MORPHOMETRIC STUDY OF "THE DOBHAN KHOLA DRAINAGE BASIN"IN KASKI DISTRICT.

-Kabi Raj Subedi[1]

Introduction :

The Dhobhan Khola is a tributary stream of the Seti river. This drainage basin lies in the North-Eastern part of Pokhara Valley, covering an area of 18.91 Km^2.

Among the various parameters which control the geohydrological condition of a basin, geomorpphology is undoubtedly the most dominant. In this paper an attempt is made to present a brief account of quantitative geomorpnology of the Dobhan Khola drainage basin.

Surface features are the product of various endogenetic and exogenetic processes and river action is the main exogenetic process in developing various landforms on the earth's surface.

The present study therefore covers a single drainage basin "The Dobhan Khola drainage basin", and different orphometric characteristics are analysed here.

Morphometry is defined as measurement of shape or geometry of any natural form - be it plant, animal or relief feature.(strahler, 1975)

In the present context, the measurement of different morphological characteristics of the Dobhan Khola drainage basin is taken to be the morphometry.

According to Dury, morphometry may be defined as "the measurement and mathematical analysis of the configuration of the Earth's surface and of the shape and dimensions of its landforms" (Dury, 1970) The scholar has emphasised morphometry as the measurement of the landforms related to fluvial process with mathematical or quantitative analysis.

Strahler (1952) has emphasised that analysis of drainge basin either as single unit or as a group of baains, taken together, comprises a morphological region that has particular relevance to basins and these provide convenient units into which an area can be subdivided. The development of landscape is equal to the sum total of the development of each individual drainage basins which have been formed due to a process which are similar to each other. At the same time, however, these basins are evolving in a way which in not very different from one another.

Geomorpholgy will achieve its fullest development only when the forms and processes are related in terms of dynamic system and the transformation of mass and energy are considered as function of time .

A drainage system whether of water or ice, within the geographical confines of a watershed, represents such a dynamic system.The component unit of the geomorphology is a drainage basin and analysis of the basin forms proved remarkably fertile approach to the general problem of quantitative description. Therefore, quantitative method of analysis of drainage basin is the only reliable quantitative description of geomorphological chararacter. By this approach different properties of drainage system within a planimetric area have been measured and mathematical procedures have been used as far as possible.

Keeping these views in consideration an attempt has been made in this direction by selecting the Dobhan Khola Drainage Basin as the study area, where heavy floods and huge landslides are taking place every year in the rainy season and siltation or sedimentation in Lake Rupa has become a serious problem.

In this study, the devices postulated by R.E. Horton and developed by A.N. Strahler and others have been followed.

