



Processes of channel migration of Kundil river in Sadiya, Assam, India.

Ratul Das and Barnali Gogoi

1 & 2 Department of Geography, Cotton University, Guwahati, India

Abstract

Channel migration is common in alluvial channels, but the rate of migration and processes involved are varied. The Kundil River is an important tributary of river Lohit, flowing through the alluvial plains of Sadiya in the easternmost part of Assam, India. This paper attempts to investigate the rate, extent and the processes of channel migration for the period 1945-2014. Topographical maps and satellite imageries of different years (1976 to 2014) are used for the study. ERDAS Imagine 9.1 and Arc GIS 9.3 software are used for processing these spatial data. It has been found that there are significant changes in the river course during this period. The bank line shifting of the river has been determined separately for the periods 1945-1988, 1988-2014 and 1945–2014 with fifteen cross sections at an interval of approximately 3 kms. Maximum bank line shifting is found to be 1.88 km (1945-1988). However, the migration is not unidirectional all throughout the channel. The processes involved in lateral shift of the river channel can be grouped into three categories: 1. alteration of flow direction due to cut-off, 2. widening of the channel in response to bar development, 3. progressive shifting of meander bends

Keywords: channel migration, lateral shifting, cut off, meandering, Kundil river, Sadiya.

1. Introduction

Channel migration is a natural process observed in many alluvial channels. Lateral shift of channel has drawn attention of scholars of diverse fields as it has physical as well as social implication. It is also a widely studied phenomenon in geomorphology. Channel movement is essentially a vector property, with channels moving both laterally and downstream through processes such as bank erosion, avulsion, bend migration and extension (Hooke, 1977, Gurnell et al.1994). The threshold of channel migration is determined by the magnitudes of forces acting to erode the bank and forces resisting erosion (Nanson and Hickin, 1986; Millar and Quick, 1993; Micheli and Kirchner, 2002). Erosive forces are essentially a function of channel size and slope (Nanson and Hickin, 1986), and resisting forces are a function of bank material and vegetation characteristics (Millar and Quick, 1993; Micheli and Kirchner, 2002). Kundil River is an important north bank tributary of Lohit

River flowing through alluvial plains of Sadiya, Assam. The River Lohit is one of the most important tributaries of the mighty Brahmaputra. Kundil river drains geologically unstable mountains and hills of Arunachal Pradesh and suddenly debouches to the plains of Brahmaputra valley. As it enters the plain its gradient decreases suddenly and becomes laterally unstable. The region experiences high intensity rainfall in monsoon season which causes heavy floods. According to Schumm & Lichy (1963), 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. Bank erosion is experienced every year in the river and there are shifts in the course of the river also.

2. Study area

The study area is situated along the southern foothills of eastern part of Himalayan Ranges. The Sadiya region

is a plain area surrounded on three sides by major tributaries of the mighty river Brahmaputra namely Dihang, Dibang, Lohit and the Brahmaputra itself. The upper part of the area may be said to be a zone of transition between the Himalayan Mountains and the Brahmaputra plains, and displays the typical characteristics of the piedmont plains of the Himalayas whereas lower part consists of flood plain. The Kundil River rising from Tethaliang Peak (3295m) in the western part of Mishimi Hill, flows south then west and southwest to join Lohit river as a right bank tributary. The basin covers an area of 1178 km² (Gogoi, 1997). The basin comprises both mountains and plains. However, the major part of the basin is developed in the mountains. The selected area falls within the Survey of India topographical maps no 83 M/9, and 83M/13 and extends

from 27°47' N. to 27°58' N. latitude and 95°40'E. to 95°58' E. longitude. The river flows for a distance of 51.87km with the basin area of 321.82sqkm (2014) within the study area in Assam. Another river called Balijan also flows parallel to the River Kundil in the eastern part of Sadiya Region, which meets the Kundil at a place called Kaliapani (Gogoi, 1997) during rainy season, which can also be considered as a factor for the highly dynamic nature of the Kundil River during that season. It may be concluded on the basis of studies by authors like Coleman, 1969; Goswami, 1985; Sarma, 2005; Ahuja and Goswami, 2006; Sarkar and Thorne, 2006 ; Wiebe, 2006, that the unique geology and geomorphology of the region are responsible for the highly erosive characteristics of the Brahmaputra River and its tributaries.

