

# Hydro - Geomorphic and Socio - Economic Aspects of River Bank Erosion: Middle Diana River Basin, Jalpaiguri, West Bengal

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**Abstract:** Riverbank erosion is one of the most unpredictable and critical type of fluvial hazard that takes tolls less in lives but more in livelihood such as agricultural land and homesteads along with other livelihood options that are evacuated. River Diana, the main right bank tributary of the Jaldhaka, originates in Bhutan and flows south - westward into Jalpaiguri. The present study concentrates on middle Diana basin where intense problems of bank erosion and spilling exist. Channel migration and severe bank failures have taken place almost every year that have severe impact on surrounding areas. Because of the dynamic nature of the braided river and the failure of structural measures, the sufferings of the people continue.

**Keywords:** Erosion and Accretion, Bank line Shifting, Avulsed Rivers, Flow pattern Change, Flow Diversion

## 1. Introduction

Stream bank failure and subsequent land loss is a destructive natural hazard that over time has resulted in the formation of the productive flood plains and alluvial terraces common in the middle and lower reaches of Diana river. Human activities have altered the natural processes in the present day rivers. The activities in one location (riverbank protection, riverbed excavation) can alter the flow velocity patterns and thereby affect erosion on the opposite bank and the scouring/sedimentation process of the downstream riverbed (Miyazawa, Sunada & Sokhem, 2008).

### Locational Environment

The studied part of the basin represents a zone of transition between the Himalayan Mountains and the Ganga plains and

displaying intrinsic characteristics of the piedmont alluvial fans of the Himalayan foothills. In the duars, River Diana, the main right bank tributary of the Jaldhaka, originates in Samtse province of Bhutan and flowing south - west ward into Jalpaiguri (Fig 1). Most of the mountain catchment of River Diana is covered by dense natural forest and in the foothill zone, the area is densely populated and human impact on the environment is most significant. The illegal mining and deforestation causing several natural hazards and instability of slope in the upper catchment of the basin. The mountain foreland is built up of alluvial fans and higher elevated terraces. The tea plantation in the higher hill terraces also responsible for slope failure and land degradation. Occurrences of floods lead to a direct loss of forest, tea gardens and settlement, leading to the transformation of land in this area.

