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CHANNEL LEANING OR CHANNEL FATTENING AND QUASI MISFIT STREAM GENERATION

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Abstract: *Present paper aims to find out effect of channel bifurcation and channel linking on donar and receiver river its causes and process of evolution in lower catchment of Mayurakshi River. Toposheets of Survey of India and satellite imageries (IRS 13, LISS III) have used to detect evolutionary process. Field measurements through field survey have done to collect primary data. It is found that just after channel bifurcation, the width of the master stream has drastically reduced and width of the receiver river has increased. This kind of disproportionate stream width character between upper and lower reaches of channel bifurcation and linking sites is called quasi misfit stream as the character of those altered channel is not completely analogous with misfit stream.*

Keywords: *Channel Fattening, Channel Leaning, Channel Diversion, Pseudo Natural Channel Linking, Mayurakshi River Basin, Cross sectional Change, Quasi Misfit Stream*

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INTRODUCTION

A misfit stream is either a stream or river that is either too large or too small to have eroded the valley in which it flows. This term is also used for a stream or river with meanders that obviously are not proportional in size to the meanders of the valley or meander scars cut into its valley walls. If the misfit stream is too large for either its valley or meanders, it is known as an over fit stream. If the misfit stream is too small for either its valley or meanders, it is known as an under fit stream (Dury, 1964, Neuendorf, 2005).

Misfit streams can also be caused by reductions in the discharge of the stream. Channel size responds rapidly to variations in discharge but valley size responds over much longer timescales. Many causes of reduced discharges are possible. If misfit streams are widespread in an area, climate change, particularly a reduction in precipitation, is likely to be the cause (Dury, 1958 and Dury, 1964). If a single river appears to be a misfit stream, it may be as a result of anthropogenic interference through groundwater extraction or dam construction upstream. Natural causes include stream capture or other changes in drainage patterns (Manville, 2004).

The capture or diversion of a part of the river course by another strengthen river is called river capture or river diversion or stream piracy, or stream hijack. It is the effect of lateral and head ward erosion of a channel. The stronger river which captures the other stream is called *captor river*, while part of the river captured by the stronger one is called *captured river* or diverted river or pirated river. The grading of the river is determined on the basis of relative amount of water volume, river gradient, erosive power etc. Head ward erosion is the main cause of river piracy in the mountainous region while lateral erosion and meandering intersection are also important causes for river capture in the flat land areas. *Beheaded stream* is the lower part of the weaker consequent stream below wind gap. It is called beheaded because source region of the river is diverted to neighbouring stronger river. This beheaded stream is also known as misfit stream because there is no parity between width of the upper and lower reach of the river as usually happens as well as width is so wider in respect to existing beheaded length it is termed as misfit river (Dury, 1958). Sometimes, reduce of active channel width also creates misfit stream. It means if the active channel width where through which water flows at present is so narrow in respect to total

width of the channel, it could be termed as misfit stream. After rejuvenation, when valley within valley is developed, this kind of misfit stream may generate (Sinha, 1996).

Ouasi misfit stream character is not absolutely alike with misfit stream both in respect to width or length parameters. Hypothetically, width of the channel increases downstream. So many local/regional causes are directly and indirectly responsible for regional level variation and deviation of these principles (Moriswa, 1985). If any case river is not being pirated by any other river but due to bifurcation from main stream, width and volume of the discharge may be drastically reduced in the main stream or due to linking of any distributaries from neighbouring stream with other stream, discharge, specifically width or other morphological dimensions may be increased in very observable scale, this type of altered streams are called quasi misfit stream.

River bifurcation may be temporary or semi-permanent, depending on the strength of the material which separates the distributaries. For example, a mid-stream island of soil or silt in a delta is most likely temporary. A location where a river divides around a rock fin, e.g. a volcanically formed Dike, or a mountain, may be more lasting. A bifurcation may also be man-made, for example when two streams are separated by a long bridge pier (Morisawa, 1968, Leopold et al., 1964).

Over the past 14 years, it is being concentrated to study on what happens to water flow and sediment (mud, sand and gravel) at river confluences, where two channels combine into one. However, it has rather neglected paying as much attention to understanding what happens when one channel splits into two or more channels (Morisawa, 1985). As a result of this we do not really know very much about how the river is divided, the influence that this division of the channel has one on the water flow and fluid turbulence and, crucially, how sediments are moved through and around these complicated river divisions. Knowledge and understanding of the process of channel bifurcation is vital if we are better to model and manage many of our natural waterways and better predict how and where they both transport and deposit their sediments (Richards, 1973, Bloom, 1979, Richard, 2001). Although ongoing research is beginning to fill in some of these gaps in our understanding through the use of laboratory experiments and mathematical models, this has not been matched by sufficient progress in measuring and quantifying the bifurcation process in

natural river channels, very often because natural rivers are far harder to study and the technology required has simply not been available.

STUDY AREA

Mayurakshi river of Jharkhand plateau and Bengal Basin is one of the well known name in the river map of India. Its unique hydro-morphological behaviour is also interesting. Mayurakshi River emerges at Jharkhand from Trikut Hills' (Near 10 km south of Deoghar in Santal Pargona District) at an elevation of 400 meters, flows down 380 km. long course through a large part of Eastern India. Massanjore dam over the river constructed on 1956, Tilpara barrage over it on 1971 etc. have made the channel morphological phenomena complicated (Mukhopadhyay & Pal, 2009). Total area of this river basin is 6400 sq.km. including three main sub basins namely Mayurakshi, Dwarka and Kuya. Kultore barrage over Kuya river also controls up and down stream morphological conditions. From the absolute point of view the study area is located between 23° 40' N to 24° 34' N latitude and 86° 58' E to 88° 10' E longitude. Important settlements like Deoghar, Dumka, Massanjore, Suri, Sainthia, Kandi etc. have taken shape within the basin area over centuries.