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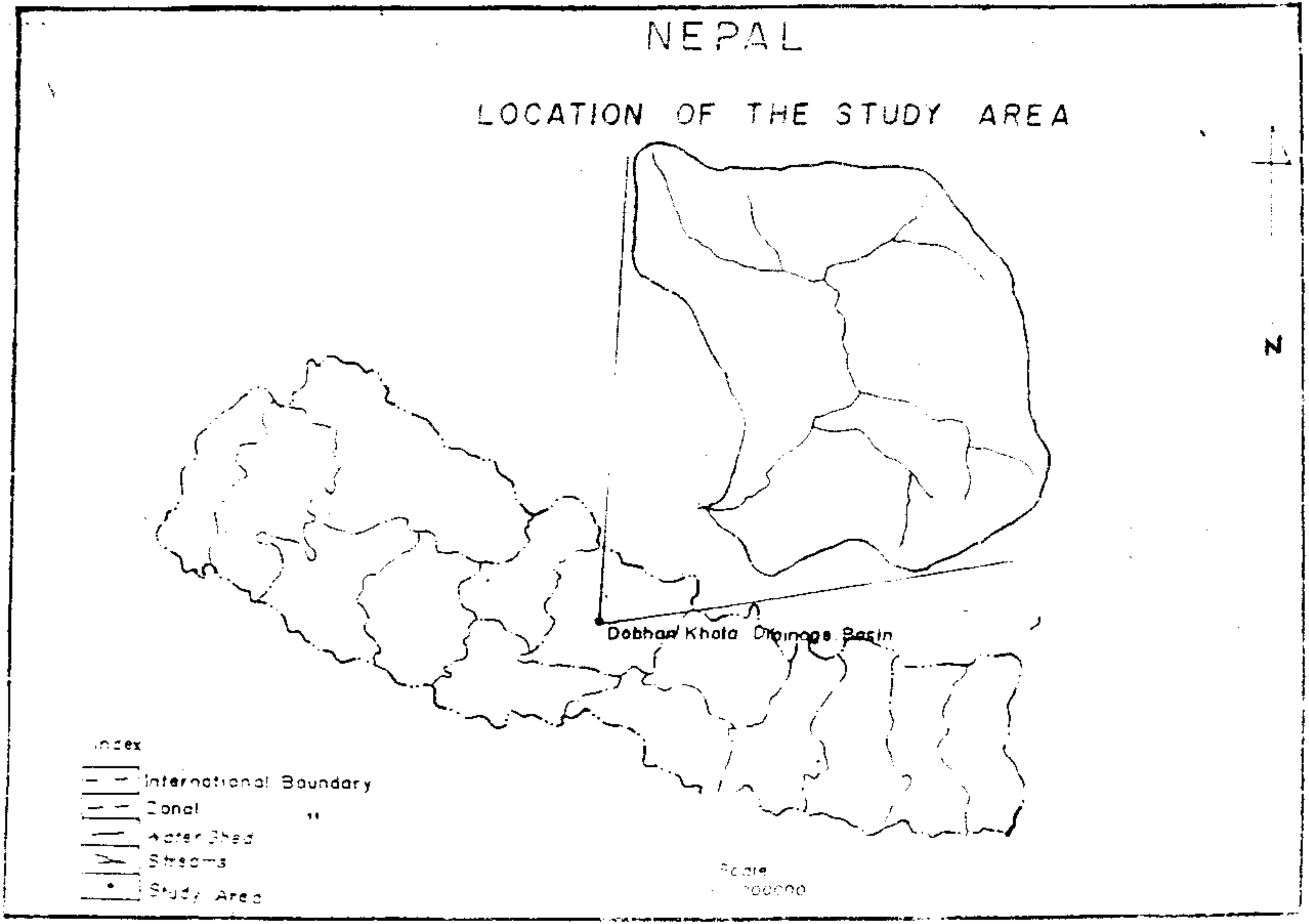

NEPAL
LOCATION OF THE STUDY AREA
N
Dobhan Khola Drainage Basin
Index
International Boundary
Zonal
Water Shed
Streams
Study Area
Scale

Objective

The main objective of this study is to explore the morphometric characteristics of the Dobhan khola drainage basin by counting, measuring and visualising different properties of the basin which will be useful to measure the environmental degradation (floods, landslides, soil erosion and heavy sedimentation in Lake Rupa) in this basin.

Methodology

For the fulfilment of the objectives and to analyse the morphometric characteristics, this study is primarily based on primary data obtained from the topographical map No. 71/D/4 with 1" to 1 mile scale.

As the study is at micro- level, the whole channel segments of the drainage network within the study area have been counted and their linear, and areal properties have been measured with opisometer and inch graph. The morphometric characteristics as mentioned earlier have been analysed using different devices formulated by R.E. Horton and developed by A.N. Strahler and others.

To find out the relationships among different properties exponential regression analyses have been done. For this regression analysis, semi-logarithmic graph (constant ratio scale) is used, where horizontal 'x' axis is in arithmetic scale and verical 'y' axis is in constant ratio scale. See Fig. 4 'a' and 'b'.

Location of the study Area

The Dobhan Khola Drainage Basin is situated at the extreme north eastern part of Pokhara valley which is mainly extended in the central hilly region of Nepal. This basin extends between 28.11' 45" N.to 28.14' 15"N. latitudes and 84.7'15" E. to 84.10'3" E with longitudes an area of 18.91 km^2.

Topographically, this basin is a narrow valley, extending from the north west to the south east. It is flanked by high hills like-Syaklung, Lipeyni, Beteni, Begnas, Rupakot, Virchok and Chisapani. About 80% of the topography of this basin is covered with hilly areas and only 20% of the land is below 762m. The height of this basin from the sea level ranges from 625 meter to 1420 meter. The highest part is Syaklung Danda 1420 m. and the lowest part is the point where Dobhan Khola meets the Lake Rupa 625 meter. (See Fig 2.)

