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LINEAR ASPECTS OF THE WAINGANGA RIVER BASIN MORPHOMETRY USING GEOGRAPHICAL INFORMATION SYSTEM

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ABSTRACT:
The Quantitative fluvial characteristics of the Wainganga river basin have been discussed under linear aspects. The Wainganga River is one of the major tributaries of Godavari River. The total river basin area is 49949.68 Sq. km. The total length of the Wainganga River is 638.91 km, of which 270.2 km lie in Madhya Pradesh. It than travels 32 km along the border between Madhya Pradesh and Maharashtra, while the remaining 336.17 km lie in Maharashtra. As the main objectives of this work was to discover holistic stream properties from the measurement of various stream attributes, detailed Morphometric analysis is carried out for the seventh-order drainage sub-basins of the Wainganga River catchment and discusses their feature and characteristic and also attempt to find out the stages of geomorphic development with the help of different Morphometric parameter viz., streams order, streams number, streams length, mean streams length, bifurcation ratios etc.

This study would help the local people to utilize the resources for sustainable development of the basin area.

KEY WORDS: *Linear Aspects , Geographical Information System , major tributaries , Wainganga River catchment .*

INTRODUCTION:

Linear aspects of the basins are related to the channel patterns of drainage network wherein the topological characteristics of the stream segments in terms of open links of the network system (streams) are analyzed. In the study area geological structure and lithology influe- nce the arrange- ment of the drainage line or network pattern. Resistance to the erosion of the rock differs with the type of the rock and forms various drainage patterns. When rock is homogeneous and surface is essentially flat without any directional control dendriatic pattern develops. The River Wainganga shows the above characteristics which result into dendriatic pattern. The drainage network development in the Wainganga river basin is very typical which is seen everywhere in the hilly basaltic area. The network development in Wainganga River is mainly controlled by structure. The orientation of the tributary and the main streams is governed by joints and fractures.

The Wainganga river basin consists of 9472 streams of different order. Analysis of the stream orientation reveals that 7% streams join the main stream from north, 24% from south, 13% from East, 5% from West, 6% from NE, 14% from SE, 19% from NW, 11% from SW. Most of the rivers that originate in the upland area of Deccan Plateau are sinuous in the source region. But the Wainganga channel is straight at source and meandering at confluence. In most of the places straight channel pattern is observed in segments.

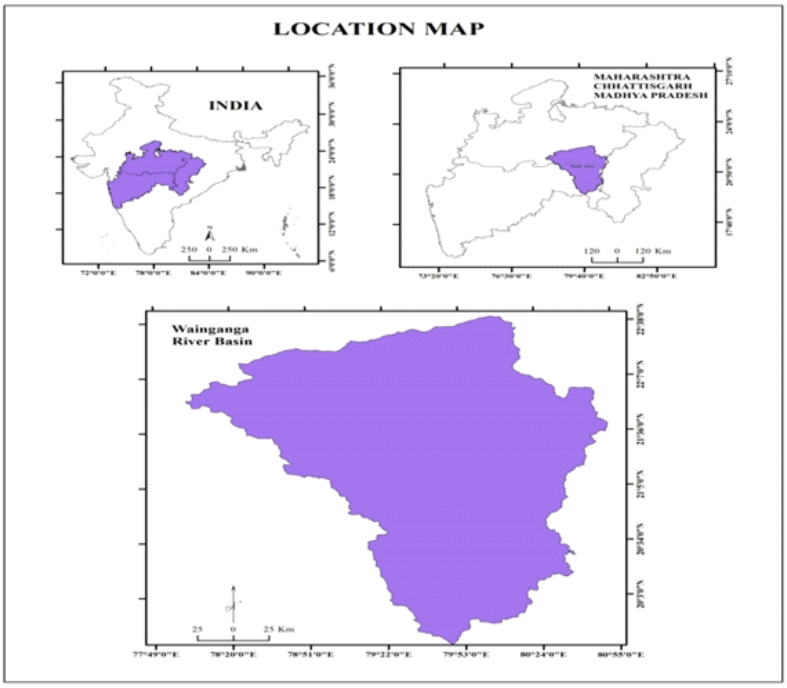
STUDY AREA

The Wainganga River is one of the major tributaries of the Godavari River. The Wainganga River rises at El 640.0 m near village Partabpur (21°57'N & 79°34'E) about 20 Km from the town of Satapura plateau and flows in a wide half circle, bending and winding among the spurs of the hills from the west to the east of the Seoni District of Madhya Pradesh. (Map No.1).

