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Depositional Activities of the Lower Bhogdoi River: Jorhat District, Assam

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Abstract: *The Bhogdoi river originates in the Naga–Patkai hills of Nagaland and flows into the Brahmaputra through Assam. The rise of the Brahmaputra bed after the great earthquake of 1950 increased the intensity and frequency of floods in the plains. This necessitated the construction of embankments. Such an embankment blocked the course of the lower Bhogdoi near its mouth in 1956 and compelled it to end at the wetlands of Khalihamari and subsequently to extend its course by 46.5 km. The longitudinal profile of the river indicates that at the confluence of plains and hills there is a conspicuous drop of slope and the gradient of the river near Khalihamari is only 5 cm km^{-1}. This resulted in heavy deposition in the wetland itself. Upstream of the wetland, the river has undergone siltation due recent landuse change and caused rise of the river bed. Now Bhogdoi is flowing above the average level of Jorhat town and the area is exposed to a constant threat of submergence and flooding. Heavy and unplanned collection of sand is likely to cause channel instability leading to problems like bank erosion and slumping etc. However, the opportunity of sand mining is also providing scope for employment to a large number of people.*

Introduction

A drainage basin can be seen as a working system with energy inputs of sunlight and precipitation and outputs of stream discharge and load. Erosion, transportation and deposition are the three major activities of a river which are subject to frequent changes over time and space. Human interference like blocking of river course, construction of embankments and dams and diversion of channel and changes in the land use within the basin directly affect the activities of a river and have far-reaching influences.

The study area

The Bhogdoi is an inter-state river, the basin of which occupies the geographical territories of Nagaland and Assam. In Nagaland, the river has a hilly course in the Tertiary Naga–Patkai ranges (Mokokchung district). In Assam, it flows through the southern Brahmaputra plains of Jorhat district (Fig. 1). The river is known with different names at different places in the hills. Historical documents describe the lower river with the name of Disoi. During the eighteenth century the king wanted to straighten the channel of the river so that it flows close to the *Rajabahar* (royal rest house) at Jorhat town and a new channel was dug up. This newly excavated channel of the Disoi river was renamed as the Bhogdoi which eventually