Climatically, this basin is similar to Pokhara valley. Heavy rainfall occurs in the rainy season (June-August) and higher temperature is recorded in May.

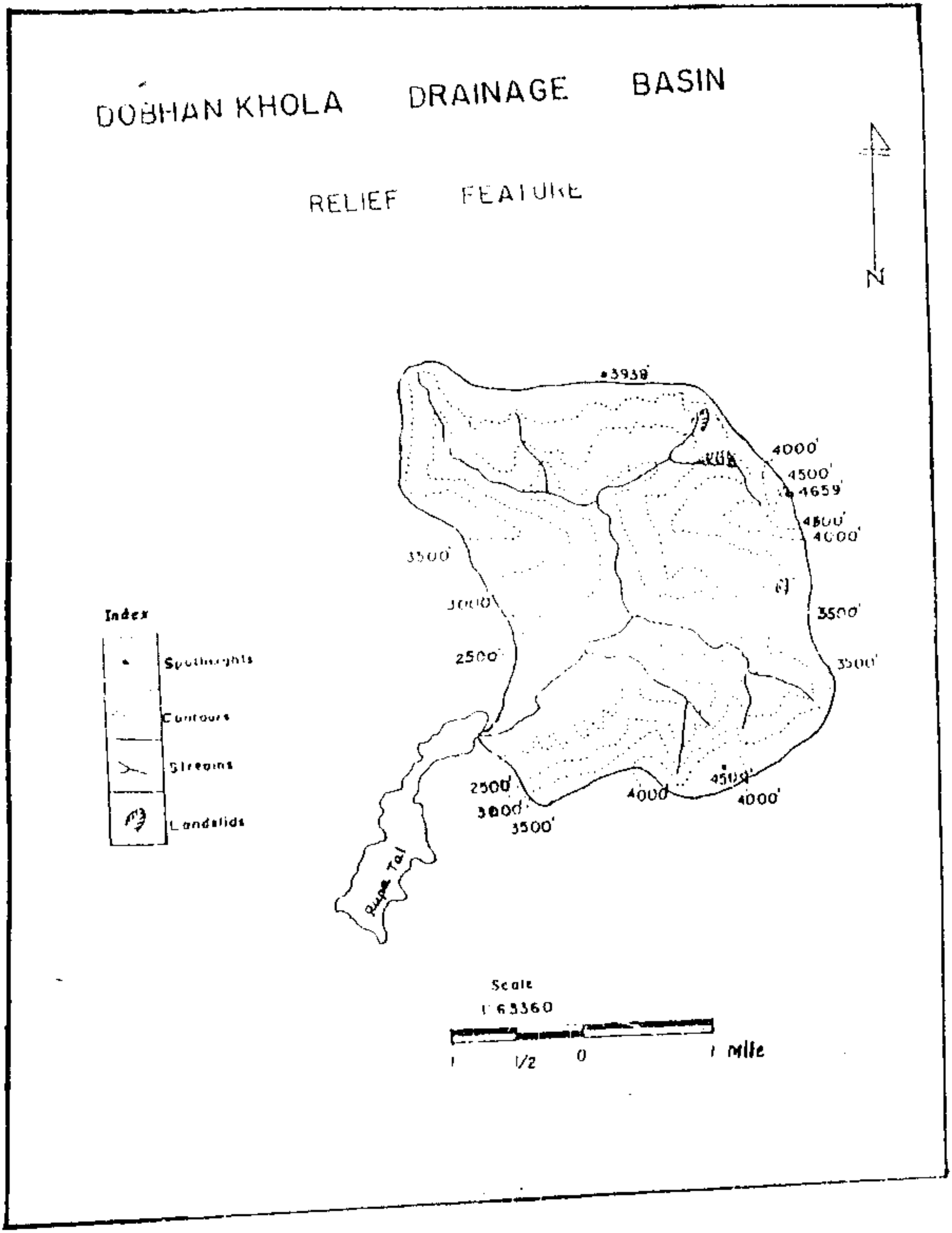
Vegetation plays a dominant part in checking soil erosion or in the process of differential erosion and evolution of different landform. Roughly about 40% of the area of this basin is covered with vegetation. The dominant vegetation is forest mainly in south facing slopes and mixed jungle in the north facing slopes. Natural vegetation of the south facing slopes has been cleared away for settlement and for cultivation, which has led to heavy floods and huge landlsides in the rainy season.

