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*International Journal of Current Research*
*Vol. 7, Issue, 11, pp.23373-23380, November, 2015*

**INTERNATIONAL JOURNAL OF CURRENT RESEARCH**

**ISSN: 0975-833X**

## RESEARCH ARTICLE

# A STUDY OF BANK EROSION AND BANKLINE MIGRATION OF THE BARALIA RIVER, ASSAM, USING REMOTE SENSING AND GIS

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**ARTICLE INFO**

***Article History:***
Received 17th August, 2015
Received in revised form
26th September, 2015
Accepted 02nd October, 2015
Published online 30th November, 2015

***Key words:***

Bank line Migration,
Multi-temporal database,
GIS.

**ABSTRACT**

Rivers are one of the most dynamic entities over the earth's surface. River channels are confined to symmetrical and definite track. They persistently shift their courses over the space through time. A river has its tendency to attain an equilibrium condition so as to adjust itself with the varying fluvial-geomorphic as well as climatic conditions. Changes in river channel and its immediate surroundings over space and time require historical analysis and careful observation of the river system. For the implementation of any watershed management programme micro-level study of spatio-temporal channel changing pattern of a river basin is necessary. Based on such significances, the Baralia River of Assam has been selected here which flows from the Bhutan Himalayas. The present study is primarily aiming at the investigation of the subsequent changes in the channel and secondarily upon the dynamics of its banklines over space and time. A multi-temporal database has been developed based on Survey of India Topographical Maps and Satellite Imageries for a comprehensive and scientific analysis. The controlling factors and variables of these changes have also been examined. Field observations, various statistical techniques have been used for computation along with GIS software for mapping and final layout preparation. The results can thus be utilized as baseline information for the policy making to combat against the bank-erosion hazard.



***Citation*:** Swarup Jyoti Baishya and Dr. Dhrubajyoti Sahariah, 2015. "A study of bank erosion and bankline migration of the baralia river, assam, using remote sensing and gis", *International Journal of Current Research*, 7, (11), 23373-23380.

## INTRODUCTION

The river channel network is not confined to a symmetrical track. The river changes with respect to time and space. River channel migration and shifting is one of the important fluvial physico-climatic processes by which a river can readjust to variation in hydrology, sediment load and active tectonics. Lateral shifting is a type of change of immense importance which can be detected by its asymmetric position in the river valley and the evidences of its spatio-temporal shift in one direction (Schumm et al.). In different parts of the world people have been trying to cope with the problem applying various technical know-how. But despite these efforts, damages are increasing year by year. The main causes behind this are the increasing activities on the flood plains and upsetting of their ecological balance. The main aim of the present paper is to study the channel configuration of the Baralia River with a special emphasis on erosion and deposition. This study will be useful for devising effective remedial measures to prevent erosion and deposition. Uncontrolled runoff erodes the soil with a devastating consequence.

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The sensitive areas of erosion need constant vigilance and care. Natural vegetal cover is a binding factor of the soil particle, it also reduces the velocity of the surface runoff which in turn lowers the erosive power of the flow wrongful interference by man with the natural vegetation resulted in wanton destruction of vegetation in the study area for the purpose of settlement and agriculture this may have serious repercussions on the flood and erosion hazard of the region as evidenced in many other similar situation (Morgan, M.A, 1969).

### Study Area

The Baralia River in North-East India which is a right bank tributary of Brahmaputra originates from Nagrijuli tea estate, where some small channels from Bhutan hills find their way as underground flow into lowlying area there. This river covers a length of 75 km before it joins Pagladiya near Dusutimukh on its left bank. In the upper reach spill from river Balti joins it on the right bank just about 2.4 km below Nagrijuli tea garden. Another river named Nona joins Baralia on its right bank at Shamukhaghat 10 km from its confluence with Pagladiya. The river in its entire length drains an area of 270 sq. km. from the plains through which it flows except some run off from Bhutan hills through Balti river. The river has formed meanders in its

entire length. The Baralia basin lying between the longitude 91°28' E and 91° 42' E and latitude 26° 19' N and 26° 43' N (Figure 1).

Erosion and deposition areas have been estimated using GIS software tools with the shifting bank lines in the study period and also from the field data other secondary datas.

