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SOME PECULIARITIES OF THE STREAM HIERARCHY IN THE AREA OF ROHTAS PLATEAU : A GEOGRAPHICAL ANALYSIS

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ABSTRACT

The present paper attempts to identify some peculiarities of the stream hierarchy in the karst area of the Rohtas Plateau in Bihar. Some of the basins are peculiar in shape and size in which the bifurcation ratio rises abnormally to very high values of 10 to 14. The trunk stream is met with small unbranched numerous streams amounting Rb abnormally high. This leads to conclude that the rivers flow through subsided karst valleys which are narrow and elongated.


Rohtas Plateau

KEYWORDS : *stream hierarchy , bifurcation ratio rises , trunk stream.*

INTRODUCTION

The Karst area of the Vindhyan Plateau is well marked by the peculiarity in the shapes and sizes of different river basins. The streams is general enter into a different type of terrains on the lower reaches from a homogeneous terrain of the upper reaches of their courses. The lower parts of rivers are flowing in elongated subsided valleys produced due to collapse of upper sandstone strata, and almost all the rivers in the area form waterfalls with sharp breaks of gradient. As a result, the trunk stream is met with a small number of unbranched streams causing abnormally high bifurcation ratio (Rb). The analysis of stream hierarchy shows that the bifurcation ratio between different stream orders of most of the drainage basins does not conform to the general Strahler's limits of Rb between 3 and 5, rather some basins are showing abnormally high values of 10 to 14 while others reaching the theoretically possible lowest value of 2. The inter-relationship between the logarithms of stream number (Nu), stream length (Lu) and cumulative length (Lu) on the one hand and stream order (u) on the other was found to be governed by the linear relationship.

STUDY AREA

Extending from 24°30' to 25°00' N latitudes and 83°20' to 84°05' E longitudes and covering an area of about 2340 square kilometres of the district of Rohtas in the State of Bihar in India, the Rohtas Plateau is drained by many streams (Fig. 1). The southern scarps of the Rohtas Plateau forms the water parting between the Son and the Ganga. The main rivers which flow towards the north are Karamnasha, Kohira, Sura, Karsotha, Durgawati, Dhoba, etc. The study area is a plateau, not a basin. So it includes numerous drainage systems in both full and part courses. However, there are some ten drainage basins (Table-1) which are the complete system. The Durgawati basin, although occupies a greater area of the plateau, does not have its complete watershed within the Plateau.

Stratigraphically the Rohtas Plateau is the easternmost continuation of the Vindhyan system which extends from Rajasthan on the west to Bihar in the east. From the bank of the Son river one can clearly observe the beds of limestone, shales, conglomerates, sandstones, etc. on the south and south-east facing steep scarps (Prasad and Prasad, 1989).

