



Floods in the Ganges-Brahmaputra-Meghna river basins in Bangladesh: An overview on *Charland* settlement relocations pattern¹

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Abstract

Introduction: Torrential monsoon rains, lightning, and landslides are common in Bangladesh and the northeastern Indian states of Assam and Meghalaya during the summer. But the intensity of the severe weather that pummeled the low-lying region in mid-June 2022 stands out. After weeks of downpours, flooding has swamped millions of homes and displaced hundreds of thousands of people in India and Bangladesh, according to reports from humanitarian agencies. Officials from the hard-hit Sylhet region of Bangladesh have called the floods the worst to hit the area in more than a century.

The physical characteristics of geographic location, river morphology, and the monsoon climate render Bangladesh highly vulnerable to natural disasters, primarily floods and cyclones. River flood has exerted a more significant impact on the culture, society, and economy of Bangladesh. The Ganges-Brahmaputra-Meghna (GBM) river carries 2.4 billion tonnes of sediments annually, and these sediments are settled on the bed of the major rivers channel and the remaining portion carried into the Bay of Bengal.

Material and methods: The newly emerged land in the river channel is called *char* or

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diara. Purba Khas Bandarkhola Mouza is a unique *char* and revenue village located in the Padma River basin. The *char* people and the settlements of *char-lands* are under threat due to floods and *char-lands* erosion. The Padma is a meandering river and has a high river bank and *char-land* erosion and accretion character in the channel. The excess water during the monsoon causes widespread flooding that damages *char-land* settlements, agricultural crops, infrastructures, communication networks, and livelihood. Purba Khas Bandarkhola Mouza of Char-Janajat union is highly affected by annual floods and *char-lands* erosion.

Bangladesh has a unique hydro-geological setting and deltaic floodplain which is jointly formed by the deposition of the Ganges (Padma), Brahmaputra (Jamuna) and Meghna River. The physical characteristics of the geographic location, river morphology and the monsoon climate render Bangladesh highly vulnerable to natural disasters, primarily, floods and cyclones. River flooding has exerted a great impact on the culture and socioeconomic activities. The excess of water happens during the monsoon season because of widespread flooding that damages *char-land* settlements, agricultural crops, infrastructure and communication networks.

Results: The results of this research showed that *char* people have to move, and settlements have to be relocated from one place to another, within the *char*/or outside the *char*. The dwellers are displaced from the *char* and again come back to the native *char* when the new land emerges in the river channel. This study aims to develop a comprehensive plan for *char-land* sustainable settlement, people sustainability, and livelihood in the Padma River channel. The study is carried out based on primary and secondary data sources. The results show that the average interval of displacement is every five years at Purba Khas Bandarkhola Mouza. The cyclic dislodgment range is 90 km² ranges and pulls, and push factors are the root cause of displacement. Therefore an integrated management plan is necessary for the *char-land* livelihood, migration, and settlement sustainability.

Conclusion: The *char* settlement relocation, people displacement, rural livelihood, and annual foods are interlinkage in riverine Bangladesh. Almost every year, more than 30 thousand *choura people* of Char-Janajat face and struggle against the floods and *char-land* erosion. The study finding shows that the flood and *char-land* erosion is the main reason for people's cyclic dislodgment and settlement relocation in the same *char* and outside the *char* within 90 km² range in the Padma River channel in Sibchar Upazila of Madaripur District.

The Purba Khas Bandarkhola Mouza is one of the vulnerable unstable *char-land* in Bangladesh where the *choura people* are cyclically moving and migrating because of unstable *char-land* and uncertain livelihood. The finding also shows that the mouza has been changed. It is shaped and size due to erosion and accretion due to devastating floods. Therefore the *char* inhabitants have been displaced a maximum of 17 times and a minimum of six times within 50 years of *char* life which is a threat to *char* livelihood and sustainable *char-lands* development. Moreover, the flood in the erosion of *char-lands* is a challenge for managing *char* settlements, cultural landscape protection, agricultural cropping systems maintenance, crop biodiversity, and the riverine ecology of Char-Janajat Island. Therefore, the findings of this study are strongly recommending the following

concluding remarks that could be implemented in Purba Khas Bandarkhola Mouza as well as in *Char-Janajat* of Sibchar Upazila in Madaripur District as an alternative approach to solve the *char-land* erosion, people displacement, and settlement relocation problems in the river basins in Bangladesh.

Keywords: Bangladesh, Floods, Ganges-Brahmaputra-Meghna Rivers, Settlement Adaptation, Settlement relocation.

1. Introduction

Bangladesh is a highly flood and riverbank erosion-prone area in the world. The countries' part of the Ganges-Brahmaputra-Meghna drainage basin covers 1.76 million km², and only 7.5% lies in Bangladesh (Elahi, 1987.1991). There are 257 rivers in Bangladesh, and 59 of them are Transboundary Rivers which play an essential role in flooding the deltaic floodplain. The Ganges (Padma) is one of the potential rivers in Bangladesh which build huge *char-lands* in the river channels. During the monsoon (June-Sept), the excess water causes widespread flooding, which damages crops, infrastructure, *char-land* settlements, communication networks, and life (Alamgir, 1977; Mofizuddin, 1983; Alam, 1989). Some natural elements and factors are not favourable to human existence. Floods that occur in the *char-lands*, which are potential threats to human life and resources in terms of loss and damage, emerge from the intersections between extreme geophysical events and a vulnerable livelihood in the *char-lands* (Ali, 1981; Haque, 1997). The cause of floods in Bangladesh is based on monsoon precipitation in the GBM catchments; snow and glacial ice melt with monsoon rain in the Himalayas and runoff generated by heavy local rainfall. There are no systematic records of annual floods available until the 20th century, including 1987 and 1988, 1998, 2002, 2004, and 2008. The recently flooded land area increased from 35 % in 1974 to 71 % in 2004, compared to the flooded land area in 1954. Suspended sediment load reached as high as 13 million tonnes per day during the flooding period (Coleman, 1969). The newly emerged land known as *Char* or *Diara* is the Bengali term for the mid-channel island that periodically emerges from the riverbed as accretion (Hanna, 1996; Baqee, 1998.1993.1986). This new land is fertile and a valuable natural resource. The *char-land* landscapes are of great importance for their exceptional hydro-geological setting. The physical characteristics of the geographic location, the rivers morphology, and the monsoon climate render the *char-lands* highly vulnerable to natural disasters (Baqee, 1986.1997; Coleman, 1969). Over 12 million *chaura* people live in the *char-lands* and struggle against monsoon floods and riverbank erosion.