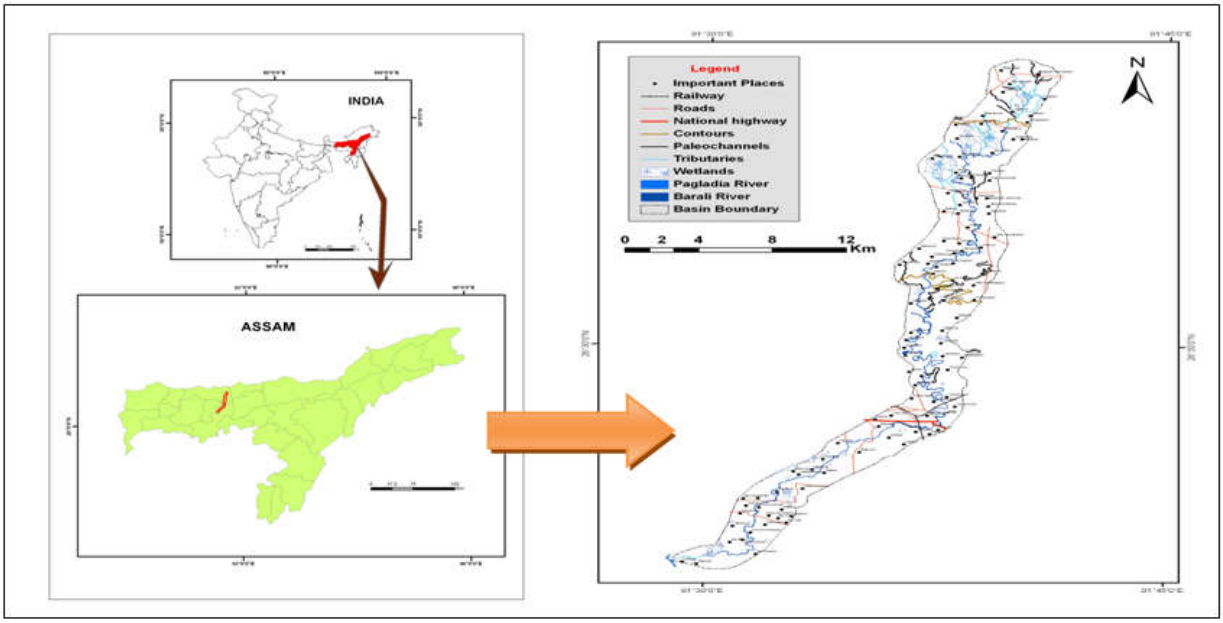


**Figure 1. Location map of Baralia basin in Assam**

## Objectives

The principal objectives of the study may be outlined as follows:

- To study the migration of the Baralia River bank line in the study area.
- To examine the effects of erosion on the study area.
- To examine the protection measure taken by the government.

## Methods of Study and Data Base

Identification of the channel migration pattern of rivers from SOI toposheet and satellite images of different years using GIS and Remote Sensing technology is found very much useful for studying the fluvial geomorphology of a river. Many researchers in recent years have used RS and GIS techniques for studying channel changes of different rivers. However, the channel changes and bankline migration of the present course of the Baralia River has not been done yet. To study the changes in the flow pattern of the Baralia River in Assam, four years of data over a span of thirty eight years (1970, 1990, 2002 and 2008) have been considered. The SOI toposheets of 1970 and satellite images of Landsat TM of 1990, Landsat ETM $^{+}$ of 2002and IRS LISS-III of 2008 are used for this purpose. In the first step, the toposheets and satellite images were georeferenced using GIS software ARCGIS 9.3. Bank lines of these years were digitised from the georeferenced toposheets and satellite imageries using the same software and then the bank lines are overlaid. The overlaid bank lines give us the overall channel migration pattern of the Baralia from 1970 to 2010 and the rate of erosion and deposition. Bank line migration was measured taking 13 cross-sections along the present river.

Both empirical and field survey is done for collecting various types of data. Finally, direct field observations were made and data and photographs were collected from erosion prone site. The data collected from both primary, secondary sources and from GIS maps are then processed, tabulated, analysed and interpreted.