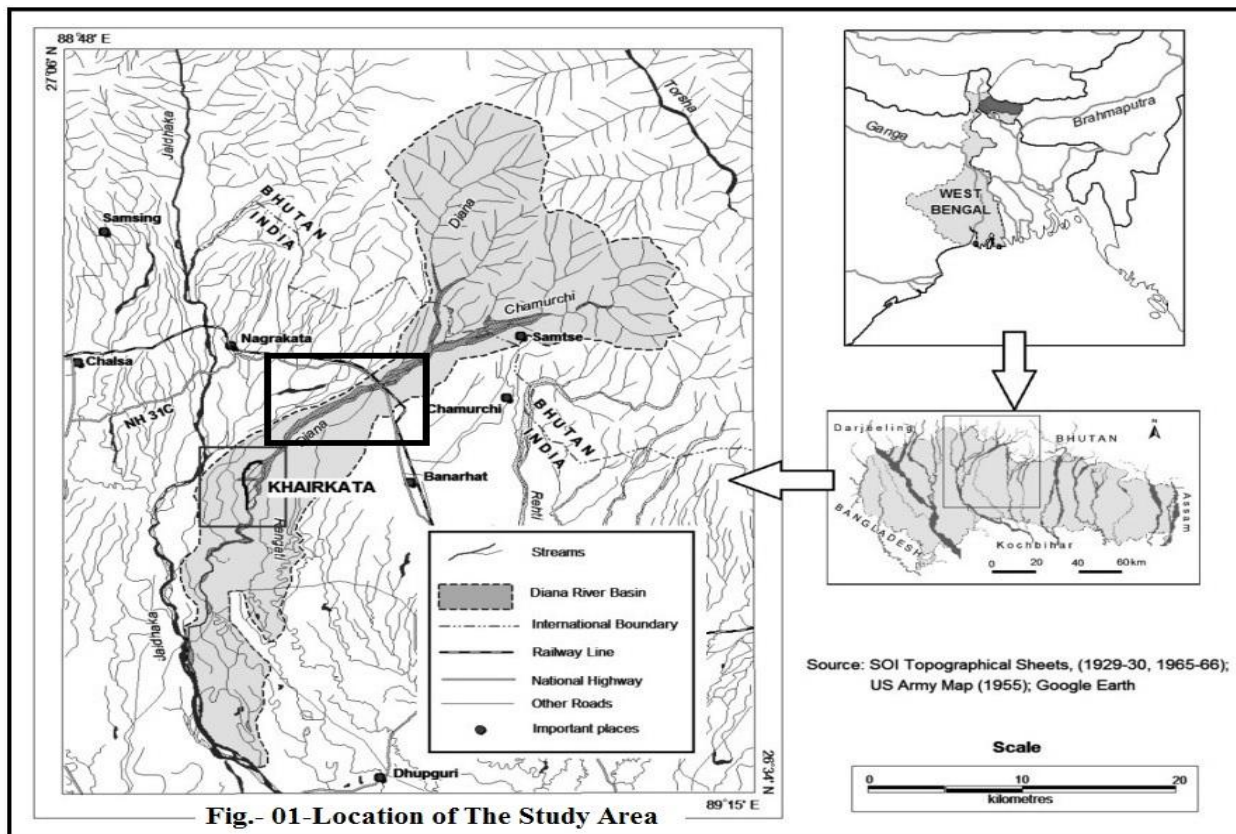


Fig.- 01-Location of The Study Area

Figure 1

The lower - middle part of the basin is affected by flash flood which imports huge number of sediments of various sizes and flood plain deposits in the *alluvial plain* are made by fine - grained sediments and over bank deposits. As a result, this area has experienced the massive transformation of the land use and Land cover system. The present analysis concentrates on the middle part of the Diana basin, where severe problems of bank failure and spilling exist.

## 2. Objectives of Study

The Primary objective of the study is to investigate the causes, consequences, amount, and distribution of degraded land along the middle part of the Diana River System where spilling, flashing, avulsion and stream diversion are most common geomorphic phenomena. **The major objectives are to:** - a) *Delineate the fluvio - morphic peculiarities of the middle Diana basin;* b) *distinguish the Spatio - temporal variations in the trend of river bank erosion in the study area;* c) *review the nature of land erosion hazards and measures adopted to check bank erosion;* d) *analyse the possible causes and impacts of bank erosion;* e) *suggest measures for effective control of bank erosion for holistic development.*

## 3. Methods of Analysis and Data Base

The present research is primarily based on field data following the modern methods of analysis and techniques. Temporal change and shifting of channel and bank lines was analyzed for the last 95 years using the *Mouza map* of Jalpaiguri District, *Survey of India Topographical sheets* and satellite images of several periods. **In the pre - field stage,**

collection of maps, Images and other relevant information were collected for the preparation of base map and preparation of field. The satellite images in digital form for the whole area between 1991 and 2011 from *Landsat 5 TM* (spatial resolution 30 m) and *Landsat 7 ETM+* (spatial resolution 15 m) have been collected for analysis and interpretation. **In the field,** intensive field work has been taken into account for hazard analysis and subsequent land transformation and loss. **In the post field stage,** modern method of analytical techniques in the GIS platform have been considered for taking inferences.

### Problems of Bank Erosion - - Past and Present

From the year 1917 to present, the River Diana, after downgrading in the foothill zone it has been observed that the Diana never flows in the stable track, so Diana and its tributaries have been shifted, avulsed and diverged more or less to its present position. Huge amount of forest land, settlement, agricultural land, land of tea gardens are being submerged into the Diana river. Moreover, more or less, 1 to 1.5 km of land have been transformed into the river channel diagonally from north - west to south - east direction. The River Ghatia, Khuji Diana, and several other small channels are created and encroached several hundred acres of land of Khairkata, Chengmari Tea Garden, Red Bank Tea Garden and many other small villages on both sides of River Diana. (Fig. - 02). Since 1950, Diana avulsed through the rivulets Jhumar and Rangati just south of Kalabari Tea Garden, and smashed several hundred acres of land in the surrounding areas.