The *char-lands* of Padma River are undergoing rapid hydro-morphological changes due to natural and anthropogenic causes (Hooper, 2001). The Padma is a meandering river and has a high rate of riverbank erosion and accretion in the channel. In the monsoon time (June-September), Brahmaputra (Jamuna) can deliver its water discharge of 100,000 m³/s (FAP, 1996; Mofizuddin, 1983). The sediments carried by the rivers have aggraded the river bed, which

negatively impacts the floodplain and the *char-lands* (Baqee, 1998. 1993). The Purba Khas Bandarkhola Mouza of *Char-Janajat* of Sibchar Upazila of Madaripur District is part of the Ganges active delta and located in the main channel of the Ganges-Padma River (Coleman, 1969; Islam, 2016. 2014). The *Char-Janajat* is inundated by the monsoon floods every year, and in consequence, people have to displace their settlements and scatter from one place to another. The crops of the *char-lands* depend on soil quality (Islam, 2016; Islam and Gnauck, 2009; Islam *et al.*, 2018a.2018b.2019). The soil quality and fertility of the *char-land* relate to floods and clay siltation. The agricultural cropping pattern in the *char-land* differs from that in other country places because of the instability of *agricultural* land (Elahi, 1991; Baqee, 1986). The *chaura* people have to relocate because of the frequent massive floods and trends of the river bank and *char-land* erosion. Their dwellers are displaced from the *char* and return to the native *char* when new land emerges in the river channel. The relocation distance of the *char* settlement is about 12 km range on average. The interval of displacement is about five years at the Purba Khas Bandarkhola Mauza. The settlements displacement and population changes are reliant on the floods occurrence and riverbank erosion at the Purba Khas Bandarkhola Mouza. The present research outcome would be a valuable contribution to making a national plan for flood disaster management and adaptation in the *char-lands* in the Ganges delta (Kabir, 2006; Islam, 2014. 2016).

2. Material and methods: Objectives of this Study

This study aims to investigate the nature of the *char-lands* erosion and settlement relocation due to floods in the Padma River basin area and to measure the vulnerability of *char* livelihood. Finally, formulate some practical recommendations for sustainable livelihood and settlements in the *char-lands* in the Padma River basin in Bangladesh. Geographical Information Systems (GIS) application could be a potential tool that is advantageous for decision-making for the *char-land* people and settlement sustainability in the river basin in Bangladesh.

3. Geographical Location and Physical Characteristics of the Study Area

The Purba Khas Bandarkhola *Mouza* is a revenue village of *Char-Janajat* union, located in the Padma River basin in the Ganges delta in Bangladesh. The Purba Khas Bandarkhola Mouza is under Sibchar Upazila, which is

situated between 23° 15' and 23° 30' North Latitude and 90° 05' and 90° 18' East Longitude (Figure 1). Purba Khas Bandarkhola Mouza is 6.73 km², and the population of seat no two is estimated at 1350 in 2008. The present study has been carried out at seat no 2 of Purba Khas Bandarkhola Mouza. The mouza under the union of *Char-Janajat* (area 31.94 km²) is under the Sibchar Upazila of Madaripur District. The whole *char* (Island) is called as *Char-Janajat*, and its area was 84.09 km² until 2003. The population of the Char-Janajat union was 13,958 until 2003 (BPC, 2003), and presently it is estimated over 35,000 (until 2008).

The Purba Khas Bandarkhola is an area bounded by *Char-Janajat* Mouza, Char-Amirabad, *Akater-Char*, Boro Khas Bandarkhola, Bandarkhola union, Katalbari union, Panchchar union of Sibchar Upazila (Figure 1). The two rivers are the Padma and Arial Khan, influenced by the Purba Khas Bandarkhola Mouza formation, erosion, and accretion (Figure 1). The majority of the *char* people (55%) are involved in the agricultural farming profession. Agricultural labour is 11%, wage labour is 3 %, small traders 3 %, transport 2%, fisherman 3 %, service 4%, student 13% and others 6 %, this is the scenario of Purba Khas Bandarkhola Mouza (Figure 1), and it is different from the mainland.