## Significance of the Study

Flood and bank erosion is a major problem in the plains of the Baralia basin. Heavy rainfall in the hilly reach as well as in the plains, lack of adequate gradient to drain out the high discharge of the rivers, increasing silt load due to increased deforestation and landslide in the upper catchment, breaching of embankments are the main causes of flood in this part of the basin. Geotectonically fragile and seismically sensitive segment of the basin further accentuates the flood and erosion scenario. Flood history indicate that regular large floods have breached the embankments, created areas of bar development and caused bank erosion and aggradation and channel migration in the study area. The river has changed its course several times since the past and the channel migration study shows the shifting of the river towards western side. But in this study, we have selected the present stretch of the Baralia river in Assam and its bank line change due to erosion and sedimentation from the past. Floods of very high magnitude may be a contributing factor to channel widening and river bank erosion along with associated changes in the channel pattern.

# RESULT AND DISCUSSION

In this study, we have digitized both banks and channel from SOI Toposheet (1970), Landsat, (1990), ETM + (2002) and

IRS LISS-III (2008) images in vector layers and after overlaying those we have depicted four final output maps for four reaches, viz. Nagrijuli Tea Garden to Baraliapar, Baraliapar to Lahapara, Lahapara to Bathan and Bathan to Pagladiya River i.e., Figure 2,3,4and 5. The channel pattern of the Baralia River in Assam changes continuously.

The shifting of the channel from 1970 to1990, 1990 to 2002 and 2002 to 2008 along both banks was measured in 13 cross sections along the river and the result are presented in Table: 1,2 and 3. It is seen that the highest erosion that took place in the right bank was along the section KK' (201m) and in the left bank along the section MM' (82m) in the year 1970 to 1990.