In the downstream course, the spacing is too narrow and relief pattern is so mundane that there is a complex interplay among individual reaches of the sub basins and individual basin demarcation for all the sub basins is difficult (Pal, 2010). Channel diversion, shifting of channel, channel piracy by man, massive sand heap on river bed etc. are some principle features of this river basin specifically in the downstream areas. Some of the channels from main river (Mayurakshi) have met with right hand tributary Kuya river over course of time and these are in changing course of fast evolution.

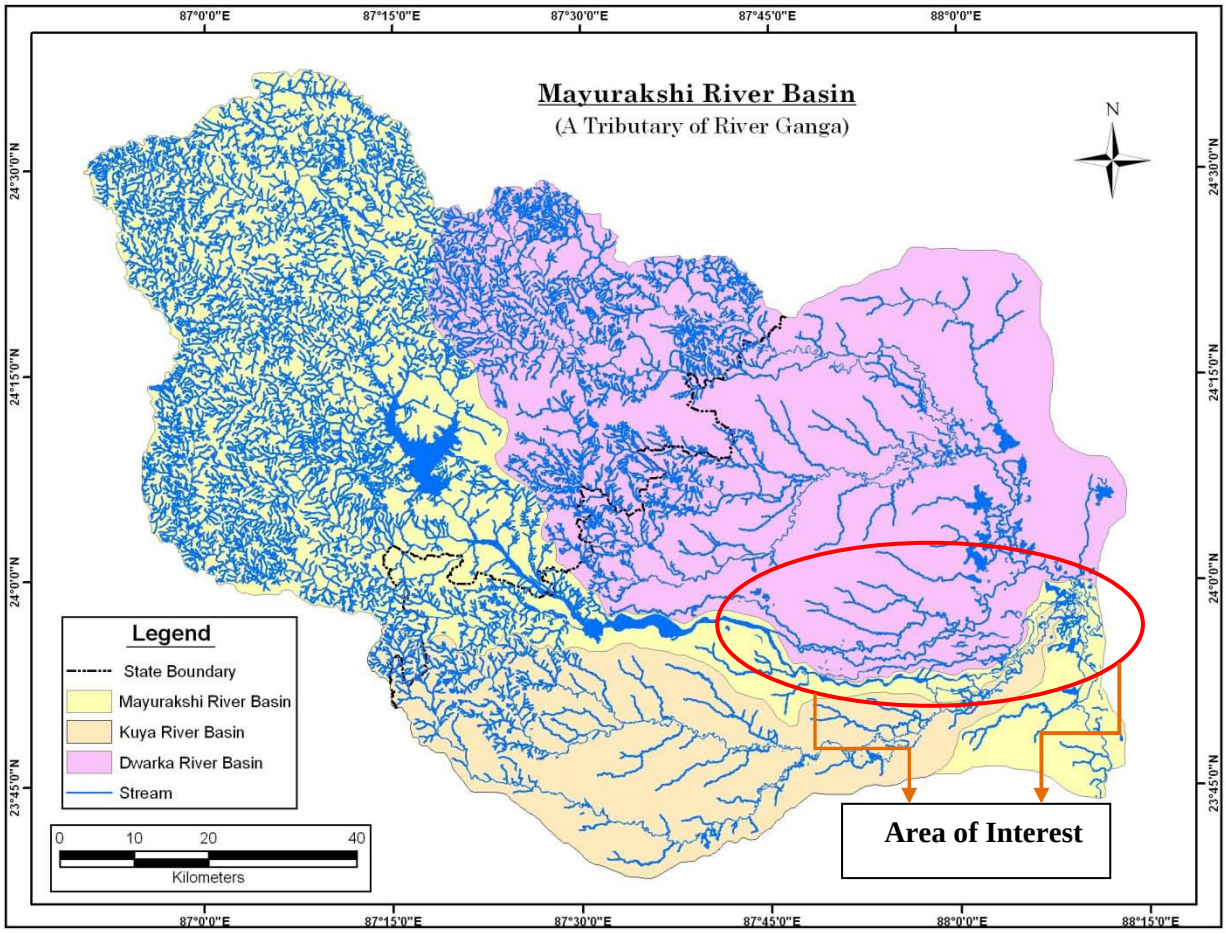

Fig. 1

MATERIALS AND METHODS

Most of the data have been collected from direct field observations and measurements. Toposheet of SOI, recent satellite imageries, perception of the bank dwellers etc. to detect the change of morphological and hydrological parameters. Arc GIS and Surfer 8 software have used to present data in required form. River features have been traced from toposheets of the previous year and recent satellite imageries as well as field investigation. Width related data has been collected from direct field measurement on more than 50 sites in different reaches of the basin. Locations of the sites have measured with the help of GPS and cross section and width measurement has been done using Dumpy Level Survey.