All the rivers named above have been originated from Bhutan hills and after getting down from the hill the rivers transported huge number of pebbles and boulders which

have devastating effects on both sides of the bank where series of tea gardens are located. After the construction of embankment at Kalabari to save the productive land, the course of Diana was thrown back to its own, but it still has a tendency to avulse to river Rangati. The Kalabari

embankment led to the diversion of the main flow of Diana to its right bank which in turn resulted in bank erosion and channel spilling along Khairkata and its surrounding areas (Fig. - 03A)

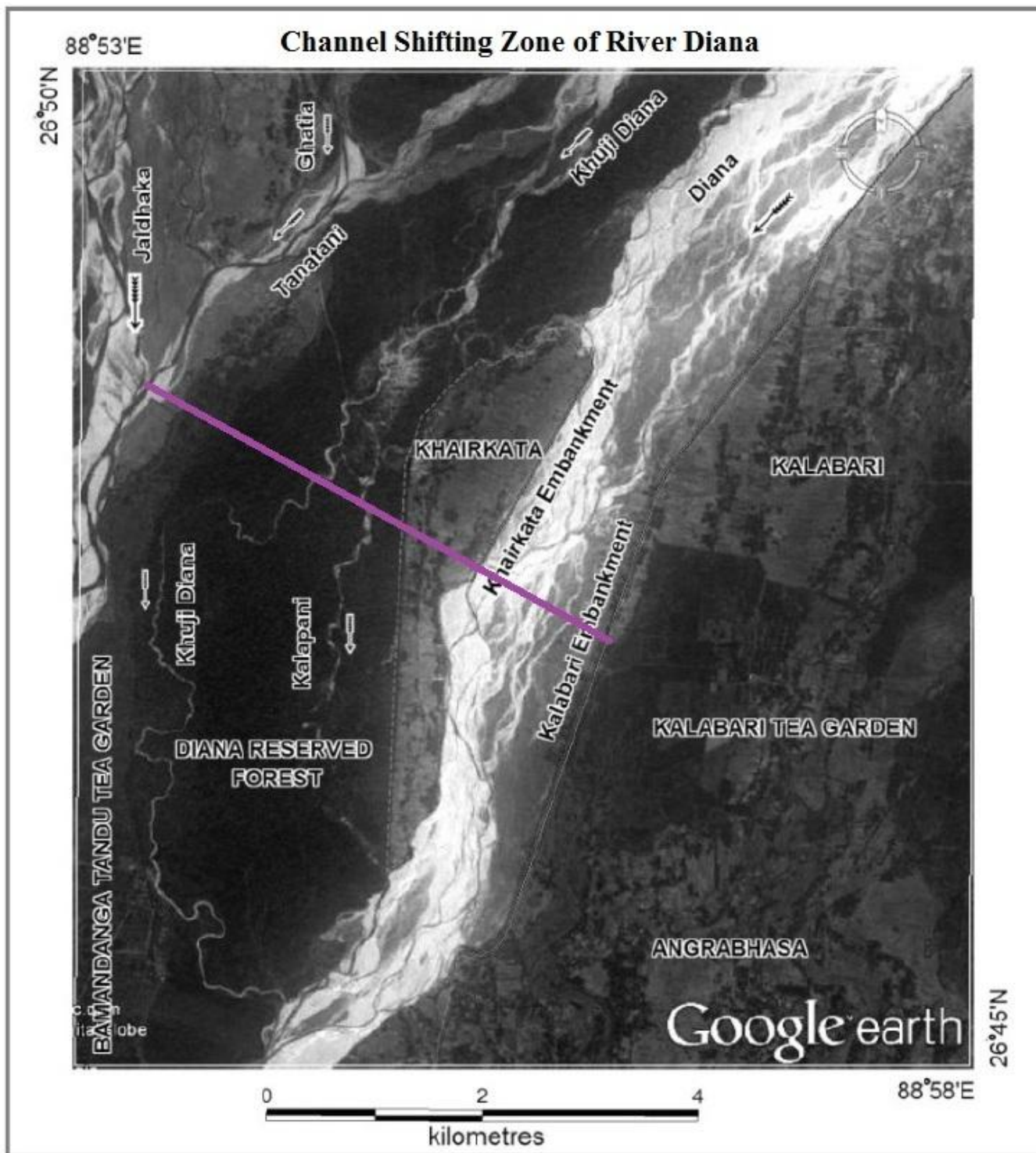


Figure 2

River Diana flows between the Red bank and Kalabari Tea garden and along the eastern margin of the Khairkata village. Kalapani, a small spill of Diana takes off just north of Khairkata, flows along its west, and rejoins Diana near the southern margin of the village. Within this zone Diana bifurcates into several channels with numerous in - stream flows, covering 1 to 1.5 km diagonally from north west to

south east and a large portion of land of tea garden and villages are transformed to the river channel. There are several pockets of land in and around the area which are at present within the river bed. All these channels have bank full discharge during the monsoons which in turn creates devastating situation. Since 2000, land loss due to bank



erosion and channel in and around the area engulfed huge amount of forest area (*Fig - 3B*).

