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RESEARCH ARTICLE

WATERSHED MANAGEMENT OF THOPPIAYAR UPPER BASIN USING REMOTESENSING AND GIS

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ABSTRACT

The study area is one of the watersheds of Thoppaiyar River. Covering an area of 269sq.km.and lies between $11^0 50'00''$N - $12^0 02'00''$N latitude and $78^0\ 02'00''$E – $78^0 18'00''$E Longitude In south of shervaroyan mountains northern part of the Salem district and Southern part of the Dharmapuri district. The study area is mainly covered by red soil and black cotton soil to the minor extent. The infiltration capacity is moderate to poor. The entire study area is occupied by the Precambrian crystalline rocks. The recent formation is marked by river alluvium and soil. Thoppaiyar upper basin is divided into twenty mini-watersheds. As a whole Thoppaiyar upper basin having five orders of stream. But the mini-watershed differs in the ordering system. The first order streams are numerous in the mini-watershed 1, 2 and 3. These are due to highly elevated portions of Shevaroy Mountains. Particularly in Lokur and Mulivi the drainage are in the slopes of Shevaroy Mountains. So the entire study area has been further divided into 20 mini-watersheds named mw1 to mw20. ranging in geographical area 269sqkm and has been taken up for prioritization based on morphometric analyzing using GIS and Remote sensing techniques. The drainage density varies between 1.15 and 10.92 indicating low drainage density. In the study area, the low drainage density indicates the region has highly permeable subsoil and thick vegetative cover. The elongation ratio vary from 0.6 to 1.0 over a wide variety of climatic and geologic types. Values close to 1.0 are typical of regions of very low relief, whereas values in the range 0.6 – 0.8 are usually associated with high relief and steep ground slope (Strahler, 1964). These values can be grouped into four categories namely (a) circular (>0.9), (b) oval (0.9 to 0.8), (c) Less elongated (<0.7). The Re of mini-watershed of the study area varies from 0.47 to 0.84. The circularity ratio (Rc) is influenced by the length and frequency of streams, geological structures, land use/land cover, climate, relief and slope of the basin. The circulatory ratio range between 0.28 to 0.61.The compound parameter values are calculated and the mini watershed with the lowest compound parameter is given the highest priority. The mini watershed has a minimum compound parameter value is likely to be subjected to maximum soil erosion and susceptible to natural hazards. Hence it should be provide with immediate soil conversion measures.

INTRODUCTION

Water is a precious natural resource, without which there would be no life on Earth. We, ourselves, are composed of two-thirds water by body weight. Our everyday lives depend on the availability of inexpensive, clean water and safe ways to dispose of it after use. As a source of water, groundwater obtained from beneath the Earth's surface is often cheaper, more convenient and less vulnerable to pollution than surface water. The growing pressures on land for food, fibre and fodder in addition to industrial expansion and consequent need for infrastructure facilities due to ever increasing population have given rise to competing and conflicting demands on finite land and water resources.

Study area

The study area "Thoppaiyar upper basin" falls within the three taluks namely Omalur, Yercaud and Pappiredipatty northern part of the Salem district and Southern part of the Dharmapuri district. The area is bounded within latitudes $11^0 50'00''$N - $12^0\ 02'00''$N and Longitudes $78^0\ 02'00''$E – $78^0 18'00''$E. The area covered by Survey of India Topo maps No. 58 I/1, 58 I/5, 57 L/4 and 57 L/8 of scale 1:50,000. The Thoppaiyar basin falls 60km south of Salem City and 10km south of Shevaroy Mountains. The area is well connected by State Highways and National Railway Roads. The total aerial extent of the study area is 269 Sq.km. The location map of the study area is given Fig. 1.The rain gauge station is present in the Danishpet Forest Range Office and maintained by the office of the Forest Ranger, Danishpet. There are other rain gauge stations are present, one at Yercuad in the Shevaroy Mountain and another one at Omalur Taluk Office. The fifty-year of average rainfall of Danishpet region is 965.60 mm .The main food crops are Paddy, Cholam, Kambu, Ragi and Oil seeds of castor. The other cash crops are coffee, Sugarcane, Coconut, Tapioca, Groundnut and Cotton in selected region. Drainage basins lose water and sediment through evaporation, deposition, and

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stream flow. A number of factors influence input, output, and transport of sediment and water in a drainage basin. Such factors include topography, soil type, bedrock type, climate, and vegetation cover.