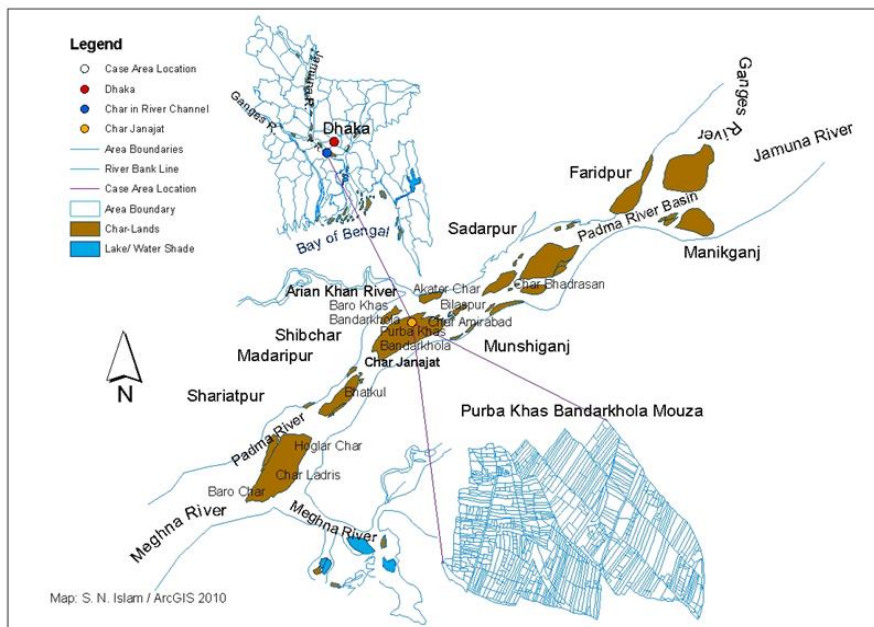


Fig. 1- The geographical location of the case study area in the Padma river channel



4. Data and Methodology

The study has been conducted based on primary and secondary data sources. The primary data on *char-land* erosion, settlement relocation, people displacement, *char* livelihoods information were collected from the local people of seat no 2 of Purba Khas Bandarkhola Mouza through Participatory Rural Appraisal (PRA) practice and informal interviews. Besides this, a questionnaire survey on 101 families of Purba Khas Banderkhola Mouza (6.73 km²) of Char-Janajat Union of Sibchar Upazila of Madaripur District from 1997 to 1999, and a three months socio-economic survey with *char* people in 2003 and 2008. Besides this geomorphological, anthropological village-settled study and questionnaire survey for benchmark data collection were conducted. A complete enumeration of the households covering the landholding pattern, tenancy, agricultural cropping system, marking, occupation, demographic character, literacy, etc., was collected in 2003 and 2008 at the Purba Khas Banderkhola Mouza. Some standard approaches for information and data collection and analysis were used, including review literature of studies to get a basic understanding of *char-land* development and rural livelihood. The secondary data inputs came from different publications of the government agencies, NGOs reports, and research organisations such as BIDS, CIRDAP, ADAB in Bangladesh. An integrated practice of the PRA method was used to develop *char* erosion maps, settlement relocation patterns, and people cyclic displacement in the case of *char-land*. Some interpretations of life history analysis were organised with *char* people to develop the diagram of *char* people's cyclic dislodgment pattern. Collected data and information was analysed and visualised using EXCEL, VISIO 32, and ArcGIS 9.2 software. The times series Remote Sensing imageries from 1995 to 2008 have been used to investigate and compare the trends of *char-lands* erosion, settlement relocations, people displacement, and land use changing pattern in the Purba Khas Bandarkhola Mouza of *Char-Janajat* Union of Sibchar Upazila of Madaripur District. Besides, two quantitative data-based case studies have been arranged with two different *char* families living and cyclic displacing for the last 50 years in *Char-Janajat* island of Padma River channel. A leading person from every family delivered the chronological historical data and recognised the settlement relocation places in different years, cyclic displacement, and *char* livelihood information. This data and information have been used to develop the people, cyclic dislodgment models.



5. Geographer and Anthropologist View

The problems of the *char* settlements due to monsoon floods and riverbank erosion in the large rivers in Bangladesh remain underrepresented. Key researchers in this connection are Elahi (1987.1989.1991), Baqee (1993.1997), Mamun & Amin (1999). Elahi (1987.1989), and Elahi (1991) discussed the eternal struggle of the people for survival on the western bank of the Jamuna River in the Rajshahi division and described how they coped up with the conditions and resettled on the banks after erosion. Wiest (1987) discussed the point of cultural anthropology on the Brahmaputra floodplain and *char-lands* erosion in Bangladesh. Baqee (1993) discussed that the settlements originate through the sponsorship of powerful elites and inevitably grow through a filtration process. The scenarios described the existing socio-economic relationship in the *char-lands*, which become increasingly complex. Mamun & Amin (1999) discussed people's perception of the vulnerable *char-lands* and suggested several strategies to reduce their sufferings. Haque (1985) provided an overview of indigenous knowledge and practices of people while coping with river erosion and floods. The earlier study on *char-lands* carried out by Adnan in 1991 pointed out the dynamics of power in remote villages of Barisal (Adnan, 1991). Currey (1996.1986) documented the overall changes in predominantly *char*-settlements in the Rangpur district in Bangladesh. Ali (1980) attempted to outline the evolution of the laws that operate in the *char-lands*. Hanna (2001) discussed in her study on indigenous and engineering knowledge in Bangladesh, especially on Jamuna River's *chars*. The specific literature reviews suggested that the opinion of Sociologists, Economists, Anthropologists, and Geographers are almost the same. In most cases, the Geographers have collected data and analysed the point of socio-demographic and physical problems of river basins. The problems of *char-lands* are not solved due to the lack of proper research in these areas. Hence, it is essential to carry out more in-depth applied research in terms of analysis, modelling, and prediction of *char-land* people movement and settlement relocation and displacement.

6. Floods and *Char-lands* Erosion in Bangladesh

The primary cause of floods in Bangladesh is rainfall in the catchment areas of the rivers of Bangladesh. Situated in the monsoon belt with the Himalayas in the north, Bangladesh falls in the region of very heavy rainfall. About 80 percent of the rainfall occurs during the five months from May to September.



