

## **A Study Of Drainage System Of The Rapti Valley**

-P. N. Pradhan\*

### **Introduction**

The Rapti Valley is a part of southern Nepal, sandwiched between the Mahabhart Lekh and the Churia ranges which are internationally known as the Lesser Himalayas and the Siwaliks respectively. A valley thus sandwiched and stretching longitudinally is known as 'Dun' and hence the Rapti Valley is called the 'Rapti Dun' having an area of 3251 square kilometres. It is located between 27°21'20" N and 27°47' N latitudes and 81°6'37" E and 85°12'3 E longitudes. The Rapti which drains this valley is a tributary to the Gandaki, locally known as the Narayani. It is the fifth order stream of the Ganges. The major tributaries of the Rapti, river are the Karra, the Samari, the Manabari, the Lothar, the Buri Rapti, the Khageri, and the Ren.

This valley looks like a truncated leaf, narrow in the east and gradually broadening to the west. It is 110 kilometres long with a varying width from 21 to 39 kilometres.

The Rapti valley comes within the monsoonal regime and receives an annual rainfall of 2100 millimetres. But here precipitation is highly concentrated as more than 81 percent of the rainfall occurs during June to September which is the wettest period in the valley. January to March is the driest period accounting less than 5 percent of the total annual rainfall. During the monsoon, due to excess surface run off, fluvial erosion is the dominant exogenetic factor in determining the landforms, aided by the high slope values of the young folded mountains.

### **Origin of Drainage System**

The Rapti river, 123 kilometres long, is the last tributary with consider-

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\* Dr. P. N. Pradhan is a Research officer in APROSC, Kathmandu.

able length of the Narayani within the Nepalese territory. It flows from Alkadamer east and joins the Narayani at Khoriamohan. It originates immediately after the origin of the new valley, and this origin of the valley occurred during the upper Pleistocene period which saw last known great Himalayan orogenic movement.

The primeval Himalayan rivers were directly flowing from north to south. Their north-south courses are still maintained north of the Mahabharat Lekh. But during the mid-Miocene period they were unable to continue their courses because of the rising Mahabharat Lekh, and ultimately, most of the rivers had to abandon their original courses. This has happened in the case of the Marsyangdi, the Buri Gandaki, the Trisuli and even the Bagmati (Fig. 1). New small and intermittent streams might have started from the newly rising Mahabharat Lekh. Once again, eventually, those small and intermittent streams might have been modified during the upper Pleistocene period when the Churia elevated to the present shape and the Rapti Valley was formed and upon this valley the present drainage system is being evolved.

#### Drainage Density

No one has yet ascertained the drainage density of the rivers of Nepal. So it is not possible to compare the drainage density of the Rapti Valley with the national figure at this present moment.

The drainage density of the Rapti Valley is found out by applying the formula postulated by Horton<sup>2</sup>

$$\text{Drainage density, } Dd = \frac{\sum L}{A}$$

Where L = the total length of streams

A = the area, both are in the same units.

1. Streams having less than 3 kilometres are omitted. These are either too short, or too seasonal, or both.
2. R. E. Horton, "Erosional Development of Streams and their Drainage Basins, Hydro-physical Approach to Quantitative Morphology", *Bulletin of the Geological Society of America*, Vol 56 (1945), pp. 275-370.

This valley comprises eight major sub-basins including the Rapti sub-basin itself and this indicated by the table. The highest drainage density occurs in the Buri Rapti sub-basin (0.50 km. per sq. km.). The arithmetic of the drainage density of the Rapti Valley works out to be 0.42 kilometre per square kilometre, but the statistical mean is 0.45 kilometre per square kilometre. The latter is more realistic because it occurs in three of the eight sub-basins (Fig. 2).

Table No. 1  
BASIN-WISE Drainage Density

No	Streams	Area in sq. km.	Length in km.	Density/sq. km.
1.	Khageri	318	143	0.45
2.	Buri Rapti	111	55	0.50
3.	Lothar	171	75	0.44
4.	Manahari	460	194	0.42
5.	Rapti	1633	668	0.41
6.	Semari	105	47	0.45
7.	Karra	87	39	0.45
8.	Reu	366	167	0.46
	Average	2251	1383	0.42