RESULTS AND ANALYSIS

Width Pattern From Source to Mouth in Mayurakshi River Course

Width pattern of Mayurakshi River has declined from source to mouth which is reverse to the hypothetical trend. In the middle catchment of the basin like Ektala, Sainthia, Boipur etc.

the width of the river is very extended but in the confluence it is abnormally narrow. Bifurcation and channel diversion from main channel toward river Kuya and draining of water from the parent river is one of the main causes behind such narrowing down of river course. Construction of rail bridge at Sainthia, bridge for road way at Ektala etc. have widened the width of the channel on those sites. At the confluence of the river, the width of the channel is only 16m. Such bottle neck channel could be explained in response to bifurcation of channel from Mayurakshi river, sticky alluvial soil of the region, influxing of river to the wetland areas, loss of hydraulic capacity of the stream etc. (Pal, 2011, Pal, 2012).

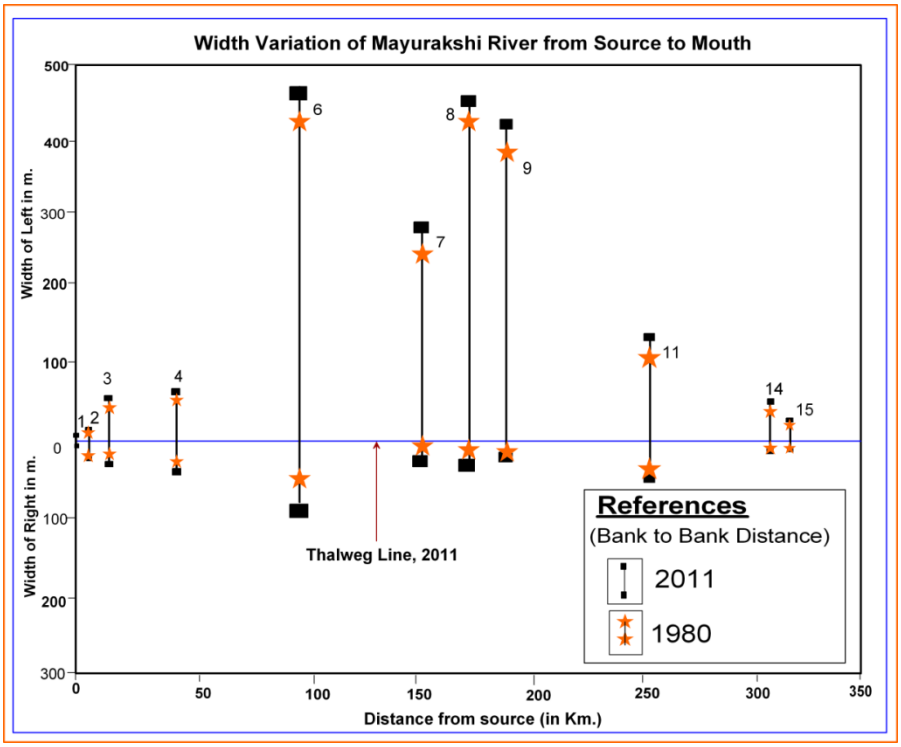

Fig. 2

Width Pattern from Source to Mouth in Kuya River Course

In contrast with normal pattern of width, in case of Kuya river, the width of river has also slightly declined downstream. Average width of the river is 52.02m. Few places are there where width is far low or above average width. For example at Milanpur 1 (Site 10), the width is very narrow (19m.) due to cohesive soil and deep channel. At Kultore Barrage, (Site, 5 in fig. 3) the width is 110.2m. Such abnormal widening of channel is only because of the passing of huge volume of water released from barrage all on a sudden during peak monsoon and excavation of sand and soil in its right bank. Interestingly, in most of the middle reach, the width of the channel is very narrow but it has again widened in the down

reach. Pseudo natural channel linking explains such uncommon phenomena in Kuya river (Ghosh et al., 2012). It is pseudo because this phenomena of channel linking is to some extent regulated by man.