During the year of 2012, due to the devastating flood in the north Bengal plain, the Khuji Diana changed its course and

merged with the smaller channels, flooding the villages in and around the studied basin. Khairkata and surrounding villages were completely inundated as the diverged flow of Khuji Diana was merged with Diana and so flooded the entire area. The Diana and its Fig.- 3A

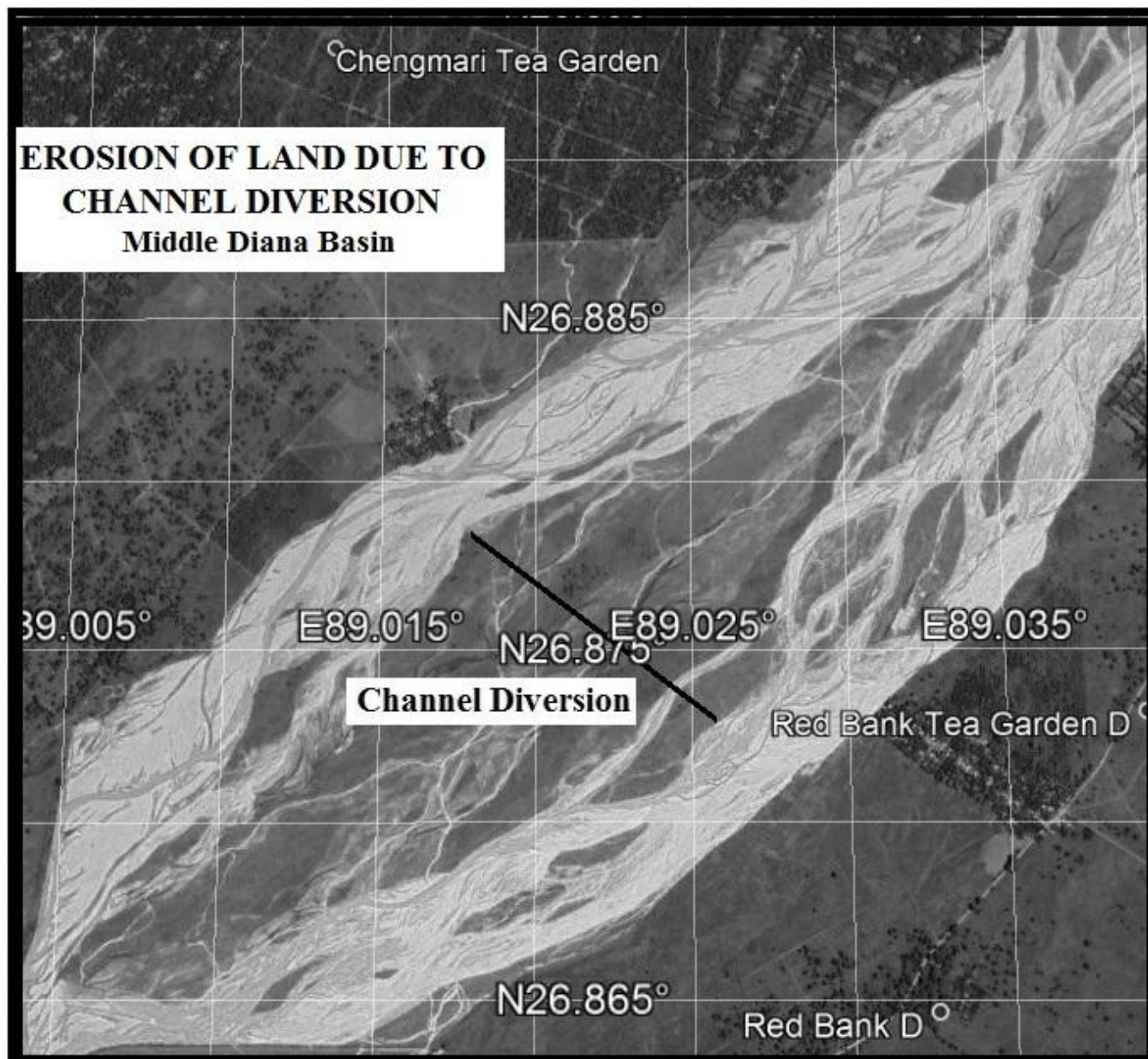


Figure 3A

linked channels encroached the entire area which creates massive loss of productive land and human life. The Khuji Diana and Kalapani Channels also ravaged the surrounding forest lands. The main flow of Khuji Diana has now merged with the Kalapani just upstream of the newly constructed bailey bridge.