The drainage density primarily depends on relief and rainfall and, secondarily, on infiltration capacity of the terrain and vegetation cover. Keeping aside the Reu and the large area of the Rapti sub-basins, all other sub-basins are located on the northern half of the valley, if one draws a line from the source of the Karra river to the mouth of the Rapti river. The northern sub-basins get higher rainfall, have got the strong relief and higher altitude and are composed of crystalline and metamorphic rocks which have got least infiltration capacity and fairly dense vegetation. Hence the sub-basins which are situated in this northern part have got higher density. Contrary to the northern part, the southern part is composed of non-resistant rocks; hence it possesses high infiltration capacity, is densely forested with low relief because nearly half of its area is situated in the rain shadow area. These reasons contribute to the low

PROBABLE ORIGINAL DRAINAGE COURSES  
BEFORE THE RISE OF THE MAHABHARAT  
LEKH

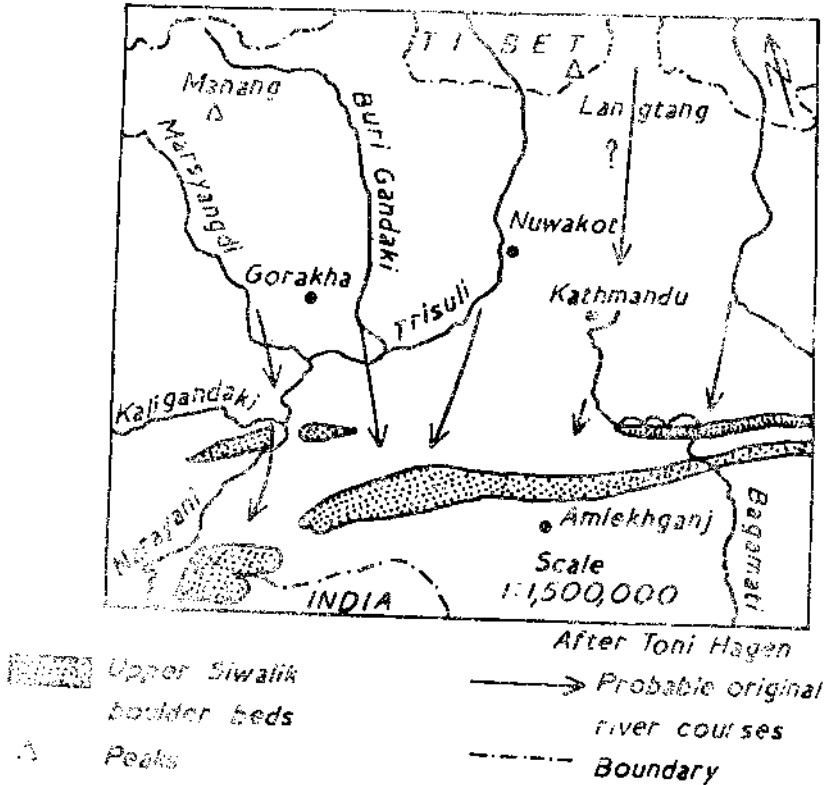


Fig. 1.

drainage density of the Rapti sub-basin. On studying the Reu sub-basin, one finds a different picture. Though it is situated in the southern part of the Rapti river and its conditions are similar to the southern part of the Rapti sub-basin (except in rainfall), its density figure is higher, being next to the Buri Rapti sub-basin. It is probably due to its locational advantage. It is situated between the Churia and Someswor ranges, easily accessible to the rain bearing monsoon as the Churia-Someswor pass is low. Hence it receives high rainfall which results in high drainage density to this area.

**Drainage Texture**

The drainage texture is one of the important criteria recently introduced<sup>3</sup> from which it may be easy to find out the nature of topography whether it is highly dissected or not.

The texture ratio is expressed by the equation

$$T = \frac{N}{P}$$

where T = texture

N = number of cranalations on the selected contour

P = the length of the perimeter of the basin in kilometres or fractions thereof.