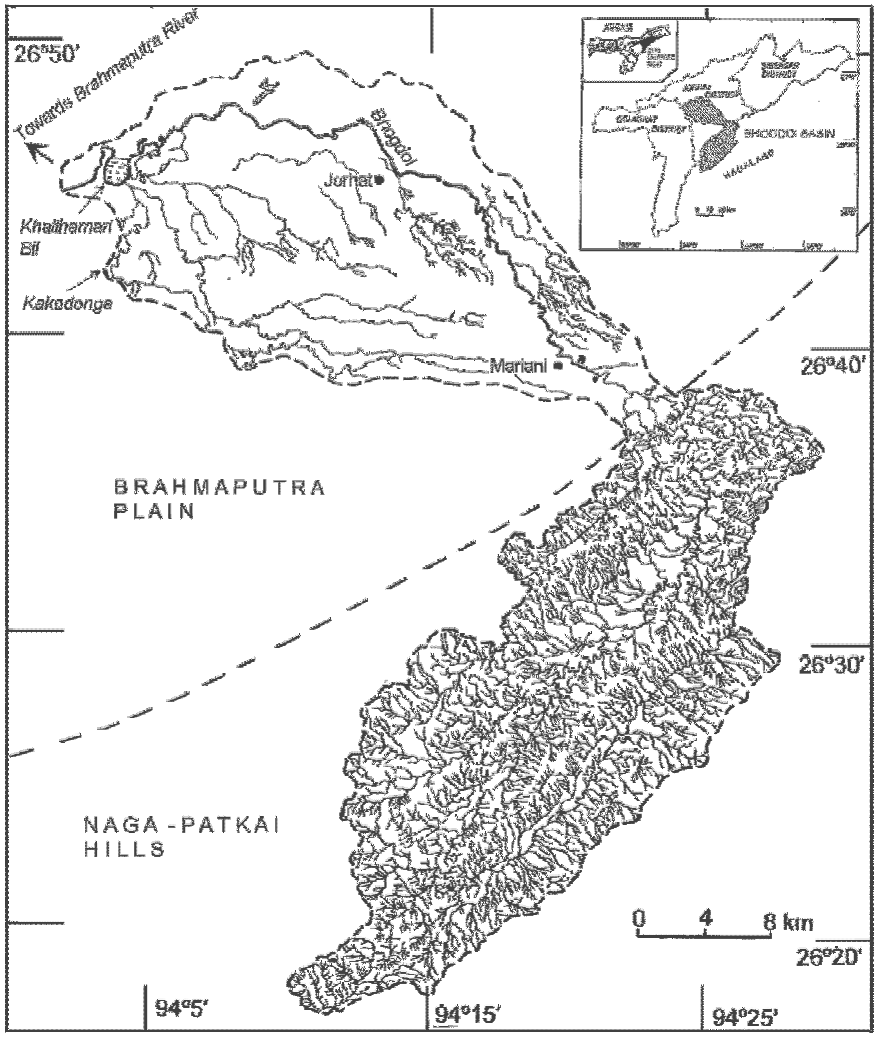

Figure 1. The Bhogdoi basin

became the name of the entire lower part of the river (Sharma, 1993). According to ancient records, the Bhogdoi was a gently flowing river and was not known to cause any major devastation in the past. The lower Bhogdoi flows through extensive paddy fields noted for bumper rice production since time immemorial.

The present study is on the lower part of the Bhogdoi basin (26°17' –40' N, 94°10' –29' E). The Bhogdoi river has a total length of 162.5 km from its source to mouth and a total basin area of 946 km^2. It has an average annual discharge of 6,072 m^{3}s^{-1} (Bora, 2001). Nearly 60% area of the basin is occupied by the hills of the Naga-Patkai range, while the rest of it is in the southern Brahmaputra plains.

The basic objectives of the present study are Ï% to trace the history of recent changes in the channel of lower Bhogdoi, Ï% to relate these changes and other physical factors to sedimentation of the river and Ï% to evaluate the impacts of sedimentation.

Materials and methods

The study is based on both primary and secondary data. The base map is prepared

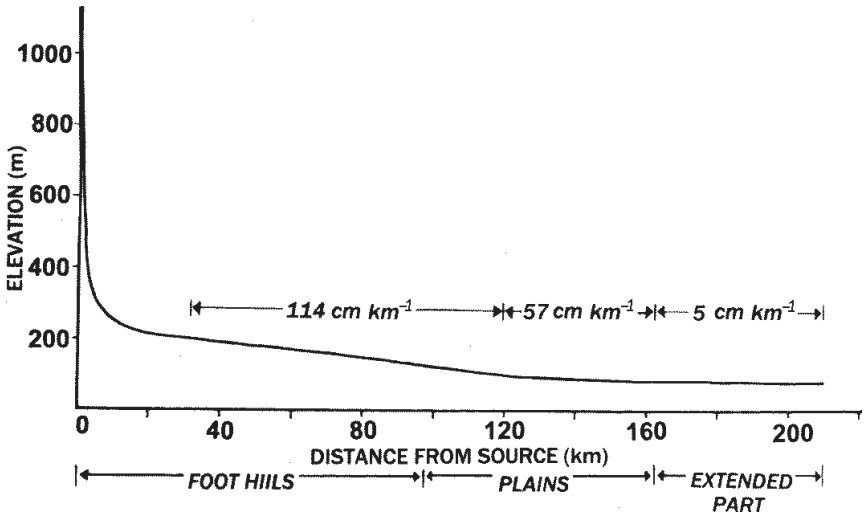

Figure 2. The long profile of the Bhogdoi, showing variations in gradient

from the Survey of India topographical sheets bearing numbers 83J/1–3, 5–7 with RF 1:50,000 and 83J with RF 1: 250,000. Long profile of the river is drawn on the basis of the topographical sheets. The hydrological data are taken from the Upper Assam Irrigation Division, Water Resource Department, Government of Assam. The historical information is collected from various sources (e.g. Sharma, 1989; Taher and Ahmed, 1998; Taher, 2000). Data relating to deposition of sand in the river bed are calculated through measurement in the field. Some village surveys were also done to trace encroachments in forested areas of the basin.

The lower Bhogdoi: Characteristics and changes

The Bhogdoi has 100 km of its total length in the Naga–Patkai hills. The remaining 62.5 km of the river flows through the plains. Following the great earthquake of 1897, the rising water of the Brahmaputra washed away an extensive area in its southern bank and several wetlands developed in the lower Bhogdoi basin. According to a survey conducted in 1917, the river continued to flow through these newly developed wetlands to reach the Brahmaputra (Sharma, 1993).