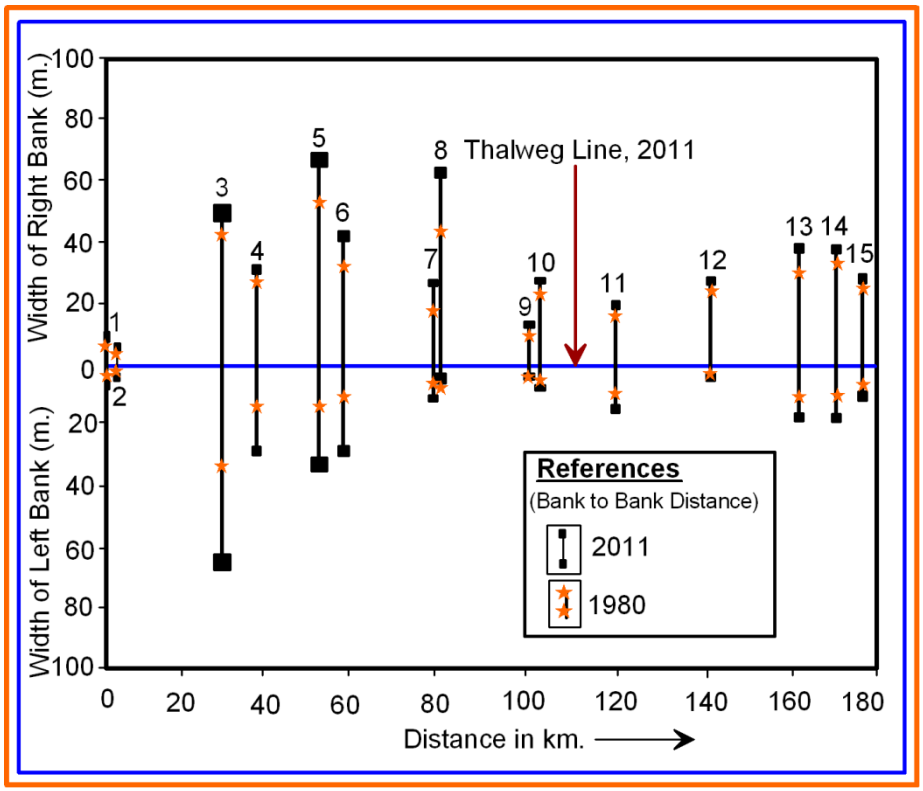

Fig. 3

Channel Fattening and Leaning

Channel bifurcation and linking is very natural process in every structurally confined and unconfined river. The nature of bifurcation and linking is of different types and those are observed in different parts of the reach. In Rarh Bengal, the evidences of such bifurcation and linking is found mainly in middle and lower catchments. Due to man induced natural causes, over course of time, these bifurcated channels and linkers have been changing their positions i.e. point of bifurcation, course of movement, point of linking etc. In association with it the hydrological and morphological characters of the donor river (from where bifurcation starts) and receiver river (to which the bifurcated river debouch) have also been modifying.

Figure 4 explains the changing characters of the interlinking and bifurcations over time. In the downstream course, river Mayurakshi and Kuya are flowing in very close proximity. Near Sundarpur bridge and Harischandrapur two of the bifurcated branches of Mayurakshi river

have emanated and linked with Kuya river. Through course of movement, the directionality of the bifurcated rivers has changed several times. Sometimes loss of one linker channel has forced to form another one. Bifurcated channel has formed water logging e.g. Maldah wetland due to lack of proper draining route of the bifurcated channel to the main river. Link after main river course has changed several times both morphologically and hydrologically. Often it is happened that after linking of bifurcated channel, the width of the river has widened, volume of the discharge has risen up and over all the energy level or working capacity of the receiver river Kuya has increased. This event is termed as *Channel Fattening*. On the contrary, when one linker river has lost its existence, gradually link after river course has become lean both in morphological stature and hydrological strength even some cases total existence of the channel has disappeared (vide fig. 4). This phenomenon is called *river piracy*.

The 1st bifurcated channels traversing the interfluves of Mayurakshi and Kuya has lost its existence over course of time due to forceful embanking of the bifurcation site. Irrigation and water way authority has erected this lofty embankment in this site to protect flood along sides the bifurcated channel. After this forceful incident, Receiver River did not get substantial amount of water and as a result the Kuya River reach in between 3rd linking site and 4th linking site has become lean (vide fig. 4). It is an example of weakening or thinning of river.