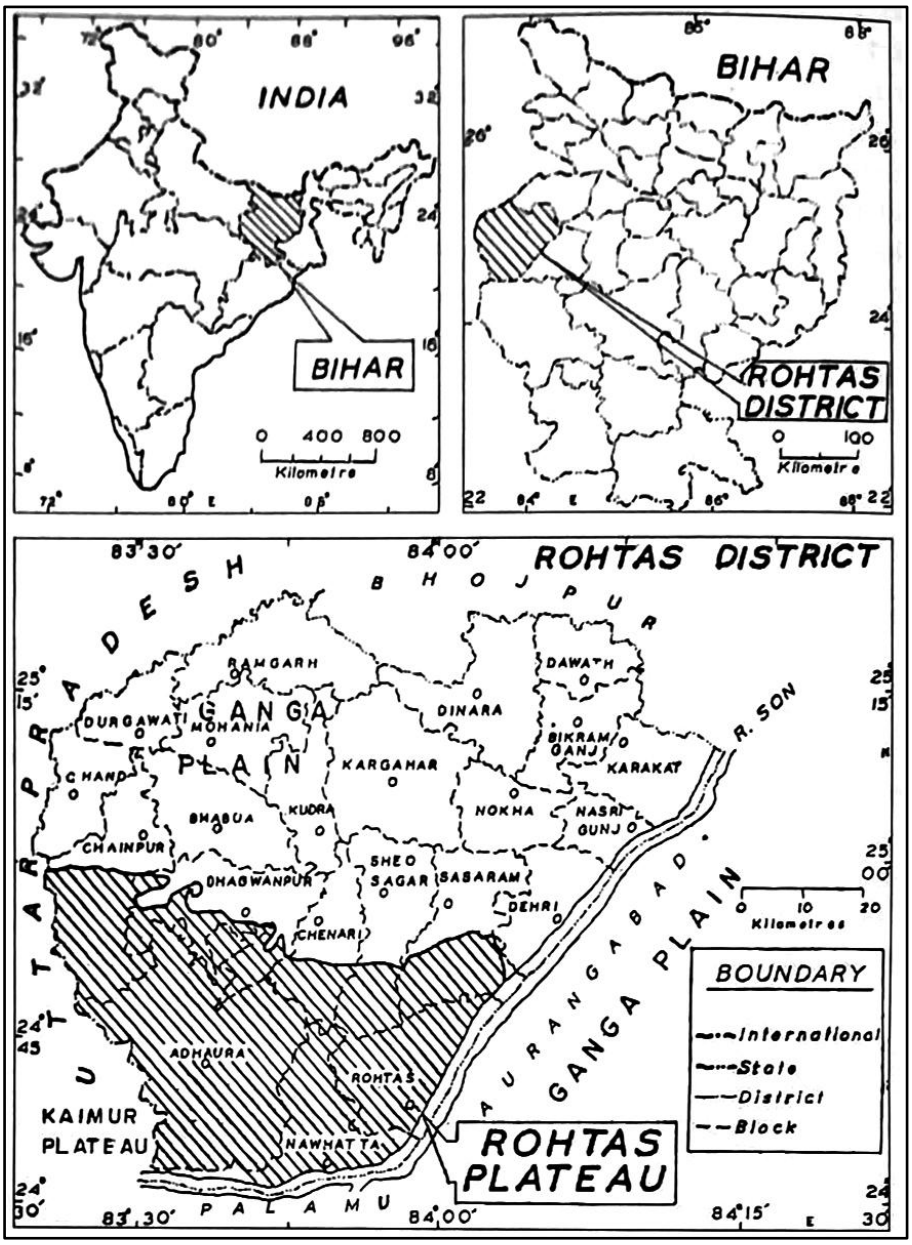


Fig. 1: The Rohtas Plateau and Its Space Relations

OBJECTIVE AND METHODOLOGY

In order to have an idea about the shape, size, morphology and structural characteristics of the basins and thereby evolution of the Rohtas Plateau, an analysis of stream ordering has been made. It is also to examine the laws of Horton and Strahler (Prasad, 1977) in the context of a karst area. For the purpose, ten drainage basins have been demarcated and quantities analysis of their drainage composition have been made. The basins have been traced from 1:50000 topographical maps. The network has been sub-divided into individual lengths of channel or channel segments, according to a

hierarchy of orders of magnitude on Strahler's scheme. The number and lengths of segments of each order were then counted, measured, computed and tabulated.

In this analysis we have used Strahler's scheme for stream ordering of ten drainage basins of the Rohtas Plateau. The map (Fig. 2 & 3) of two drainage basins have been given here as representative basins of the ten basins. According to Strahler values of bifurcation ratio (Rb) between 3 and 5 are characteristics of natural stream system' (Strahler,1971). The Rohtas Plateau being structurally composed of almost horizontal strata of limestone, shale and sandstone with a thick capping of the Vindhyan sandstones (150 to 300 metres) and their being no structural variation over the plateau top, theoretically Rb should remain between 3 and 5. We, therefore, thought it worth-while to apply Strahler's scheme for the analysis of stream ordering of the basins of the Plateau.

Main Observations

On the basis of the computed data (Table-1 to 3), the following observations may be made:

Goptha Basin
Table-1

Stream Order	No. of Streams or Segments	Bifur-cation Ratio	Total Length in kms.	Mean Length of Segments in km.	Cumulative Length mean length in km.	Length Ratio
U	Nu	Rb	L	Lu	Lu	RL
First	419		394	0.94	0.94	
		4.51				1.50
Second	93		131	1.41	2.35	
		3.88				1.65
Third	24		56	2.33	4.68	
		4.80				4.12
Fourth	5		48	9.60	14.28	
		2.50				0.57
Fifth	2		11	5.50	19.78	
		2.00				2.73
Sixth	1		15	15.00	34.78	
		17.69	**655**			

Average Rb-3.53

Table -2
Dhoba Basin

U	Nu	Rb	L	Lu	Lu	RL
First	206		222	1.08	1.08	
		5.02				0.94
Second	41		42	1.02	2.10	
		4.10				2.94
Third	10		29	2.90	5.00	
		10.00				14.83
Fourth	1		43	43.00	48.00	
		19.12	**336**			