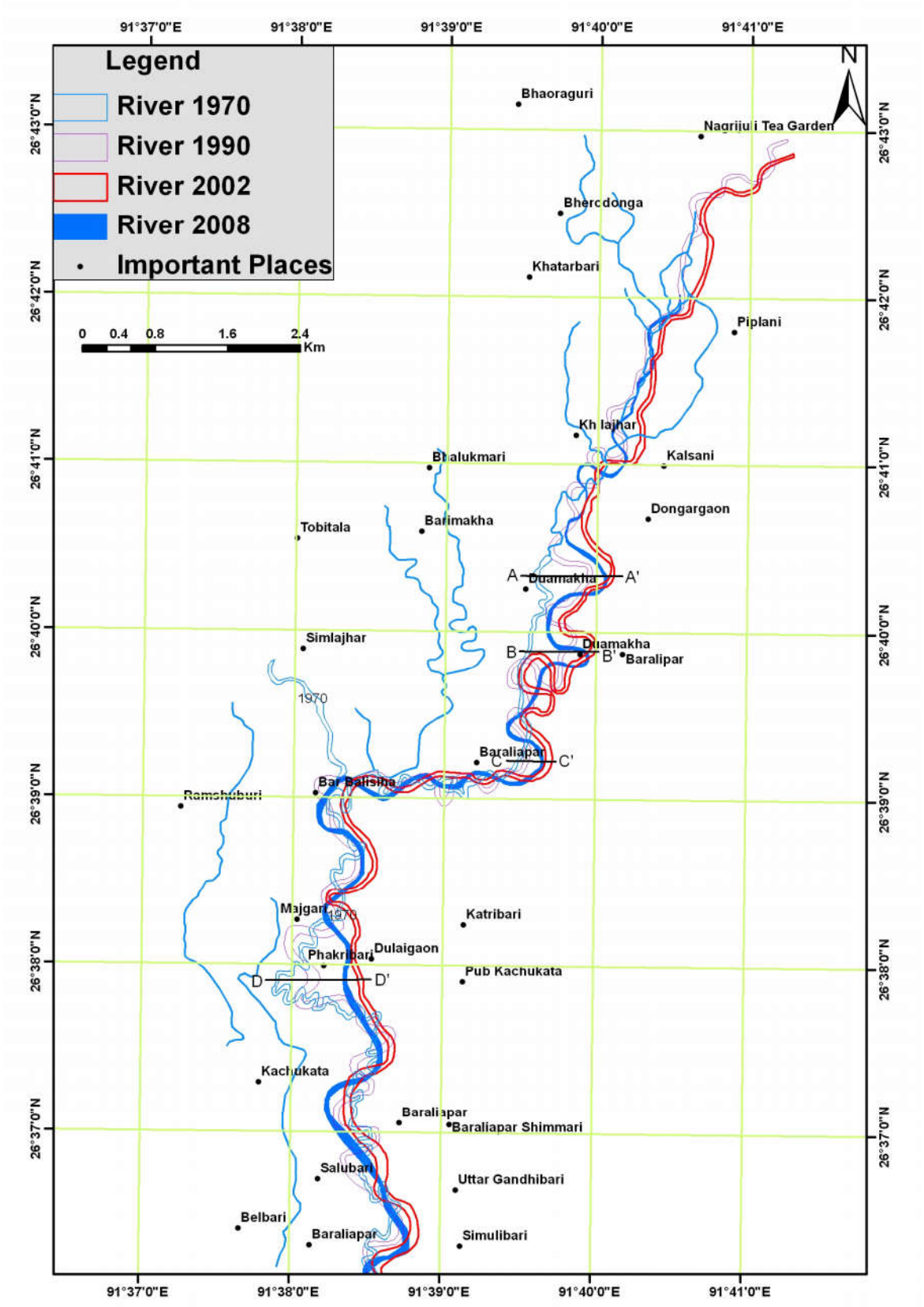


**Figure 2. Changing course of Baralia river from 1970-2008 (NagrijuliTea Garden to Baraliapar)**

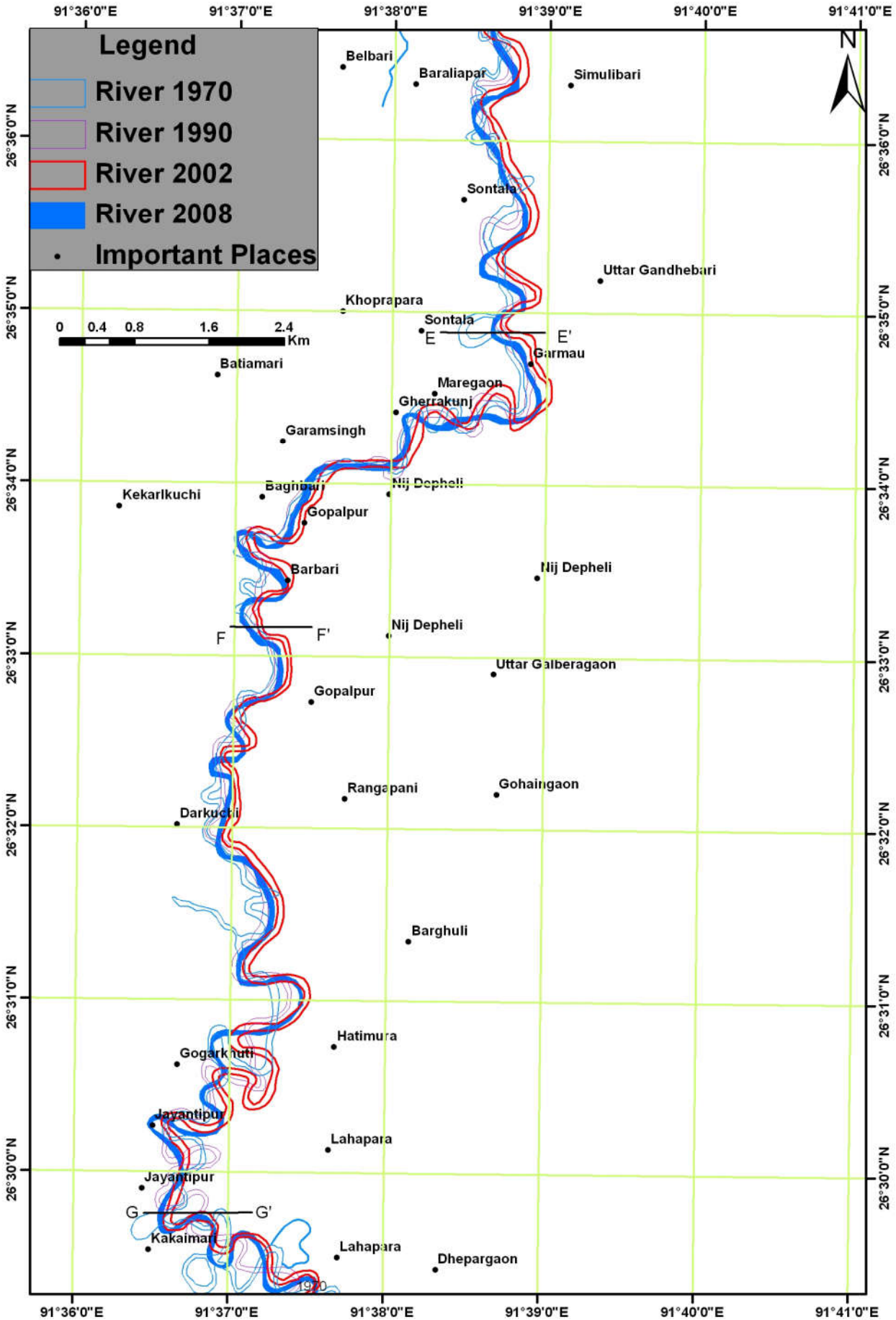


**Figure 3. Changing course of Baralia river from 1970-2008 (Baraliapar to Lahapara)**

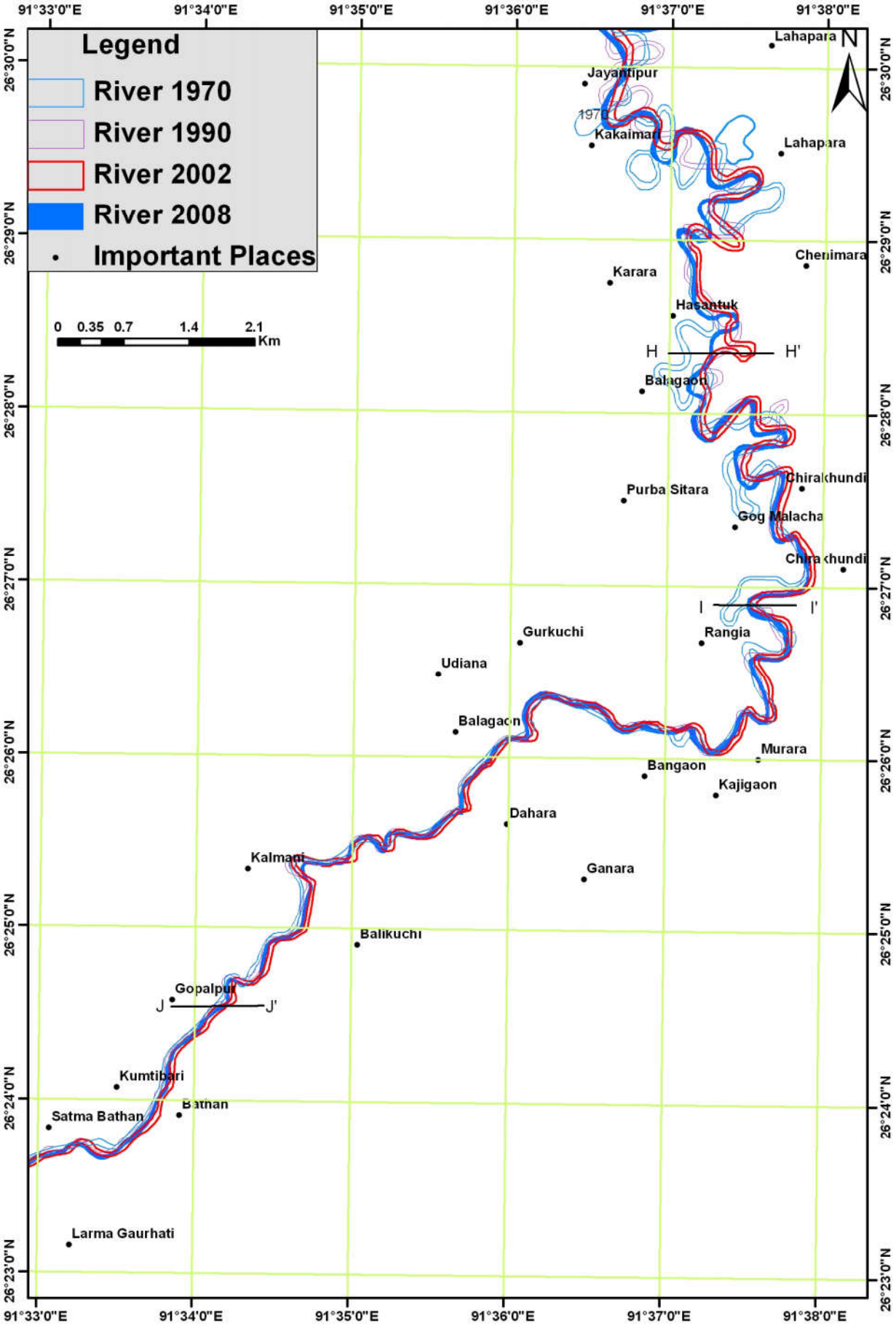


**Figure 4. Changing course of Baralia river from 1970-2008 (Lahapara to Bathan)**

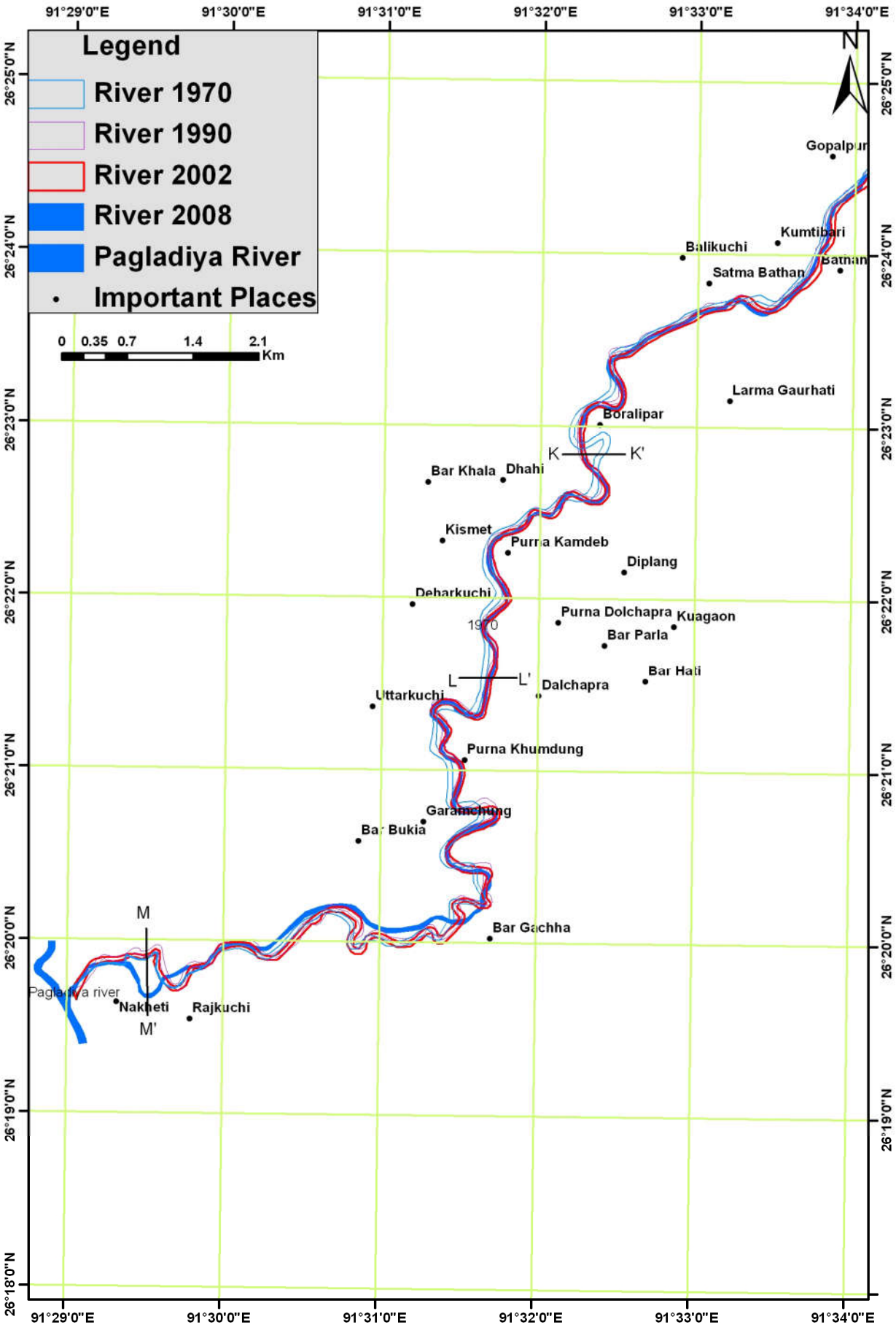


