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Identification of River Migration Using Geospatial Data: A Case Study of The Lower Part of River Ajay Near Katwa Town

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ABSTRACT
River migration is important and significant geomorphological processes that are involved with lateral movement of both sides of the river and it migrates throughout the entire floodplain. Ajay is one of the most important non-perennial rivers that involves with migration of bank especially Lower part which is very close Katwa Town. At present context, River Ajoy has drastically eroded the sideward portion and through this process river width of Ajoy is gradually increased day by day. Due to the study of River migration, the morphometrical patterns are also identified. For this study, 1927 PS Map, 1968 Topographical Sheet, 1990 Landsat TM, and 2016 Resourcesat LISS-III satellite images are used. All maps are deeply analyzed and calculated to find out the river width and the river bank erosion. Geospatial data is analyzed with the help of ArcGIS Software. By this analysis, we have found the nature of erosion which is mainly highlighted on the confluence point of the river and human activates are also affected due to the changing behavior of this river.
KEYWORDS: Bankline Erosion, Channel Shifting, Confluence Point, Floodplain, Geospatial data, Thalweg point Thematic Map, Sand Mining.

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I. INTRODUCTION

Ajay is a non-perennial river that originates on a small hill, Deoghar in Jharkhand and then it flows through Jharkhand and West Bengal. The river creates boundaries between Jharkhand and Burdwan district and finally, it joins to the Bhagirathi River near Katwa subdivision in Purba Burdwan District, West Bengal. The total length of the river is 288 km. Morphometrical changes are a valuable aspect of geomorphological studies. Morphometrical changes of the river also influence on the river channel. River discharge condition may affect the change of morphometry, the high-level discharge may affect the surrounding landform of the river bank, may influence the change of morphometric features (P.K. Sen. 1993).

II. OBJECTIVES

The present study will try to fulfill the following objectives:

- To measure the changing pattern of the Ajay River course (near Katwa) in comparison with a long period of time (1927-2016).
- To analyze the Riverbank line shifting pattern of the Ajay River in different years.

III. LITERATURE REVIEW

- D. Knighton(1984) tried to describe in his book entitled, “Fluvial Forms and Process”, that the pattern of river flow may affect the morphological pattern of a river.
- P.K. Sen(1993) mentioned in his book entitled, “Geomorphological Analysis of Drainage Basin”, river morphology totally controlled by the condition of river discharge. It also affects the surrounding landforms.
- M. Gustausion. and E. kolstrup (2006) analysis of the geomorphological characteristics of a landscape in their Research paper entitled, “A new symbol and GIS-based detailed Geomorphological Mapping System Development: Renewal of A scientific discipline” for understanding landscape development.

- C. Laha. and S. Bandyapadhyay (2013) described in their paper entitled, "Analysis of the changing morphometry of River Ganga, shifting monitoring and Vulnerability Analysis using Space-Borne Techniques: A Statistical Approach", that bank erosion for channel migration demands available stream energy that reaches its peak level during bank full stage.
- S. Roy. A. and S. Sahu(2006) has mentioned in his paper named "paleo-path investigation of the lower Ajay River (India) using archaeological evidence and applied remote sensing", that the variation of density of basement rocks played a major role to control the channel migration.
- N.J. Ety. And S. Rashid. (2017) outlined in their paper entitled, "Changing Pattern of the downstream of Ganga Rivercourse: A Comparison with Rennell's map of 1970", that the erosion and accretion process is the major aspect which is observed just because of the hydrological processes and that's why River morphology changes its position rapidly.

IV. DATABASE & METHODOLOGY

Explanation of past, present, and future of any geomorphological event require a particular method and approach for analysis according to Chorley (1966), the integrated approach to research methods in geomorphology include field observation, laboratory observation, office observation, and theoretical work. Entire analysis has prepared on the basis of secondary data. All data have been collected from various sources which are farther analysis through several GIS Software such as are GIS 10.3, Erdes Imagine and Q-GIS and the projection used here for geo-referenced is WGS 1984 UTM Zone 45N.