#### Temporal Change of Bank line Shifting

During the span of 1990 - 2001 maximum erosion occurred along a 3.5 km stretch downstream from the existing

Khairkata embankment. In the recent years, bank erosion has been mostly concentrated upstream of the existing embankment. From 1990 - 2001, both Khairkata village and the Diana Reserve Forest along the right bank of Diana lost a considerable amount of land area. During 2001 - 2011, the total erosion along the right bank has been much less, so consequently

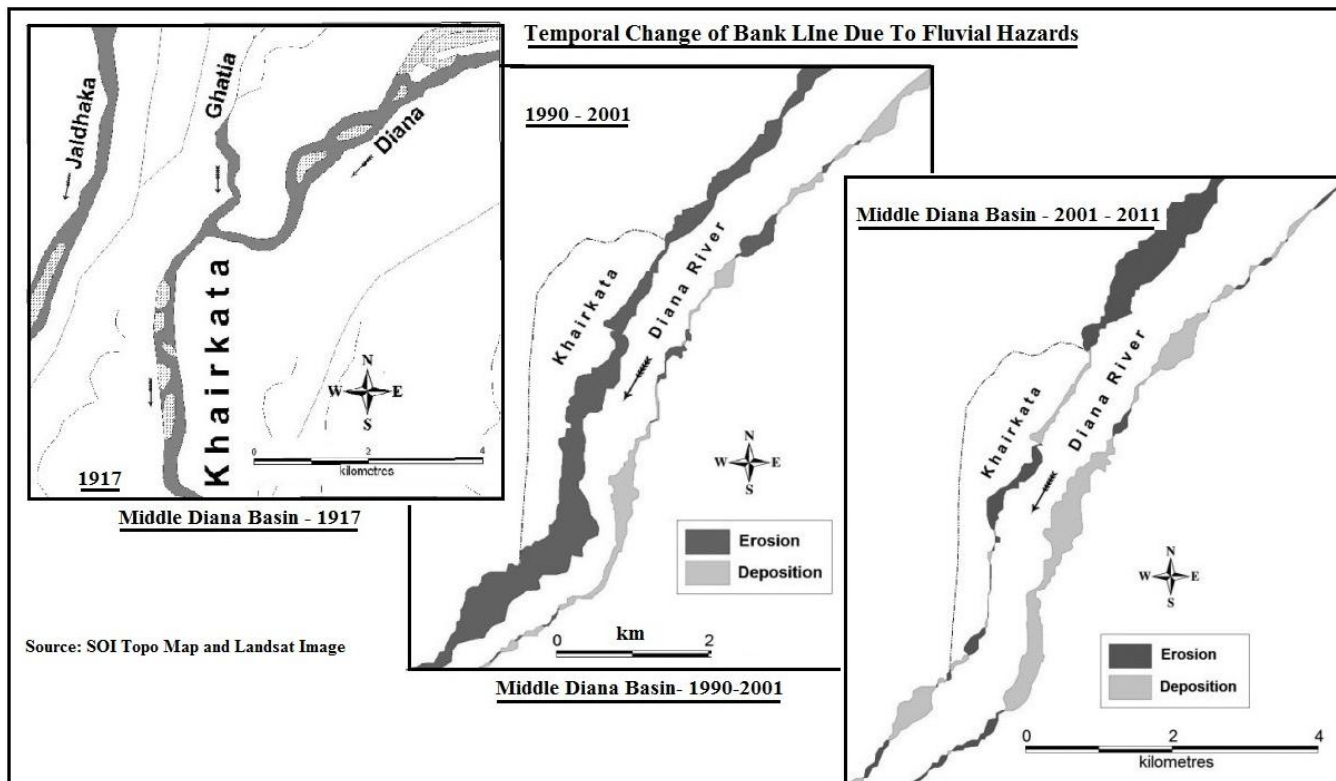


Figure 3B: Temporal Change of Bank line due to Fluvial Hazard (Bank Erosion)