In 1950, another great earthquake measuring 8.7 in the Richter scale rocked Assam and the entire northeast India resulting in extensive landslides on the hillslopes, loosening of the soil, subsidence and fissuring of ground that increased sediment load of the rivers. Changes in the courses and configurations of the streams also occurred (Dutta, 2001). Moreover, the rise of the bed of the Brahmaputra after the great earthquake increased the intensity and frequency of flood in the plains of Assam. Recurrent flooding incidents started to occur mostly after the earthquake of 1950 (Bora, 2001). This necessitated construction of a number of embankments at different places along the Brahmaputra and its tributaries including Bhogdoi. Such an embankment, aligned along the southern bank of the Brahmaputra, blocked the course of the Bhogdoi near its mouth in 1956. This compelled the river to end at one of the wetlands (*bil*) of the area known as Khalihamari. The lower segment of the Bhogdoi still exists as *Mara* (dead) Disoi on the northern side of the embankment. The Khalihamari wetland has an outlet to Kakodonga, a river coming down from Naga hills to the plains of Assam. The Kakodonga

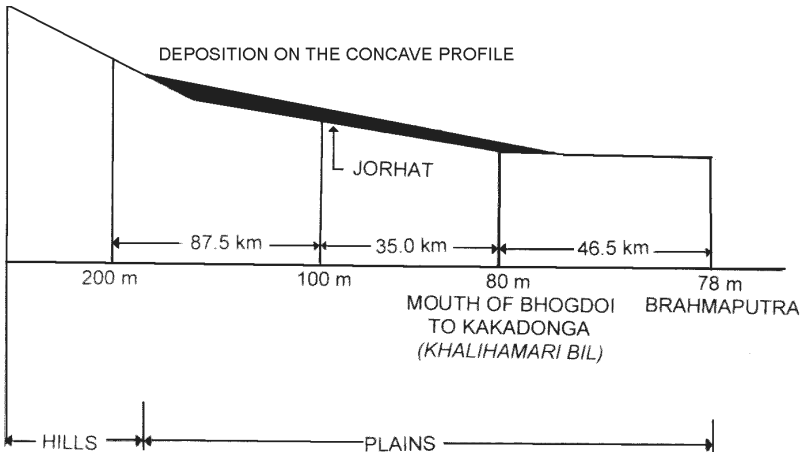

Figure 3. Schematic diagram showing lower Bhogdoi's concave profile and area of deposition

ends at Gelabil. The Gelabil is a channel of the Brahmaputra which takes off from that river and rejoins it at a point lower down in its course. At present Gelabil carries the discharge of the Bhogdoi and Kakodonga to river Dhanshiri that finally meets the Brahmaputra. Because of this, the Bhogdoi now has to flow an additional of 46.5 km to pour into the Brahmaputra, resulting in channel elongation. The gradient of this elongated part is only 5 cm km^{-1}. This also caused the river to discharge its water into the Brahmaputra at a point 43 km downstream from its earlier mouth. This has a direct impact on the depositional behaviour of the river in its course through the plains (Fig. 3).

Channel sedimentation: Causes and effects

Subsequent to the 1956 blockage and its consequences, the sediments carried by the Bhogdoi started to be deposited in the Khalihamari wetland and it was gradually filled up. As per the observations of some elderly local residents, the wetland, which was known to have depths of 8 to 10.5 m at places some 60 years back, is now subjected to heavy siltation. The depositional activities got accelerated in the wetland as the gradient of the river dropped from 57 cm km^{-1} to only 5 cm km^{-1} (Fig. 2). The area which was earlier an inaccessible wetland has now turned into an agricultural area mostly suited for wet paddy cultivation with the river flowing through it. During recent field visits, it was noticed that settlements have started to develop near these agricultural fields.

The upland course of the Bhogdoi passes through an area with thick vegetation cover and sparse population. Before entering into the plains of Assam, the river passes through a belt of three reserved forests belonging to the Assam Forest Department, covering a total area of 225.63 km^2. According to the Census of India (1971), the number of encroached villages in the three hill reserved forests of present Jorhat district was only seven with a population of 810 persons. The census of 1991 shows 14 villages with a population of 1,337 persons. Surprisingly, the number of encroached villages within the reserved forests and their total population showed a decline in 2001 census at 12 and 1,268 respectively. Investigations revealed that some of these villages are being claimed by both Assam and Nagaland and are enlisted in the census records of both the states. It also came to light that the particulars shown against a given village vary significantly in the two records. Compilation of these two census reports shows that the actual number of encroaching villages

was 16 and the population was 2,457. In a survey conducted by the authors in 2009, the number of encroaching villages in the reserved forest area was found to be 27 with a total population exceeding 4,000. Nearly all of them are Naga people who used to live and practise shifting cultivation on slopes. The damages made to the forest resources due to shifting cultivation and other associated activities like constructions and clearing of forests for plantations of tea crop in the uplands led to gross landcover change in the area by extensive depletion of forests and deterioration of the environment. Consequently, the rivers coming down from the hills of the Assam–Nagaland border recorded an increasing trend of sediment load during the last few decades which is reflected in the amount of siltation in the river bed