The *char-lands* are repeatedly affected by the massive floods, with concomitant riverbank erosion because of the shift of river channels (Ahmed & Smith, 1988; Hassan & et al., 2000). The newly formed lands (*char-lands*) (Figure 1) and eroded riverbanks are inhabited by some of the country's most desperate and vulnerable people. Fragile riverbanks and *char-lands* have never been abandoned because of flooding (Haque, 1985). However, the average rainfall in Bangladesh generates annually only 100 million acre-feet of water, whereas 1100 million acre-feet of water come from outside Bangladesh. Thus about 90 percent of the water carried by the river systems, namely the Brahmaputra, the Ganges, the Meghna, and other smaller rivers, is the inflow from outside the country. These rivers carry water from about 960,000 km², of which only 7.5 percent lies in Bangladesh. Water enters Bangladesh through three major channels, but the discharge takes place through one major channel. The river system has evolved to carry the normal flow of water generated in the catchment area. The catchment of the mighty Brahmaputra-Jamuna River is about 583,000 km², of which 293,000 km² is in Tibet, 241,000 km² in India, and only 47,000 km² in Bangladesh. It is the most comprehensive river system in the country, flowing from the north towards the south. The discharge during the rainy season is enormous, the highest recorded flood was in August 1988, and the river flow discharge was 98,600 m³/s (Islam, 1995).

The reasons for massive floods in Bangladesh are to be considered based on the following pieces of evidence: Snow melting in the Himalayan region; hydrographic and geomorphic changes in the Brahmaputra River basin. The river systems of Bangladesh carry 2.4 billion tonnes of sediment during an annual flood, which, in turn, reduces the water carrying capacity of the rivers, and sediment deposition causes massive floods (Coleman, 1969). In addition, a high rate of forest depletion in the GBM catchments areas aggravates flooding in the downstream areas. Unplanned development of constructions such as roads, railways, embankments, polders, etc., also obstructs water flow and aggravates flooding through these barriers.

According to the statistical evidence of Bangladesh, both in 1987 and 1988, the country experienced disastrous floods. The 1987 flood is estimated a 30-70 year event, which affected 75,300 km², almost 40% of the country's total area. The 1988 flood inundated about 82,000 km² and about 60% of the area, and its recurrent period is estimated to be 50 -100 years (BWDB).

The damage caused by the 1987 flood was staggering. According to one estimate, the total loss was about TK. 3000 (over \$ 95 m US). No sophisticated



system is so far available in Bangladesh to assess the damage due to floods. The devastating floods inundate almost all the char-lands in the GBM catchments, so the damages of the char-lands cannot be estimated during that period of havoc, in the absence of modern technology, workforce, and favourable financial conditions (Islam, 1995). In 1988 (May–September), 53 out of 64 districts was affected, and 3,000 km of roads, 180 bridges and culverts and 640 km of railway tracks, and 2700 primary schools/madras have in the rural areas have either been washed away or partly damaged (Islam, 1995). Considering historical data and information, the years 1988 and 1998 were the most devastating floods.

The official sources are indicating the damage of crop-acreage at TK. 4.93 million, and rice production lowered by 2.4 million tonnes per year (Islam, 1995.1993; Miah, 1988). The average annual flow of the Jamuna River at Bahadurabad (the point where the Brahmaputra enters Bangladesh) is estimated to be 501 million acre-feet. August has always been the month when widespread flooding has occurred. Floods from May to July are usually high time in the catchments of Brahmaputra-Jamuna and the Meghna, from August to October due to the combined flows of that river and the Ganges. As a result, the flow of the Brahmaputra-Jamuna is more erratic than that of the Ganges. The gradient of the Jamuna averages 1:11,850, which is slightly more than that of the Ganges. During the monsoon, the Jamuna widens up to 20 km in some parts and transports between 60,000 to 100,000 m³/s water (FAP, 1996). The rainy season brings down something like 13 million tonnes of sediment per day (Coleman, 1969; Hanna, 2001), which helps to format the *char-lands* in the Jamuna-Padma Rivers channels.

7. Results

7-1. Impacts of Floods on Char-lands and Changing Rural Livelihoods

Bangladesh is a country that lies mainly at the bottom of the floodplains of three major rivers, the Ganges, Brahmaputra, and Meghna. Each year monsoon floodwater inundates the country, leaving both adverse and favourable impacts upon its people's lives, particularly causing widespread damage to standing crops, livestock, infrastructure, and road network. Most of the natural hazards result from the potential for extreme geophysical events, such as floods, to create an unexpected threat to human life and property. When severe floods occur in areas like *char-lands* occupied by humans, they can create natural disasters that involve the loss of human life, settlements, and

other property, plus severe disruption to large urban and rural communities (Figure 2). The Jamuna is braided in nature, within the braided belt of the Jamuna; there are lots of *chars* of different sizes. An assessment of the 1992 dry season Land Sat image shows that the Jamuna contained a total of 56 large island *chars*, each longer than 3.5 km. In addition, there is an additional number of 226 small island *chars*, varying in length between 0.35 and 3.5 km. It includes sandy areas as well as vegetated *chars*. In the Jamuna, the period between 1973 and 2000, *chars* have consistently appeared in the reaches opposite to the Old Brahmaputra off takes, north and east of Sirajganj, and in the southernmost reach above the confluence with the Ganges.

From 1981 to 1993, about 729,000 people were displaced by river bank and char-land erosion in Bangladesh. Floods are more or less a recurring phenomenon in Bangladesh and often have been within tolerable limits. However, occasionally they become devastating. Each year in Bangladesh, about 26,000 km², 18% of the country is flooded. During severe floods, the affected area may exceed 55% of the total area of the country. On a yearly average, 844,000 million m³ of water flow into the country during the humid period (May to October) through the three main rivers, namely the Ganges, the Brahmaputra-Jamuna, and the Meghna. This volume is 95% of the total annual inflow. By comparison, only about 187,000 million m³ of stream flow is generated by rainfall inside Char-Janajat, a large char in the Padma river basin. Figure 2 shows the impacts of massive floods on the char-land in the Padma-Jamuna river channel in the Ganges delta.

