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Morphometric and Sub-Watershed Analysis of Taraka Watershed, H.d. Kote Taluk, Mysuru District, Karnataka, India Using Remote Sensing and Gis Techniques.

***BASAVARAJU and D NAGARAJU**

Department of Studies in Earth Science, Manasagangotri, University of Mysore.Mysuru-570006. Karnataka, India.

Abstract

The current research work is an attempt to study of drainage area covering 429 sqkms comprising of 10 sub-watersheds they are namely Heggadadevanakote, Budanuru, Kodasige, Yedenhundi, Sunkadakatte, Nagarahole, Muruganahalli, Heggadapura, Kalhalla, Sarathihole. The research area has strong structural control shows that the 10 sub-basins named as the normal category. Different parameters of morphometric were used, Arc-Info and Arc -View GIS software was used to analysis the morphometric parameters and drainage characteristics, Sub-basin have been delineated by drainage pattern. The drainage pattern suggesting very coarse to coarse texture and the density explains the texture of drainage is related to coarse as geomorphic development their late youth stage and values suggest that Form factor, Circulatory ratio, Sub-basins are circular to elongated in shape.

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Keywords
H.d Kote;
Morphometry Analysis;
Remote Sensing & Gis;
Taraka Watershed.

Introduction

Remote sensing application is wide in all fields especially on aspects of surface covering a large area. Surface feature is very useful for morphometry of particular area of interest in terms of drainage. Remote sensing application using software Arc GIS is very useful analyzing the relationship between runoff, geomorphic and geographic characteristics for morphometry of drainage. The quantitative analysis of watershed gives us an idea about many hydrological aspects. Lithology, slope pedology plays a major role to form watershed. This paper will explain a detail hydrological aspects study area taraka watershed at district Mysore, Karnataka covers 429 km^2. Arc GIS maps will be better tool to understand the particular area under study of morphometry on watershed expressed as quantitative analysis description of the drainage pattern in watershed. The establishing of drainage pattern on the behavier of the hyrological system

CONTACT Basavaraju basavadrpete@gmail.com Department of Studies in Earth Science, Manasagangotri, University of Mysore.Mysuru-570006. Karnataka, India.

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of the watershed area. The quantitative discription and analysis of land forms of drainage basin. The assessment grondwater management groundwater potential zones and physical changes in nature respones over time on drainage system by human impact. A classification of watersheds based on stream oders was first conducted by Horton, which later explained by Strahler(1952)

Material and Method

The GSI topographic map of the 1:50,000 scale map were utilized for delineating the study area. Software using the ArcGIS 9-2.The main concept of the drainage basin are order and length of stream, bifurcation ratios and length of the overland flow (chow,1964;padmini), this is strahler stream classification system.