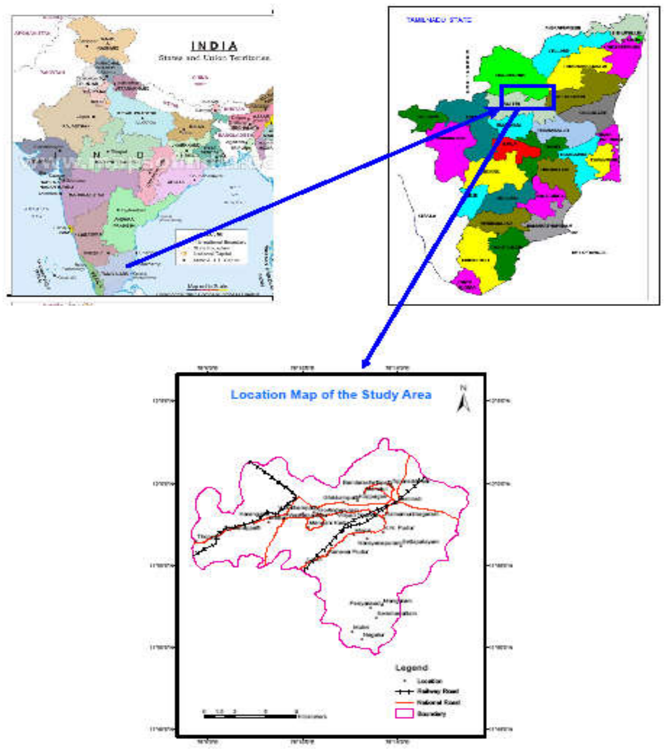

Fig. 1. Study area

METHODOLOGY

In the present study, the parameters considered for prioritization of mini watersheds are from the natural resources thematic data, including drainage density, groundwater prospects, irrigated area, forest cover and water lands derived satellite imagery and socio economic data. There are three major components in the study viz. a) Field data collection include geological mapping; b) Meteorological data collection from Public Work Division (PWD); c) Remote sensing study through Landsat TM satellite imagery and SRTM data. The Landsat TM and SRTM satellite image was geometrically rectified with respect to the Survey of India (SOI) topographical maps on 1; 50,000 scale using ERDAS IMAGINE 8.7 software. The drainage pattern for delineated sub-watersheds was exported in Arc GIS 9.1 software for used to morphometric analysis.

Parameter in Morphometric Analysis

In the presently study, the morphometric analysis for the parameters namely basin perimeter, stream order, stream length, bifurcation ratio, stream length ratio, basin length, drainage density, stream frequency, elongation ratio, circularity ratio, form factor, etc., has been carried out. Various notations are used in morphometric analysis and various Methodologies adopted for Morphometric analysis is showing in (Table 1).

Stream order

River systems are a type of network: that is, they consist of a series of links which connect nodes. Networks can be analyzed with respect to two main sets of properties: the topological aspects of stream networks concern the interconnections of the system, whereas the geometrical aspects involve length, area, shape, relief and orientation parameters. The basic element of stream networks is the stream segment, or link. This is a section of stream channel between two channel junctions or, for "fingertip" tributaries, between a junction and the upstream termination of a channel. Stream order expresses the hierarchical relationship between segments. It is a fundamental property of stream networks since it is related to the relative discharge of a channel segment. Various systems of streams ordering have been proposed, but the two most frequently used are those of Strahler and Shreve. In the Strahler system a stream segment with no tributaries is designated a first order segment. A second order segment is formed by the joining of two first order segments, a third order segment by the joining of two second order segments and so on. It is important to that with the Strahler ordering method there is no increase in order when a segment of one order is joined by another of a lower order. In contrast the stream ordering system proposed by Shreve defines the magnitude of a channel segment as the number of fingertip tributaries that feed it. As a stream magnitude is closely related to the proportion of the total basin area contributing runoff, it provides a good estimate of relative stream discharge for small river systems. Stream order as defined by Strahler has been applied to numerous river systems and has been shown to be statistically related to various elements of catchment areas morphometry. It's shown in (Table 2). The sub watershed map is shown in Fig. 2.

Stream length

The numbers of streams of various orders in a sub-watershed are counted and their lengths from mouth to drainage divide are measured .The stream length (Lu) has been computed based on the law proposed by Horton (1945) for all the 20 mini-watershed (Table 2). Generally, the total length of stream segments is maximum in first order streams and decreases as the stream order increases. The sub watershed Breadth and length map is shown in Fig. 3.

Mean stream length

According to Strahler (1964), the mean stream length is a characteristic property related to the drainage network and its associated surfaces. The mean stream length (Lsm) has been calculated by dividing the total stream length of order 'u' and number of streams of segment or order 'u' (Table 2). The drainage map is shown in Fig. 4.