**Figure 5. Changing course of Baralia river from 1970-2008 (Bathan to Pagladiya River)**

**Table 1. Changing Course of Baralia River from 1970-1990 in meters**

| Section | Left Bank | Right Bank |
|---|---|---|
| AA' | 596 | 570 |
| BB' | 366 | 406 |
| CC' | 82 | 99 |
| DD' | 343 | 447 |
| EE' | 81 | 71 |
| FF' | -31 | 50 |
| GG' | 153 | 134 |
| HH' | 378 | 366 |
| II' | 294 | 299 |
| JJ' | -3 | 27 |
| KK' | -196 | -201 |
| LL' | 61 | 32 |
| MM' | -82 | -23 |

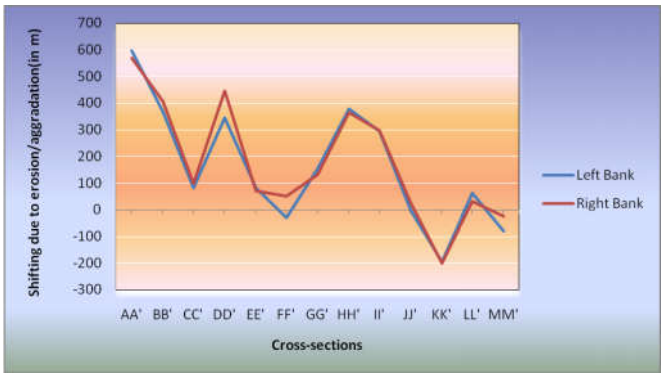


**Figure 6. Changing course of Baralia river from 1970-1990**

Minus sign (-) indicates shifting towards left bank and plus sign (+) indicates shifting towards right bank from 1970 position

**Table 2. Changing Course of Baralia river from 1990-2002 in metres**

| Section | Left Bank | Right Bank |
|---|---|---|
| AA' | 247 | 248 |
| BB' | 319 | 308 |
| CC' | 263 | 262 |