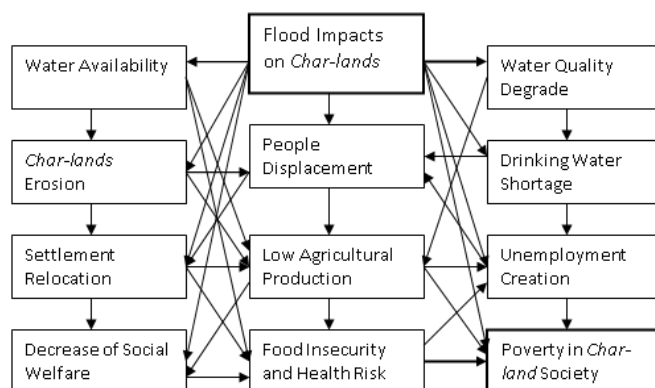


Fig. 2- Flood impacts on the *Char-lands* in the Padma-Jamuna river channel in Bangladesh

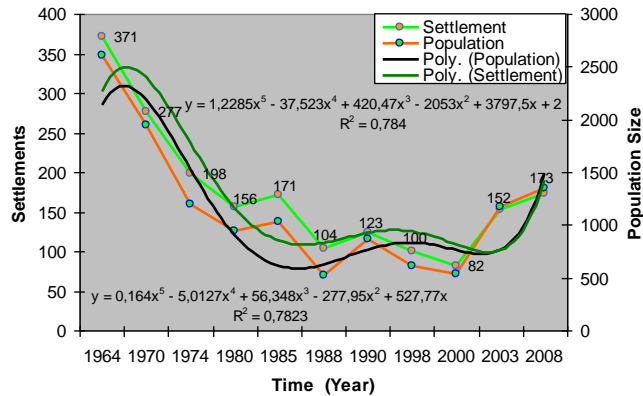


Fig. 3- Settlements and population in the Purba Khas Bandarkhola Mouza

Annual floods inundate the entire char. The inhabitants of char-land have to live with flood or to migrate in a safe place. Floods and riverbank erosions are the most threatened natural phenomena for the Char-Janajat people, and almost 6,000 people face flood problems in the *char-land*. In the Purba Khas Bandarkhola Mouza, there are 3000 people were living in the past (Figure 3). Nevertheless, the population and settlements figure could not be estimated permanently because of random flooding, *char* land sliding, and riverbank erosion. Every year people have to move and adapt the strategy to live with floods. Whenever the riverbank erosion creates a fragile environmental situation, the court people have to relocate from their original home. Figure 3 shows the population and settlements increasing and decreasing trends at the Purba Khas Bandarkhola Mouza in the Char-Janajat union (Figure 1) of Madaripur district in Bangladesh. Figure 3 shows the settlement and population increasing and decreasing tendency in the *char-land*. There is a close relation between settlements and population in char-lands. In figure 3, it has been stated that in 1964 are 371 settlements, and the population was around 3000. In 2000, there were only 82 settlements, and the population was 574, and in 2008 there were 171 settlements, and the population was around 1400 (Figure 3).

Understanding char livelihoods of the riverine islands (bar) in the Padma river channel and their vulnerability to land erosion disasters, it is necessary to explore how human needs and wants interact and adapt with nature, transform nature into resources by developing its different facts. Therefore, it is vital to know the socio-economic and livelihood system and resilient to the impacts of flood and char-land erosion hazards. Vulnerability is determined by the



interplay of several factors, such as awareness, condition of settlement stability, and infrastructure (Mamun & Amin, 1999).

7-2. *Char-Lands* erosion and Accretion Pattern in the Padma River Basin

Deltaic sediments of quaternary formation characterise the riverine floodplain land. Combining these sediments with high water content from the annual wet monsoon, a low degree of compaction, and a large amount of runoff materials from water flows is the root cause of adjusting their bed configurations (Haque, 1997). In the Padma River channel may shift laterally by more than 300 metres annually. This process makes *char-land* erosion a devastating natural hazard in Bangladesh that pushes people to displace for a short time or permanently (Haque, 1997). Moreover, the *entire char* is called *Char-Janajat* (Figure 4), is unstable and prone to annual flooding, and uncertain of rural livelihoods.

The main Padma River channel flowing on the eastern side of the river bank is now flowing in the western bank, but the river channel's wideness is shrinking. The channel in the western bank side was almost closed in 2009. The main river channel has shifted again in the eastern bank side.

7-3 Unstable Settlement Locations in PURBA KHAS BANDARKHOLA MOUZA

The settlement relocation in the *char-land* in Bangladesh is a common feature to the people of Bangladesh, and they are learned how to survive with massive floods in the *char-lands*. The impacts of massive floods in *char-lands* are tragic and vulnerable, which is demonstrated in figure 4. The riverbank erosion and char landslide make the *Char-Janajat* more vulnerable. The settlements, livelihood, and cropping systems are unstable over there. *Chaura people* always fight against poverty and food insecurity. Figures 5 show the quantity of settlement and relocations patterns at different times in the Purba Khas Bandarkhola Mouza of Sibchar Upazila, of Madaripur district. The cyclic movement of people and their settlement relocation occurs rapidly in the *char-lands* in the Jamuna-Padma River channel. The *Choura people* of Purba Khas Bandarkhola Mouza (Figure 5) of *Char-Janajat* face socio-economic and habitat problems such as settlement displacement, crops production, communication, and business (Figure 2). The place where people settle down permanently or temporarily and build houses and create a living environment and other facilities is primarily called settlement. In general, it can be said that a place that is the shelter for human society and ecology is a settlement (Morote & Hernández, 2021).