Table 1. Sources of database

Source of Data Base	Type of Data Base	Map Projection	Remarks
Survey of India	PS Map	WGS_1984_UTM Zone_45_N	Scale=1" to 1 Mile
Survey of India	Topographical Map	WGS_1984_UTM Zone_45_N	Scale=1cm to 50000cm
United State of Geological Survey	Thematic Map	WGS_1984_UTM Zone_45_N	Spatial Resolution 30 meters
National Remote Sensing Centre (Bhuvan Store)	Liss-III (Resourcesat),2016	WGS_1984_UTM Zone_45_N	Spatial Resolution 23.5 meters

The changing part of a river Ajay discusses from the geomorphological background. The base map of this study area is 1927 PS MAP. Apart from this 1968 toposheet, 1990 TM Map, 2016 LISS Image is used to detect the changing behavior of the river course as well as the river bank line. All map is using into one projection which is WGS 84 UTM 45N.

V. RESULT & DISCUSSION

- **Delineation of Bank line of Ajay River.**

it is very difficult to determine the river line of river Ajay. In every year it was shifted marginally in a different direction. Four types of data have been used to determine the bank line of river Ajay. These are PS map, SOI Toposheet, Land Sat ETM+ and Resource sat LISS-III. As the Landsat TM Band 4(0.76-0.90um) is suitable for land wanted interfaces separation.

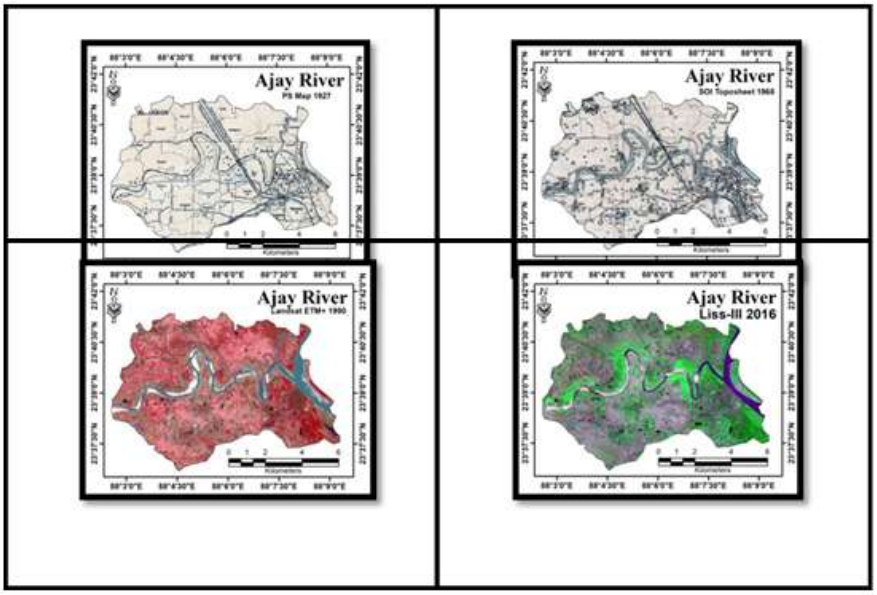


Figure 1.Delineation of bank line of Ajay river in different temporal scale from 1927-2016

- **The shifting pattern of Ajay River (1927-2016)**

For the identification of the shifting pattern of the Ajay river is very difficult especially near Katwa Town because some bank line of river Ajoy is controlled by human activity. Several maps are used (1927 to 2016) to the shifting nature of the river. All maps are superimposed on the base map (1927 PS Map) then draw five cross profile (CP-1,2,3,4,5) and noticed that major eroded portion of is SW direction it means towards Katwa and deposited the other side towards Ketugram block. Gradually river changes its position from NE to SW direction which is the impact upon the land use pattern of SW part or Katwa block.

