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ASSESSMENT OF CHANNEL WIDTH DISPARITY OF THE MAJOR RIVERS WITHIN MAYURAKSHI RIVER BASIN

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ABSTRACT
This paper aims to find out the asymmetric pattern of channel width distribution in reference to thalweg line among different sub basins (Mayurakshi, Dwarka and Kuya) of a single master basin; estimating river bank stability etc. Empirical field observation and views of the bank dwellers have employed to prepare data base for this work. Result shows that there is asymmetric pattern of width distribution among different rivers and tendency of bank recession reveals reverse situation among the each others. Mayurakshi river has proved to be the most instable regarding the considered parameter. Strong human intervention is largely responsible for asymmetric pattern of channel width, river bank instability etc.

Key Words: Channel Width Asymmetry, Riverbank Stability, Comparative Status of Width Pattern and Antagonistic Exposure of the Sub Basins Width

INTRODUCTION
Each river has its own morphological character, trend and evolution. Width of the river depends on slope, discharge, depth, bank materials, flow characters etc. (Leopold and Maddock, 1953; Moriswa, 1985; Bloom, 1979). Human being also exerts ample stress on river morphology through their activities (Pal, 2012; Let and Pal, 2011). Bridge construction across river without providing enough space for through passing, regulated discharges from barrages and dam, river bank cultivation and bank failure etc. are some human cultivated causes of site and river specific change of river width (Mukhopadhyay and Pal, 2009). Davis has mentioned the stages of river in connection with river longitudinal slope of the river, width, depth velocity and so others hydro morphological parameters. Theoretically, Davis has established the fact that the width of a river gradually increases downstream. M. Moriswa, (1985) has explained the same in reference to increasing discharge volume. In spite of such stage wise rhythm of width, due to local causes there may be some variations in width pattern from source to mouth (Moriswa, 1968). S. Pal, (2012) has revealed that saucer shape channel of Mayurakshi brings flood condition in the downstream areas. This observation is in against of theoretical principle formulated by different fluvial scientists previously. Temporal variation of width pattern provides a brief idea about velocity, discharge status (Richards, 1973), shifting of river course and status of bank erosion or in a word the stability of river course.

Mayurakshi river of Eastern India is a significant name in the drainage history and present drainage of Jharkhand and West Bengal. It is composed with three main sub basins namely, Mayurakshi or Mor basin, Dwarka basin and Kuya basin. Being a member of same river family, how they are morphologically different in cross sectional or temporal manner is the prime concern of this paper. This paper aims to analyze the comparative pattern of width, rate of channel widening, nature of riverbank stability among Mayurakshi, Dwarka and Kuya courses.
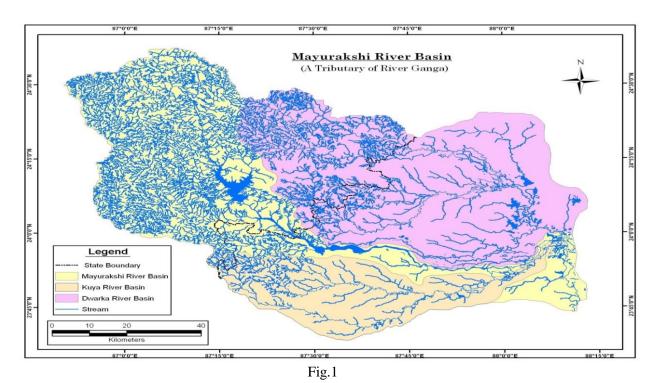
Study Area
The Mayurakshi River - a 5th tributary of Bhagirathi is a well known name in the river scenario of West Bengal and Jharkhand In our reverie country 360km. long Mayurakshi river has great impact on plateau region of Jharkhand and plain land of West Bengal. Mayurakshi River emerges at Jharkhand from Trikut Hills (Near 10 km south of Deoghar in Santal Pargona District) at an elevation of 400 meters, which flows down through a large part of Eastern India. Its winding movements

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towards south-east along with the tributaries of 'Dhobi', 'Pusaro', 'Bhamri', and 'Tepra' from Jharkhand has ended near Kagram of Murshidabad District of West Bengal. Before mixing with river Bhagirathi two major tributaries river 'Kopai' and the river Dwarka mixed with Mayurakshi near 'Chiruti' and near Talgram respectively in West Bengal. Yazoo movement of Mayurakshi river in respect to mighty Bhagirathi since Nalghosa to Kagram (40km.) is the observable feature.