The total river basin area- 49949.48 sq. km.
Latitude extension- 19°30'N to 22°30 N'
Longitude extension- 79°00'E to 80°30 E'.

AIMS AND OBJECTIVES

- To study Morphometric characteristics of the Wainganga River Basin.
- To identify the hierarchical orders of the streams and their nature.
- To identify the linear characteristic of the sub basins river.



Map No.1: Location Map of the Wainganga River

METHODOLOGY

Library Work

Exhaustive literature survey of the theme of investigation has been undertaken. Research report, published literature will be collected from various Government Institutions and Departments, Non-Governmental Organizations, libraries, Other institutes, etc. Besides, relevant literatures like reference newspaper, bulletins, review journals, books, and obtained through internet.

Field work

This phase includes visit to the study area and it's in different seasons, Dumpy level survey, GPS surveys, instrumental surveys, photographs, local information etc. it facilitated to understand the river Morphometry, changes of river channel and water utilization in various sectors.

Laboratory work

The Morphometric data have obtained from one inch topographic map of Survey of India (1:63360 or 1:250000). They are toposheet No. 55J, 55K, 55N, 55O, 55P, 56M, 64B, 64C, 64D, 65A. Includes sorting of data, digitization of various layers, preparation of maps, statistical analysis and other GIS/RS techniques, like Georeferencing, Data attachment, area calculation, Overlay analysis, Unsupervised classification, Final layouts of different maps.

RESULTS AND DISCUSSION

1. Stream Ordering

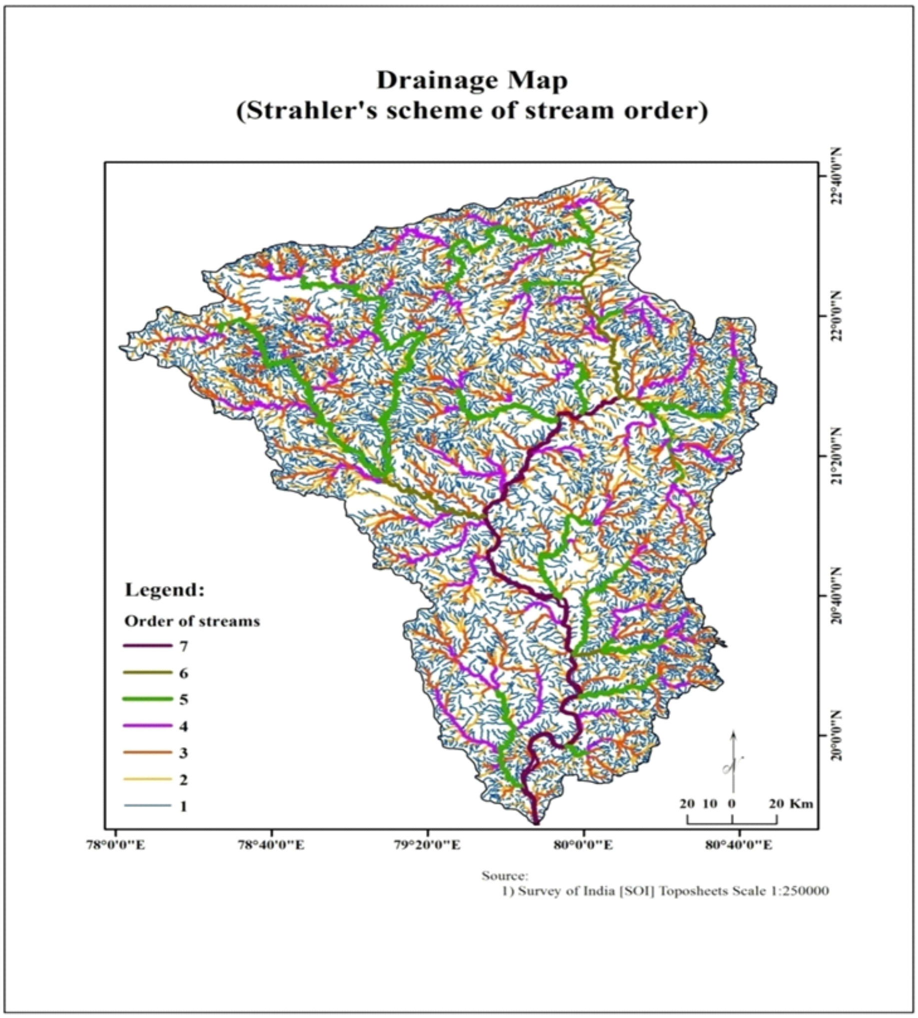
Stream ordering mentions the determination of the hierarchical position of a stream within a drainage basin.