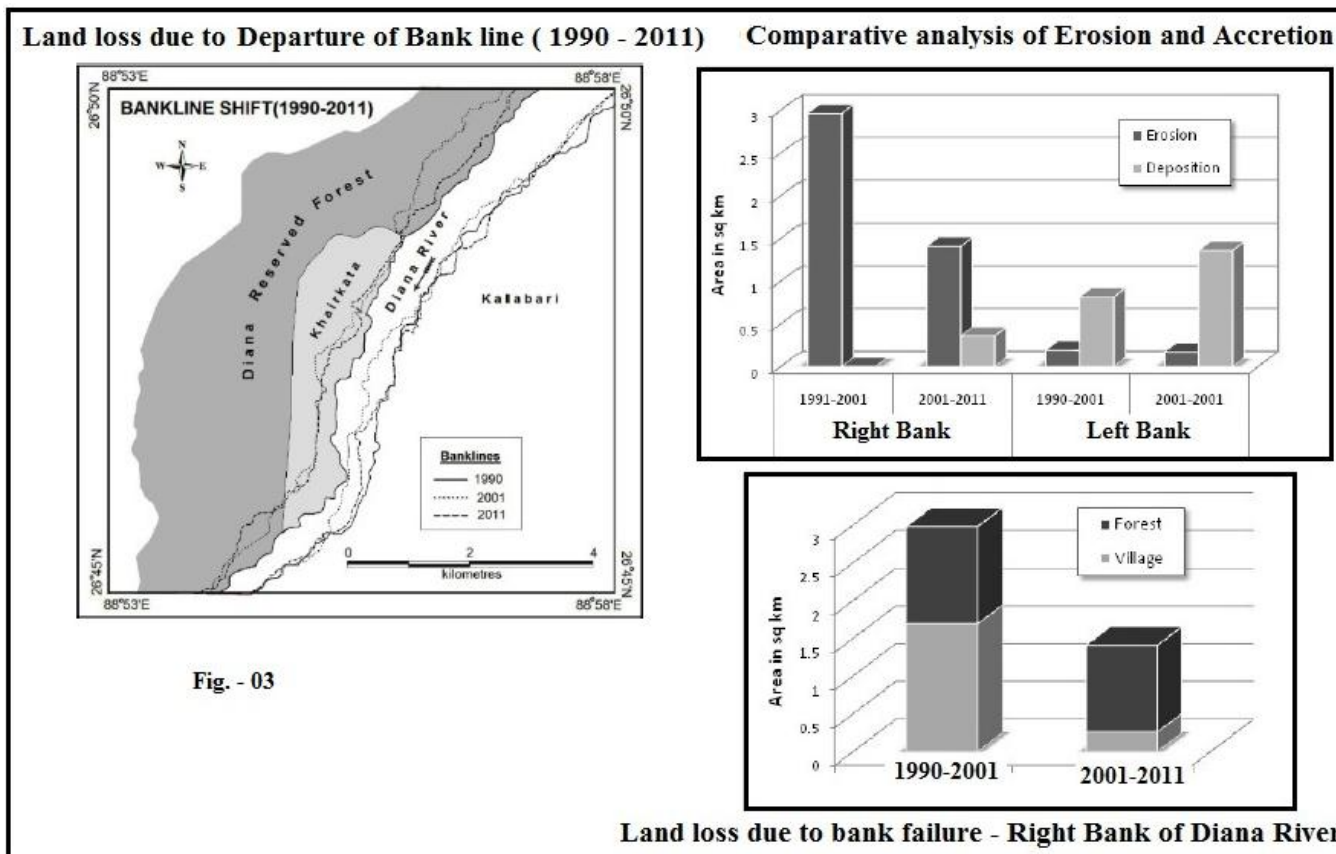


Figure 4: Comparative Analysis of Erosion and Accretion

the river is now mostly encroaching on forest land. The stretches upstream and downstream of the existing embankment are the most vulnerable (Fig - 04).

