Temporal changes of Fluvio-Morphological scenario and its impact on Settlement: A GIS based study for Mandia block, Barpeta District, Assam

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Abstract: ***The Mandia Block of Barpeta District Assam undergoes episodes of changing geomorphology due to change in Manas-Beki-Brahmaputra River System. Significant amount of Geographical area within the block is covered by this river system. Temporal change in River System leads to change in sandbars which are being used by thousands of people as their settlement and agriculture. Geospatial Technology is used to study temporal change within the Block between 1972 and 2013. Within 41 years significant change has been observed in fluvial scenario and settlement pattern in this area. The Beki river shows significant shift in its channel pattern and confluence; River Brahmaputra tend to widen towards north causing major erosion in 1972 Northern bank line. Nearly thirteen settlements got severely affected by this change. Present day directions of Remote Sensing are identification, mapping, inventory, monitoring and surveillance. Hence it is found to be an effective tool for attempting this problem of temporal behavior of the river system.***
Keywords: GIS, Beki, Brahmaputra, Bankline, sandbar, settlement.

1. Introduction

The River channel changes its course due to changes in rainfall pattern, heavy landslide in catchment area causing sudden rise in silt load, beheading of one river into another, impact of seismic activity in bed slope etc. River Brahmaputra is the second largest carrier of sediment load in the world carrying average annual sediment of 735 million tones [9]. Every year very high magnitude flood also causes channel widening, river bank erosion and changes in channel pattern [7]. Dynamic relationship between channel geomorphology, sediment transport and river flow is related to rate of erosion and deposition which in turn contribute formation and maintenance of sandbar [10]. It is observed that present surface area of the Brahmaputra river has increased from around 3000 sq.km to around 6000 sq.km since 1950 as a result of river bank erosion.

The Mandia block of Barpeta Dist., Assam is situated at the conjunction of Manas Beki River system and Brahmaputra. Every year changes in this river system bring episodes of changed geomorphic scenario to this block. Nearly 30% area of Mandia block composed of sandbars (locally known as 'chars'). Temporal change in behavior of Manas Beki river system and continuous changing braided behavior of River Brahmaputra cause dynamic changes in these sandbars. This temporary 'chars' are used by thousands of people as their settlement and agriculture. This frequent changing pattern of sandbars causes declining of agricultural land, changed population pattern leading to socio economic problems, high rate of displacement of family, unemployment, poverty etc. [2].

2. Study area

The Mandia Block located at south east of Barpeta District, Assam is considered as study area (Fig.1). The area is located between 2605'41" to 26021'38.5" N latitude and 90039'26.6" to 9101'46" E longitude. The mighty River Brahmaputra is flowing east to west of the study area. The Manas Beki river system is flowing north to south direction. This River System occupies a significant amount of geographical area of the study area. The area is mainly composed of temporally varying sandbars and alluvial floodplain.

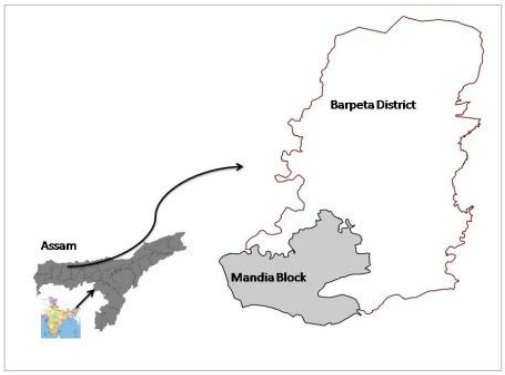


Figure. 1. Location Map of Mandia Block

3. Research objective

i) To study the Spatio-temporal variation of fluvial scenario within the study area in 41 years (1972 to 2013).
ii) To study the settlement pattern affected due to such a kind of change dynamics in last 41 years.