LOCATION MAP OF THE STUDY AREA

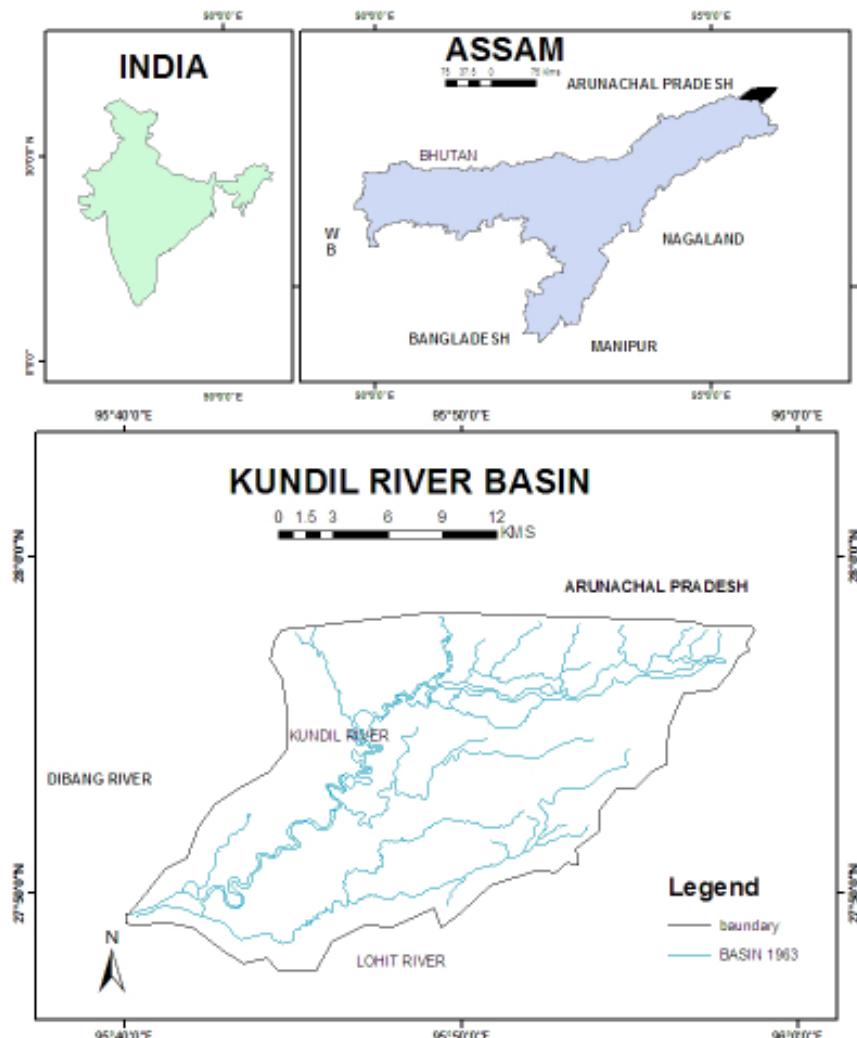


Fig. 1: Location map of the Kundil River basin, Assam, India.

3. Objectives

1. To find out the extent and the rate of bank line migration within the study period.
2. To study the processes of channel migration in Kundil River.

4. Methodology and database

For a systematic study, analysis and interpretation it is very important to choose perfect approach in any field. For the present problem spatio-temporal data of varied specifications are used involving topographical map prepared by US Army Map Service (1945) with the scale 1:250,000 and satellite imageries of Landsat TM, ETM, and ETM+ of different years of winter season from 1976 to 2014. All temporal data were geo-referenced using WGS84 datum and UTM projection and registered on a common platform for investigating the temporal variations in bank line, and other associated processes of Kundil River. All temporal data were registered in ERDAS Imagine 9.1 and further processing has been carried on Arc GIS 9.3 software. Finally, after careful processing of rectification, enhancement and edge matching technology, spatio-temporal shifts of cross section points were extracted and mapped in the GIS environment. Bank lines of

these years were digitized from the geo-referenced topographical map and satellite imageries using the same software and then the bank lines are overlaid for the period from 1945 to 2014. The bank line migration was measured taking 15 cross-sections (A-O) approximately at intervals of 3 kms (Fig 2), which were defined as being perpendicular to the flow of the base year (Gurnell *et al.*, 1994 and Lewin *et al.*, 1977). Various types of changes and other associated processes were identified by visual approach.

