank erosion. People have little choice but to stay behind when erosion occurs and deal with the consequences. Prior to the onset of erosion, they never

moved their homestead. The primary cause of this behavior is because their meager income prevents them from replacing their dwellings before they completely collapse.

Neo refuges

Many people have been displaced from their household due to river bank erosion and make them environmental neo-refugees. River bank erosion causes continuous forced migration in the following manner (Figure 10):

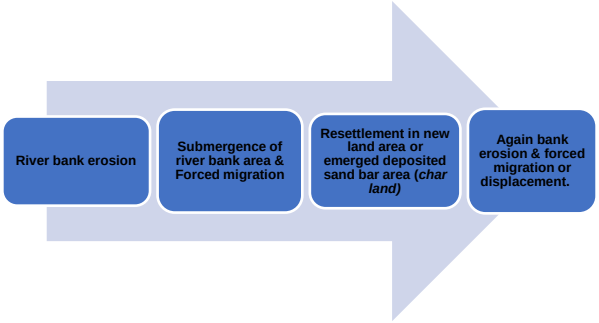


Figure 10: Migration Process due to river bank erosion

Data of socio-economic conditions of the displaced people are collected through household surveys. The results are explained below: about 40 to 50% of the displaced people are illiterate. The illiteracy rate also increases to *charland*. About 60% people are illiterate at Mahishmara Char (Nirmal char). The literate people are mostly below Madhyamik pass such as Tekpara village (Hasanpur Mouza) about 46%, Muradpur mouza (Totally) about 33%. Due to lack of educational institutions and economic distress, education is the least priority among these displaced people. It has been observed in these areas that many children and even teenagers have never been to school and are illiterate. Medical facilities in the neo-refugees' areas are very poor. Most of the areas even have no primary health centre. Most of the children suffer from malnutrition, and there are several reports of children dying due to malnutrition. Immunizations programmed for children are not properly done in many resettled areas. Sometimes deaths of pregnant women were reported because of their delayed arrival at hospitals. Socio-economic study of erosion affected displaced people has been done in the different places in Murshidabad district. Those that are displaced typically relocate locally, but there are some who migrate to far-off places. The maximum number of displacements was four times among the sample respondents. More than a third (37%) of the population within the study area has relocated at least once. Approximately 12% of respondents said they had been affected five to six times. Due to the erosion, it is utterly difficult for them to support themselves. According to the field survey, more than 15% of displaced construction workers are thought to have relocated to Kochi, Chennai, and Mumbai. Figure 11 shows migration of labourers from the affected river bank erosional zone to other parts of India and abroad.