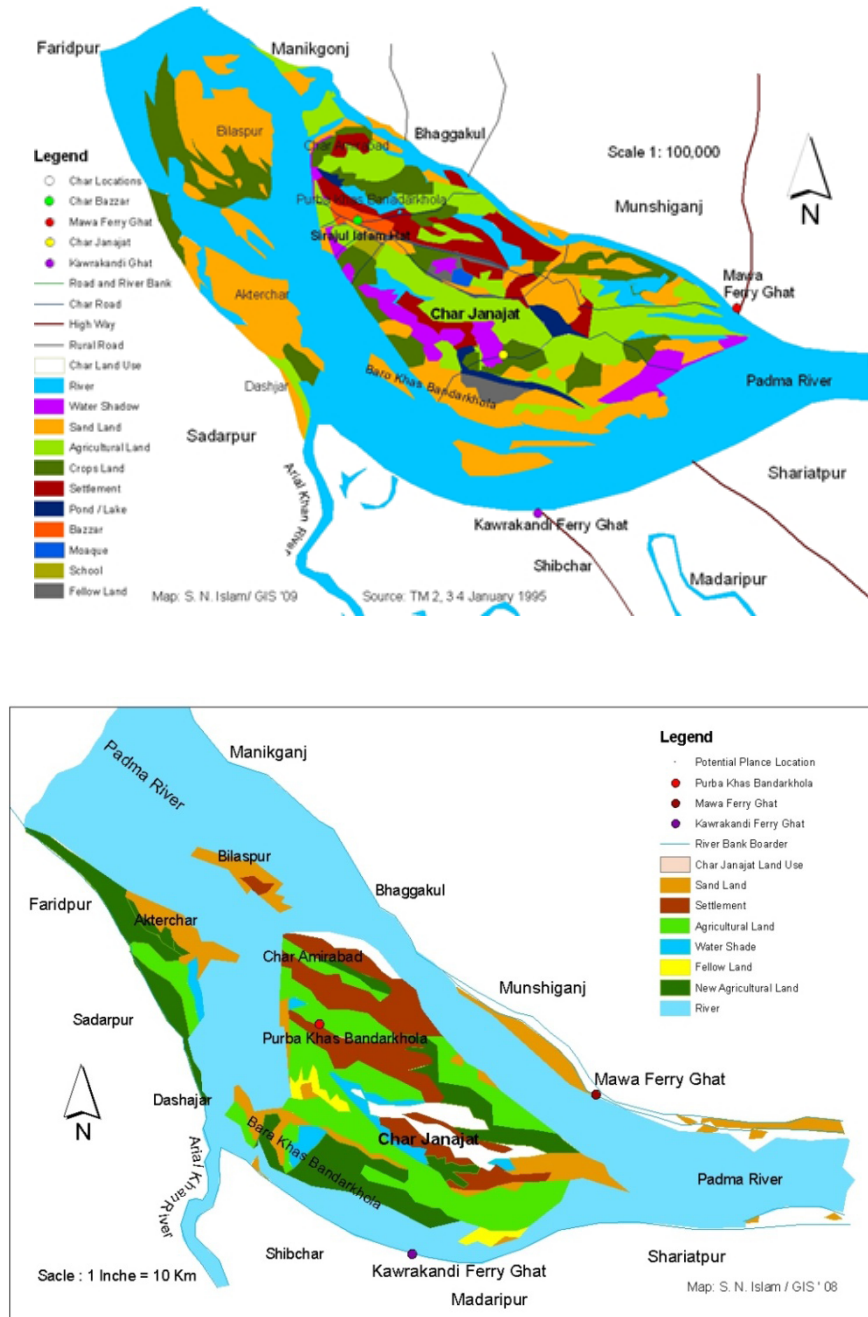


Fig. 4- The char land uses changes pattern in the Ganges-Padma River Basin in Bangladesh