4. Data used and methodology

The basic data used in the study are:
a) 1972 SOI Toposheet No 78 J/11, 78 J/12, 78 J/15, 78 J/16, and 78 N/4
b) Landsat 7 ETM+ imagery downloaded freely from USGS (www.landsat.usgs.gov/) for the year 2002
c) Indian Remote Sensing (IRS) LISS 3 imagery downloaded freely from National Remote Sensing Centre, Bhuvan portal (www. bhuvan.nrsc.gov.in/) for the year 2013
Georeferencing and mosaicing of toposheet is done using ERDAS imagine 9.2 software. River courses and sandbars for 1972 within the study area have been delineated using Arc GIS 9.3. Similarly image processing for Landsat ETM+ and LISS 3 is performed using ERDAS imagine 9.2 and generation of vector layers such as river channels, sandbars etc. is done using Arc GIS 9.3. Analysis of the study is mainly carried out using Arc GIS 9.3.

5. Results and discussion

SPATIO TEMPORAL VARIATION:

The spatio temporal variation of Beki River is significant within the study area comparing 1972 toposheet with 2002 and 2013. The confluence point of river Beki shows a significant change within this time period. The dynamics of confluence in a region is related to the local movements of the channels in the confluence region [4]. In 1972 the river flows in a NE-SW direction and continues a sinuous track up to 900 47' 44.7" E, 260 11' 43.60" N and then follows a NW track parallel to main Brahmaputra channel and meets Manas river at 900 39' 30.42" E, 260 13' 52.93". This Manas Beki system together confluence Brahmaputra at 900 38'7.3 E, 260 13' 34" N (Fig. 2). In 30 years i.e. in 2002 satellite imagery due to the northward migration of river Brahmaputra the confluence point of Beki river with Brahmaputra is shifted nearly 18 km east of the previous one (Fig. 3). In 2003 the confluence has not shift significantly but the fluvial scenario gets complicated as many interconnected channels get developed between Brahmaputra main channel and Beki-Manas River (Fig. 4). The channel sinuosity [7] in 1972 is 1.47 indicating river tend to follow sinuous to meandering pattern. It gets reduced to 1.32 in 2002 probably due to meander cut off and decrease in reach length caused by Brahmaputra bankline migration. In 2013, one large meander have been developed just upstream the confluence affecting its sinuosity to 1.53 (Fig. 5).