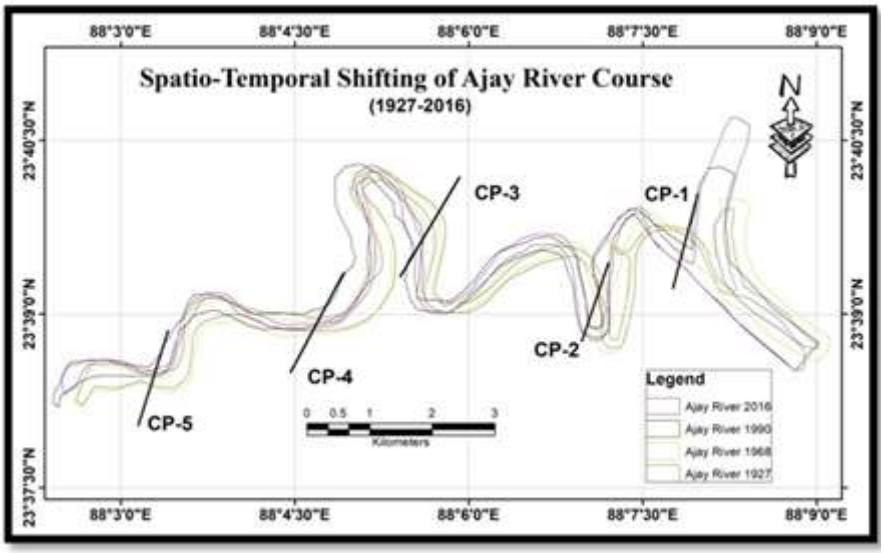


Figure 2. River width in different cross section from 1927 to 2016

- **Bank line Shifting (1927-1968)**

Five cross profile is used to measure the erosional and depositional nature of river Ajay. In this comparison, it was found that left bank (NE) eroded 70 mts. where right bank eroded 290 mts (SW) and the other side of all cross section shows that right bank eroded much more than the left bank. The following table shows the nature of bank line shifting or the nature of river bank erosion of River Ajoy.

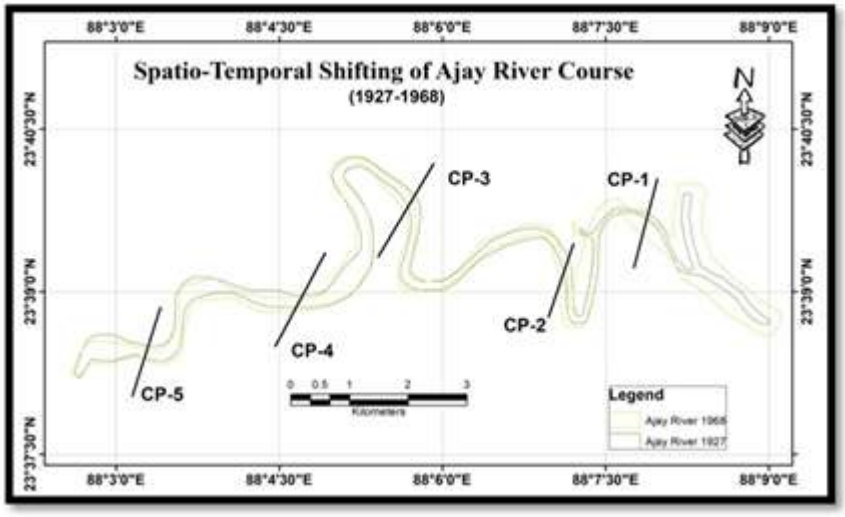


Figure 3.bankline shifting of Ajay river from 1927 to 1968

Table 2.Width variation in different cross section from 1927 to 1968

Cross Section	River Width, 1927(Km)	River Width,1968 (km)	Right Bank (m)	Left Bank (m)	Direction of Migration
CP-1	0.08	0.30	290	70	SW
CP-2	0.23	0.30	220	140	SW
CP-3	0.26	0.24	90	100	SW
CP-4	0.23	0.23	56	50	SW
CP-5	0.21	0.16	7	60	SW

Source: (Prepared by Author)

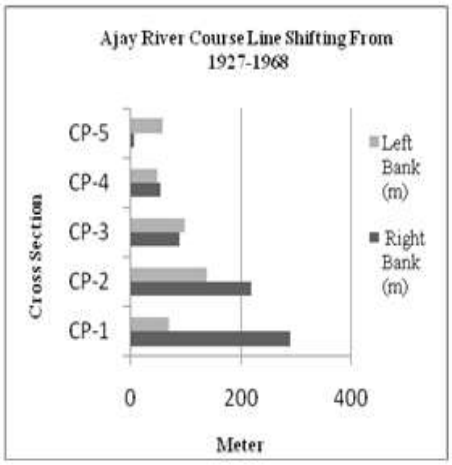


Fig 4.River cross line shifting (1927-1968)