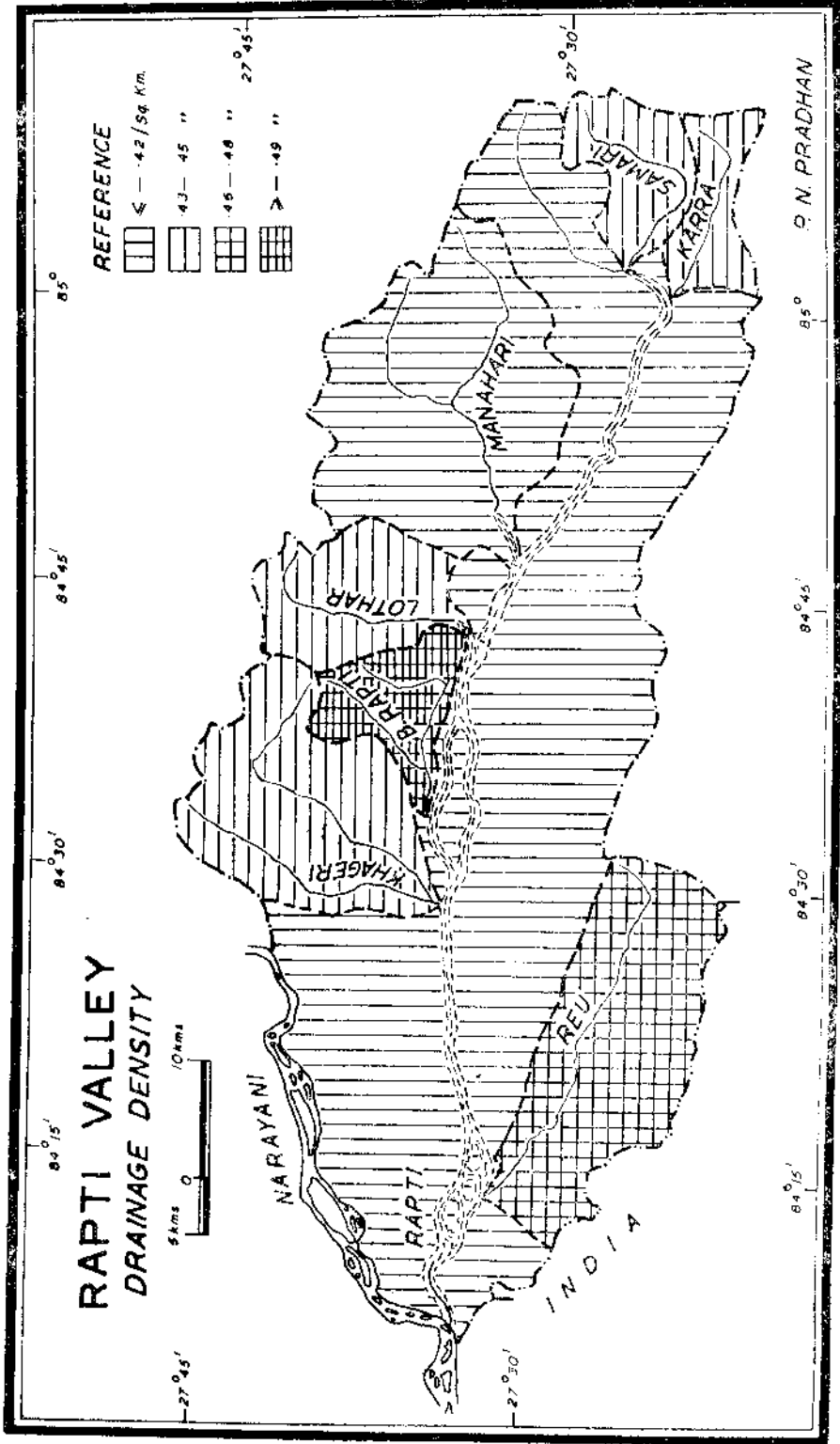
The following table shows the basin-wise equation of the drainage texture of the Rapti Valley:

**Table No. 2**  
**Drainage Texture**

Stream basins	No. of Cranalations	Length of the Perimeter	N/P	Area in sq. km.
1. Khageri	27	76	0.36	313
2. Buri Rapti	19	50	0.38	111
3. Lothee	28	56	0.50	171
4. Manabari	74	95	0.76	460
5. Rapti	161	303	0.53	1633
6. Samari	26	48	0.54	105
7. Karra	27	50	0.54	87
8. Reu	58	89	0.65	366

The drainage texture of the Rapti Valley is classified into four categories such as coarse, medium, fine and ultra fine on the basis of data given in the above table.

3. K. G. Smith, "Standards for Grading Texture of Erosional Topography", *American Journal of Science*, Vol. 248 (1950), pp. 655-68.