Mayurakshi river has 6400 sq.km. basin area which is constituted by the transitional zone between the mega physiographic provinces of the Chottanagpur peninsular massif and the Bengal basin.

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.

Fig.1

METHODS AND MATERIALS
Width related data has been collected from direct field measurement on more than 50 sites in different sites of the rivers. Locations of the sites have measured with the help of GPS and cross section and width measurement has been done using Dumpy Level Survey. Previous information regarding the same has been collected from previous literatures and bank dwellers. To compare the degree of temporal change of river bank recession or encroaching channel asymmetry indices has formulated and used. Frequent change of river bank means sharp tendency of the instability of river. In this article site specific stability index for each and every selected site and average stability index for the whole river have formulated and implemented to set a standard scale of comparison among the selected rivers.

Channel asymmetry index $CAI = \dfrac{\overline{CW}_{mi}}{\overline{CW}_{ma}}$ $\overline{CW}_{mi} = average\ minimum\ width$

$\overline{CW}_{ma} = average\ maximum\ width$

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Site Specific Stability Index (SSI) has used to measure the river bank stability of in different selected sites along a channel. CAI value ranges from 0-1. CAI=0 means high level asymmetry and 1 means low level asymmetry.

$$SSI = \frac{1}{Rcw}$$ SSI= Site specific stability index for channel widening;   Rcw= Total channel widening

in period of time in different sites

Average Stability Index (ASI) has calculated to estimate river bank stability for entire channel.

$$ASI = (\sum_{i=1}^{n} \frac{1}{Rcw})/n$$ ASI= Average stability index for channel widening for entire channel;   n= Number

of sites

SSI and ASI range from 0-1. Value nearer to '0' means less stability; '1' means high stability of the bank. If the minimum value is less than 1m., all widening values should be converted into smaller units like meter to cm.

RESULTS AND DISCUSSION
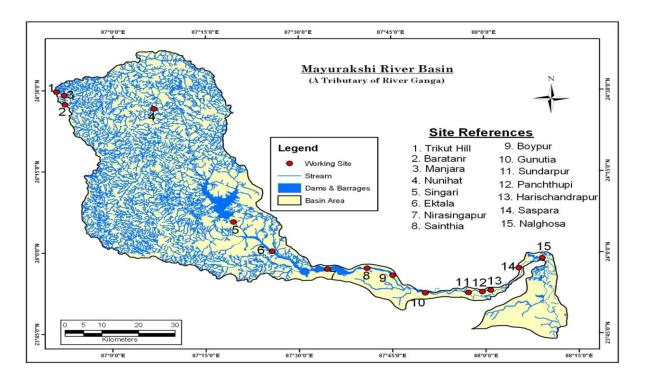*Width Pattern in Different Major River within Mayurakshi River Basin*

Fig. 2
Mayurakshi River
Width pattern of Mayurakshi river has declined from source to mouth. 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.

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Site specific stability index of the river bank in the extreme upper and lower catchment is high and very low in the middle part of the course. Along with expected natural vectors, unexpected level of human intervention is the major reason behind such river bank instibility in this middle course.

Table 1: Width Distribution Pattern along Mayurakshi River

Sl. No.	Site	Distance (km.)	Width in m.						Rate of widening (m.) per year	SSI
			2011			**1980**				
			Left	Right	Total	Left	Right	Total		
1	Source	0	1.0	0.8	1.8	1.1	0.7	1.8	0	0
2	2.5 km from source	2.5	7.9	7.4	15.3	6.9	4.7	11.60	0.11935	0.27027
3	12 km up from Massanjore	41.2	58.6	27.8	86.4	42.1	22.7	64.80	0.69677	0.04629
4	1 km. downstream of Massonjore dam	61.2	75	40	115	51.4	21.4	73.6	1.33548	0.02415
6	Village Ektala (near Raniswar)	92.5	460	115.4	575.4	364	58.6	402.6	2.02580	0.00578
7	Narasingapur (Baro or main)	149.3	312	47	359	48.6	253.9	302.5	1.82258	0.01769
7	Narasingapur (Kana)	149.3	221	226.6	447.6	261	40	301.0	4.72903	0.00682
8	Sainthia	164.2	395.4	24.5	519.9	310	79	489.0	0.99677	0.03236
9	Baipur (near Satpalsa)	175.5	410.2	26.7	436.9	298.1	80.4	378.5	1.88387	0.01712
11	Sundarpur (near Panchthupi)	254.5	198	56	254	152	59	211.0	1.38709	0.02325
14	Sanspara (near kandi)	302.6	41	10.2	51.2	29.3	17.4	46.7	0.14516	0.22222
15	Nalghosa	320.7	11.2	4.3	15.5	7.2	5.4	12.60	0.09354	0.34482