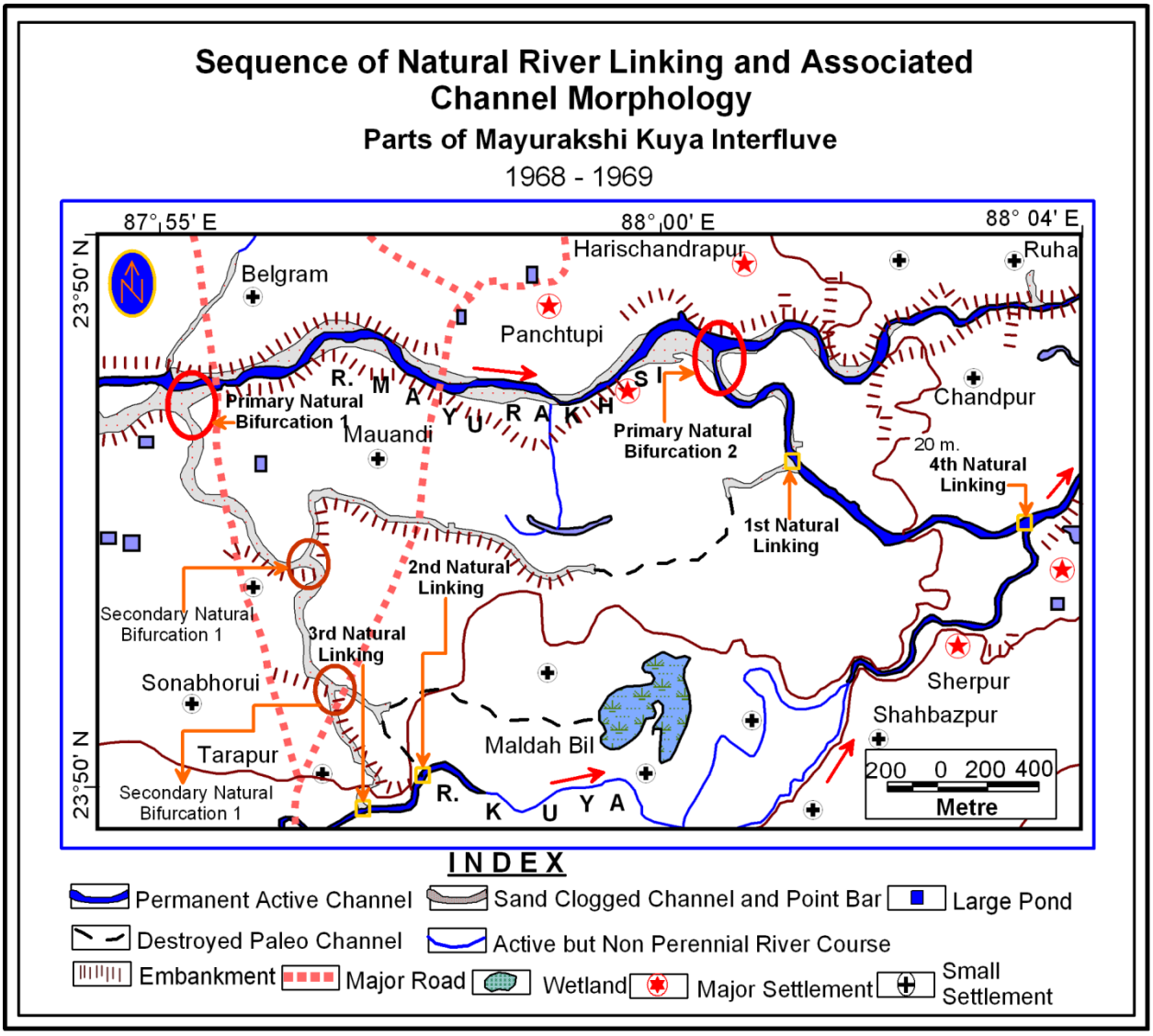

Fig. 4

On the other hand after 4th linking site, the strength of the Kuya river course has increased. In figure 5 site a and b are two sample locations of taking river cross section to prove the influence of linker river on river Kuya. In section a (before linking of present linker fig. 6), the width and depth as well as volume of discharge is less but after linking at site b (fig. 7) there is sudden increase of all the mentioned hydro morphological parameters. This condition is called *channel fattening or channel thickening*.

On the other hand the after bifurcation channel of Mayurakshi river has become sick in morphological stature and hydrological strength. Before bifurcation, the width of the channel is 424.9 m. (at site C) but it is only 162 m. after bifurcation of Mor river from master stream river Mayurakshi River. In more downstream reach, the width of the channel

has declined in significant extent. Width at the confluence stream is as narrow as only 16m. This massive decline of width due to channel bifurcation and associated other causes is known as *channel leaning or channel weakening or channel thinning*. As huge amount of sediment and water is draining to the Kuya river, overall process of action reaction for both the donor and receiver rivers have changed in very recognized or unrecognized dimensions.