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FIG. 2

Table No- 3  
Texture Categories

Categories	Texture	Area in sq. km.	% of the area in sq. km.
< 0.50	Coarse	600	18.45
0.51-0.60	Medium	1825	56.14
0.61-0.70	Fine	366	11.26
> 0.70	Ultra Fine	460	14.15

In this valley, the drainage texture varies from 0.36 in the Khageri sub-basin to 0.76 in the Manahari sub-basin (Fig.3). In other words, it is coarse in the former and ultra fine in the latter. When one relates this texture to areas, more than 56 percent of the area falls under medium texture topography, about 18 percent under coarse, about 11 percent fine, and about 14 percent ultra fine. Its mean texture value is not much deviated from the areal texture value. The mean of the drainage texture of the valley as a whole comes to 0.52.

According to Smith<sup>4</sup>,

Mean texture,  $T_m = \frac{\sum (AN/P)}{\sum A}$ , in which A represents area for individual drainage basin, and N/P the texture ratio for each basin as previously defined.

	$\sum A$ (sq.kms)	$\sum (AN/P)$	$T_m$
Rapti Valley	3251	1695.83	0.52

In this valley ultra fine texture develops in the Manahari sub-basin and coarse texture in the Khageri. The former has higher relief, fair vegetation cover, resistant rocks, and probably high rainfall due to its elevation and position, but the latter has low relief, is well forested, might be receiving a little less rainfall.

Thus the Manahari sub-basin is highly dissected one because ultra fine texture is developed there. The ultra fine texture develops when the relief is greatest.