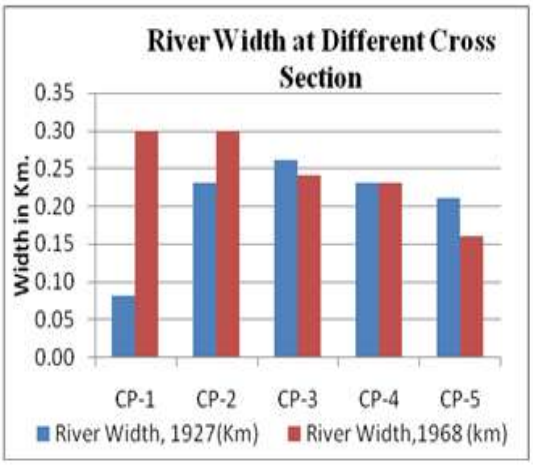


Fig 5.Bank width variation (1927-1968)

From the above diagram, it appears that at the Cross Section 1, the river width was 0.08 km and 0.30 km in 1927 and 1968 respectively. The river was shifted towards South-West direction right bank is much more eroded than left bank due to the trend of river flow. It is noticeable that the right bank portion much more shifted to the right direction than a left bank to the entire period.

- **Bank line Shifting (1968-1990)**

In this period it is cleared that first three cross-section represents that the nature of erosion is pointed towards SW direction as because the river join into the Bhagirathi river in the SE direction and SW part of Katwa block which was eroded gradually and the other two cross-section reflects that the left and right bank was eroded in the negative direction (NE) due to the human interference.

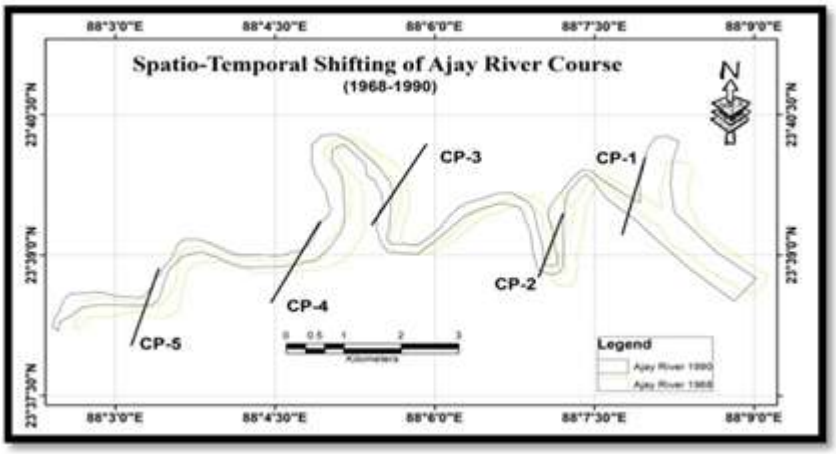
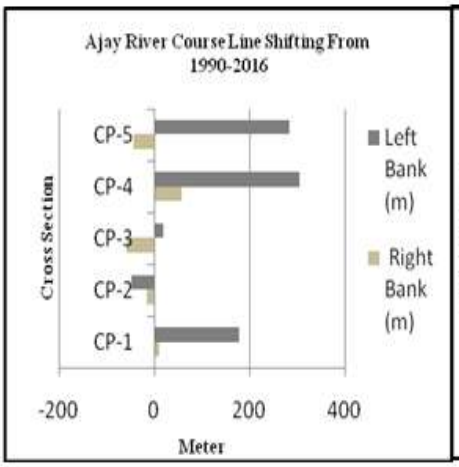


Figure 6.Bankline shifting of Ajay river (1968 to 1990)

Table 3. Width variation in different cross section from 1968 to 1990

Cross Section	River Width, 1968(Km)	River Width,1990 (km)	Right Bank (m)	Left Bank (m)	Direction of Migration
CP-1	0.30	0.30	163	156	SW
CP-2	0.30	0.16	460	600	SW
CP-3	0.24	0.49	670	418	SW
CP-4	0.23	0.36	-150	-260	NE
CP-5	0.16	0.41	-156	-384	NE

Source: (Prepared by Author)



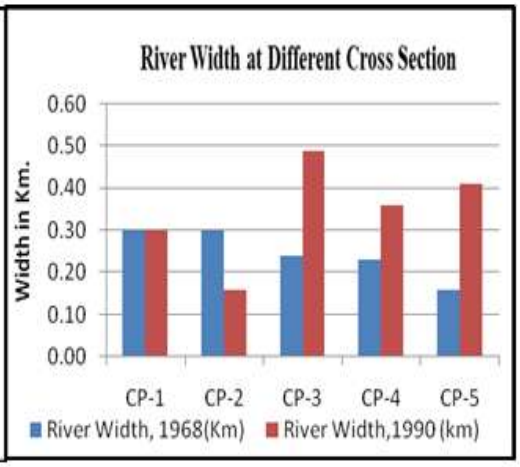


Fig7. River cross line shifting (1927-1968) **Fig 8. Bank width variation (1968-1990)**