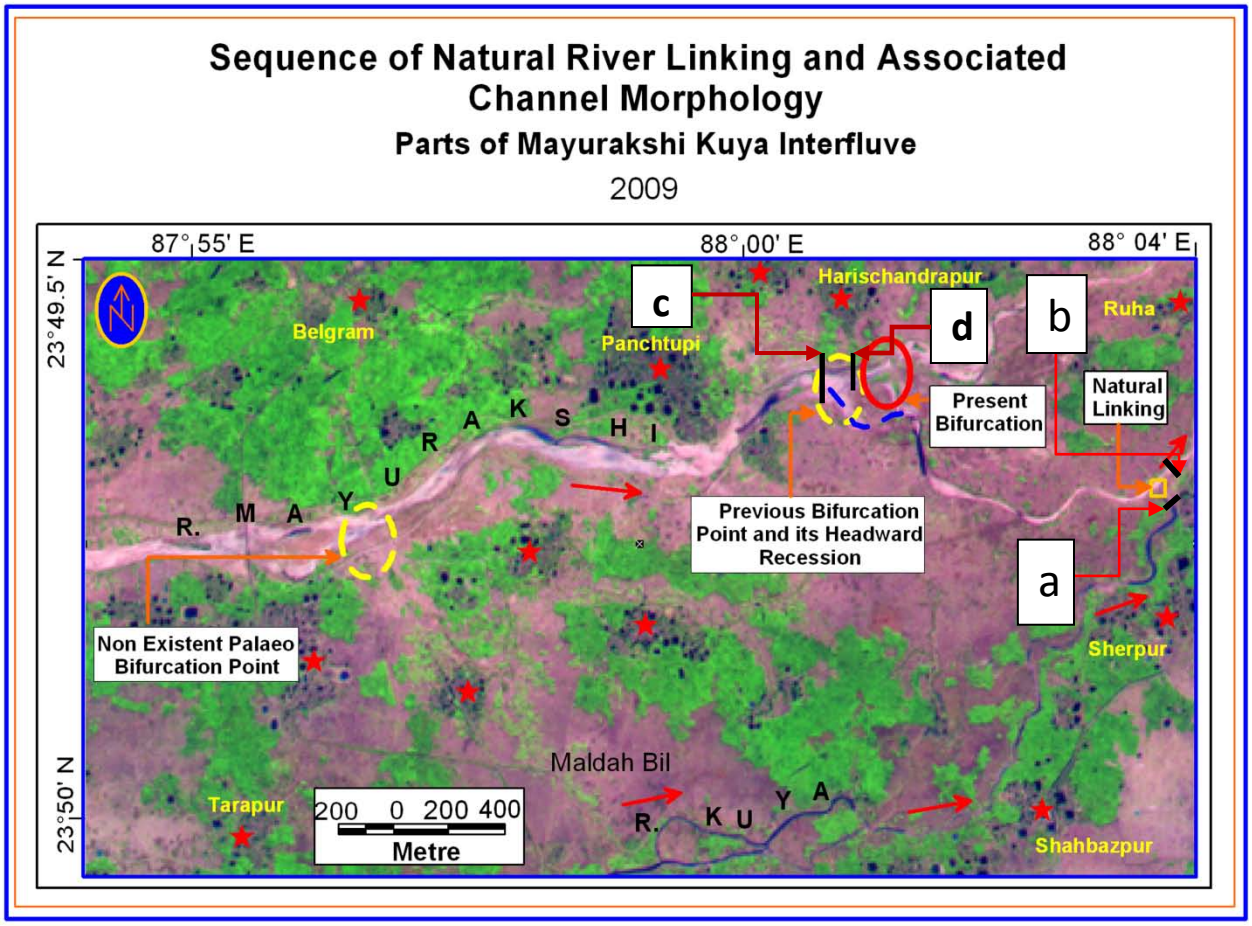

Fig. 5

The concept of Misfit River is basically applied to describe disproportional width depth condition, valley width and channel width condition, width depth and discharge ratio of the river. If anyway width of the river increases or decreases downstream disproportionately in reference to width of the existing upstream reaches, the river is called as *Quasi Misfit River*. In this present study due to channel bifurcation, width of the master stream (Mayurakshi River) has drastically reduced just downstream of channel bifurcation and width of the receiver stream (Kuya River) has increased downstream just after linking of bifurcated

stream (Mor River) from Mayurakshi river. These altered forms of streams (both Mayurakshi river and Kuya river) are known as Quasi misfit stream.

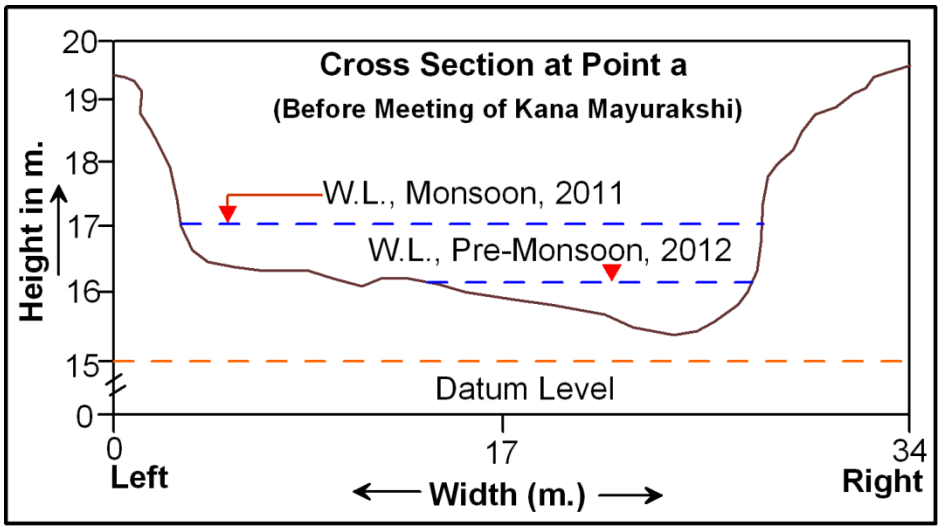

Fig. 6

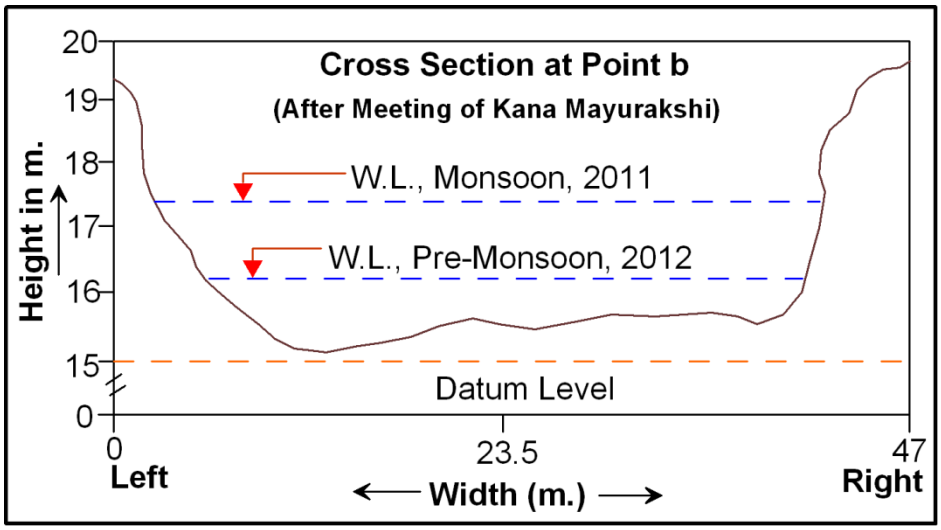

Fig. 7

In figure 5, the present morphological condition of the same interfluves area has been presented. It clearly shows that the first bifurcated channels or natural linkers have totally lost their existence. People have occupied this river command area even river channel through the extension of agriculture. Field survey, Oct., 2011 has also help to experience this regretful incidence of *river piracy* or *river thiefting* by human being. According to bank dwellers' opinion, ceasing of river has helped to abate flood in this surrounding area of the then bifurcated stream. But they have also confessed that the boro (summer) agriculture, rabi crops have been hampered due to dying of this river because this river was used to supply irrigation water for the command area. So, obviously, to reclaim the agriculture of

the monsoon period, people have been committing sacrifice of the irrigation based agriculture of the non monsoon season. Loss of river immediately forced to adopt a new set of agricultural patter.