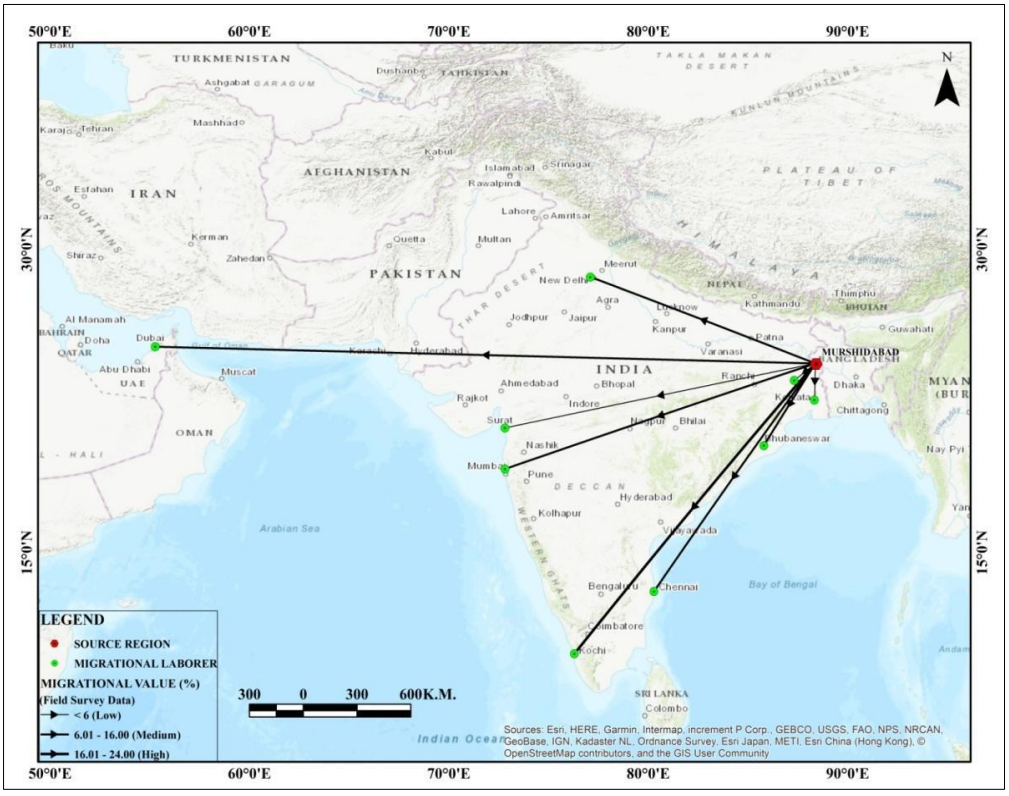


Figure 11: Flow path of emigrational labourers from riverine society

Major Findings

i. The majority of displaced individuals suffer greatly from poverty, with monthly incomes ranging from Rs 2000 to Rs 5000.

ii. 72% of the homes in the region are kacha.

iii. Previously, agriculture served as the majority of people's source of income, but due to the loss of all agricultural land, the situation has changed completely. The majority of individuals now work as construction labourers to support their families.

iv. According to the study, 22% of the study area's residents are at risk for river bank erosion since they reside close to the bank line (Figure 12).

v. In the research region, 65% of the population has lost their homes costing at least Rs1.5 lakh rupees.

vi. 13% of people have lost 2.5 acres of agricultural land, and 25% have suffered from financial losses up to Rs5 lakh.

vii. The monthly expenditure of about 81% people is less than Rs 5000.

viii. 49% of people spend just Rs 600 per month on education.

ix. 37% of the population in the study region has relocated once or more.

x. The study has found that most of the construction labourers have migrated to Kerala, Chennai, Mumbai and Delhi.

Figure 12: Present status of the Padma River bank erosion – ***A. Recent River Bank Erosion Ground truth evidence at Farakka; B, D & E. Recent River Bank Erosion Ground truth evidence at Dhulian (During Bank Erosion); C. Recent River Bank Erosion Ground truth evidence at Maya (Lalgola); F.Recent River Bank Erosion Ground truth evidence at Dhulian Municipality ward no 17***

Conclusions

The river bank erosion takes place at an alarming rate due to low level technological adjustment and ill directed planning. As the district is situated near the border area, since the independence of India (1947) a large number of people have emigrated from East Pakistan (Bangladesh), changing the socio-economic and demographic scenario in the district, people becoming marginalized. The environmental neo-refugees of Murshidabad district have faced multi-dimensional problems and have lacked basic amenities for survival. In these circumstances, the preventive measures and human preparedness must be undertaken to control the river bank erosion. Simultaneously basic amenities have to be provided to environmental neo-refugees for uplifting the socio-economic condition of these people. The changing river courses have both positive and negative impacts on human life. Many landscapes are developed due to changing river courses in the district such as river cut-off, *charland* and alluvial deposition etc. Later river cut-off is transformed into *bills* or swampy lands. These *bills* act as wetlands. Excessive flood water holds these wetlands and reduces the flood. These wetlands also produce

fishes and other aquatic animals and plants and also recharge the groundwater and use recreation purposes such as Mothijil. *Charlands* emerged on the river bank due to changing river courses. Victims affected by erosion take shelter at these *charlands* such as Nirmal*char*, Bamnabadchar etc. *Charlands* are also used for agricultural purposes such as vegetables, Pulses, Turmeric etc. But changing river courses have many folds negative effect than positive effect. Changing river courses have badly affected human society. River bank erosion due to changing river course causes the displacement of thousands of people in the district every year, turning them into environmental refugees.

While the total taming of the tremendous eroding force of the Padma River is impossible, local people have to learn to live upon continuous adjustment to erosion. The low-cost house building with easily detachable and movable materials like corrugated sheets, bamboo, wood etc. may be provided on *chars* and vulnerable areas. The Government should pay more attention to protect non-displaced people and relief generally provided for displaced people rather than spending huge amounts of money for engineering works. Construction of special type schools in suitable areas which plays a dual role such as education as well as shelter.