At this stage, a vast change was not visible. The river width was 0.30 km at the confluence point (CP-1) of River Ajoy but at the Cross Section three, river was extended near about 0.25 km and erosional side was found to the South-West direction, the right bank was much more affected (670m) than the left bank (418m) of River Ajoy near Katwa Town. This migrational nature was totally positive in term of direction. Cross Section 4 & 5 represents the negative movement of the River Ajay. Right bank shifted near about 150m towards the left side and left bank was shifted 260 m to the left side which indicates North-East direction. The negative direction was found due to the huge amount of sand mining to the left side of the river Ajay. So the left bank was extending and thalweg point was shifted towards the left side.

- **Bank line Shifting (1990-2016)**

In between 1990 & 2016 river has migrated both sides in different cross section. Incross-section-1, it was 179m and eroded in the right side of the bank whereas Cross Section 4 &5, it was 305 & 284 m respectively at the right side and cross-section 2& 3, it was -15, -59 m respectively because of the anthropogenic factors.

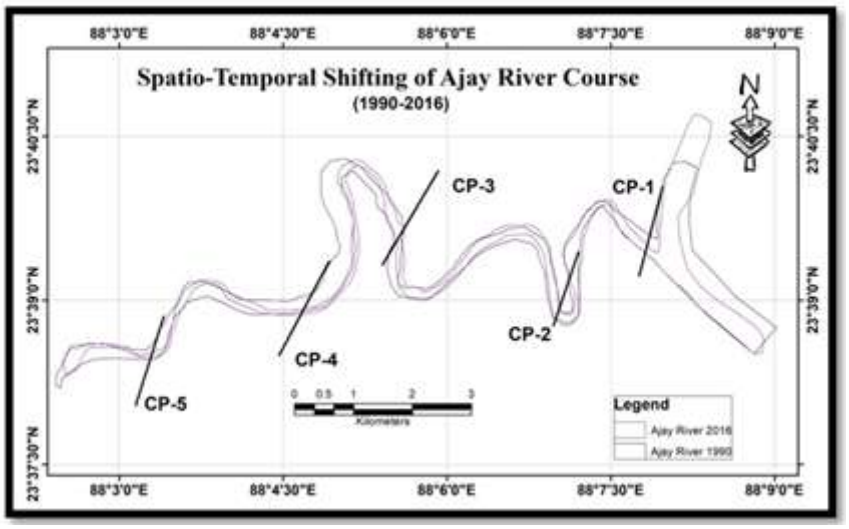
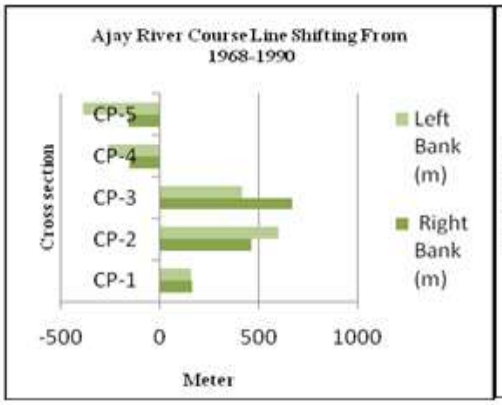


Figure 9.Bankline shifting of Ajay river (1990 to 2016)

Table 4. Width variation in different cross section from 1990 to 2016

Cross Section	River Width, 1990(Km)	River Width,2016 (km)	Right Bank (m)	Left Bank (m)	Direction of Migration
CP-1	0.30	0.31	10	179	SW
CP-2	0.16	0.21	-15	-48	NE
CP-3	0.49	0.19	-59	20	NE/SW
CP-4	0.36	0.11	57	305	SW
CP-5	0.41	0.08	-43	284	NE/SW

Source: (Prepared by Author)