Source: Field Survey, 2011
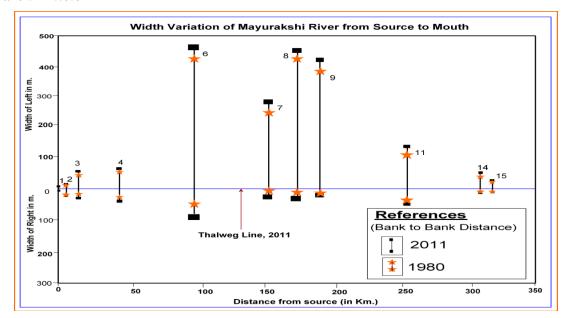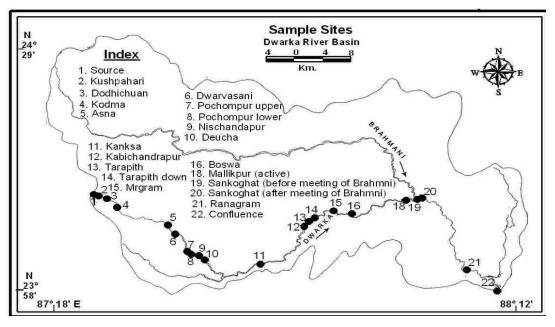
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Fig. 3

Fig. 4

Dwarka River

Generally width of the river gradually increases downward, but in Dwarka River no definite trend is noticed. No lop sided tendency of *thalweg flow* is observed toward any of one banks. Average width of the river is 58.87m. The shape of the channel is quite ellipsoidal because the middle portion of the channel is to some extent bloated than source and confluence course. Few places are there where deviation of width is very high in respect to average width. For example, near Tarapith (Site 13) the width is very narrow (37m.) due to encroachment of building toward river channel. Near downstream of Pochompur bridge (Site 8) the width is 104 m, but at the upstream of Pochompur bridge it is only

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47m. Such sudden widening of channel is only because of narrow through passing system of the bridge and speedy flow during monsoon just crossing constricted passage of flow and excavation of sand and soil in its right bank.

In Dwarka river, no definite trend of river bank instability is noticed but frequency of instability is more in the middle catchment (table 2). High rise embankment in the lower part of the reach creates artificial obstacle against natural widening of river course.

Table 2: Width Distribution Pattern along Dwarka River

| Sl. No.	Site	Distance	Width in m.						Rate of widening (m.) per year	SSI
			2011			1980				
			Total	**Left**	**Right**	**Total**	**Left**	**Right**		
1	Source point	0Mts.	1.35	0.85	0.5	1.35	0.7	0.15	0	0
2	Kushpahari	15 Mts.	2.15	1.15	1	2.15	1.1	1.05	0	0
3	Dodhichaun	2.27 Km.	2.95	1.47	1.48	2.95	1.4	1.55	0	0
4	Kadma village	6.67Km.	31	19	12	30	20	10	0.032258	1
5	Asna	22.4Km.	42.6	17	25.6	35.6	14.6	21	0.225806	0.142857
6	Dwarvasani	31.07Km.	97.7	71.2	26.5	81.4	72.2	9.2	0.525806	0.06135
7	Pochumpur-upper	36.14Km.	47	17	30	42.3	13.1	29.2	0.151613	0.212766
8	Pochumpur-lower	36.34Km.	104	17	87	86.2	14.2	72	0.574194	0.05618
9	Nischandapur	38.27Km.	120	15	105	102	9.7	92.3	0.580645	0.055556
10	Deucha	40.8Km.	115.05	22	93.05	101.4	88	13.4	0.440323	0.07326
11	Kanksa	57.07Km.	111.08	37	74.08	97.8	18.3	79.5	0.428387	0.075301
12	Kabichandrapur	76.27Km.	57.5	15.2	42.3	51.6	8.6	43	0.190323	0.169492
13	Tarapith	77.47Km.	37.8	7.6	30.2	43.4	18.5	24.9	-0.18065	-0.17857
14	Down Tarapith	78.07Km.	78.2	24.9	53.3	66.7	21.1	45.6	0.370968	0.086957
15	Margram	87.27Km.	121.85	40.85	81	96.2	32.3	63.9	0.827419	0.038986
16	Boswa;Bisnupur	90.14Km.	39.79	13.7	26.09	30.1	10	20.1	0.312581	0.103199
17	Mallikpur 1. (Defunct)	111.47Km.	37.5	12.5	25	32.4	10.4	22	0.164516	0.196078
18	Mallikpur 2. (Active)	111.49Km.	38	17.39	20.61	33.5	13.2	20.3	0.145161	0.222222
19	Sankoghat before meeting Brahmni	114.95Km.	35	27.5	7.5	30.1	25.8	4.3	0.158065	0.204082
20	Sankoghat (After meeting of Brahmni & Dwarka)	114.94Km.	77.5	15.5	62	63.9	13.4	50.5	0.43871	0.073529
21	Ranagram	142.92Km.	57.75	17.25	40.5	55.3	14.3	41	0.079032	0.408163
22	Confluence point	156.56Km.	39.5	13	26.5	34.6	11.4	33.2	0.158065	0.204082