Landuse pattern of this basin is not so diverse. This basin is used for farming, settlement and forests. Only a little part is covered by stream channels. Mainly north facing slopes are under vegetative cover (due to the lack of insolation and steepness of the slopes, these are avoided for settlement and agricultural land). But the south facing slopes are highly utilized for agriculture and settlement. Settlements developed in the south facing slopes are Syaklung, Lipeyani, Beteni and Khelabensi.

Talbensi Phant is the main agricultural area where mainly paddy is grown. Terrace farming and cattle grazing are common activities in the hill slopes. Soil erosion and landslides in monsoon period are quite common. The main problems of this basin are soil erosion and landslides in hilly slopes and heavy sedimentation in the Lake Rupa.

Morphometric Characteristics of the Basin:

For the quantitative analysis of the basin the linear and areal properties of the basin have been analysed as below:


DOBHAN KHOLA DRAINAGE BASIN
RELIEF FEATURE
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4000'
4500'
4659'
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4000'
3500'
3000'
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3500'
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1 1/2 0 1 Mile

a. Linear Properties

In linear properties, stream order, stream number, bifurcation ratio and stream length have been analysed.

i. Stream order, Number and Bifurcation Ratio

There are different methods of designating the stream order. However, the modified Strahler's method of stream order (Strahler 1952) is adopted for the present study and the number of segments of channels of each order tabulated in Table No. 1. This basin is a fifth order basin with 99,23 9,2 and 1segments in first to fifth order respectively. Which are shown in Fig No. 3 and plotted on Fig No, 4-'b'

Table No. 1
Morphometric Characteristics of Dobhan Khola Drainage Basin.

Stream Order U	Total Number of segments Nu	Bifurcation Ratio Rb=Nu/Nu+1	Total Length of Segments Stream Order U. LU in kms.	Mean Length of Segments LU in kms.	Cumulative Mean Length Elu in kms.	Length Ratio Rl=Lu/Lu-1	Total Area Au in Sq. km.	Mean Area Au in sq. km.	Area Ratio Ra=AU/Au-1
1	99	4.31	41.6	0.42	0.42	1.17	14.25	0.14	5.14
2	23	2.56	11.2	0.49	0.91	1.09	16.58	0.72	2.74
3	9	2.56	4.8	0.53	1.44	1.02	17.72	1.97	4.67
4	2	2.00	3.2	1.60	3.04	1.31	18.39	9.20	2.06
5	1		2.1	2.10	5.14		18.91	18.91	

Drainage desity : 3.33 Drainage Frequency : 7.08

Source: Compiled from Topo sheet Map., (1 : 63360): 1954

The Number of stream segments are designated by the symbol 'Nu' and the ratio between the number of a given order 'Nu' to the number of segment of the next higher order 'Nu+1' is bifurcation ratio. Symbolically $Rb = \frac{Nu}{Nu+1}$. The bifurcaton ratios for each set of stream segments have been calculated and presented in Table No. 1. The average bifurcation ratio of this basin is 3.34. Horton considered the bifurcation ratio as an index of relief and dissection. (Horton 1945). According to Shreve and Ongley the bifurcation ratio ranging between 3-5 indicate mature surfaces. According to these scholars,this basin also falls on mature stage of landform development, where the average bifurcation ratio is 3.4. (Shreve, 1966 and Ongley 1974)

ii. Stream Length :