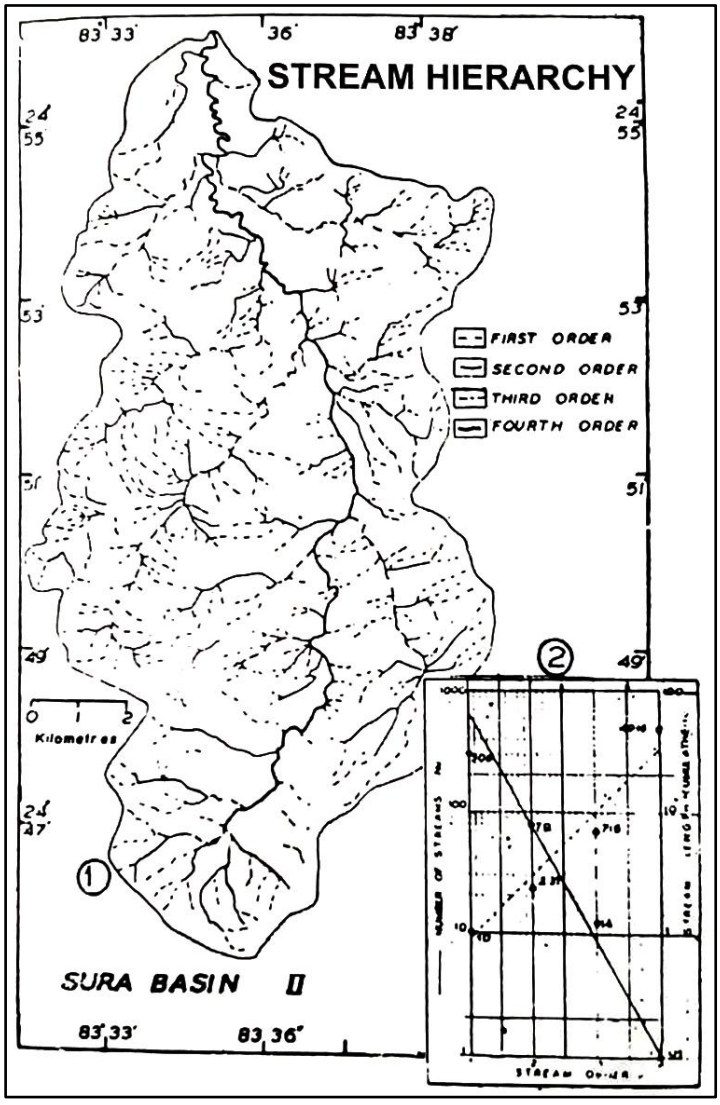
Average Rb-6.37

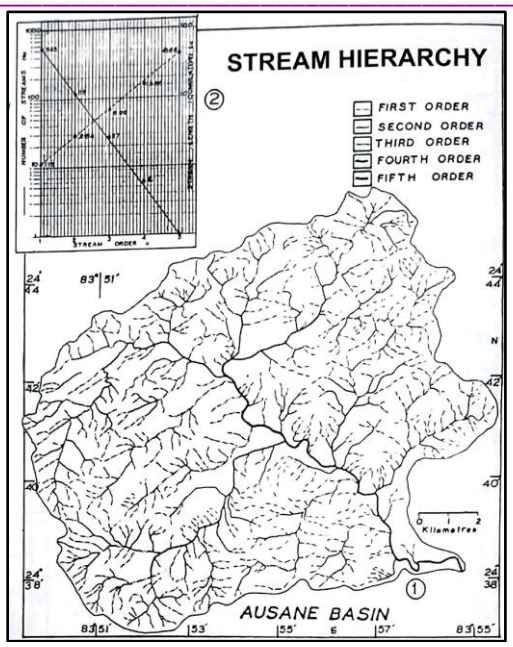
Table-3
Sura Basin II

U	Nu	Rb	L	Lu	Lu	RL
First	308		307	1.00	1.00	
		3.60				1.37
Second	79		108	1.37	2.37	
		5.64				3.49
Third	14		67	4.79	7.16	
		14.00				8.77
Fourth	1		42	42.00	49.16	
		2.354	**524**			