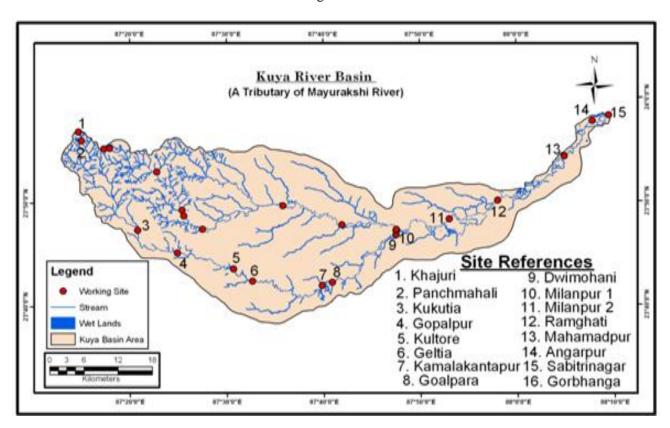***Research Article***
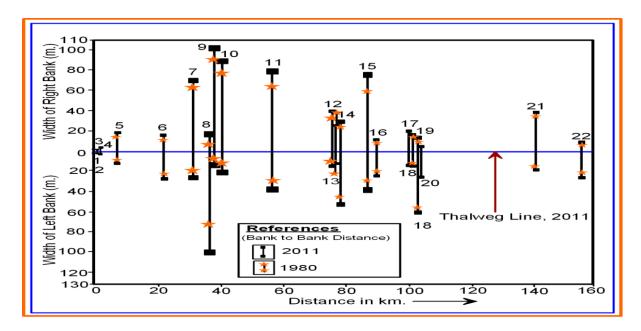
Fig. 5

Fig.6

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Kuya River

In contrast to normal pattern of width, in case of Kuya river, the width of river has 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) the width is110.2m. Such sudden widening of channel is only because of the passing of huge volume of water all on a sudden during peak monsoon and excavation of sand and soil in its right bank.

The width of the channel, in most of the sites, is more toward right which indicates erosive tendency toward left. Site specific stability index reveals that alluvial channel of the lower reach is rather stable than middle reach (table 3).

Table 3: Width Distribution along Kuya River

Sl. No.	Site	Distance	Width in m.,2011			Width in m.,1980			Rate of widening (m.) per year	SSI
			Total	**Left**	**Right**	**Total**	**Left**	**Right**		
1	Khajuri (Morapora)	12	25	11	14	19.5	9.2	10.3	0.177419	0.181818
2	Panchmohali	5	14.6	5.2	9.4	8.2	3.8	4.4	0.206452	0.15625
3	Kukutia	31	123.8	67.8	55.8	78.45	34.15	44.3	1.462903	0.022051
4	Rasulpur (Hetampur)	39	67.56	30.65	37.15	43.42	14.62	28.8	0.77871	0.041425
5	Korkori (Kultore_Barrage)	53	110.2	35	75.2	86.3	32.4	53.9	0.770968	0.041841
6	Golte	58	57.9	28.6	29.3	48.84	19.5	29.34	0.292258	0.110375
7	Kamalakantapur_Goalpara	79	39.09	12.3	26.73	23.45	8.9	14.55	0.504516	0.063939
8	Sehala_Bolpur	81	64.96	2.8	62.16	53.87	4.2	49.67	0.357742	0.090171
9	Hasulibank_before meeting of Brakeswar	103	19	2.5	16.5	16.3	2.3	14.2	0.087097	0.37037
10	Hasulibank_after meeting of Brakeswar	103.4	39.3	10.2	29.1	33.74	9.2	24.54	0.179355	0.179856
11	Miriti	122	36.7	17.7	19	34.22	8.9	25.32	0.08	0.403226
12	Mamadpur	156	31.75	3.7	28.05	26.85	6.5	20.35	0.158065	0.204082
13	Angarpur	166	56.4	18.5	37.9	49.5	14.4	35.1	0.22258	0.144928
14	Sabitrinagar	170	57.5	19.1	38.4	51.78	15.6	36.18	0.184516	0.174825
15	Gorbhanga	176	45.5	13.3	31.2	43.57	11.2	21.37	0.062258	0.518135