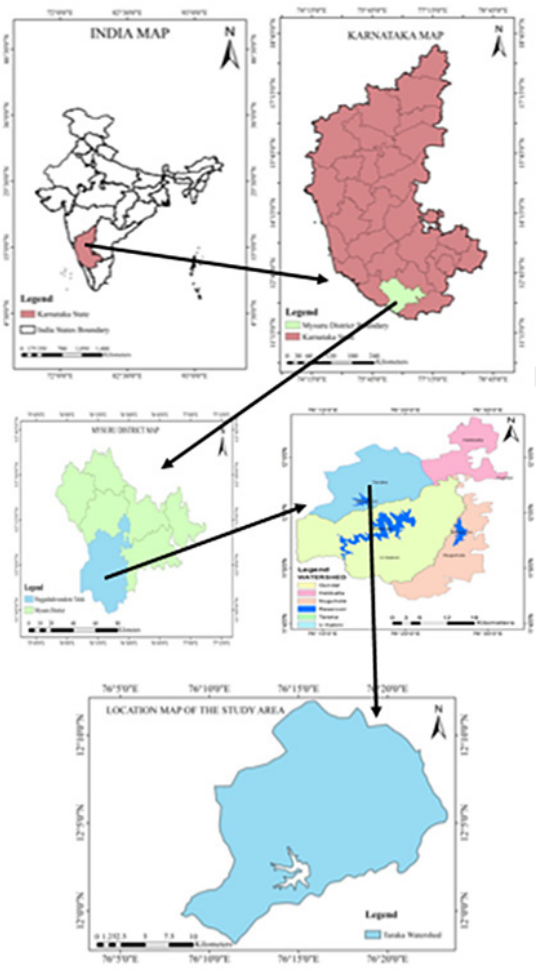

Fig.1: Location Map using Arc GIS

The basic parmeters are area (A), Stream length (Lu), perimeter(p), watershed length (L), Stream order (Nu) are found out from the watershed map. The diferrent parameters such as Stream length ratio (Rl), Ratio of Bifurcation (Rb), Stream frequency, (Fs), Density of drainage (Dd), Infiltration number (If), Form of factor (Rf), Ratio of Elongation (Re). Circularity ratio (Rc),

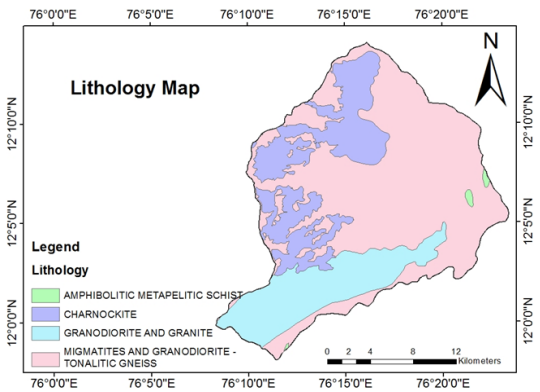

Fig.2: Lithology map of the study Area

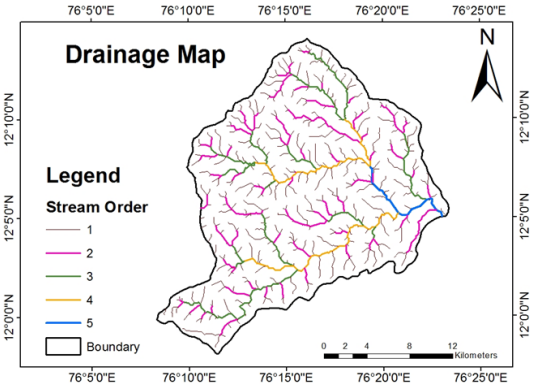

Fig. 3a: Stream order at the area

a) Study Area

The Taraka water basin is a part of the river Cauvery basin in the H D KoteTaluk, Mysore District of Karnataka. It is located between 12°00' to 12°15' North latitudes and 76°5' to 76°25' East longitudes. Taraka watershed, Mysore district, Karnatak state southern part and It comprises of 10 sub-watersheds. The area of study is 429 sq km^2. According to Survey of India 57D/4, 57D/8, 58A/1 and 58A/05 are the toposheet number. The study area connected with an all-weather motorable road (Fig.1 and 2). River Cauvery is towards North and

H D Kote towards South zone shown in Fig.1. The average rainfall is about 560mm.