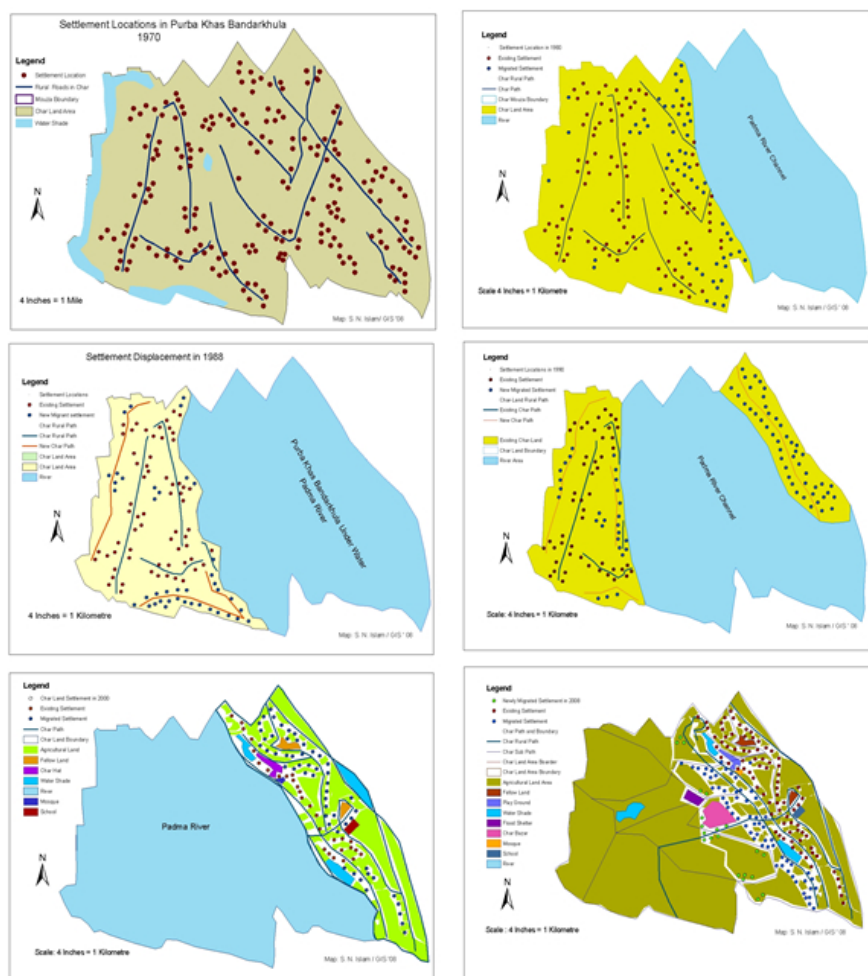


Fig. 5- Settlement patterns in: 1970 (top left); 1980 (top right); 1988 (middle left); 1990 (middle right); 2000 (bottom left) and 2008 (bottom right)

On the other hand, a place where some community people construct houses, roads, and community organisation for livelihood is also called a settlement. From time immemorial, when the culture and civilisation have been developed, people have tried to choose a peaceful place where they can take rest and food and sleep, which is called the house or home, and gradually some homes made a settlement. Settlement is one of the fundamental basic needs of human life, and gradually it has been extended to the different parts of the world. Settlement is the symbolic landmark of ancient and modern civilisations (Ahmed, 1965). The boundary lines of *char-land* villages are



often of great antiquity. Whilst the possible reasons for the origins of some nucleated designs or forms of house and homes have been postulated, there are four basic ways in which these villages could have evolved in the *char-land* (Chowdhury, 1978; Haq, 1981; Elahi, 1987).

The villages of *char-lands* in Bangladesh, which occupy the central swath of planned landscapes, were rarely in existence before 1000 AD. Village could be having developed anywhere but was united by territorial boundaries of the land available for the subsistence of their inhabitants. The first development process by steady growth from a single farmstead could have occurred when a family expanded, and the land was subdivided amongst the next generation (Figure 5). The result might be loose and amorphous if there were no features such as a road or road junctions along which to arrange the houses (Ahmed, 1965; Bhooshan, 1980). Figure 5 shows the time series scenarios of *char-land* settlement relocations patterns. In figure 5, the top left (1970) and top right (1980) represents the time frame 1970 to 1980 when the settlement pattern was a cluster pattern. In 1988 middle left and 1990 middle right show scenarios when the settlement pattern was the most random and cluster pattern. The figure shows time series scenarios of the years 2000 (bottom (left) and 2008 bottom (right) and of *the char-land* settlement pattern and, where the settlements are distributed as the random and semi-cluster basis, this is one kind of mix of random and cluster pattern.

7-4. Displacement Cycle of Basir Uddin: a Case Analysis

Basir Uddin of Purba Khas Bandarkhola Mouza was living with his family members in 1960. The family members of that time were eight persons. Father, mother, brother, and sisters were living together, leading a happy life in the *char* village of Padma River channel. It is time for Basir Uddin, who can only realise the memory of *char* village life in the Padma River. He is now 65 years old; almost 50 years ago, this Purba Khas Bandarkhola Mouza was a *Kaim-land*, and the soil was very fertile. Their house plot number was 2178 (Figure 5), which is now underwater. The river erosion and its impacts created a lot of negative attitudes to the family members.

The 1st time *char-land* erosion occurred in 1960. People concerned were displaced to the south side; it was about 2 km from the original home. Where they were displaced, it was a new place, and they had no own land, but fortunately, they got the land for yearly rent basis of Taka 1000. After two years they had to move to another new place of the same mouza its distance was more than 4 km far (Figure 6). From the south side of that present



location, they had to rent a piece of land TK again. 500 per year. After one year again, Basir Uddin moved to another new *char* of *Char-Janajat* in the Padma channel. It was also almost 4 km far from the previous distance. They settled there only three years, and after one year, Basir Uddin decided that he should move to the far distance where there is no river and riverbank or *char-land* erosion, and it will be safer than the present horrible *char* life in *Char-Janajat*. So Basir Uddin went to Shibchar and shifted there to the mainland; its distance was about 16 km from his home, and he shifted in 1989 with rented land (Figure 6). Basir Uddin and his family members were living at Sibchar for more than 13 years. After this period, he returned to his land in 2003 in the *Char-Janajat*, where his forefather was settled down, and other family members (one brother) came back with him to the same *char*, but another plot.

The distance from Shibchar to the original living place in *Char-Janajat* is about 10 km. Now it is time Basir Uddin is entirely tired of this hostile displacement of houses, and life is running one after another moment. Within his long-life experience with river, riverbank, *char-land* erosion, and displacement in the *char-lands*, he is highly tried to find some alternative solution to mitigate the impacts of floods and riverbank erosion in the *char-land*. However, he stated that "There is no alternative solution to solve this natural problem, and there is no easy way to survive in the *char-lands*. The way we live, this is reality, and we will have to live with floods, riverbank, and *char-land* erosion. This is the reality, if we would like to stay here and would like to live in the *char-land* we will have to face and adapt this environmental calamity within a natural process". The *char* people are mobile, and settlements are dynamics, and displacement of *char-land* is the normal process of *char* life, and it is moving within a cyclic process (Figure 6). The case study analysis and its findings show that the people of *char-lands* are naturally habited to deal with environmental problems, and they know how to lead the critical *char* environment in the *char-lands*. The dislodgment model shows the cyclic displacement of Basir Uddin within the *char* and outside of *char*. Considering the model, the distance of displacement can be measured on the following formula.

