Journal of Tropical Agriculture 32 (1994) : 66-69

KABBANI RIVER BASIN : A STUDY WITH REFERENCE TO HORTON'S LAWS

S. Jayasree and K. John Thomas
Kelappaji College of Agricultural Engineering & Technology, Tavanur 679 573, Malappuram, India

Abstract: A quantitative analysis of the linear morphological parameters and their relationship with average monthly monsoon discharge was conducted using the data collected from the Water Resources Divisional Office, Trichur. Most of the parameters were inter-related and obeyed Horton's laws. The smallest tributaries formed the major part of the river basin. The stream flow during the periods 1976-'80 and 1981-'85 varied with the basin shape.

Key words: Mortons law, monsoon discharge, river basin

INTRODUCTION

Rivers warrant morphological study due to their significant role in producing fluvial land forms, their relation to many other geomorphological processes and their significance for human use. Stream flow varies with the morphological parameters. Chinnamani and Vadivel (1980) studied the trend of run-off in Katery watershed due to the change in land use. Linear morphological aspects of Kabbani river basin were studied with reference to Horton's laws of stream numbers, summed stream length and average stream length (Horton, 1932). The specific morphological factors selected for the analysis were (i) stream order and the number of streams of each order, (ii) stream lengths of each order, (iii) confluence ratio, (iv) maximum straight length of the sub-basin which is an indication of basin shape and (v) monthly monsoon discharge.

The effect of these factors on stream flow was also analysed using correlation studies (Hann, 1977). The study gives an insight into the inter-relationship between the morphological factors affecting run-off.

MATERIALS AND METHODS

Kabbani river, one of the important tributaries of Cauvery river, has its origin in the Wynad taluk of Kerala and flows towards east of Western Ghats to join the main river. This river is formed by the confluence of two main tributaries, Panamaram and Manantoddy. Panamaram river has its source in the Western Ghats near Lakkidi at an altitude of about 1370 m msl. Manantoddy river takes its origin in the Tondarmudi Malai at an elevation of about 1500 m. These two rivers join together about 6.5 km north of Panamaram. From this confluence point the combined river known as Kabbani flows for a distance of about 8 km through boundary limits of Kerala and Karnataka. At Kalvalli, the river takes a northern direction and flows through Karnataka (Anon, 1974). The river basin is provided with 10 river gauge stations and 16 rain gauge stations (Fig.1).

The study was conducted through the data available at the Water Resources Divisional Office, Trichur, on Kabbani river basin. The linear morphological aspects were measured from the topographical map.

The river basin was divided into ten sub-basins, each with a river gauge station. The sub-basins were treated as separate river basins contributing to the run-off at the corresponding river gauge station. Horton-Strahler system of classification of river network was adopted. The fingertip tributaries were designated as the first order, two first order streams meet to form a second order stream and so on. Lower

order streams joining the stream were not considered for the change of order (Horton, 1932; and Strahler, 1964). The highest order which designates the main stream was considered as the order of the sub-basin. Confluence ratio was calculated using the relationship, $R_c = N_u/N_{u+1}$ where, R_c is confluence ratio, N_u is the number of streams of order u and N_{u+1} is the number of streams of order u+1. It was calculated by the method of weighted means. The summed length of streams of each order equalled the total length of streams of that order. The average stream length was obtained by dividing the summmed stream length with the number of streams of that order. The summed length ratio R_L is the ratio of the summed length of streams of a given order to that of the streams of successive order. Summed length of streams of order u was calculated by the equation, $L_u = L_1/R_{Lu-1}$ where, L_u is the summed length of streams of order u, L_1 is the summed length of streams of order one and RL is the summed length ratio. Average length ratio $r_L = R_c/R_L$. Average length of streams of order u, $l_u = L_u/N_u$. The summed length ratio and the average length ratio were calculated by the method of weighted means. Horton's laws were not applied to the second order sub-basins, namely, Manjat and Vazhavatta. Basin shape was expressed as the maximum straight length of the sub-basin. Average monthly monsoon discharge during the years 1976-'80 and 1981-'85 was analysed for their relationship with the morphological factors.

RESULTS AND DISCUSSION

According to the law of stream numbers, the number of stream segments of successive orders follows a geometric progression. The calculated and observed number of streams verified Horton's law of stream numbers, having the first term of the geometric progression as the number of the first order streams and the ratio as the confluence ratio. Per cent variation of the number of streams was less than 10 for all orders except for the highest order of the sub-basin. A deviation of about 20 per cent was noted between the calculated and observed number of highest order streams. However, the total numbers of streams were more or less the same. The last term of the geometric progression in most of the sub-basins was less than one. Shreve (1966) had explained this as due to the local conditions which might cause the transition of the stream to a higher order before the accumulation of all streams of lower orders. The law was also verified graphically. First order streams constituted the largest portion of the stream segments (75%-80%). Predominance of the lower order streams is particularly notable because human interference can easily disturb these fingertip tributaries. The preservation of the river, therefore, starts at the lowest level.