When it was asked to the people about the closing of the present bifurcated stream in the old manner, they denied accepting this kind of alteration. They strongly revealed that after flood condition is very congenial for both rabi and boro cultivation.

It should also be mentioned that this forceful closing of river will not absolute step to abate flood conditions. Mayurakshi river has a natural tendency to bifurcate right ward. So to close one source of bifurcation may encourage to several other sources of the same in some other places. This evidence is very commonly found in river Mayurakshi and Kuya interfluves. Figure 5 also highlights that the second bifurcation point has been shifting forward. This forward wandering of the right side bifurcation of Mayurakshi river also proves that forceful caution like embanking and restricting the source of the bifurcated channel is not any judicious step against flood abatement. This step is only temporally justified to shift the flood axis from one region to another but all on a sudden it may increase jeopardy to the surrounding people. From this tendency of bifurcation, it could be predicted that in next 20 years, 10 km. downstream of the river Mayurakshi from present bifurcation point may be vulnerable point of bifurcation and as a result flood conditions of the surrounding interfluves may be aggravated.

It is true that the pirated axes of the previously traversed rivers have a tendency of water stagnation during monsoon period. The Mayurakshi Kuya interfluve is so flatter that back waters of the downstream rivers may force the area to be flooded. Embanking and restricting of bifurcated channel is just a temporary step toward flood abatement but without giving adequate flood corridor this tendency could not be ceased permanently.

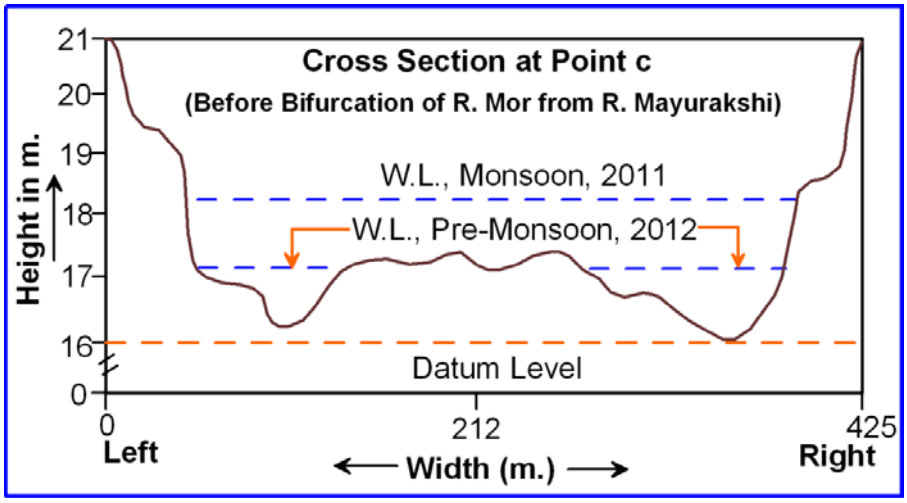

Fig. 8

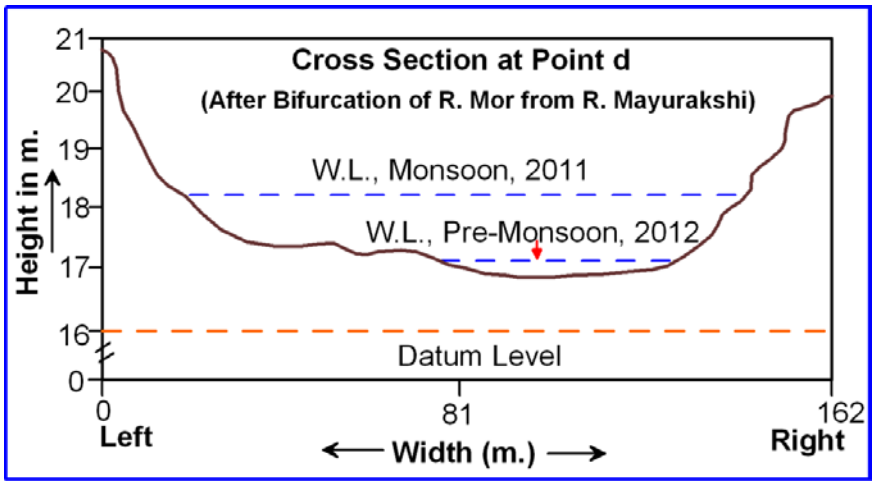

Fig. 9

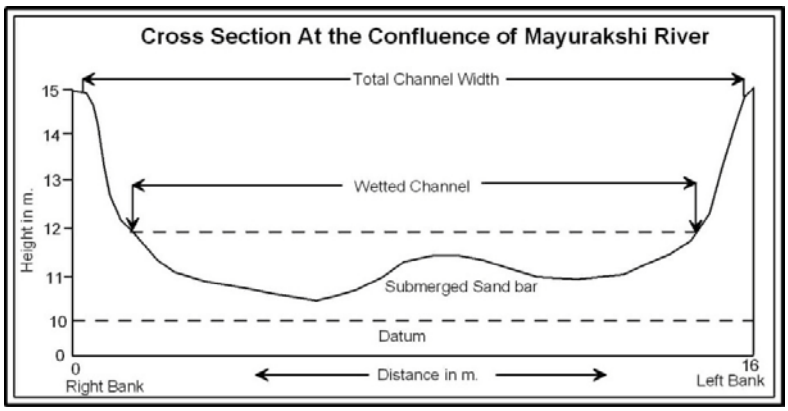

Fig. 10

In fine, some planning strategies could be introduced which will help to cope up with altered situations of river morphology and hydrology. Water availability before and after quasi misfitting conditions are largely different and therefore, readjustment of land use cropping practices etc. are necessary in the areas along sides of quasi misfit rivers. Moreover, it