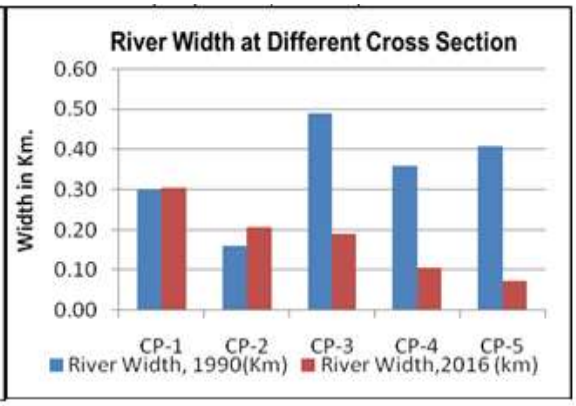


Fig10. River Cross Line Shifting (1990-2016) Fig11. Bank width variation (1990-2016)

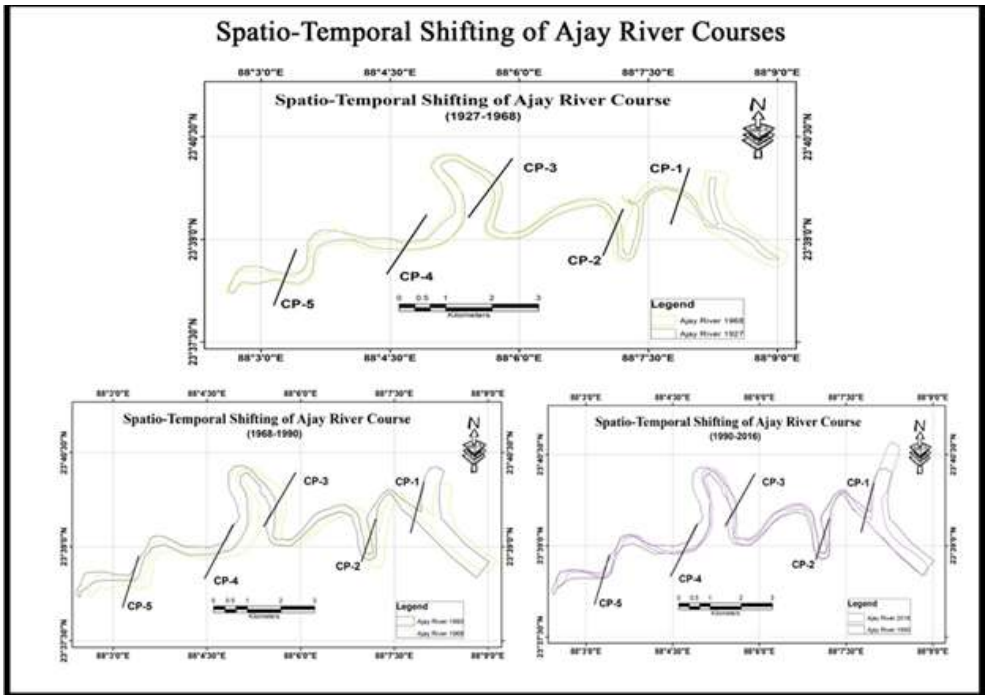


Figure 11. River width of the different cross section from 1927 to 2016

- **Statistical Analysis of River width in Different years.**

Table 5.Channel width variation of different cross section from 1927-2016

SL NO	Cross Section	RIVER WIDTH 1927s(Km.)	RIVER WIDTH 1968s(Km.)	RIVER WIDTH 1990s(Km.)	RIVER WIDTH 2016s(Km.)
1	CS-1	0.08	0.30	0.30	0.31
2	CS-2	0.23	0.30	0.16	0.21
3	CS-3	0.26	0.24	0.49	0.19
4	CS-4	0.23	0.23	0.36	0.11
5	CS-5	0.21	0.16	0.41	0.08
6	Maximum	0.26	0.30	0.49	0.31
7	Minimum	0.08	0.16	0.16	0.08
8	Mean	0.20	0.25	0.34	0.18
9	Median	0.23	0.24	0.36	0.19
10	Standard Deviation	0.06	0.05	0.11	0.08

Source: (Prepared by Author)

Due to erosion, river migration on the bank of Ajay River is characterized by rapid rates of channel migration temporally. Spatial data provides temporal information which helps us to find out the shifting nature of a river Ajoy.