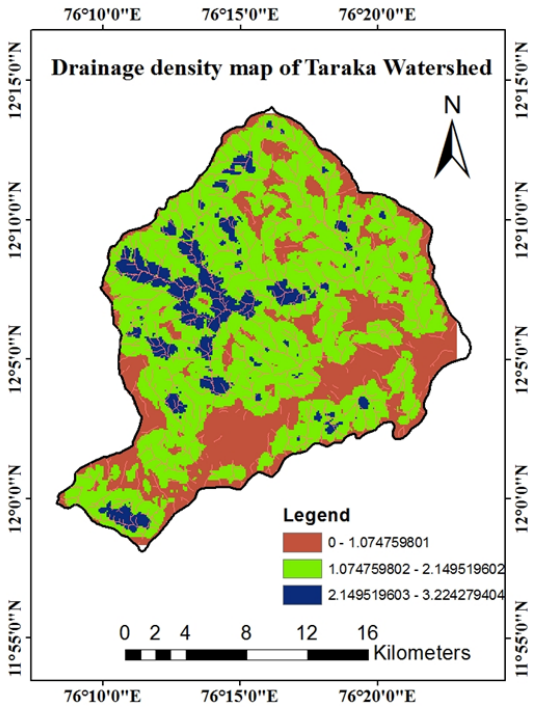

Fig. 3b: Drainage density at the study area

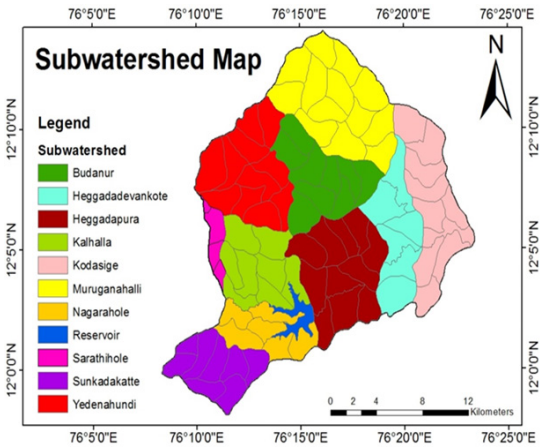

Fig. 3c: Map of Sub-watersheds

b) The lithology of the Area

The taraka watershed is a Proterozoic western block of southern part of Karnataka. Amphibolite Schistose rock of granulite facies of metamorphism which divides the Amphibolite Schist and Granitic Gneissic rocks of Archean age. This area is a typical hard rock terrain (Fig.2 and 3).

c) Morphometry Analysis

Morphometry was a tool for the measurement and calculative method of analysis to get the quantified values on the surface, shape and dimension of the land. The Taraka watershed is composed of ten sub watershed showing sub-dendritic from dendritic patterns.

d) Drainage

The procedure by which the water of an area flow off on surface streams or subsurface condition. Natural and artificial methods for effecting discharge of water by surface and subsurface system followed by passages termed as drainage. Geological structure and the natural condition of the soil are the controlling for system flowing movement pattern like vertical and horizontal. Drainage pattern of study area was prepared by topo sheets, the 5.8 m spatial resolution and interpretation keys are tone, pattern, texture, and association.

Results and Discussion

Stream order

The easiest, simplest and widely used numbering is the first tributaries rank of 1 first-order and followed second-order was defined under junction of two first-order streams (Strahler, 1964). In the same 3rd and 4th order will form in Taraka watershed. The stream order was studied 10 sub watersheds of study area. Total 669 streams are present. Out of 10 sub watershed were 5 fifth streams order, 3 were 4th orders of stream, 1 were third and second order streams. First order of stream is present in all 10 sub watershed in an area (Table-1)

Stream length

The linear length of river stream is calculated using ARC GIS data analysis techniques. In all watershed first-order which that as streams are lengthier than other which that as the orders of stream increases as the linear length of streams decreased (Horton, 1945). Natural gravity and instable slopes in a place shows this kind of characteristics. The length is high in sub watershed 1 is about 89.59 km and least at sub watershed 6 of 5.861km (Table-2)

Mean Stream Length

Mean length-Lu, of mean channel segment in stream order of u is a dimension property of revealing the size of characteristic the component on a network

of drainage and its contributing basin surface (Strahler-1964). To calculate the Total length of channel order of u, total length is divided by the number of segment Nu of that order (Table-3).