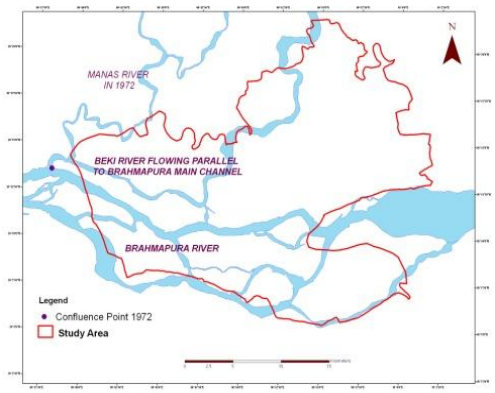


Figure. 2. River channel morphology of Mandia block in 1972

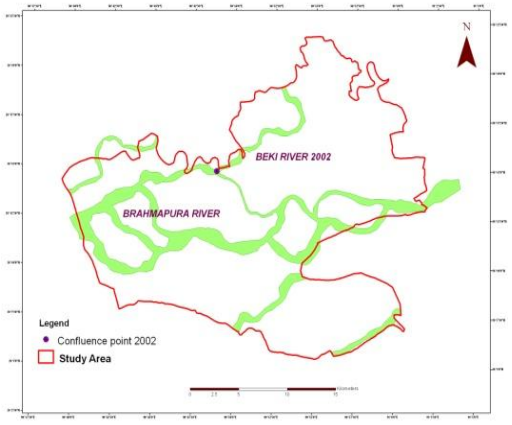


Figure. 3. River channel morphology of Mandia block in 2002

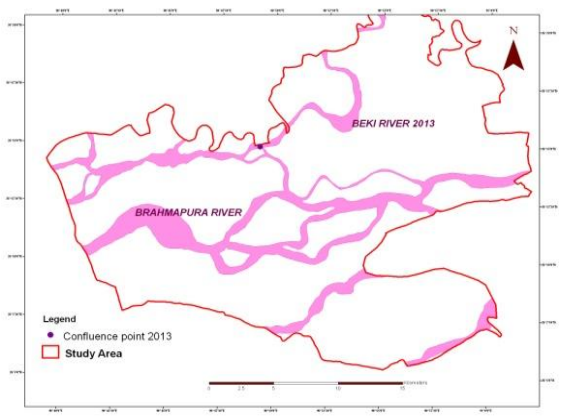


Figure. 4. River Channel morphology of Mandia block in 2013

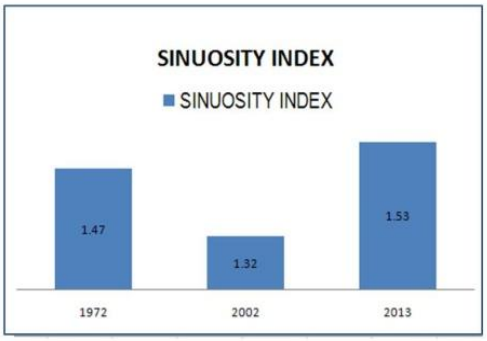


Figure. 5. Sinuosity Index pattern of Mandia block since 1972 to 2013

BANKLINE MIGRATION:

River channel migration is the lateral movement of an alluvial river channel across its floodplain due to processes of erosion and deposition on its banks and bars [3]. [1] used NDWI (Normalized Difference Water Index) for IRS LISS-3 data for identification and delineation of bank-line.

NDWI = (SWIR-NIR) / (SWIR+NIR)

NDWI image helps in identifying sand patches with higher moisture content present between the main channel and shallow water channel. This shallow water channels are also considered part of the River.

NDWI approach is used to delineate the northern bank of river Brahmaputra prominent within the study area. Comparing 1972 toposheet with 2013 satellite imagery drastic change in northern bank has been observed. Five cross sections of equal interval have been generated to study the spatial shift of northern bank within 41 years. The river shows a widening tendency towards north eroding nearly 132.29 km2 areas. At different cross sections the linear distance of migration is as follows (Fig. 6).

CROSS SECTION	DISTANCE (km)
A	5.88
B	3.67
C	7.40
D	5.47
E	1.33

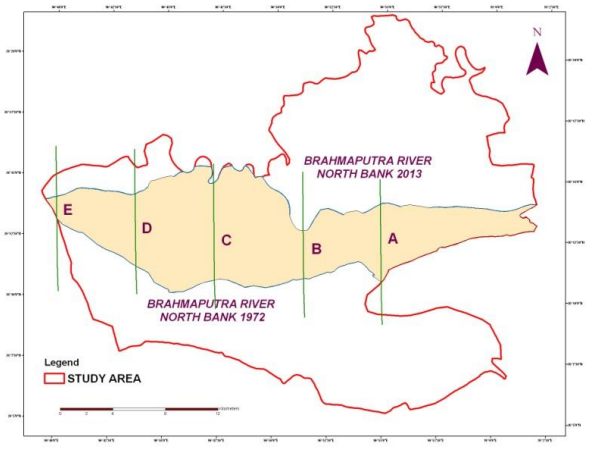


Figure. 6. Bank line migration pattern of Mandia block

SANDBAR DYNAMICS:

C. Gao et al. [5] studied changes of river islands in Yangze River based on remote sensing. Md. K. Dhali [5] has analyzed dynamic changes of bar in Teesta River between 2002 to 2014 using GIS. Sandbars within the study area is locally known as 'Char' and settlements are also named in connection to 'Char' such as 'ujirar char','rajar char' etc. From the characteristic symbol of sand features in the 1972 toposheet, its association with river channels and from settlement names the sandbars has been identified and delineated. NDWI images are of great help in identifying sand patches with higher moisture content for the year 2002 and 2013. In 1972 sandbars occupy nearly 138.79 km^2 area and are mainly distributed in southern side of the study area (Fig. 7). Increase in sandbar area is observed in 2002 imagery occupying nearly 214.39 km^2 (Fig. 8). This increase is due to change in channel geometry within 30 years of time. In 2013 imagery sandbars occupy nearly 206.44 km^2 area (Fig. 9). Sandbars tend to distribute towards more Northern side of the study area as compared to 1972. The following table and bar

diagram (Fig. 10) will show percentage and distribution of sandbar in these 41 years of time.