Hectares of agricultural land are also lost due to river bank erosion and flood. Displaced people live without proper shelter, sanitation, drinking water, even electricity such as Nirmal*char*, Bamnabad*char* etc. They are forced to migrate to other states and countries to get jobs. Huge amounts of money every year are used for bank protection but in many cases bank protection with boulders is futile. In these circumstances, a holistic approach with human preparedness will be undertaken to save the displaced people. Basic needs of the displaced people are to be ensured with providing facilities such as housing, food, drinking water, education, medical, proper sanitation, jobs etc. Establishment of police outposts or BSF camps may also develop a sense of security in *charland*. An arrangement of elevated flood shelter is absolutely necessary as chars are submerged during the rainy season. They also granted pattas or right to the *charland* for peaceful life of the *charland*.

Bank protection in this sector is mostly dependent on engineering work such as concrete spur, net wire fill boulders, and so on, but never takes into account the societal aspect. Therefore, better preparedness and scientific resettlement strategies as well as holistic planning may improve the socio-economic status of the thousands of erosion and flood victims lastly, displaced people are considered as Indian citizens; otherwise, they are helpless and hopeless.

Funding

This research received no external funding.

Author contribution

Conceptualization, methodology, writing – original draft, MM, GB. The author has read and agreed to the publication.

Conflicts of interest

The author declares no conflict of interest.

Acknowledgement

I am grateful to the thousands of erosion victims who shared their stories with me throughout the questionnaire survey and interviews. I'd also like to thank my student, Mr. Subham Kumar Roy, for preparing the text. Thank you to my students who assisted me during the questionnaire survey and interview processes.

References

Couture, S. (2008): River Dynamics and Erosion, Presented to Great Bay Siltation Commission, December1, 2008

Ghosh, S. (2015). River bank erosion and environmental neo-refugees: A case study of Murshidabad District,West Bengal, India. *International Journal of Current Research*, 7 (5), 16582-16589

Islam, T., Azman, A., Singh, P., Ali, I., Akhtar, T., Rafatullah, M., ...&Hossain, K. (2019). Socio-economic vulnerability of riverbank erosion of displacees: Case study of coastal villages in Bangladesh. *Indian Journal of Ecology*, 46(1), 34-38. https://www.sciencedirect.com/science/article/abs/pii/S1470160X16303703

Mukherjee, J. (2011). NO VOICE, NO CHOICE: RIVERINE CHANGES AND HUMAN VULNERABILITY IN THE 'CHARS' OF MALDA AND MURSHIDABAD. *INSTITUTE OF DEVELOPMENT STUDIES KOLKATA*, 28, 1- 30

Mukhopadhyay, S. C., & Das Gupta, A. (2010). River Dynamics of West Bengal: Physical Aspects (Vol. 1). *Kolkata: Prayas Publishers and Book Shellers*

Panda, S., & Bandyopadhyay, J. (2011). Morphometric Changes of Bhagirathi River at Murshidabad District Using Geoinformatics. *Journal of Geographic Information System*, 3 (01), 85 - 97. DOI:10.4236/jgis.2011.31006

Parua, P. K. (2006). Some Facts About Farakka Barrage Project (Vol. 1). *Berhampore: Silpanagari Prakasani*

Parua, P. K. (2009). Some Facts About Farakka Barrage Project (Vol. II). *Berhampore: Silpanagari Prakasani*

Parua, P. K. (2010). The Ganga: Water Use in the Indian Subcontinent (Vol. 64). *Springer, Water Science and Technology*

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

https://www.banglajol.info/index.php/JSF/article/view/14627

Raman, K. S., Kumar, S., & Neogi, B. B. (1986). Exploration in Bengal Basin India - An Overview. *Singapore: Offshore South East Asia Show*

Rudra, K. (2010). Dynamics of the Ganga in West Bengal, India (1764–2007): Implications for science–policy interaction. *Quaternary International*, 227 (2), 161-169.https://doi.org/10.1016/j.quaint.2009.10.043

Rudra, K. (2005). The Encroaching Ganga and Social Conflicts: The Case of West Bengal, India.

Census of India, (2011): Population Census of Murshidabad district, West Bengal

Govt. of West Bengal (Office of the District Magistrate, Murshidabad) (2014). Flood Preparedness & Management Plan (Murshidabad District)

Murshidabad District Gazetteers (1997): West Bengal District Gazetteers, Government of West Bengal,Calcutta, pp 1-22

Murshidabad District Gazetteers (2003): West Bengal District Gazetteers, Government of West Bengal,Calcutta, pp: 14-45