Strahler's scheme of Stream Ordering

A. N. Strahler (1952, 1953, 1957 and in Chow's 1964) modified the Horton's scheme of stream ordering by removing the problem of reclassification and renumbering of stream. According to him 'each finger-tip channel is designated as a segment of 1st order. At the junction of any two 1st order segments, a channel of 2nd order is produced and extends down to the point, where it joins another 2nd order segment whereupon a segment of 3rd order results and so forth' (A. N. Strahler, 1969), (Map No.1). Strahler's scheme is popularly known as 'stream segment method' (Table No.1).

Table No. 1. Strahler's Scheme of Stream Ordering

Sr. No.	Stream Order	Total Stream
1	1st	6502
2	2nd	2190
3	3rd	605
4	4th	153
5	5th	17
6	6th	4
7	7th	1
Total		**9472**



Map No.2: Strahler's Scheme of Stream Ordering

2.BIFURCATION RATIO (R_b)

Bifurcation ratio (R_b) which is related to the branching pattern of the drainage network, is defined as a ratio of the number of streams of a given order (N) to the number of streams of the next higher order (N).

Equation

$$R_h \quad \frac{N}{N \quad 1}$$

Where,

R_b = Bifurcation Ratio

Nμ = Number of streams of given order

Nμ+1 = Number of screams of the next higher order.

Bifurcation values are ranging from 2.97 to 9.00. The higher values of 4th (Rb- 9.00) and 5th (Rb- 4.25) order streams indicate well developed stream network. The bifurcation values in the 1st and 2nd

order are low compared to the overall bifurcation ratio of the basin. Bifurcation values ranging from 2.97 to 9.00 suggest that it is a natural river system where uniformity is seen with respect to climate, rock type and stage of development. The purpose of stream ordering is not only to index size and scale but also to afford an approximate index of the amount of stream flow which can be produced by particular network (Table No.2).

Table No. 2. Bifurcation Ratio

Stream Order	Number of Streams (Nu)	Bifurcation Ratio (R_b)
1st	6502	2.97
2nd	6502	3.62
3rd	605	3.95
4th	153	9.0
5th	17	4.25
6th	4	4.0
7th	1	---
Total	**9472**	**27.79**

Mean Bifurcation Ratio of total Wainganga River

$$XR_b \quad \frac{R_b}{n}$$

$$\frac{27.79}{7} \qquad = 3.97$$

The Wainganga River basin total means Bifurcation Ratio is 3.97, that it is a natural river system where uniformity is seen with respect to climate, rock type and stage of development (Fig. No.1).