4. Ibid., pp., 655-68.

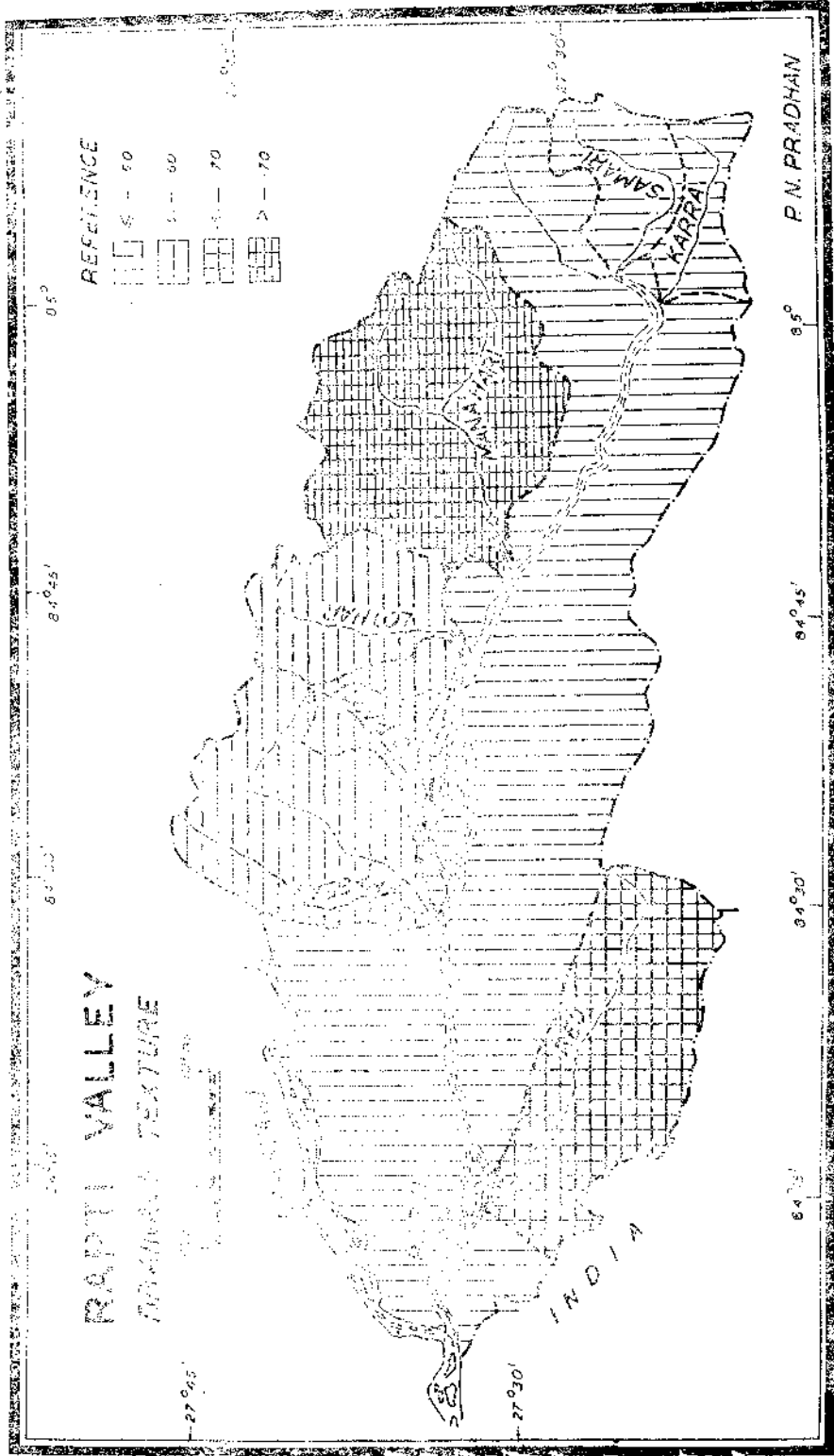


Fig. 3.



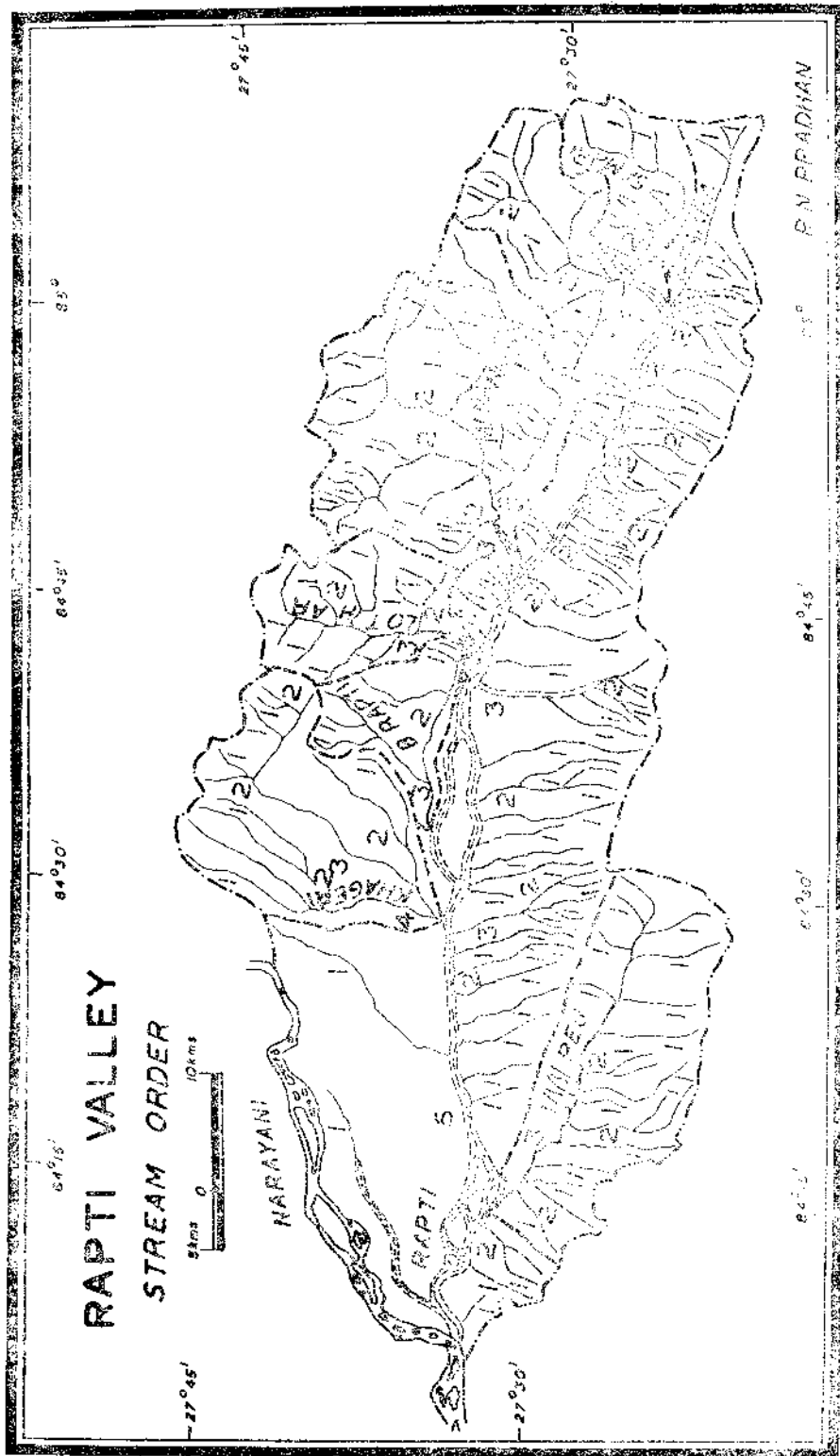


Fig 4.