The longitudinal profile of the river (Fig. 2) indicates that 80% of the total length of the river in its lower course lies below the height of 200 m, and around 54% of the total length of the river lies between 100 m and 200 m. Of the total channel length of 87.5 km between these two elevations, the average gradient is 114 cm km^{-1}. At the confluence of plains and hills there is a conspicuous decrease in slope. The river bed along this section is noted for deposition of coarse sand and is located very close to Mariani, a town situated close to the hills. The subsequent part of the river from the 100 m contour up to its terminus in the Khalihamari wetland has a length of 35 km. The base level of the Khalihamari is 80 m and accordingly, there is a fall of elevation by 20 m for a length of 35 km of the river channel. The average fall for this segment is 57 cm km^{-1}.

Upstream of the Khalihamari wetland, the river has started to experience pronounced siltation in recent decades, resulting in rise of the river bed. In 1972, a two storied building was constructed in Jorhat near the railway bridge across the Bhogdoi. The plinth level of the building was kept at an elevation of 5.5 m from the riverbed. The plinth of the same building is now only 4.15 m above the bed. This indicates that the riverbed is raised 1.35 m by deposition of a thick layer of sand in 38 years. In an unpublished official report prepared by the Water Resource Department, Government of Assam, relating to construction of embankment along the banks of the Bhogdoi, it is stated that the reduced level of the river bed was noted to be 86.34 m in 1965 at A.T. Road crossing of Jorhat. This became 88.69 m in 2009 at the same point. This denotes that there is a 1.75-m rise in the river bed in the last 44 years. The Bhogdoi is now flowing above the average level of the Jorhat municipal area. As such, the town is exposed to a constant threat of submergence and flooding the Bhogdoi, especially in the event of embankment breaching. In April 2004, a breach in embankment caused devastation in the form of inundation in greater Alengmara area located 8 km northwest of Jorhat.

Due to ongoing siltation, the frequency and intensity of inundation started to increase with time. The areas which were earlier protected from the floods of the Brahmaputra through construction of embankments, started to be inundated by the rising water of the Bhogdoi during summer. Today, deposition and aggradation of the river bed can be viewed distinctly in a span of 23 km along the Bhogdoi. In this segment, the river bed appears to stand above the agricultural fields and villages on either side of its channel. This necessitated erection of embankments on both of its banks in different phases. During the first phase, the portion of embankment from J.B. Road to Pujadubi was completed in 1972. It was extended from J.B. Road to Chengeli Ati in the second phase and from Pujadubi to Jorhat Engineering College in the third phase. Now the Bhogdoi has a 23-km long embankment from Solmara to Jorhat Engineering College along its banks.

Table 1. Sand mining from the Bhogdoi river bed

Mining site	Average daily no. of trucks: Nov–Apr	Average daily no. of trucks: May–Oct	Daily average no. of trucks	Average daily volume collected (6 m^3 per truck)
Mariani – 1	35	20	27.5	165
Mariani – 2	25	10	17.5	105
Kathanibari	42	18	30	180
Pukhuria	30	14	22	132
MES Gate	15	8	11.5	69
Jorhat	45	30	37.5	225
Malow Ali	30	18	24	144
Solmara	1	1	1	6
TOTAL	223	119	171	1,026

The section of the river between the hills and the Khalihamari *bil* shows a concave profile (Fig. 3) characterised by pronounced depositional activity. The coarse sediments are deposited mainly in the first 7.5 km span of the plain course of the river. The subsequent 20 km downstream reach, up to Jorhat, represents a mixture of both coarse and medium sediment deposition. Near Jorhat, the fine sediments predominate. The sediment data collected from the Water Resource Department, Government of Assam, which has its gauge site at A.T. Road crossing in Jorhat reveal that fine sediments constitute 37.75% of the total sediment load while the medium-sized sediment and coarse sediment constitute 36.24% and 24.01% respectively. It is for this reason the sands of the river upstream of Jorhat has high demand in the market which are used mainly for construction works. Eight out of the ten sand collection sites are located in the upstream of Jorhat town. The sand collected from the river downstream of Jorhat has low demand in the market and these are used mostly for filling purpose.