Table 1: Parameter of Morphometric and Methodology of Morphometric

Sl. no	Parameters of Morphometric	Methodology of Morphometric	Reference
1	Order of Stream (u)	Order of Hierarchical	Strahler, (1964)
2	Length of Stream (Lu)	Stream Length	Horton, (1945)
3	Mean Length of Stream (Lsm)	Lu / Nu = Lsm ; Lu=Mean length of stream order, Nu= Number segments of stream	Strahler, 1964
4	Length of Stream Ratio (Rl)	Lu/Lu-1= Rl =;Lu =Total length of stream orders (u), Total streams length of next lower order=Lu-1	Horton, 1945
5	Ratio of Bifurcation (Rb)	Nu / Nu+1= Rb, Nu=Number of segments in stream present in the order; Segments Number of the higher order= Nu+1.	Schumn, 1956
6	Mean Ratio of Bifurcation (Rbm)	Average bifurcation ratio of all order = Rbm.	Strahler, (1964)
7	Length of Basin (Lb)	Straight-line distance between the mouth of a basin and the intersected of point on the water divided on the projection of the line's direction via the main stream's sources.	Horton, (1932)
8	Perimeter (P)	water divide of Horizontal projection	Zavoianu, (1978)
9	Area of Basin (Ba)	The complete area of drained by stream systems	GIS
10	Density of Drainage (Dd)	Lu /Ba= D ;Lu=Total length of Stream of entire area orders (km); Basin Area = Au in km^2	Horton, (1945)
11	Texture of Drainage (Dt)	Nu/P= Dt ; Total number of stream orders= Nu; P=Perimeter in km.	Smith, 1950
12	Intensity of Drainage (Di)	Fs/Dd= Di ; Fs = Frequency of Stream; Density of Drainage.(DD)	Faniran, 1968
13	Frequency of Stream (Fs)	Nu /Ba= Fs; Nu=Total streams number entire area of all orders Ba= Basin Area in km^2	Horton, (1932)
14	Length Flow of Over Land (Lg)	1/ D×2= Lg; D = Density of Drainage (km/km^2)	Horton, (1945)
15	Form Factor (Rf)	Ba / Lb^2 = Rf ;Ba = Basin Area in km^2; Lb^2 = Square length of basin in km	Horton, (1945)
16	Ratio of Circularity (Rc)	4×π×Ba/ P^2= Rc; Ba = Basin Area (km^2) ; P= Basin Perimeter in km, ? = 3.14	Miller,(1953)
17	Ratio of Elongation (Re)	√(Ba/π) / Lb= Re; Ba= Basin Area in km^2 ; Lb = length of the Basin (km), ? = 3.14	Schumn (1956)
18	Shape Index (Si)	Lb^2/Ba= Si ; Lb^2 = Square length of basin in km; Ba = Area of the Basin in km^2	Faniran(1968)
19	Maintenance of Constant Channel (C)	C = 1/Dd,, where: Dd = Drainage density	
20	Coefficient of Compactness (Cc)	0.2841 x (P/Ba 0.5)= Cc ,P = Perimeter in km, Ba = Basin Area in km^2	Luchisheva, (1950)
21	Number of Infiltration (If)	Fs×Dd= If ; Fs = Frequency of Stream;	Faniran(1968)

		Dd = Density of Drainage	
22	Maximum basin height (Hmax) m	DEM or GIS analysis	-
23	Basin mouth Height (Hmin) m	DEM or GIS analysis	-
24	Total Relief of Basin (R)	$R = H_{max} - H_{min}$	Strahler (1952)
25	Ratio of Relief (Rr)	*H/L*b= *R*r ; H = Total basin relief in Kilometer; *Lb* =Length of the Basin.	Schumm (1954)
26	Relative Relief Ratio (Rhp)	R×100/P= Rhp ; R = Maximum relief of the basin P = Basin Perimeter in km	Melton, (1957)
27	Watershed Slope (Sw)	R/Lb= Sw ; R=Basin Maximum relief, Length of the Basin (*Lb*)	-
28	Aanalysis of Slope (Sa)	DEM or GIS analysis	-