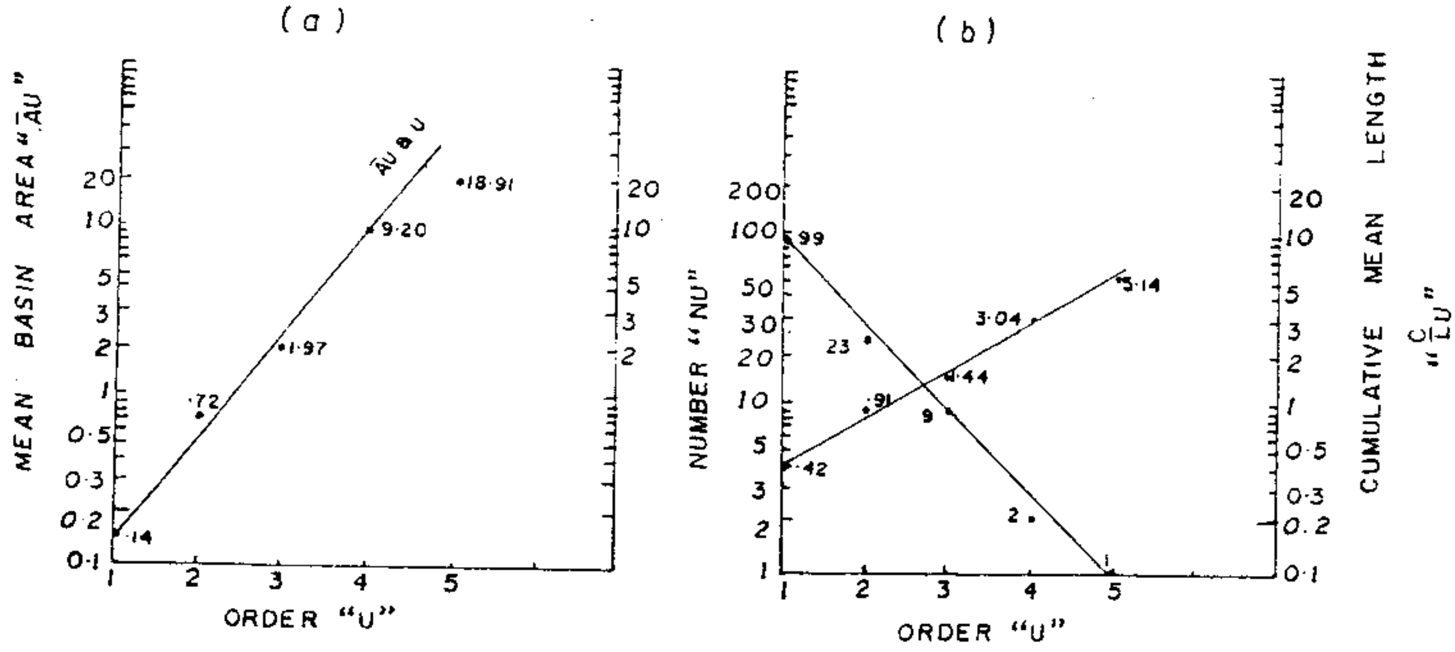
Referring to the drainage network map (Fig 3), it is apparent that the first order channel segments (in average) have the shortest length and that segment becomes longer as order increases.

The master stream of this basin is of fifth order. Total cumulative mean length of the trunk channel is 5.14 Kms. The mean length of stream segments increases roughly with a ratio of 2 times (1.6). This ratio is known as length ratio, symbolically Rl. The length ratio is the ratio between the mean length of an order Lu and the mean length of next lower order Lu -1 or mathematically $Rl = \frac{Lu}{Lu-1}$.

Mean length, cumulative mean length and the length ratio of this basin are calculated and presented in Table No. 1 and cumulative mean length is plotted on Figure 4-'b'.

DOBHAN-KHOLA DRAINAGE BASIN

MORPHOMETRIC CHARACTERISTICS OF DRAINAGE SYSTEM



h. Areal Properties :

In areal properties, orderwise area is measured with the help of inch graph and tabulated on table No. 1. Total area, mean area and ratio are symbolized mathematically as Au, Au and Ra $= \frac{Au}{Au-1}$ respectively. Besides these characteristics, stream frequency, drainage density and stream texture are analysed and presented in Table No. 1.