| DD' | 575 | 483 |
| EE' | 52 | 103 |
| FF' | 226 | 257 |
| GG' | -337 | -314 |
| HH' | -79 | -59 |
| II' | -30 | -25 |
| JJ' | 53 | 65 |
| KK' | 31 | -8 |
| LL' | 10 | -42 |
| MM' | 35 | 17 |

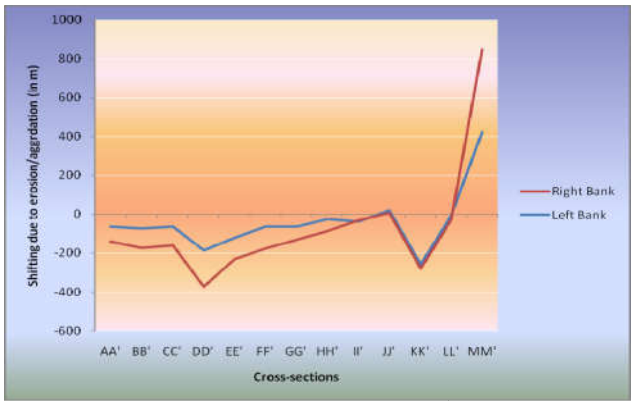


**Figure 7. Changing course of Baralia river from 1990-2002**

Minus sign (-) indicates shifting towards left bank and plus sign (+) indicates shifting towards right bank from 1990 position.

