Fluvial Geo-Morphometry of River AIE

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Abstract – *The River Aie which has flowed through alluvium tends to change its course of flow due to heavy rainfall in the foot hills of Bhutan, which causes the river course to be under huge pressure and the river tends to change its course easily. Here a study was conducted mathematically of various parameters of river course to understand the river course type and the cause for change of the course.*

***Key Words*: Morphometry, Cross-Valley Assymetry, Course change, Sinusoity Index.**

1. INTRODUCTION

Shifting of River course are taking place since centuries, which has created havoc in many parts of the world, which comprises of loss of land, destruction of structures, loss of lives, etc., which has led the geo-morphologists, geologists and archaeologists to study the condition which has led the course change for a long time and prevent destruction of materials and humans.

2. LITERATURE REVIEW

***[1] Debnath, et al (2017)*.,** study has proved the utility and application of remote sensing and GIS technology and provided a detailed assessment of spatial and temporal changes in River channel processes and adjustment of LULC types of the study area. The past and present data analyses indicate that the River Khowai has changed its channel from highly meandering (SI = 2.30) to sinuous (SI = 1.41) and modified its flood plain land use/land cover significantly. The analysis of cross sections at 23 sites across the past and present Khowai River reveals the endangered condition of the nearby settlements and infrastructures due to high bank erosion. Therefore, there is need of an in-depth study of interaction of geo-tectonic activities, geological characteristics and fluvial regime to understand the complex physical processes and to suggest a fruitful management for the River interventions. The study evaluates the effective land use study with reference to dynamic change of the channel from 0.7 km to 0.02 km in the vulnerable places. Therefore, it will be very much helpful to establish certain plans for upcoming future to mitigate the hazards and to minimize human intervention to the natural flow of the River and ensuring the growth of riparian vegetation so that the ecological and biological diversity of the flood plan area will be more prosperous and healthy than before.

***[2] Gogoi, et al (2014)*.,** studied the Subansiri River, which is a major Trans- Himalayan tributary of the River Brahmaputra, characterized by its extremely dynamic and unstable alluvial channel in Assam. In this study, the pattern of channel shifting as well as various other changes of the Subansiri River have been studied for the period from 1828 to 2011. The channel pattern of the River changes continuously with large number of channels being abandoned and new channels developed in the course of a few years. Large discharge and heavy sediment load during floods cause the River to be extremely unstable, because of which it consistently migrates laterally from the eastern side to the western side of the basin abandoning the earlier channels. During 1995 the Subansiri River was flowing through Ghunasuti and the Ghagar nala was present as a small channel in the right side of the River. But after 1995, it starts capturing the Ghagar nala abandoning the channel through Ghunasuti and straightened its course through this nala, which has become the main channel of the Subansiri River at present. The Channel through Ghunasuti was blocked by many channel bars locally known as chars‟. This channel usually disappears during winter and gets activated by water flow only during flood Season. The shifting of the channel from 1995 to 2010 along both the banks was measured in 17 cross- sections along the River.

3. STUDY AREA

The River AIE, originates at the foot hills of Bhutan (27�0'19''N 90�5'32''E) and travels 51.00 Kilometer within the boundary of Bhutan and heads towards Indian soil at Hatichar (26�1'14''N 90� 30'04''E) in the state of Assam covering 98.00 km and spills in the mighty Brahmaputra. On its path towards Brahmaputra many sub-tributaries like Burhi-AIE, Huthuti, Rowmari, Nagal-Bhanga, etc., merges with the River AIE. During its flow the River AIE has joins with River Manas at Santoshpur, Bongaigaon and later the River is named as AIE-Manas at 82.35 Kilometer from Hatichar for the rest portion. At 98.00 Kilometer from Hatichar, the River finally confluences with its Sink "Mighty Brahmaputra" near Chatala Hill (26°14'41''N 90°41'31''E) which is 5.00 Kilometer upstream of Jogighopa and the location map is shown in figure 1.