Table 2: Order, Number and length streams of sub watersheds

			Streams Order						Streams length (KM)					
Sl, no	**Sub watersheds**	**Streams order**	**I**	**II**	**III**	**IV**	**V**	**ΣNu**	**I**	**II**	**III**	**IV**	**V**	**ΣLu**
1	SW -1	IV	62	28	26	6	0	122	45.85	23.02	16.34	4.38	0.00	89.59
2	SW -2	IV	50	19	22	7	0	98	36.00	15.33	14.45	3.12	0.00	68.90
3	SW -3	V	37	17	13	0	7	74	29.22	15.53	8.23	0.00	5.79	58.77
4	SW -4	IV	34	10	5	19	0	68	33.86	7.50	4.05	9.67	0.00	55.07
5	SW -5	V	27	10	2	11	9	59	28.92	6.12	1.41	6.98	5.69	49.12
6	SW -6	II	8	2	0	0	0	10	4.26	1.60	0.00	0.00	0.00	5.86
7	SW -7	IV	44	22	7	16	0	89	36.01	16.16	4.45	9.23	0.00	65.85
8	SW -8	V	36	15	12	4	0	67	24.78	11.34	6.69	1.74	0.00	44.55
9	SW -9	IV	19	8	5	1	0	33	12.39	5.09	2.25	0.12	0.00	19.84
10	SW -10	III	26	9	14	0	0	49	20.95	6.09	9.57	0.00	0.00	36.61

Table 3: Mean and ratios of stream length of sub watersheds

		Mean length of streams (km)					Length of Stream ratio			
Sl, no	**Sub watersheds**	**I**	**II**	**III**	**IV**	**V**	**II/I**	**III/II**	**IV/III**	**V/IV**
1	SW -1	0.73	0.82	0.62	0.73	0	0.50	0.71	0.27	0.00
2	SW -2	0.72	0.8	0.65	0.44	0	0.43	0.94	0.22	0.00
3	SW -3	0.78	0.91	0.63	0	0.82	0.53	0.53	0.00	0.00
4	SW -4	0.99	0.75	0.81	0.5	0	0.22	0.54	2.39	0.00
5	SW -5	1.07	0.61	0.7	0.63	0.63	0.21	0.23	4.95	0.81
6	SW -6	0.53	0.8	0	0	0	0.37	0.00	0.00	0.00
7	SW -7	0.81	0.73	0.63	0.57	0	0.45	0.28	2.07	0.00
8	SW -8	0.68	0.75	0.55	0.43	0	0.46	0.59	0.26	0.00
9	SW -9	0.65	0.63	0.45	0.12	0	0.41	0.44	0.05	0.00
10	SW -10	0.8	0.67	0.68	0	0	0.29	1.57	0.00	0.00