**Table 3. Changing Course of Baralia River from 2002-2008 in metres**

| Section | Left Bank | Right Bank |
|---|---|---|
| AA' | -63 | -76 |
| BB' | -75 | -98 |
| CC' | -65 | -93 |
| DD' | -186 | -186 |
| EE' | -122 | -109 |
| FF' | -65 | -111 |
| GG' | -65 | -66 |
| HH' | -24 | -60 |
| II' | -39 | 8 |
| JJ' | 19 | -9 |
| KK' | -258 | -21 |
| LL' | -5 | -21 |
| MM' | 424 | 426 |


**Figure 8. Changing course of Baralia river from 2002-2008**

Minus sign (-) indicates shifting towards left bank and plus sign (+) indicates shifting towards right bank from 2002 position

**Table 4. List of area (hectares) of the villages eroded away during the period 1970 to 2013**

| Sl.No. | Name of the villages | 1970-1990 | 1990-2002 | 2002-2008 | 2008-2013 |
|---|---|---|---|---|---|
| 01 | Duamakha | - | 112 | 223 | 214 |
| 02 | Baralipar | 59 | - | 143 | 170 |
| 03 | Dualigaon | - | 225 | 170 | 210 |
| 04 | Garmau | 138 | - | 178 | 207 |
| 05 | Niz-Defali | 245 | - | 168 | 209 |
| 06 | Nakheti | - | 137 | 123 | 123 |

Source: WRD, Chandmari, Circle Office, Field Survey Data

**Table 5. Population of the villages affected by erosion during the period 1970 to 2013**

| Sl.No. | Name of the villages | 1970-1990 | 1990-2002 | 2002-2008 | 2008-2013 |
|---|---|---|---|---|---|
| 01 | Duamakha | - | 678 | 134 | 178 |
| 02 | Baralipar | 78 | - | 134 | 112 |
| 03 | Dualigaon | - | 132 | 111 | 316 |
| 04 | Garmau | 789 | - | 525 | 345 |
| 05 | Niz-Defali | 398 | - | 456 | 789 |
| 06 | Nakheti | - | 566 | 666 | 890 |

Source: WRD, Chandmari, Circle Office, Field Survey Data

The line diagram indicates that sedimentation is more pronounced in both banks in comparison to erosion. The

negative values (-) indicate the shifting due to erosion and the positive values (+) indicate the shifting due to deposition. In the year 1990 to 2002 in the bank erosion is more active in left bank along the section GG' but if we compare the whole statistics here also sedimentation is more pronounced except the sections HH'where erosion is more in right bank and in II' where erosion is more dominant along left bank of the river which indicates shifting of the channel towards western side. Again in the 2002 to 2008 erosion is more dominant along the section KK' (258m) in the left bank of the river and in the right bank erosion is more active along the section DD'(186m). The width of the channel in different cross-sections along with the total width change. From the figures we can see the overall pattern of channel changes different sections from 1970 to 2008. It is seen that except the position FF' and JJ", in all other sections width has changed significantly due to erosion and sedimentation in both banks. From the study of bank positions of 1970 to 2008 it is found out that 800-900m of fertile land had been eroded away in this area. Villages like Duamakha, Baraliapar, Garmau, Niz Defali, Barbalisiha and Nakheti are severely affected by erosion. Sedimentation also takes place in few villages. Erosion is more dominant in the upper and middle part of the river because of which the width of the river has increased significantly and shift towards the western side.

**Conclusion**

Flood and erosion lead to channel migration of the Baralia River in Assam. Erosion is more pronounced in both banks than the sedimentation. From 1970 to 2008 the bank line of the river changes significantly. Erosion is more dominant in both the upper and middle part than in the lower part of the channel. Width increases mostly in the middle part due to erosion than in the upper and lower part of the Baralia River. A large part of agricultural land as well as homestead plantation and rural settlements are affected by erosion every year. Various flood and erosion protection measures such as earthen embankments, spurs, porcupines etc. are used to protect the area. But they are not enough as a long term measure. A comprehensive scientific study of the bank materials as well as morphology of the river is needed to protect the area using eco-friendly materials and techniques such as Geotextile bags (or Geobags) for construction of embankments to protect river banks from severe scouring and erosion. They are also good for vegetative growth and provide habitat for species that are living around water and vegetation.

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