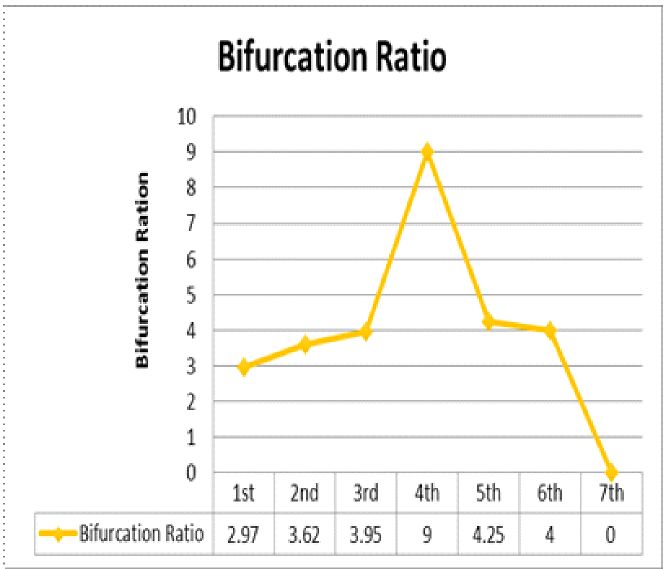


Fig. No. 1. Bifurcation Ratio

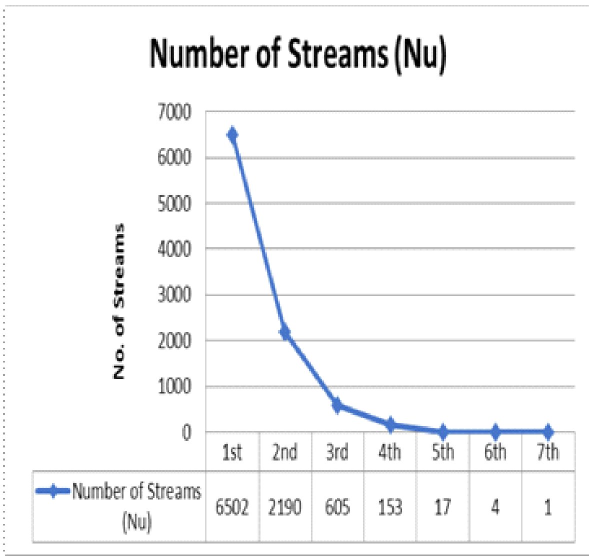


Fig. No. 2. Number of Streams

3.Law of Stream Numbers

The law of stream numbers relates to the definite relationship between the orders of the basins and stream numbers. R.E. Horton's law of stream numbers states (1945) 'that the number of stream segments of successively lower orders in a given basin tend to form a geometric series beginning with the single segment of the highest order and increasing according to constant bifurcation ratio.

The number of streams of a given order in a drainage basin systematically with increasing stream order (Fig. No.2).

Negative Exponential Functional Model

$N\mu = R_b^{(k-\mu)}$

Where,

$N\mu$ = Number of stream segment of a given order

R_b = Constant bifurcation ration

μ = Basin Order

k = Highest order of the basin.

Example: (1) Number of stream segments of 1st order,

$= N_\mu = 3.97^{7-1}$

$= N_\mu = 3.97^6$

$= N_\mu = 3915.10$

Example: (2) Number of stream segments of 2nd order,

$= N\mu = 3.97^{7-2}$

$= N\mu = 3.97^5$

$= N\mu = 986.17$

Table No. 3: Hypothetical Stream Number (Negative Exponential Functional Model)

Stream Order	Number of Streams Segments	Bifurcation Ratio (R_b) Constant
1st	3915.10	3.97
2nd	986.17	3.97
3rd	248.40	3.97
4th	62.57	3.97
5th	15.76	3.97
6th	3.97	3.97
7th	1	3.97
Total	**5232.97**	

The regression lines involving negative exponential function model have been drawn for same sample basins on the following equation.

Lag Y = lag a - bx

Where,

Y = Stream Number

X = Stream Order

a = constant
b = Regression co- efficient.