5. Result and discussion

5.1. Extent of bank line shifting

An analysis of the maps and the satellite imageries shows that the nature and extent of the bank line shifts are quite different from time to time. A general trend of bank line migration is shown in fig-2. The shifting of the channel from 1945 to 2014 along both the banks is measured in 15 cross- sections taking the bank line of 1945 as base line and the results are presented in table1. However, the bank line shifts are not uniform during all the periods for both left and right banks. The maximum bank line shifting that took place in the right bank was 1.80 km at the cross section L (Table-1) and in the left bank at cross section O during the period of 1945-1988.

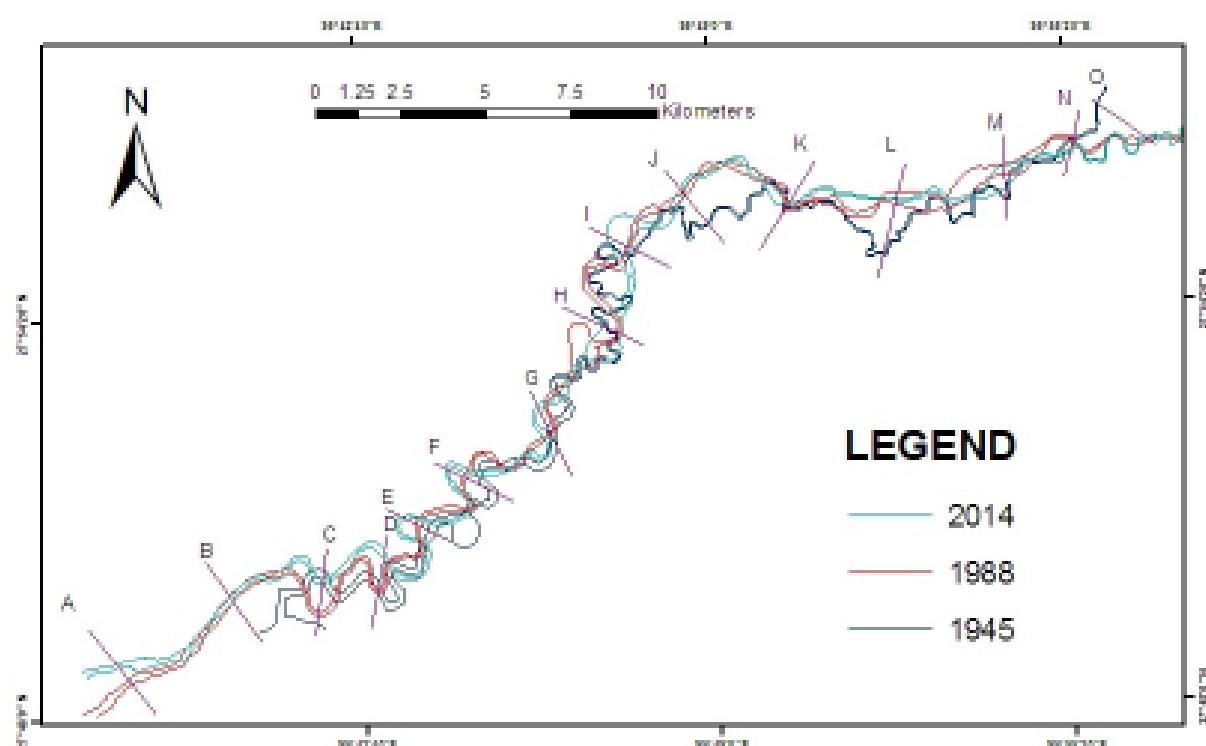


Fig. 2 : Bank line shifting of Kundil River course in Sadiya region during 1945 –2014.