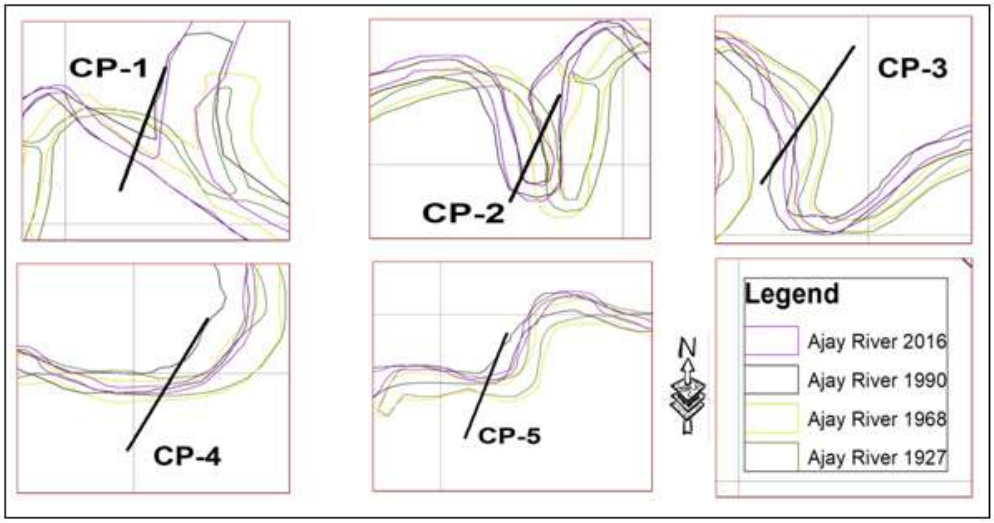


Figure 12. Spatial and temporal variation of channel pattern in different cross section from1927-2016

In 1927, maximum river width was 0.26 km in CS-4 and the minimum river width 0.08 km in CS-1. Mean cross-section of all is 0.20 km and the median was 0.23 km. and values are normally distributed from the average value is 0.06 Standard Deviation. Skewness is -1.87, negative and kurtosis is 3.85. So the distribution is not symmetric.

Again in 1968, maximum river width was 0.30km which was noticeable in CS-1 & 2 and the minimum is 0.16 km in CS-5. And the mean river width was 0.25 km. Values deviate from the mean values is 0.05 Standard Deviation and the Skewness -0.69 which is negative and the kurtosis is also negative -0.15 it means the distribution is the totally negative direction and the distribution is purely non-symmetrical.