should also be mentioned that after misfitting, channel narrowing may constrict abundant flow during monsoon period. Similarly, diversion of huge water from Donar River to Receiver River may also creates exaggeration of water as well as may invite flood in the downstream reach. To save the surrounding regions from such flood incidences, construction of lofty embankment astride of river Kuya and Myurakshi again forced those rivers to combat another process of new channel adjustment. Of course, this type of phenomena is noticed both in case of Mayurakshi and Kuya river. So, river oriented planning should be resettled accordingly in question of sustainability.

REFERENCES

1. Bloom, A.L., (1978). Geomorphology, Printice Hall of India Private Limited, New Delhi.
2. Bloom, A.L., (1979). Geomorphology, Printice Hall of India Private Limited, New Delhi.
3. Dury, G. H. (1958). Tests of a general theory of misfit streams. *Inst. Br. Geogr*., *Trans. Pap.*, 1958, Vol.25, 105–118.
4. Dury, G. H. (1964). *Subsurface Exploration and Chronology of Underfit Streams.* Professional Paper no. 452-A. U.S. Geological Survey, Reston, Virginia.
5. Ghosh, K. et al. (2012). Assessment of the Hypothetical Trend of Morphological Parameters: Kuya River Channel, Eastern India. International Journal of Environmental Engineering and Management, Vol. 3, Number 1, pp. 37-44.
6. Leopold, L. B., Wolman, M. G. and Miller, J. P. (1964). Fluvial Processes in Geomorphology. Eurasia Pub. House (Pvt.) Ltd. New Delhi-55. Pp 411-30.
7. Leopold, L.B. and T. Maddock, (1953). The hydraulic geometry of stream channels and some physiographic implications, USGS Professional Paper 252, pp. 1-57.
8. Manville, Vern & Wilson, Colin J. N. (2004). The 26.5 ka Oruanui eruption, New Zealand: a review of the roles of volcanism and climate in the post-eruptive sedimentary response. *New Zealand Journal of Geology & Geophysics* vol. 47, No.3, pp. 525–547.
9. Morisawa, M. E. (1968). Streams, their dynamics and morphology. Pubd. McGraw-Hill Book Company, New York. P 175.
10. Morisawa, M., (1985). Rivers (Forms and Processes), Longman, London and New York.

11. Morisawa, M., (1985). Rivers (Forms and Processes), Longman, London and New York.
12. Mukhopadhyay, S. & Pal, S. (2009). Impact of Tilpara Barrage on the Environment of Mayurakshi Confluence Domain – A Granulometric Approach, Indian Journal of Geomorphology, Vol. 13 & 14, No. 1 & 2., 2008-2009, pp. 179-187.
13. Mukhopadhyay, S., Mukhopadhyay, M. and Pal, S. (2010). Advance River Geography, acb publication, Kolkata
14. Neuendorf, K.K.E., J.P. Mehl, Jr., and J.A. Jackson, J.A., eds. (2005). *Glossary of Geology* (5th ed.). Alexandria, Virginia, American Geological Institute. pp 779.
15. Pal, S and Let, S. (2011). Channel Morphological Trend and Relationship Assessment of Dwarka River, Eastern India, Global Journal of Applied Environmental Science, Nov., 2011. Vol. 1, No. 3, pp.221-232
16. Pal, S. (2010). An Appraisal of Geo-economic Environment of Major Wetlands Within Kandi Block, Murshidabad District, West Bengal, Ph. D. Thesis, Visva-Bharati, Santiniketan, West Bengal.
17. Pal, S. (2011). River Flood: Dynamics. Detection. Prediction, Perspective of Subtropical Region, Lambert Publication, Germany.
18. Pal, S. (2012). Changing Inundation Character in Mayurakshi River Basin: A Spatio Temporal Review, Practising Geographer, Vol. 14, No. 1, September 2010, pp. 58-71.
19. Pal, S. (2012). *Post* Dam Hydro-geomorphic Alteration: A Study of Dwarka River, Eastern India, International Journal of Applied Environmental Science, New York, USA. pp. 24- 48.
20. Ray, C. (2001). The causes of flood of Sept.,2000 in West Bengal vis- a-vis the roles of the Massanjore Dam and the Tilpara Barrage, Sechpatra, (1)
21. Richard, G.A. (2001). Quantification and Prediction of Lateral Channel Adjustments Downstream from Cochiti Dam, Rio Grande, NM, Ph.D. Dissertation, Colorado State University, Collins, CO.
22. Richards, K.S., (1973). Hydraulic geometry and channel roughness – a non-linear system, American Journal of Science, Vol. 273, pp. 877-96.
23. Sinha, R. (1996). Channel avulsion and floodplain structure in the Gandak– Kosi interfan, north Bihar plains, India, *Z. Geomorphol. N.F. Suppl.*, Vol.103, 249–268.