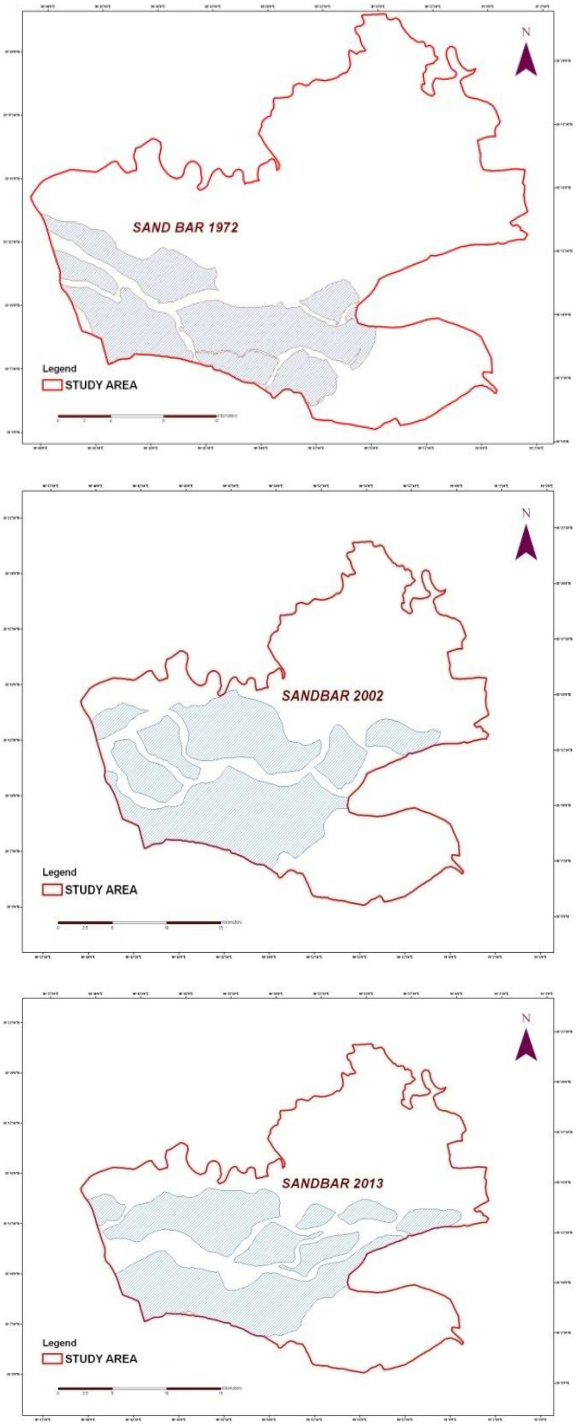


Figure. (7/8/9) Sand Bar distribution Pattern in Mandia block since 1972 to 2013

I. **TABLE I.** SHOWING THE AREA OF SAND BAR IN MANDIA BLOCK SINCE 1973 TO 2013

Year	Sandbar area (km^2)	Percentage of sandbar
1972	138.79	22.70
2002	214.39	35.07
2013	206.44	33.76

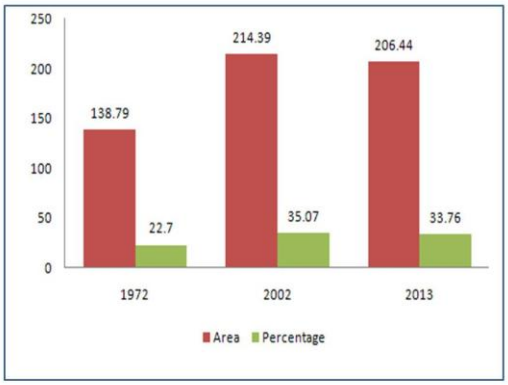


Figure. 10. Bar diagram showing the change dynamics of sand bar area.

AFFECTED SETTLEMENTS:

The changed fluvial scenerio brings significant changes in settlement pattern within the block.The following stable settlements identified in 1972 toposheet undergo severe erosion due to the northward migration of river Brahmaputra. Settlements at Bandarmura, Bagbopathar, Pub Dewaldi, Ramapara Pam, Dalagaon, Sutirpar, Sargaon, Polar Pam, Ranir Pam, Dharmapur, Manikpur, Garalar suti and Habi Dongra affected by channel change are shown in Fig. 11, 12, 13 and 14.