Six sand *mahals* (quarries) belonging to Assam Forest Department have ten sand collection sites between Mariani and Jorhat city. It is to be noted that collection of sand from the Bhogdoi bed continues all round the year except two or three days when the water level attains its maximum peak during monsoons. In addition to the channel bars, sand is mined from the bed and these are stored on the banks to be subsequently loaded to trucks. An attempt is made in Table 1 to estimate the annual total volume of sands collected from the river bed of the Bhogdoi.

Though there is seasonal variation in the collection of sand from the river, on an average, 171 truck-loads of sand are supplied daily to various construction and filling sites of the district. The average volume of one truck-load of sand is 6 m^3. As such, a volume of 1,026 m^3 of sand is taken out every day from the river bed. If this collection continues at the same rate, the annual volume of sand collection can be estimated to be 374,490 m^3. It may be mentioned here that the Bhogdoi supplies nearly 70% of the total demand of sand in the district. In spite of collection of more than 350,000 m^3 of river deposits every year that too for several years, the river bed is aggrading.

During 1970–1980, the average rate of discharge of the river was 75 $m^3 s^{-1}$ and the annual volume of suspended sediment was 83 ha m (Sharma, 1993). It has been found from the data collected from the Water Resource Department, Government of Assam, that at

present the average suspended sediment load of the river at Jorhat gauge site is 0.0087% to total volume of water. Assuming the same discharge (as during 1970–1980) to continue today, the river is now carrying a volume of 2,057 ha m suspended sediment every year at the same gauge site. This suggests that the suspended sediment load of the river has increased 24 times in a period of 30 years. The proportion of fine sediment exceeds the medium and coarse sediments at this gauge site. This may be attributed to the fall of gradient of the river bed and heavy collection of relatively coarser river bed deposits in the upstream of the gauge site.

Conclusions

Siltation in the bed of the Bhogdoi river has created several associated problems in the basin, particularly in its lower part. The major problem is flood of the river caused due to bed aggradation. In order to check inundation, embankments along both the banks were constructed resulting in dislocation of settlements.

Occasional breach in the embankment causes sudden inundation leading to loss of life and property. It also causes damage to agricultural lands. On the other hand, people living near the banks of the river are exposed to constant threat of flood during summer.

The sediments of the river have already filled up a major portion of the Khalihamari *bil,* which was noted for visit of various migratory birds. The filling-up of the wetland has restricted the area for these migratory birds.

The loss of direct link of the Bhogdoi with the Brahmaputra has brought about a decline in the fish population and other aquatic life forms of the river. Before the closure of the Bhogdoi mouth in 1936, fishes from the Brahmaputra used to come upstream to Jorhat and the neighbouring areas and the river had plenty of fresh water species.

Unplanned scouring of the bed due to sand collection may cause channel instability. It is observed that sand is collected mainly from a very small segment of the river course. Heavy collection of sand, that too from a small segment of the river, is likely to cause an imbalance in the fluvial regime. This may, in turn, induce other associated problems like bank line migration, bank erosion, bank slumping etc.

The elongation of the river course and consequent bed aggradation has, however, opened up some economic benefits. The river bed provides one of the most important construction materials in the form of sand and the Bhogdoi is the only source of good quality sand in Jorhat district. This is providing a scope for employment to a good number of people in various activities relating to collection of sand from river bed. The Khalihamari *bil* which was an inaccessible wetland in the past has now become a productive agricultural field, meeting demand of food for a growing population. Regular collection of sand from river bed is indirectly helping towards reduction of flood level also.

References

Bora, A.K. (2001) Drainage and Flood. In Bhagabati, A.K., Bora, A.K., Kar, B. (editors) *Geography of Assam*, Rajesh Publication, New Delhi: 36–51.

Census of India (1971) *District Census Handbook of Sibsagar District,* Directorate of Census Operations, Assam.

Census of India (1991) *Village Directory and Primary Census Abstract of Assam,* (on CD), Directorate of Census Operations, Assam.

Census of India (2001) *Administrative Atlas of Assam*, Directorate of Census Operations, Assam.

Census of India (2001) *Village Directory and Primary Census Abstract of Assam,* (on CD), Directorate of Census Operations, Assam.

Dutta, A.K. (2001) *The Brahmaputra*, National Book Trust, New Delhi.

Sharma, J.N. (1993) *The Rivers of Assam* (in Assamese), Asom Sahitya Sabha.

Sharma,S.P. (1989) Integrated survey for water

resource development in north east India, *Geographical Horizon*: 9–11.
Taher, M. (2000) Sibsagar district in 19th century: A study in historical geography (in Assamese), *Bhougolika*, 11: 1–10.
Taher, M. and Ahmed, P. (1998) *Geography of North East India,* El Dorado Publication, Guwahati.

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