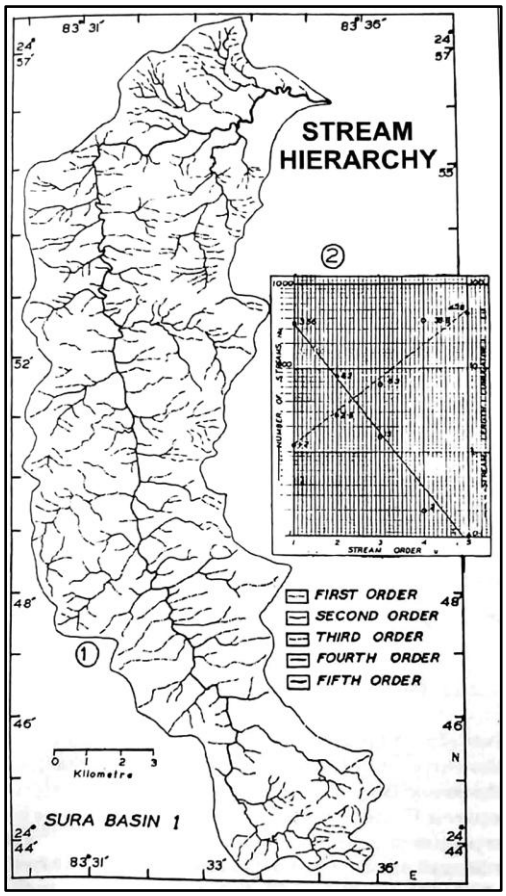
Average Rb-7.84

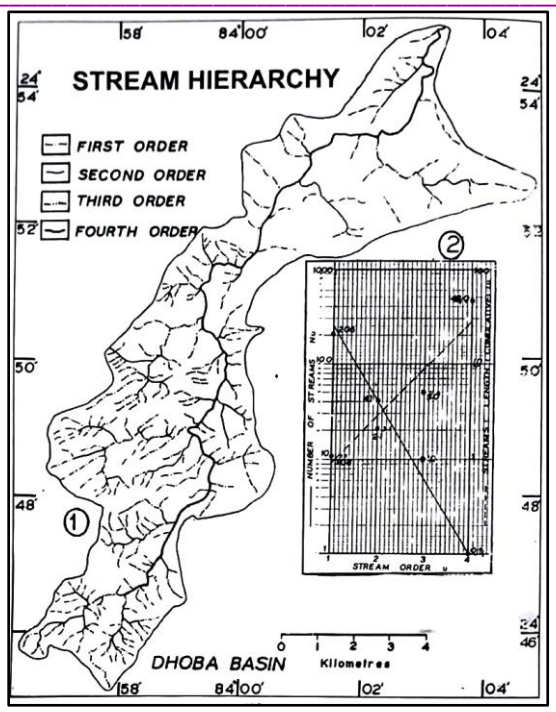
(1) The bifurcation ratios between different stream orders of none of the drainage basins exactly conform to the general Strahler's limits of Rb between 3 and 5, although the average values of Rb lie between 3 and 5 for all the river basins except Dhoba and Sura II;





(2) In Goptha, Lorsi, Karsotha, Sura I and Durgawati basin, the bifurcation ratios (Rb) were found to decrease below the lower limits of 3 between the higher stream orders finally reaching the theoretically possible lowest limit of 2 except in the case of the Durgawati basin in which it is 2.50;
(3) In case of some of the basins Rb between one stream order to another goes beyond the higher limit of 5 and





rises abnormally to very high values of 6, 7.5, 10 and 14 between 3rd and 4th order streams in case of Koel, Sura I, Dhoba and Sura II basins respectively, and to 5.50 and 6 between 4th and 5th order in Durgawati and Ausane basins respectively. In Dhoba and Kohira, Rb between 1st and 2nd order streams is 5.02 and 5.11 respectively; in Karsotha it is 5.50 between 3rd and 4th orders, and in Sura I and Sura II it is 5.5 and 5.64 between 2nd and 3rd order streams; In order to have an idea about the shape, size, morphology and structural characteristics of the basins and thereby evolution of the Rohtas Plateau, an analysis of stream ordering has been made. It is also to examine the laws of Horton and Strahler (Prasad, 1977) in the context of a karst area. For the (4) The variation of logarithm of stream number (Nu), length (Lu) and cumulative length (Lu) with stream order (U) seems to be governed by the linear relationship, although marked deviations were observed at the points where the bifurcation ratios were abnormally high to low.

CONCLUSION

The abrupt change in shape of the river (from top of plateau to the lower reaches) causes the number of streams to drop down to a large extent in the next higher order (in the plain region) from that on the top of plateau. This is probably the reason of sharp rise in the bifurcation ratio between different orders of the rivers (of which one order is in the Plateau top and the next order in the lower reaches).

The plots of logarithms of stream number (Nu), stream length (Lu) and cumulative length (Lu) versus stream order (U) seem to be governed well by the linear relationship. But departure of the observed points from the straight lines are found in the orders between which Rb has been abnormally high or low. The departure of maximum in case of Sura basin II shows the highest value of 14 (average Rb-7.54). It is minimum in case of Ausane basin (average Rb-4.88) in which the variation in Rb between different orders in relatively small. These observations suggest that the inter-relationship between logarithm of Nu, Lu, or Lu versus U is represented well by a straight line given by

$$\log Y = Au + B \qquad ...(1)$$

Where Y = Nu, Lu or Lu, A represents the slope of the line and B represents the intercept of the line on the Y-axis only in the case in which Rb ranges from 3 to 5 (Strahler's normal limits) and deviations are observed from the straight line at the points where Rb shows abnormal variation.

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