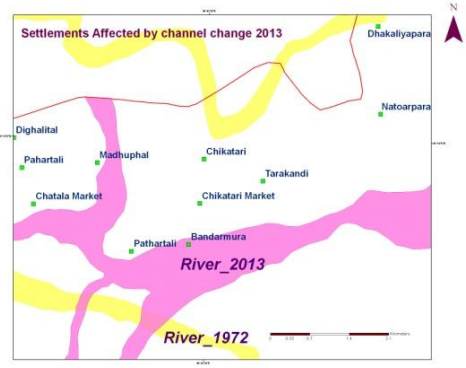
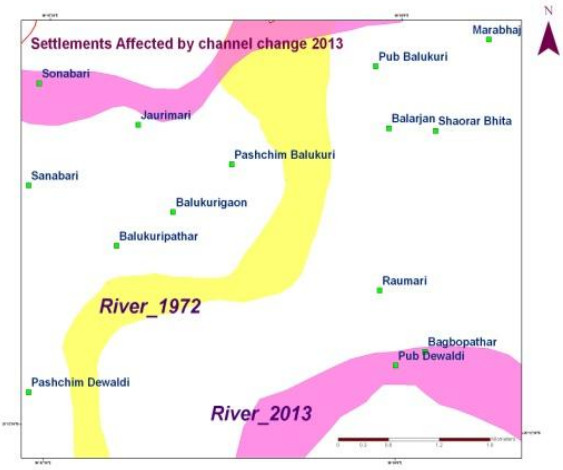


Figure. 11



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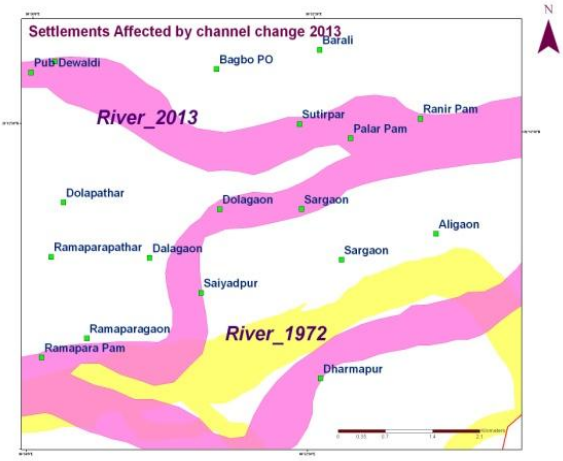

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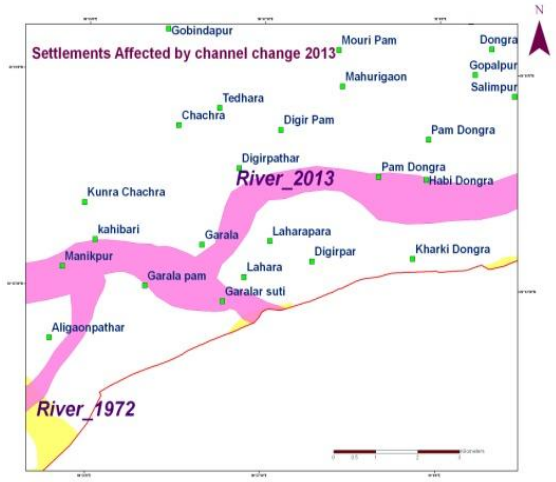

Figure 14.

6. Conclusion

The study reveals the dynamics of river morphology within 41 years. The Beki river confluence with Brahmaputra has shifted significantly. The Brahmaputra itself migrate northward eroding 132.29 km2 area. An increase in sand deposition of nearly 11.06% has been observed within the study area in these 41 years of time. Nearly thirteen settlements identified in SOI toposheet have been undergone severe erosion. It is also observed that permanent occurrence of sand bars are seen along southern part of the river whereas fresh formation of river channel and sand bars appears towards northern part of the river system. This type of study can be further helpful in application of Geospatial technology in different sorts of physiographic and socio-economic parametric analysis in Block or watershed level study. It may also help policy makers to adopt successful plan for landuse, settlement, river training works, irrigation etc.

References

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