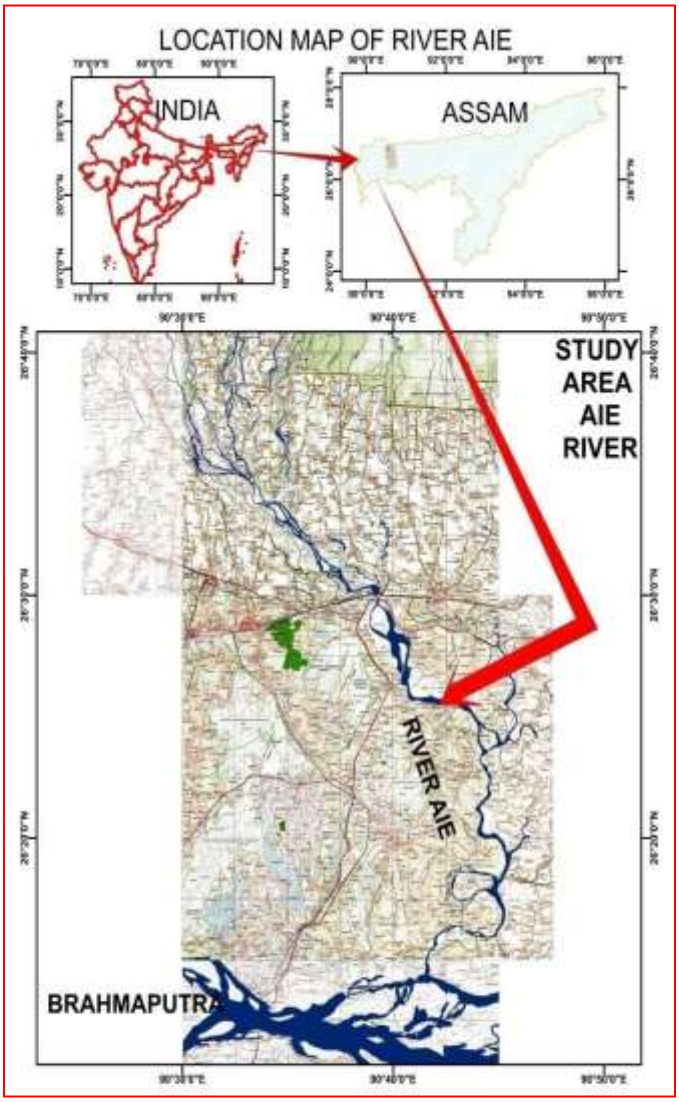

Figure.1. Location Map of River Aie.

The River AIE is a flashy and shallow River. It conveys huge quantities of silt at high flood period. It has a huge tendency to change its course frequently at alluvial areas. It is more destructive than other Rivers nearby like Champamoti, Manas, Beki, etc.

4. MATERIALS AND METHODOLOGY

The data used in determining the parameters for course change are as follows:-

1. Toposheet of the year 1955 of SOI.
2. Toposheet of the year 2009 of SOI.
3. LISS image for the year 2015 (ISRO).
4. Mathematical Formulae.

5. RESULT AND DISCUSSION

The parameters that are mathematically evaluated for the River were determined to study the type of River and its characteristics that is underlying in changing the River course. These parameters were determined by mathematically calculating the various parameters by their established formulae.

The various parameters are as follows:-

(i). Cross-Valley Asymmetry.

(ii). Sinuosity Index.

(iii). Lateral Entrenchment Ratio.

(iv). Profile Characteristics.

(v). Change in alignment of the River.

5. (i). Cross-Valley Asymmetry: - Cross-Valley Asymmetry is a technique to determine the morphometric property of the channel. It is determined in terms of degree of Asymmetry that the River hold while passing though the surrounding area from the mouth or source to the sink i.e., Sea, Ocean or River. The cross valley asymmetry is nothing but the determination of the River's adjustment with the surrounding environment.

Cross valley Asymmetry can be derived mathematically by the following formula:-

$$\mathbf{CVA = D_A/D_D}$$

Where,

D_A = Distance between the channel and the centerline of the basin.

D_D = Distance between the basin margin and the centerline of the basin.

When the River flows though the mid way or the centerline of the River channel the cross valley asymmetry of that River will be ZERO as there is no change in the distance between the channel and distance between the basin margin to the centerline of the basin in equal or unchanged during the path of flow i.e., the River channel is straight. Therefore the River is symmetry. This kind of situation is possible when the bed material is good and can resist erosion as well force of huge discharge that is carried by the River by the confined channel. When the River does not flows though the mid way or the centerline of the River channel the cross valley asymmetry of that River will be ONE as there are changes in the distance between the channel and distance between the basin margin to the centerline of the basin during the path of flow i.e., the River channel is sinusoidal in nature. Therefore the River is asymmetry. This kind of situation is possible when the bed material is mainly of alluvial deposit and erosion takes place in huge quantity due its binding capacity of the particles as well force of huge discharge that is carried by the River. Thus the River represents the branching pattern throughout the River. The value calculated for the River AIE for the cross valley asymmetry is 0.64. The value thus represent that the River is asymmetric in nature and therefore large scale shifting takes place when an external force like Flash flood takes places, which is very dangerous in nature.

5. (ii). Sinuosity Index: - Sinuosity Index is a parameter to determine the sinusoidal curve the River that is undertaken while flowing though its course in a shape of sinusoidal wave. Sinuosity Index the calculation of deviation of the path of flow of the River from its ideal path of movement between the source to the sink. Mathematically, Sinuosity Index is calculated by the following formula:-

SI = CL/SL

Where,

CL = Actual Channel Length between the source and the sink

SL = Straight line length between the source and the sink Sinuosity Index (SI) = 1.0, when there are no shifting of the River within the channel and the channel is referred as straight River. Sinuosity Index (SI) > 1.0, when there is shifting of the River within the channel and the channel is referred as meandering River. The Sinuosity Index value is 1.05 after calculation. The data were extracted from LISS 2015 satellite data. Since the value is 1.05, the type of sinuosity of the entire River is weak. On considering the entire the channel the River is almost straight in the entire course. The load it carries are- suspension, mixed and bed load.