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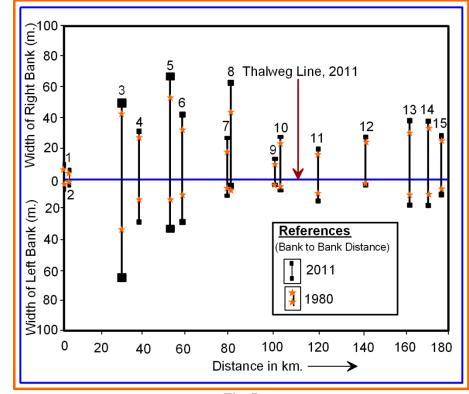
Fig. 7

Table 4: Channel Asymmetry and Average Bank Stability Indices

Indices	Mayurakshi river		Dwarka river		Kuya river		Remarks
	1980	2011	1980	2011	1980	2011	
Channel asymmetry index (CAI)	0.409238	0.267741	0.6192	0.4867	0.472618	0.545902	Channel Asymmetry has increased over time in Mayurakshi and Dwarka river
Average Stability Index (ASI)	0.084235		0.145704		0.180219		All the rivers are facing bank erosion; The rate of it is maximum in case of River Mayurakshi
Range of SSA	0.0005-0.3448		0.05-1		0.04-0.51		River banks of Mayurakshi is highly instable as measured in some selected sites followed by Kuya.

Inter Basin Discordance and Accordance
Width Pattern
Mayurakshi and Kuya rivers have saucer shape or close mouth course. It means width of the river course has declined downstream. But Dwarka river has open mouth course. Width of the channel has been increased over time in most of the sites.

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Distribution of river width in left and right sides of the thalweg shows that Dwarka river and Mayurakshi river has rightward migrating tendency while Kuya river shows the reverse tendency. Within a single basin this kind of contrasting width disparity reveals in internal pattern of geological and pedological diversity among different basin.

Channel asymmetry has been increasing over time in Mayurakshi and Dwarka river but it has been reducing in Kuya river. Some cases of river straightening through neck cut off or chute cut off processes and consequent new channel adjustment has reverted the situation.

Average stability index is value is very low in Mayurakshi river. It means rate of bank erosion and river course widening rate is susceptibly high than other two rivers. In this connection it should be mentioned that excessive intervention of man on this river has largely disrupted the natural rhythm of the channel and normal process of bank erosion. Greater volume of discharge, extensive command area etc. may also have a significant impact on greater river bank instability. Other two rivers e.g. Kuya and Dwarka also reveal the river bank instability as per their ASI values. But the intensity of it is quite less. Site specific stability index also shows the same trend of river bank erosion.

Conclusion

Width of a river channel partly explains the energy of the channel, velocity status, erosional capacity, carrying capacity and competencies etc. Distribution of channel width in two sides of the thalweg also provides ample information about bank material status, geological condition etc. But, these normal interpretations will have no values when man is the strong agent of land deformation and channel modulation. These rivers have intervened by man in different ways. Dam or barrage constructions have paved the way to widen the channel in the downstream areas but embankment construction has restricted even the normal process of channel widening. Massive flood during 1978, 2000 etc. have irregularly heaped up huge sand in one side of the channel force channel to be asymmetric. Unexpected regulation of channel width by man in terms of widening or narrowing can break down the normalcy of hydrological and morphological rhythm of the channel. Mayurakshi river is severely caught by this problem than rest two.

Another important observation should be mentioned that within a single basin, different sub basins can behave antagonistically and proper explanation is not possible with the help of only natural parameters.

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