Table No. 4: Law of Stream Numbers (Strahler's)

Stream Order (X)	Number of Streams (Y)	X^2	Log Y	X.log Y
1^{st}	6502	1	3.8130	3.8130
2^{nd}	2190	4	3.3404	6.6808
3^{rd}	605	9	2.7817	8.3451
4^{th}	153	16	2.1846	8.7384
5^{th}	17	25	1.2304	6.1520
6^{th}	4	36	0.6020	3.6120
7^{th}	1	49	0.0000	0.0000
? **X= 28**	? **Y= 9472**	? **X^2= 140**	? **Log Y = 13.9521**	? **X.log Y=37.3413**

i. $X \quad \frac{X}{n}$

$$\frac{28}{7} = 4$$

ii. $Y \quad \frac{Y}{n}$

$$\frac{9472}{7} = 1353.14$$

iii. $Log\, Y \quad \frac{\log Y}{N}$

$$\frac{13.9521}{7} = 1.9931$$

iv. $b \quad \frac{n \;\; X.\log Y \qquad X.\log Y}{n \;\; X^2 \qquad X^{\;2}}$

$$\frac{7 \quad 37.3413 \qquad 13.9521}{7 \quad 140 \qquad 28^{\;2}} = 14.5986$$

v. a = log Y¯ - bX- = 3.1313 - 14.5986 X 4 = 55.2310

vi. Y = a + bX (X=1) = 55.2310 + 14.5986 X 1 = 69.8296 Antilog = 2.1213

vii. Y = a + bX (X=7) = 55.2310 + 14.5986 X 7 = 157.4212 Antilog = 2.3289.

4.Length Ratio and Law of Stream Length

The proportion of increase of mean length of stream segments of two successive basin orders is defined as length ratio (R_L). The average length of stream of a given order in a drainage basin increases systematically with increasing stream order.

The length ratio representing the proportion of increasing mean length of stream segments of two successive order have been calculated on the basis of following equation,

$$RL \quad \frac{\bar{L}}{\bar{L} \quad 1}$$

When

$$\bar{L} \quad \frac{L}{N}$$

Where,

$\bar{L}\mu =$ Is the mean length of all stream segments of a given order (μ)

ΣLμ = Is the sum of lengths of all stream segments of a give order.

Nμ = Is the number of stream segment of a given order.

RL = 1.0001

The regression line (Fig.3.) drawn on the basis of following regression equation.

Table No. 5: Stream Length (km)

Sr. No.	Stream Order	Number of Streams (Nu)	Total Stream Lengths (km)	Mean Streams Lengths (km)	Mean Streams Lengths ratio
1	1^{st}	6502	20207.89	3.11	
2	2^{nd}	2190	6199.44	2.83	
3	3^{rd}	605	3098.49	5.12	
4	4^{th}	153	1714.64	11.21	
5	5^{th}	17	1074.70	63.22	
6	6^{th}	4	352.70	88.175	
7	7^{th}	1	287.00	287.00	
Total		**9472**	**32,934.86**		**1.0001**

Stream Order vs. the Stream Number

Graphical appearance (Figure 3.) of the total stream length aligned with the stream order can also be organized in a semi-log plot as suggested by Strahler (1957). It is observed that the number of stream segment increases with decreasing stream order in the entire sub basins i.e. negative regression relation.

Stream Order vs. the Stream Length

Commonly, the total length of stream segments decreases with stream order. Graphical representation of the total stream length beside stream order was also prepared in a semi-log plot as recommended by Strahler (1957). The wide-ranging logarithms of the number of stream of a given order, when plotted against the order, the points lie on a straight line (Horton, 1945). The Wainganga River sub-basin plot (Figure 4.) between stream order and total stream length shows negative exponential functions, indicating that the total stream length decreases with increase in stream order indicating that development of drainage is higher for the lower order.