Displacement Length (DL) = Starting Point + Distance of Ending Point of Displacement

A (1960-1962) = 3 km

B (1962-1965) = 4 km

C (1965-1968) = 4 km

D (1968-1969) = 16 km

E (1968-1969) = 5 km

F (1989-2003) = 10 km

Therefore Displacement Length:

$$\begin{aligned} (DL) &= A (3\text{km}) + B (4\text{km}) + C (4\text{km}) + D (16\text{km}) + E (5\text{km}) + F (10\text{km}) \\ &= (3 + 4 + 4 + 16 + 5 + 10) \text{ km} \\ &= 42 \text{ km} \end{aligned}$$

The total displacement length (DL) is 42 km

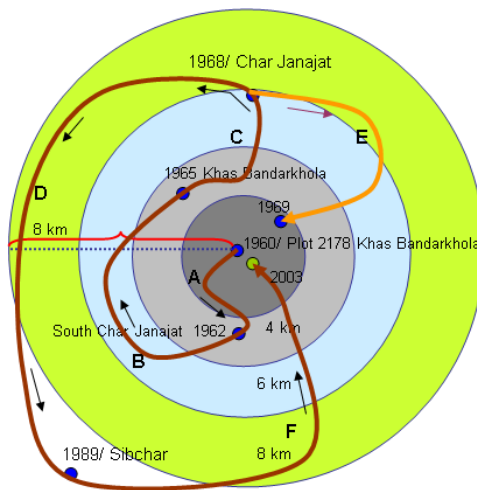


Fig. 6- People dislodgment model based on Basir Uddin's life cycle on the *Char-land*

The duration of living in the char-land of Basir Uddin is 43 years (1960 - 2003)

Yearly average dislodgment length is $42/43 = 0.976$ km

The total dislodgment time is 6 (times within 43 years), and the average dislodgment trend is $43/6 = 7.16$ years that means Basir Uddin displaced his home every seven years on average, and every time the average distance was $42/6 = 7$ km within the Purba Khas Bandarkhola and outside of *Char-Janajat*.

7-5. Discussion on Dislodgment Model Results

There are two case studies have been analysed based on quantitative and qualitative data sources. The results of these two dislodgment models of char people cyclic displacement in a different location within the *char-land* and outside the *char-land*. Table 1 shows the model results of two case studies on



Basir Uddin (Case analysis) of Purba Khas Bandarkhola Mouza of Shibchar Upazila.

The result shows that the people of *char* life of the Padma River channel are cyclic movement and unstable life. The average displacement of Basir Uddin 42 km, and he have been living on average for the last 45 - 50 years. The yearly average distance of displacement is 1.35 km; the interval of displacement is every five years. They have been displaced in different mouzas and outside of the *char* ten times. The models (Figures 6) show two *char* family members' cyclic displacement locational tendency. The average number of family members is nine. It has been stated that Basir Uddin has been displaced in different places with 8 and 10 family members. There are some potential factors, including pull and push factors of migration and displacement of *char* people, besides this social security, *char* rural power politics, 4th generation land property, and cultural identity are the root causes to return to the native *char* after a long-staying at outside of the native *char*. It is very much a usual scenario in the *Char-Janajat* of the Padma River channel.

8. Conclusions

The *char* settlement relocation, people displacement, rural livelihood, and annual foods are interlinkage in riverine Bangladesh. Almost every year, more than 30 thousand *choura people* of *Char-Janajat* face and struggle against the floods and *char-land* erosion. The study finding shows that the flood and *char-land* erosion is the main reason for people's cyclic dislodgment and settlement relocation in the same *char* and outside the *char* within 90 km² range in the Padma River channel in Sibchar Upazila of Madaripur District.

The Purba Khas Bandarkhola Mouza is one of the vulnerable unstable *char-land* in Bangladesh where the *choura people* are cyclically moving and migrating because of unstable *char-land* and uncertain livelihood. The finding also shows that the mouza has been changed. It is shaped and size due to erosion and accretion due to devastating floods. Therefore the *char* inhabitants have been displaced a maximum of 17 times and a minimum of six times within 50 years of *char* life which is a threat to *char* livelihood and sustainable *char-lands* development. Moreover, the flood in the erosion of *char-lands* is a challenge for managing *char* settlements, cultural landscape protection, agricultural cropping systems maintenance, crop biodiversity, and the riverine ecology of *Char-Janajat* Island. It is necessary to find an alternative approach or adaptation strategies for sustainable livelihood in the *char-lands* of Padma



River channels in the Ganges-Brahmaputra delta in Bangladesh. Therefore, the findings of this study are strongly recommending the following concluding remarks that could be implemented in Purba Khas Bandarkhola Mouza as well as in *Char-Janajat* of Sibchar Upazila in Madaripur District as an alternative approach to solve the *char-land* erosion, people displacement, and settlement relocation problems in the river

Table 1- Model results of two case studies on Basir Uddin (Case analysis) of Purba Khas Bandarkhola Mouza of Shibchar Upazila

Case Studies	Total Length (km)	Living time in Char (Year)	Interval Of Displace (Year)	Distance p/y km	Average Distance (km)	Amount of Family Member	Displace Time
Case 1 Basir Uddin	42	43	7.16	0.976	7	8	6
Average	42	43	7.16	1.476	6.55	8	6

basins in Bangladesh. An interdisciplinary, integrated *char-lands* settlement and migration policy development plan should be developed based on the riverbank and *char-land* erosion, traditional cropping system in the Purba Khas Bandarkhola Mouza of Sibchar Upazila of Madaripur District in Bangladesh.

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10. Conflict of interest

None declared.

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