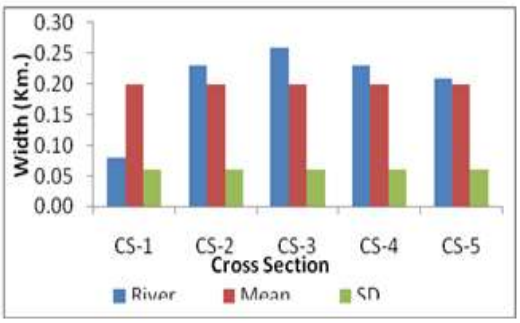


Fig 13.River width variation in different cross-section in 1927

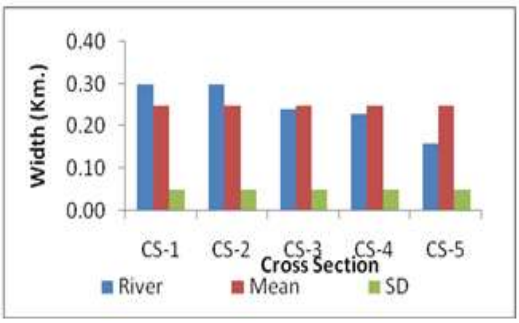


Fig 14. River width variation in different cross-section in 1968

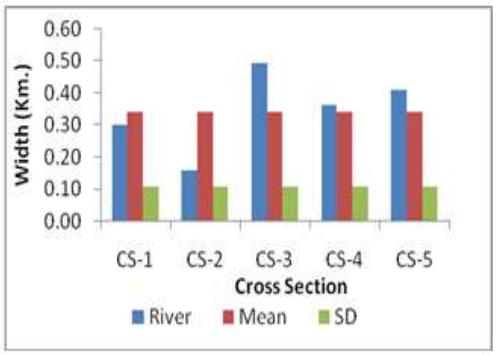


Figure 15.River width variation in different cross-section In 1990

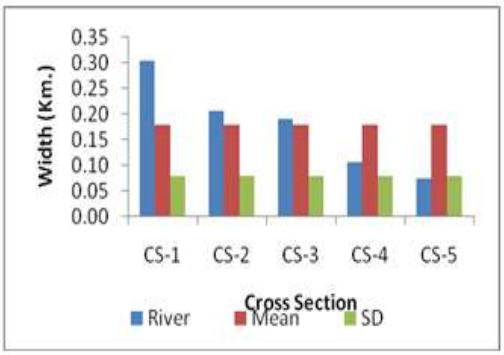


Figure 16. River width variation in different cross-section In 2016

Now in 1990, maximum river width was 0.49 km in CS-3 and the minimum river width was 0.16 km in CS-2 and the mean river width is 0.34 km and the median is 0.36. Values are normally distributed away from

mean in between 0.11 standard deviation and the Skewness and kurtosis are -0.63 & 0.52 respectively. So the distribution is purely nonsymmetric.

And finally in 2016, the maximum river width was 0.31 km in CS-1 and the minimum river width was 0.08km in CS-5. Mean is 0.18 km and the median is 0.19 km. And the values are distribution away from mean 0.08 and the Skewness and kurtosis are 0.43 and -0.50 which is strongly representing a negative or non-symmetric distribution.

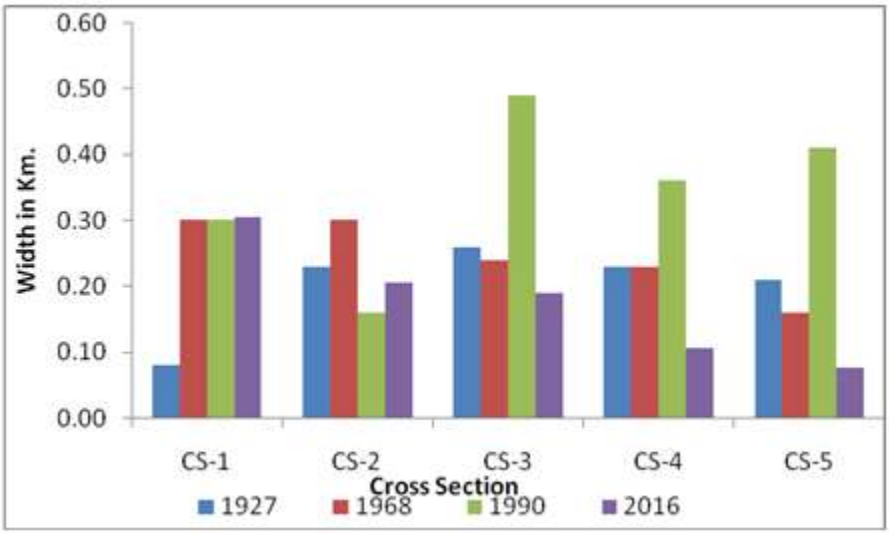


Figure: 18 River width of the different cross-section in different years

Cross Sections shows the noticeable characteristics of this river Ajoy in different temporal scale. River width gradually increases in CS-1, 0.08km in 1927, 0.30km in 1968, 0.30 km in 1990 and 0.31km in 2016. In this way, it is clearly measured the river width in different years and somewhere its decrease and somewhere its increases. Maximum river width is remarkable in 1990 and 2015.

- **Causes of Migration**

The main causes of river bank migration of river Ajay near Katwa town are as follow. In this study, area of river migrates due to huge rainfall and during flood in 2000 the River water spread over the banks and it's also stimulating for erosion in the surrounding areas and also the river channel. Apart from this ,a massive amount of sand mining affected the morphometric pattern as well as the channel morphology of Ajay River.This is because, sand mining influence to change the thalweg point of a river and anthropogenic factor such as artificial river bank, cementization of surrounded river bank etc. influence the river migration.

VI. CONCLUSION.

Erosion and deposition are common processes for controlling geomorphological landforms. Rivers flow its own natural way and regularly changes size; shape etc. Riverbank erosion is the most common incident which changes the morphometric pattern of a river. Ajay River which meets with Bhagirathi River towards the southeast direction. And over a long period, it's eroded the riverside portion. Which is directly and indirectly affected human activities. Due to huge sand mining from Ajay River, the thalweg point is affected and the morphometrical pattern of this river also changes. Natural Flood is another important factor that controls the nature of river migration of both banks of River Ajoy. Maximum side ward erosion is noticeable in the SW direction which is located to the North-Western part of Katwa Block.

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