**Consequences of River Bank Erosion**

The studied basin along with the surrounding region are flood - prone by nature, because all the rivers from Bhutan and associated Himalayan regions, after getting down from steep hill slope, are carrying huge volume of water and sediment within this narrow zone of the flood plain. *The*

*specific contributory factors for reduction in carrying capacity of rivers, thereby resulting floods and erosion are - a) Intense and Continuous Rainfall during the rainy season; b) Illegal felling of trees, so degradation of forest for timber, mining, roads and settlements; c) Intensive mining and quarrying activities in the Catchment area of Bhutan Hills for valuable minerals like dolomite, limestone, gypsum, talc, quartzite etc.; d) Recurring Landslide hazards in Upper Catchment of the Basin; e) Illegal and unplanned encroachment of River bed for various human activities and construction of bridges; f) In stream Gravel and Boulder Mining which are always creating fluvial hazards. Apart from that, the following are the major consequences;*

**Land loss due to Bank Failure** - - Bank failure and associated land degradation has an adverse effect on the livelihood pattern and processes in the region as settlements and infrastructure are destroyed, productive lands are wiped out and so employment opportunities are reduced. Riverbank erosion largely affects poor and marginalized people as they have the least capacity to resist and to recover from the natural hazards (Greenberg, 1986; Rogge and Elahi, 1989).

**Loss of Agricultural Land** - - Most of the villagers are dependent on agricultural activities on small land holdings. So, in such condition people have no way to survive.

**Lack of Economic Opportunities** - - Due to loss of land and settlements, people who are engaged in agricultural and other primary occupation, often lose their job. In such a condition, they have to migrate temporarily to search job opportunity.

**Destruction of Settlement and Infrastructure** - - The most adverse effect of bank erosion is the loss of settlement makes the population more vulnerable to live a decent life. They wish not to leave their location till the maximum dislocation. The main reason behind such behaviour is that they have to search ways of income and also to adopt new mode of social life.

**Degradation of Forest areas** - - Another significant mode of degradation caused by bank erosion is the destruction of the dense tropical forest land. The forests of North Bengal, which are directly linked to forests of Bhutan and Assam, form important migration corridors for wildlife.

#### 4. Findings and Suggestions

The studied part of the basin and its surrounding areas are continuously experiencing the processes of river shifting, channel migration, flow line shifting, avulsion and flow diversion almost every year during rainy season. Flood, bank failure and subsequent land loss are major processes of transformation of land from one category to other. Most often, measures are taken immediately after the disasters and interventions are taken in the form of relief provisioning. Repeated displacements of the rural population are common in the erosion - prone districts of North Bengal and such frequent movement hinders the implementation of recovery and the long term rehabilitation programmes. The marginalized and poor people not only lose property but also

experiences socio - economic deprivation through displacement. The severity of floods has further amplified under the influence of human intervention. If this recurrent phenomenon is not mitigated, it would be difficult to achieve the economic development of the region in spite of the activities and efforts being undertaken by various agencies. *Land relocation assurance* is one of the appropriate strategies to cope up with such disaster. Furthermore, measures should be taken in different level to *minimize the loss*:

- a) Sustainable embankment construction and its maintenance
- b) Proper awareness program on disaster preparedness involving local institution and local self government
- c) Massive program of afforestation and reforestation should be implemented with the experience of local knowledge and its proper maintenance.
- d) Illegal deforestation and mining activities should be checked as preventive measure.

Bank failure, river shifting and uplifting of river bed, associated with flash floods, are behavioral response of rivers, adjusting fluvial dynamics in the Duars region. Long term policies like *floodplain zoning and corridor restoration program* are essential to lessen the vulnerability of riverbank erosion. This tries to organise the flood defenses in such a way that land that is near the river and often floods is not built on.

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#### References

- [1] *Azim Uddin, A. F. M, Basak, J. K. (2012), Effects of River bank Erosion on Livelihood, Unnayan*
- [2] Onneshan - The Innovators, Dhaka, Bangladesh.
- [3] *Bannerjee, S. S., Saha, M. Chakraborty, S., Poddar, B. C. (2003), Environmental Hazard of Tea Garden Belt in Jalpaiguri, West Bengal, Environmental Planning, Map India.*
- [4] *Coleman, J. M. (1969), Brahmaputra river: Channel processes and sedimentation, Sedimentary Geology, 3 (2 - 3): 129 - 239*
- [6] *Rogge, J. and Elahi, K. (1989), The Riverbank Impact Study: Bangladesh, University of Manitoba, Winnipeg*
- [7] *Richards K, Chandra S, Friend P (1993), Avulsive Channel Systems: Characteristics and Examples. Geological Society 75: 195 - 203.*