During the 1945-2014 period major bank line migration has been measured at cross sections H, J, L and O. Apart from that, there is no definite trend of movement in either direction; the river fluctuates in

both the directions. There were many meander bends in 1945 within the study reach, many of which straightened in 2014 through bank line shifting and other associated processes of Kundil River.

Table 1 : The bank line shifting of Kundil river from 1945-2014(in kilometers)

CS	Right bank						Left bank						
	1945-1988		1988-2014		1945-2014		1945-1988		1988-2014		1945-2014		
	R	L	R	L	R	L	R	L	R	L	R	L	
A		.577							.608				
B		.034								.005			
C	1.20	1.043					1.00	.943					
D	.240	1.162		.851			.030		.956		.953		
E	.428		.410		.090		.414		.483		.030		
F	.723		.583		.164		1.00		.578			.044	
G		.151	.916		.887		.394		.770		.076		
H		.341	.537		1.202			.422	.030			1.275	
I	.224		.666		.085		.179		.076			.064	
J	1.16			.095	1.423		1.07			.071		1.437	
K	.057			.153	.443			.092		.208		.365	
L	1.80			.138	1.57		1.51		.120			1.60	
M	.935			.030	.649		.724			.417		.589	
N		.027		.416	.065			.019		.388		.076	
O		1.79	.047			1.87			1.88		.045		1.86

Source : Calculated by the researcher

5.2. Types of channel change of the Kundil :

The changes that have taken place in the river Kundil may be grouped into the following categories, 1. alteration of the direction of flow due to cut-off, 2. progressive meander formation and shifting 3. widening of a channel in response to bar development.

5.2 1. Alteration of the direction of flow due to cut-off

Channel cut off includes both chute and neck cut

off. Chute cutoff (fig.3A) involves partial cutoff of a meander loop forming a new, but still curved reach (Greg H. Mack et al 1998). Neck cut-off (fig.3B) is a flood plain 1983). These can be considered as major fluvial processes of Kundil River. In 1945, the river possessed 67 bends, which decreased to 37 in 1988 and became 38 in 2014. It is however, difficult to say with conviction, at least from the available source of information, whether this straightening was affected by true neck cut-off or chute cut-off. Due to the lack

of supporting evidence of the periodic sequence of channel change during intervening periods, the duration

of time required for completion of these *cut-offs* could not be determined accurately.

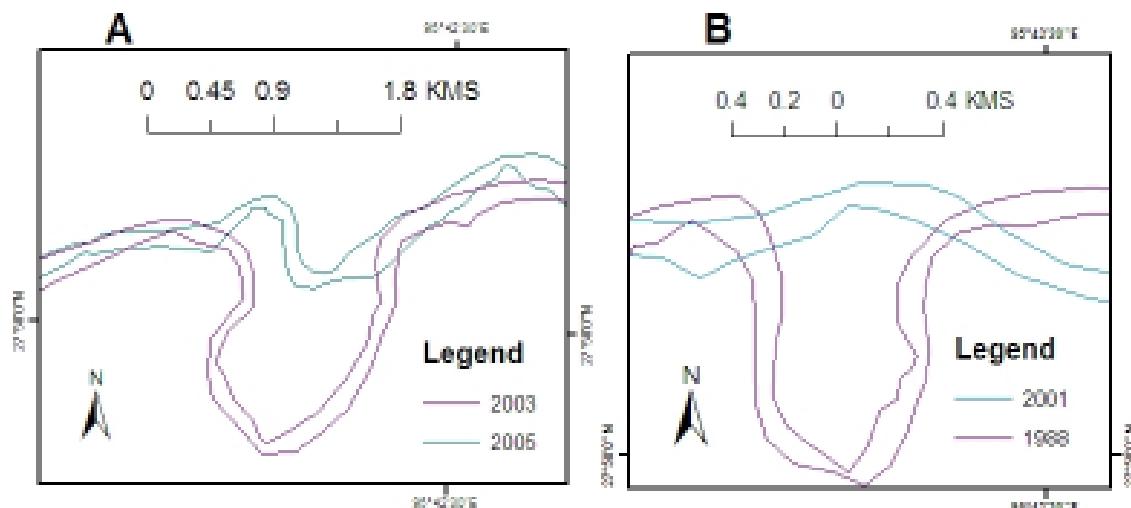


Fig 3: Well-defined examples of (A) chute cut-off and (B) neck cut off of the Kundil river