Total area of this basin is 18.91 Km^2 which is also a mean area of the fifth order stream. The area ratio indicates the ratio between mean area of the order "u" basin and lower order basin "u-1". In this context area ratio between first and second, second and third, third and fourth, fourth and fifth are different but the average area ratio is 3.65km^2. Orderwise mean basin areas are plotted on fig. 4'a'.

i. Stream Flow and Basin Area :

One of the purposes of fluvial morphometry is to derive information in quantitative form about the geometry of the fluvial system that can be co-related with hydrological information. According to Strahler discharge and area of the watershed seem very much co-related. Discharge increases with increasing area of the watershed. Due to the lack of informations, the discharge of this basin can not be obtained. But such knowledge would be essential in desinging hydraulic structures, such as dams, bridges and irrigation diversions.

ii. Drainage Density :

From the drainage network map of Fig.3, one should measure the total length in km of all channels and divide this figure by the total area in sq. km.of the entire map or watershed, there the drainage density is found. Drainage density denotes the total length of stream divided by the total area. Symbolically $D = \frac{Lk}{Ak}$.

Drainage density of this basin is 3.33, which is greater than the drainage density of the Kathmandu valley. (Poudel, 1983-84)

There are so many factors affecting the drainage density as (1) rock type (hard resistant rock, such as intrusive granitic rock, sand stone, and quartzite tend to give low drainage density and clay and shales, even a small watershed can supply enough run-off for channel erosion and create high drainage density). (2) infiltration (coarse sand and gravel tend to give low drainage density and clay and shales tend to give high drainage density). and (3) vegetative cover, which tend to form a low drainage density.

According to above descrption rock type and vegetation cover are the main responsible factors to give low drainage density in this basin.

iii. The Drainage Texture :

Drainage texture mainly depends on the texture of topography. Higher the drainage density finer the texture and lower the density, coarser the texture. Strahler has given four sheets of topographical map of U.S.A. where he has has shown that drainage density and the texture of topography are closely related. (Strahler, 1975) Sheets, drainage density and texture of topography given by A.N. Strahler are as follows :-

Sheet	Drainage Density		Texture of topography
A	3-4	miles/Sq.mile	Coarse
B	12-16	"	Medium
C	30-40	"	Fine
D	200-500	"	Ultra fine

The above proves that coarse texture creates low drainage density or coarse drainage texture and fine texture creates high drainage density of fine drainage texture.

Texture of topography of Rapti valley is determined P.N. Pradhan (1980) on the basis of selected contour cranulation within the perimeter of the basin, developed by Smith (1950). But in the present study, respecting Strahler's idea, Singh's method is followed. He has graded the basins depending on drainage density as follows (Singh, 1967)

Density	2	2 - 4	4 - 6	6 - 8	8 - 9
Texture	Very coarse	Coarse	Moderate	Fine	very fine

This method is also followed by Chandrashekhar and Naganna (1983) for the Geomorphic study of the Chikkahagari basin in Karnataka, India.

The Dobhan khola drainage basin is graded as a coarse textured basin, on the basis of drainage density which is about 3.33.

iv. Drainage Frequency :

Frequency of the drainage is the ratio between the number of segments of all orders and the total area of the basin. In this context, the drainage frequency is 7.08/km^2 . Thus there are so many small stream channels which flow in monsoon periods and contribute to drainage frequency but little to drainage density due to the very short length.

Conclusions

On the basis of the analyses of different properties of the drainage basin and field observation, some conclusions are drawn here as follows.

This basin has reached the mature stage of landform development, on the basis of bifurcation ratio. It has coarse texture of topography on the basis of drainage density. It is mainly drained by first order stream segments because about 74% stream segments and 75% of area is under first order streams. This figure indicates the monsoonic nature of the streams. There are 7.08 stream segments /km^2 whereas the drainage density is 3.33., which also proves that numbers of stream segments are more but the length in average is very short. Due to this fact, these streams are not so useful for the purpose of irrigation and hydropower generation. Heavy floods and huge landslides are taking place every year in the monsoon period and beds of first to fourth order streams are completely dry in winter or dry season.

Unmanageable or unscientific farming system, deforestation, cattle grazing in forest areas are the most responsible factors for creating flood havoc, landslides, soil erosion and heavy siltation or sedimentation problem in Lake Rupa.

From the view point of tourist industry, this lake should be preserved, otherwise after 50 or 60 years it will be changed into a narrow valley and its once pristine waters would be only found in the pages of history books.

To take measures against these problems, afforestation programme should be initiated, farming system should be changed, dams and dykes should be made on either side of the streams and attention should be given by the geographers as well as the concerned experts such as hydrologist, hydrogeologists, engineers, geomorphologists to solve the problem of this basin.

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