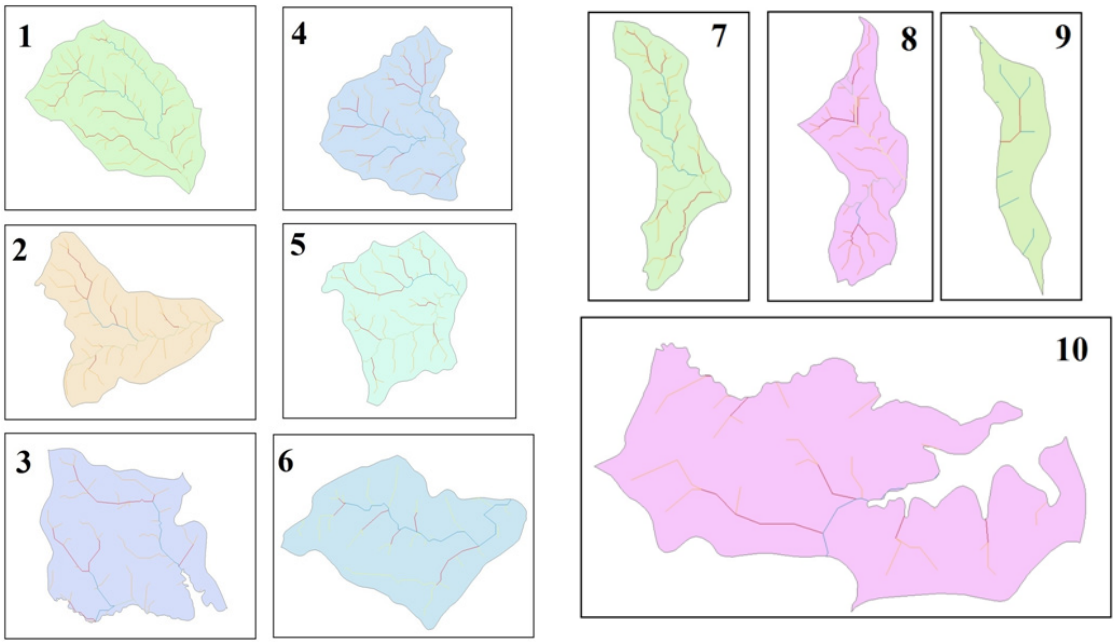

Fig. 4: Subwatershed of study area.
1 Muruganahalli, 2. Budanuru, 3 Kalhalla. 4. Yedenhundi, 5. Heggadapura, 6. Sunkadakatte, 7.Kodasige, 8. Heggadadevanakote, 9.Sarathihole, 10. Nagarahole

Bifurcation ratio

Bifurcation ratio (Rb) means ratio of stream order to consecutive next order of streams. The 1st order stream doesn't have tributaries. The 1st and 2nd order streams received by 3rd order streams as tributaries (Schumn, 1956). The 1.06-18.99 value ranges in bifurcation ratio shows the drainage pattern was influenced the geological features and structures. The high value shows stronger geological structures with good topography (Table-4).

Table 4: Bifurcation ratios, density of drainage, texture of drainage, intensity drainage and frequency of stream of sub watersheds

Sl. no	Sub watershed	Ratio of Bifurcation (Rb)				Mean ratio of bifurcation (Rbm)	Stream frequency (Fs)	Drainage density (Dd)	Drainage intensity (Di)	Drainage texture (Dt)
		I/II	II/III	III/IV	IV/V					
1	SW -1	1.99	1.41	3.73	0.00	1.78	1.70	1.25	1.36	3.46
2	SW -2	2.35	1.06	4.63	0.00	2.01	1.76	1.24	1.39	2.93
3	SW -3	1.88	1.89	0.00	0.00	0.94	1.44	1.14	1.26	1.82
4	SW -4	4.52	1.85	0.42	0.00	1.7	1.52	1.23	1.23	2.09
5	SW -5	4.73	4.34	0.20	1.23	2.62	1.55	1.29	1.20	1.71
6	SW -6	2.67	0.00	0.00	0.00	0.67	1.41	0.82	1.71	0.58
7	SW -7	2.23	3.63	0.48	0.00	1.58	1.53	1.13	1.35	2.64
8	SW -8	2.18	1.70	3.85	0.00	1.93	1.70	1.13	1.50	1.92
9	SW -9	2.43	2.26	18.99	0.00	5.92	1.31	0.79	1.65	0.86
10	SW -10	3.44	0.64	0.00	0.00	1.02	1.51	1.13	1.33	1.93

Table 5: Compactness coefficient, Maintenance of channel Constant, Land flow Length, Shape index

Sl.no.	Sub watershed	Compactness coefficient (Cc)	Maintenance of channel Constant (C)	Land flow Length (Lg)	Shape index (Si)
1	SW -1	0.07	0.8	0.4	0.17
2	SW – 2	0.08	0.80	0.4	0.15
3	SW – 3	0.11	0.87	0.43	0.24
4	SW – 4	0.10	0.81	0.4	0.23
5	SW -5	0.13	0.77	0.38	0.26
6	SW -6	0.34	1.21	0.6	0.35
7	SW -7	0.08	0.88	0.44	0.14
8	SW -8	0.12	0.88	0.44	0.19
9	SW -9	0.21	1.26	0.63	0.21
10	SW -10	0.11	0.88	0.44	0.27

Table 6: Basin area, length of the Basin, ratio of Elongation, Perimeter, Form factor, ratio of circularity, Infiltration number and Shape index of the sub watersheds