### Stream Orders, Number, Lengths, and Bifurcation Ratio<sup>5</sup>

In the Rapti Valley the maximum order of stream is 5<sup>6</sup> (Fig. 4). Order of streams are based on the map scale. In the same basin, if the scale of a map is large, order will be more, and vice versa. The present stream order is based on 1:250,000 map.

After ordering the streams, the number of streams is counted in each order and their length is measured from source to mouth and their average length is found out.

TABLE No 4  
Stream Orders, Lengths, and Bifurcation Ratio

Stream Order	No. of Streams	Total length (in kilometres)	Mean length in kilometres	Bifurcation Ratio
1	132	753	5.70	
2	31	316	10.19	4.26
3	7	165	23.57	4.43
4	1	31	31.00	7.00
5	1	123	123.00	1.00
	172	1388	8.07	4.17

In addition to streams having length of 3 kilometre, this valley contains 172 big and small streams, their average length being 8.07 kilometres.

The bifurcation ratio was first introduced by Horton.<sup>7</sup> It means the ratio between the first order and the next lower order. The bifurcation ratio of the streams works out to be 4.17. Horton's analysis which was applicable to this region suggests that the bifurcation ratio ranges from about two for flat or rolling drainage basin upto three or four for mountainous or highly dissected drainage basin. As expected, the bifurcation ratio is generally higher for hilly, well dissected drainage basins than for rolling basin. Strahler in disagreement to Horton's ratio maintains that

5. Based on Horton's analysis.

6. If the omitted 3 kilometre streams are included in stream order then the maximum order will be six.

7. Op. cit. Horton, pp., 275-370.

there are just over three times as many first-order segments as second-order; over four times as many second-order segments as third-order; three and five-thirds times as many third-order as fourth-order; and three times as many fourth-order as fifth-order. The difference in these bifurcation ratios can be attributed to change variation in the shape of any stream network.<sup>8</sup>

Though the Rapti Valley's mean ratio is similar to Horton's analysis, its individual values are somewhat deviated. After fourth-order, values differ much, the ratio between fourth and fifth streams order results 7 to 1. According to Leopold and others<sup>9</sup> the individual ratio tends to equal 3.4. This shows that stream orders are not proportionately developed, i.e., they are either in the premature or early mature stage.

The Manahari, the Rapti and the Reu sub-basins have got similarities in the bifurcation ratio which are 4.75, 4.57, and 4.50 respectively and tend to equal the mean bifurcation ratio of the Rapti Valley. It shows that the drainage development in these sub-basins is gradual in process.

TABLE NO. 5  
Sub-basin-wise Studies

No.	Sub-basin	Order of Streams	No. of Streams	Bifurcation Ratio	Area in sq. km	Mean length in km.
1.	Khageri	4	12	2.17	318	11.92
2.	Buri Rapti	3	6	2.50	111	9.17
3.	Lothar	3	11	3.00	171	6.82
4.	Manahari	3	27	4.75	460	7.33
5.	Rapti	5	81	4.57	1633	8.19
6.	Samari	2	7	6.00	105	6.71
7.	Karra	2	6	5.00	87	6.50
8.	Reu	3	22	4.50	360	7.59

8. A. Strahler, *Physical Geography* (New York: John Wiley and Sons Inc., 1960), p. 377.

9. L. B. Leopold et al., *Fluvial Process in Geomorphology* (New Delhi: Surasia Publishing House (Pvt.), 1969), p. 138.

**Conclusions**

Rapti Valley, before 1954, was practically in natural state. After 1954, in this valley, large scale human settlements have been started and its natural balance was highly disturbed which still persists with alarming situation. Forest are fast depleting that give free play to rivers. Consequently the rivers have become more aggressive and hence floods and change in its courses during monsoon have become common phenomena. The present study of Rapti Valley system may serve as a benchmark for future study.

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