2. Progressive meandering formation and shifting

Formation and shifting of meander bends from one place to another is a common phenomenon in an alluvial channel. During the observation of historical maps, a number of oxbow lakes found in the last 69 years (1945–2014) and this suggests that meander migration has been one of the common

mechanisms of channel shift in the river Kundil. Fig; 4 shows the shifting of meander bends in different places in different years. The various types of movement of bend that is translation, rotation and extension are also observed in the study reach during 1945 to 2014. Well-defined examples of extension and rotation type of movements are given in figure 4 (A) and (B) respectively.

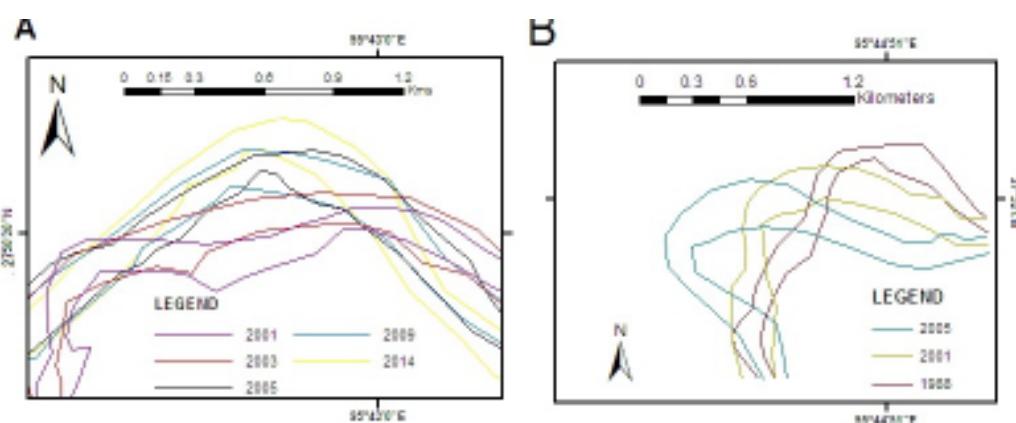


Fig 4: (A) meander extension; (B) meander rotation & translation of Kundil river.

3. Widening of a channel in response to bar development

The term bar is used for any major element in the river bed which is either exposed or slightly submerged (Sarma, 2005). There are numerous examples of minor bar formation in the Kundil river.

Here, maximum widening is measured up to a width of .937km. During the period 1988-2014 the bar formation is more in the river than the previous periods.

6. Conclusion

The changes taking place in the Kundil river

channel over a period of 69 years are studied in three different segregated periods of time. It is observed that major changes in the Kundil River channel resulted due to the cut off processes such as chute cut off or neck cut off and meander bend shifting. During the period from 1945-1988 cut offs are more as compared to 1988-2014. It was found during the analysis that most of the fluvial processes of Kundil River are active in the flood season as this river frequently meets another river called Balijan in that season. The huge amount of sediments which the river Kundil carries also plays a role in some of these processes.

After careful discussion, it was found that the changes taking place in the Kundil river channel in the period from 1945–1988 and 1988-2014 are varied. No definite trend of migration is observed in both the

banks, but there is a westward migration of both the banks in lower course of river near the mouth. Maximum bank line migration was observed during the period from 1945-1988 at the cross section O in which both the banks shifted towards the left side of the river. Widening of the river at places up to 0.937 km has been observed in certain time period which is many times higher than average rate of widening. It is mostly because of the formation of temporary sand bars and islands within the river. Finally it must be mentioned that a comprehensive scientific study of the bank materials as well as morphology of the river is required to protect the area using eco-friendly materials and techniques such as bamboo barrack and geo-bags etc for construction of embankment to protect river banks from severe bank line erosion and shifting.

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