Sl. no.	Sub watersheds	Area of Basin (Ba) Sq. km	Basin length (Lb) kms	Perimeter (P)	Form factor (Rf)	Elongation ratio (Re)	Circularity ratio (Rc)	Infiltration number (If)
1	SW -1	71.83	12.14	35.24	20.61	0.78	0.73	2.12
2	SW – 2	55.78	8.7	33.44	18.91	0.96	0.63	2.18
3	SW – 3	51.43	12.56	40.62	14.51	0.64	0.39	1.64
4	SW – 4	44.64	10.51	32.50	13.76	0.71	0.53	1.86
5	SW -5	37.96	9.93	34.46	12.04	0.7	0.4	1.99
6	SW -6	7.11	2.50	17.12	4.50	1.2	0.30	1.15
7	SW -7	58.22	8.54	33.67	19.92	1	0.64	1.72
8	SW -8	39.38	7.64	34.78	14.24	0.92	0.4	1.92
9	SW -9	25.16	5.18	38.28	11.05	1.09	0.21	1.03
10	SW -10	32.52	9.06	25.37	10.80	0.71	0.63	1.70

Stream frequency

It is explained (Horton, 1932) as the stream segments total in number of all total orders per unit area. The values range from 1.31-1.76. The entire 10 sub watershed indicates fractures controlled channel (Table 3).

Drainage texture

As per the definition of Smith, 1950 explained in terms of very coarse, coarse and fine texture. The watershed number 3, 5, 6, 8, 9 and 10 were very coarse. Watershed number 2, 4, 7 were coarse texture. Fine texture was absent as per the calculation (Table.4).

Elongation ratio

It means analysis the basin shape (Schumn, 1956). The values were generally from 0.71 to 1.2. It means geological and climate condition plays a major role. Range from 0.71-1.2 is usually steep slope and high value of relief (Table.4).

Form factor

The form factor Rf, which are the dimensionless total area of the basin ratio, can be used to indicate the drainage basin of outline shape is quantitative expression of Au of the square of basin length L0. The area of the ratio square of the streams length.

(Horton, 1945). The values ranges from 4.50-20.61 the basin is almost narrowed length basin (Table.4)

Drainage density

The degree of drainage characterized by development within the basin, purely in qualitative terms such as well-drained and poorly drained are commonly used (Horton, 1945). The controlling factors are length of streams, weathering resistance and rock formations, permeability apart from vegetation and climate. High density drainage is represented in the regions of impermeable and weak and sub surface of hilly regions. The values ranges 0.87-1.29 density of drainage at area was fall under low density (Table-4)

Circularity ratio

As per the definition of Miller (1953), "The ratio 0f circularity is expressed as the ratio of the area, The basin area of the circles whose perimeter is equal to the basins of the perimeter" as mentioned in the Table1. It means stream frequency and stream length. The circularity ratios values Varied from 0.21 –0.73 elongated basin in shape wise.

Length of the overland flow

The water flow average length on surface before it became a stream it might be horizontal and drainage divides point finally drains to a same point (Horton, 1945). This is nothing but reciprocal of density of the area drainage. The surface flow water values varied from 0.38 to 0.63. The lithology and physiographic conditions are controlling factor.

Conclusion

The Taraka watershed situated at the south part of Karnataka. River Cauvery is towards North, and H D Kote towards South. The area of study is 429 sq km2. The taraka watershed is composed of ten sub watershed are showing Dendritic to sub-dendritic patterns. Total 669 streams are present out of 10 sub watershed. The length is high in sub watershed number 1 is about 89.59 km and least at sub watershed number 6 is about 5.86km. The bifurcation value ranges from 1.06-18.99. These reading shows the drainage pattern is influenced the geological features and structures. Controlled channel and low drainage density. High relief and almost narrowed channel very coarse 6 watershed and 4 coarse drainage density. The surface flow water depends on the lithology and physiographic conditions are controlling factor.

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Conflict of Interest

The authors do not have any conflict of interest.

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