5.(iii). Lateral Entrenchment Ratio:- Lateral Entrenchment Ratio is the ratio between the lengths of the left bank to the length of the right bank of a River. Lateral Entrenchment Ratio Index is calculated by the following formula:

ER= LL/LR

Where,

LL= Length of the left bank

LR= Length of the right bank.

Lateral Entrenchment Ratio helps in identifying the amount of bank shifting that has taken place within the River. Lateral Entrenchment Ratio = 1, when there is no bank shifting.

Lateral Entrenchment Ratio > 1, when the channel has shifted towards its left bank at the given section of the River.

Lateral Entrenchment Ratio < 1, when the channel has shifted towards the right bank at the given section of the River. The Lateral Entrancement value is 0.97 after calculating the length of both the banks and dividing left bank to the right bank from LISS 2015 satellite data. Since the value is less than 1, therefore the River tends to shift towards the right bank of the River channel.

5. (iv). Profile Characteristics: - The elevation of the River was determined from the software Google EarthPro in the 3D mode, where a distinct elevation above mean Sea level is available, the data is extracted and plotted statistically in a graph and a visualization is obtained to have a clear image of the elevation of the River channel flowing mainly through the alluvial deposits. From the data, long profiles of the Rivers channel have been prepared. The River is almost flatter. Figure.6.9. shows the elevation of the River above mean Sea level from Hatichar (Indo-Bhutan Border) to Brahmaputra (Jogighopa) is shown in figure 2.

Figure.2. Elevation of the River Aie.

5. (v). Change in alignment of the River:- Change in alignment of the River can be plotted or extracted by comparing the extracted data from the Survey of India prepared Toposheet and satellite data like LISS of different years. The data gives a distinct visualization of the changes that has taken place due to various reasons like meandering in the alluvial plain, obstruction due to human action, etc. The toposheet of 1955 and 2009 and LISS data for the year 2008 and 2015 were used in the determination process and the differentiation is shown in figure 3.

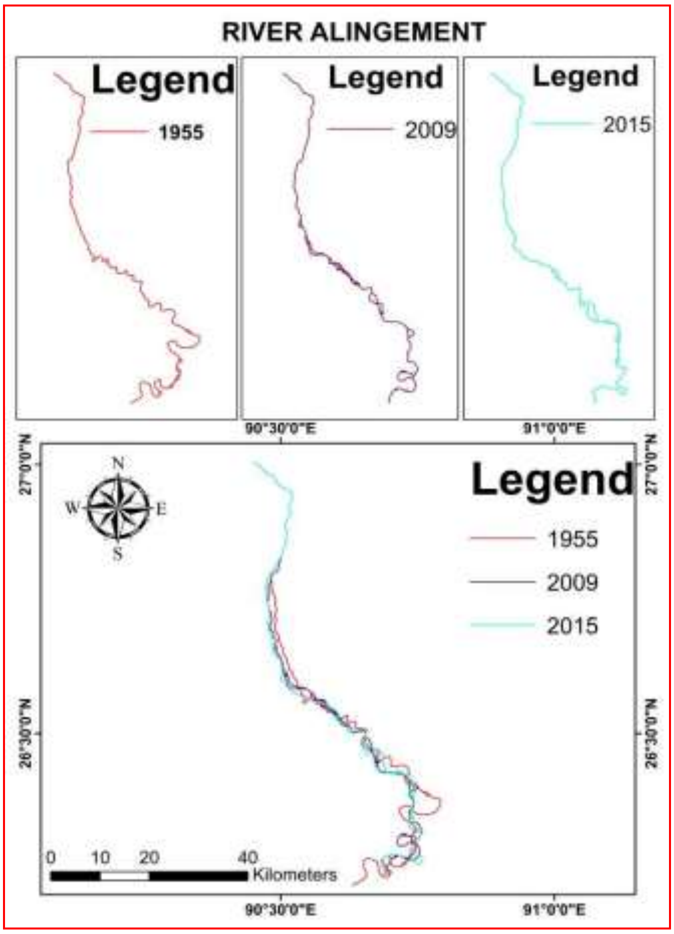

Figure.3. Overlapping of image of the River course of the Year 1955, 2009 & 2015

6. CONCLUSION

From the analysis of the channel morphometry, it was found that the River is asymmetric and shifting of the River towards the right bank. The sinuosity index is very weak for the entire channel. The elevation difference of the River in the alluvial plain is very low, i.e., the River is flatter in the alluvial deposits. From the analysis of lateral and longitudinal displacement or shifting it can be concluded that during the span of years from 1955 to 2009, it has been seen that the River has an average lateral shifting of 1.43 Km and reduction in longitudinal distance of the River by 42.71 Km. And from the analysis of lateral and longitudinal displacement or shifting it can be concluded that during the span of years from 2009 to 2015, it has been seen that the River has an average lateral shifting of 0.32 Km and increase in longitudinal distance of the River by 7.96 Km. Overall the River has an average shift of 0.875 Km.

ACKNOWLEDGEMENT

The author is very grateful to Mrs. Meena Singha madam for imparting knowledge on RS and GIS, which has helped in the completion of the research work.

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