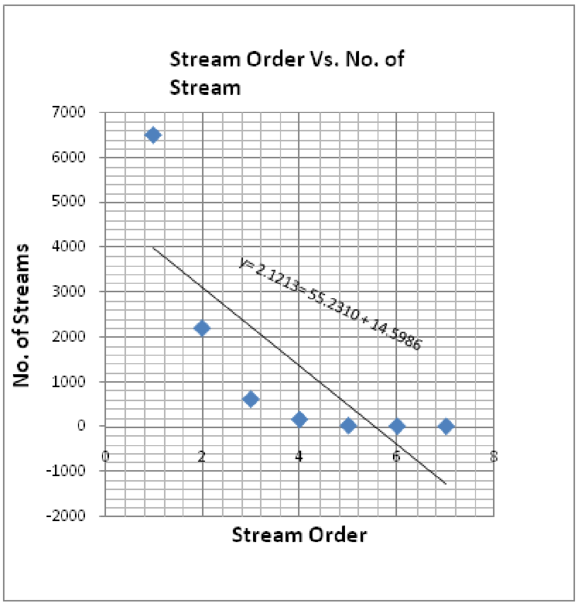


Fig. No. 3: Stream order vs Stream number (-ve correlation)

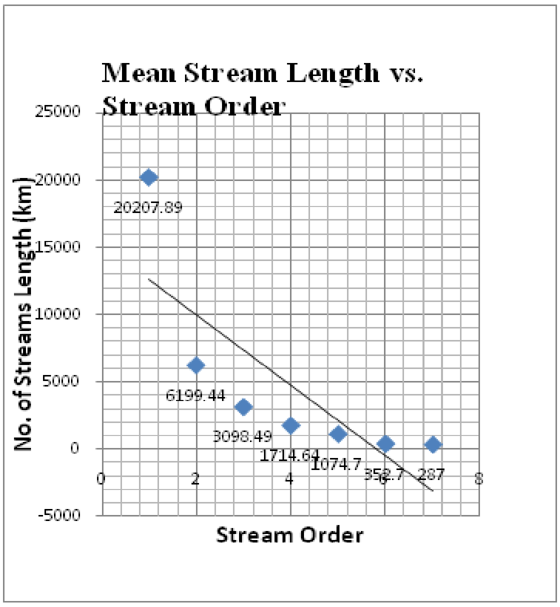


Fig. No. 4: Mean stream length vs. Stream order plotting

REFERENCES

1.Brice J.C. (1964): Channel patterns and terraces of the Loup River in Nebraska, US Geological, and Survey Professional Paper. pp. 422-D

2.Chorley R. J. (1969): The drainage basin as the fundamental geomorphic unit, In Water, Earth and Man (edited by R.J. Chorley). Methuen, London. pp. 77-100.

3.Clarke J.I. (1966): Morphometry from maps, in Essays in Geomorphology (edited by G.H. Dury), Heinmann London. pp. 235-274.

4.Horton R.E. (1932): Drainage basin characteristics, Trans. Amer. Geophysics. U. Vol. 14. pp. 350-361.

5.Joshi V. U. and Kale, V. S. (2005): Anomolous sinuosity in an ephemeral stream, Deccan Trap region, India: The role of local base level. Transactions, Japanese Association of Geomorphologists, Trans. Jap. Geom. Union. 26-1. pp. 1-12

6.Kulkarni Savita (2011): “Geomorphological study of rock bed and gravel bed channel: A case study of Dhul River Channel, Maharashtra Unpublished Ph.D. thesis Tilak Maharashtra Vidyapeeth Pune. pp. 16-30.

7.Leopold L.B., Wolman M.G. and Miller J.P. (1964): Fluvial Processes in Geomorphology, W.H. Freeman and Company. pp. 522.

8.Lubowe J.K. (1964): Stream junction angles in the drainage pattern, American Journal of Science, Vol. 262. pp. 325-339.

9.Muller J.E. (1968): An introduction to hydraulic and topographic sinuosity index, Ann. Assoc. American Geography, Vol. 58, No. 2. pp. 371-385.

10.Singh Savindra (2009): Geomorphology, Prayag Pustak Bhavan, Allahabad, pp. 353-368.

11.Straher, A.N. (1957): Quantitative analysis of watershed geometry, Trans. American Geophysical Union, Vol. 38. pp. 913-920.