According to the law of summed lengths, the length of streams of successive orders follows a decreasing geometric progression. The deviation of calculated and observed lengths for the first and second order streams was less than 10 per cent in all sub- basins. But, the law deviated for higher order streams, the length being higher than those predicted by the length ratio. The extent of deviation varied from 30-50 per cent. As a stream enters flatland, lateral erosion prevails due to the decrease of slope followed by braiding and meandering of the water-course and thus the length of streams increases considerably. Most of the streams acquire a higher order in this course of flow. The increase of stream length for these orders may be the cause of deviation of the law established for the drainage system in the mountainous and hilly areas. Per cent deviation of the total length of streams was less than 10 in all sub-basins.

The law of average stream length states that the average length of streams of successive orders forms an increasing geometric progression. But, the law was not obeyed for orders greater than three,

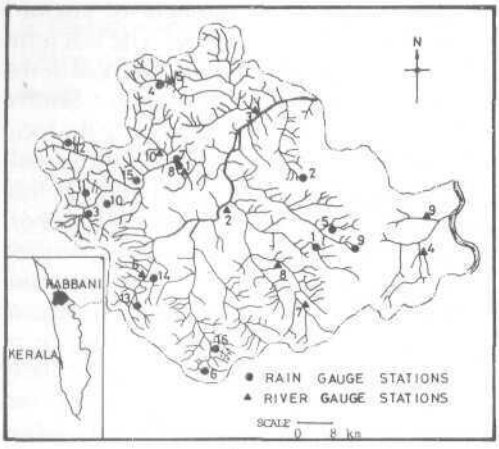

Fig 1. Map of Kabbani river basin showing hydrological stations

(Rain gauge stations: 1.Ambalavayal 2.Chedalath 3.Koroth 4.Kottiyoor 5.Kuppady 6.Lakkidi 7.Manantoddy T.O. 8.Manantoddy K.S.E.B. 9.Muthanga 10.Makkiyad Monastery 11.Mukki 12.Periya K.S.E.B. 13.Thariode Estate 14.Thariode K.S.E.B. 15.Valat 16.Vythiri. River gauge stations: 1.Manantoddy 2.Panamaram 3. Baveli 4.Muthanga 5.Thirunelli 6.Choorani 7.Vazhavatta 8.Kakkavayal 9.Manjat 10.Thondar)

the deviation being 30-40 per cent. This is in conformity with the results obtained by Morisawa (1962). Most of the sub-basins extended over two major relief units, the high land and the low land having the rocks of different characters offering resistance to erosion. Consequently, the graphical plot of the summed stream length and average stream length with the order of the stream had two straight line portions; for lower orders and for higher orders (order greater than three).

The number and summed length of streams of successive orders were found to have very low correlations with the average monthly monsoon discharge. The shape of the basin showed a direct relationship with the average monthly monsoon discharge of the periods 1976-80 and 1981-'85. The discharge increased with the order of the stream (Table 1). Morphological imbalance of the river basin, thus, affects the discharge in the streams.

ACKNOWLEDGEMENT

This article forms a part of the M.Sc. (Ag.Engg.) thesis submitted by the senior author to the Kerala Agricultural University, 1990.

Table 1. Reladonship between order, maximum straight length and discharge

Sub-basin	Order	Maximum straight length of sub-basin (km)	Average monthly monsoon discharge, Mm^3	
			1976-'80	1981-'8 5
Manjat	2	-	7.73	5.42
Vazhavatta	2	10.80	17.26	7.50
Kakkavayal	3	21.20	16.25	28.05
Muthanga	3	18.40	35.26	35.94
Thirunelli	3	14.00	36.31	22.66
Thondar	3	18.80	24.77	17.96
Baveli	4	36.80	44.94	34.52
Choorani	4	15.60	56.50	25.07
Manantoddy	5	38.80	221.02	60.03
Panamaram	5	42.00	14.87	12.96

REFERENCES

Anonymous, 1974. Water Resources of Kerala. Kerala P.W.D., Government of Kerala, Trivandrum, p. 91-99, 211-213

Qlinnamani, S. and Vadivel, R.S. 1980. Hydrological characteristics of a watershed in transition - A case study. /. *Instn. Engrs. India.* 61 : 159-162

Hann, C.H. 1977. *Statistical Methods in Hydrology.* Iowa State University Press, Ames, Iowa, p. 196-262

Horton, R.E. 1932. Drainage basin characteristics. Trans. Am. Geophys. Union. 14 : 350-361

Morisawa, M.E. 1962. Quantitative geomorphology of some watersheds in the Appalachean plateau. *Bull. Geol. Soc. Am.* 73 : 1025-1046

Shreve, R.L. 1966. Statistical law of stream numbers. *J. Geol.* 74 : 17-37

Strahler, A.N. 1964. Quantitative geomorpholoy of drainage basins and channel networks. *Hand Book of Applied Hydrology.* (ed. Chow, V.T.), McGraw Hill Book Company, New York.