Stream length ratio

Stream length ratio (RL) may be defined as the ratio of the mean length of the one order to the next lower order of stream segment. Horton's law (1945) of stream length states that mean stream length segments of each of the successive orders of a basin trends to approximate a direct geometric series with streams length increasing towards higher order of streams. The RL between streams of different order in the study area reveals that there is a variation in RL in each sub-basin. This variation might be due to the change in slope and topography. Mini-watershed 16 and 20 shows are increase trend in the length ratio from lower order to higher order indicating nature geomorphic stage. Whereas other mini-watershed, there is a change from one order to another order indicating the youth stage.

Bifurcation ratio

The term bifurcation ratio (Rb) may be defined as the ratio of the number of the stream segments of given order to the number of segments of the next higher order (Schumn, 1956). Horton (1945) considered the bifurcation ratio as an index of relief and dissections. Strahler (1957) demonstrated that bifurcation ratio shows a small range of variation for different regions or for different environment except where the powerful geological control dominates. It is observed from the (Table 4), the Rb is not same from one order to its next order. These irregularities are dependent upon the geological and lithological development of the drainage basin (Strahler, 1964). The lower values of Rb are characteristics of the mini-watershed which have suffered less structural disturbances (Strahler, 1964) and the drainage patterns has not been distorted because of the structural disturbances (Nag. 1998). The mean bifurcation ratio (Rbm) may be defined as the average of bifurcation ratios of all orders. In the present case, Rbm varies from 2.41 to 5.45 and all mini-watershed in Thoppaiyar fall under normal basin category.

AERIAL ASPECT

Different morphometric parameters like drainage density, texture ratio, stream frequency, form factor, circularity ratio, elongation ratio and length of overland flow have been discussed in detail.

Drainage density

Horton (1932) has introduced drainage density (D) into American hydrologic literature as an expression to indicate the closeness of spacing of channels. It is defined as the total

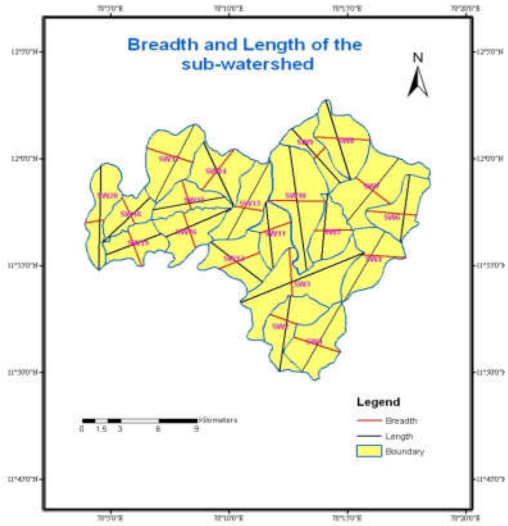

Fig. 3. The sub watershed Breadth and length

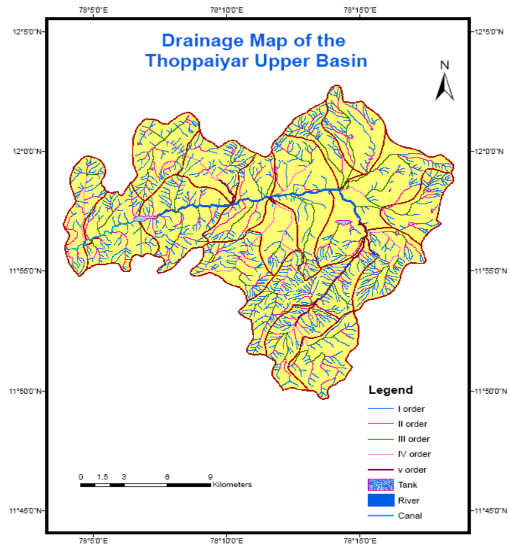

Fig. 4. The drainage

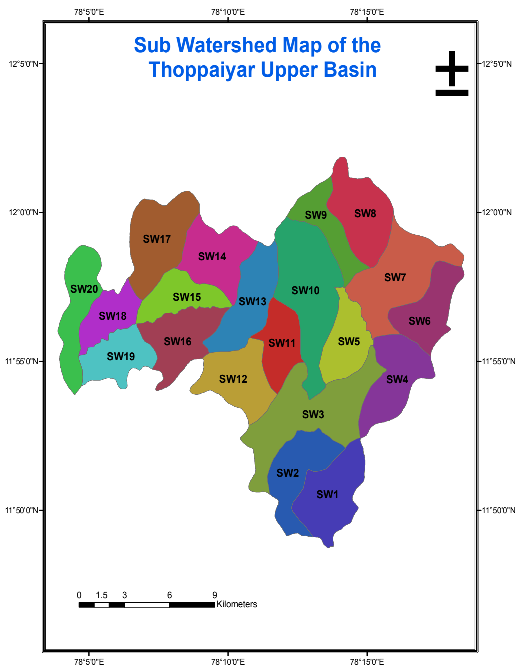

Fig. 2. The sub watershed

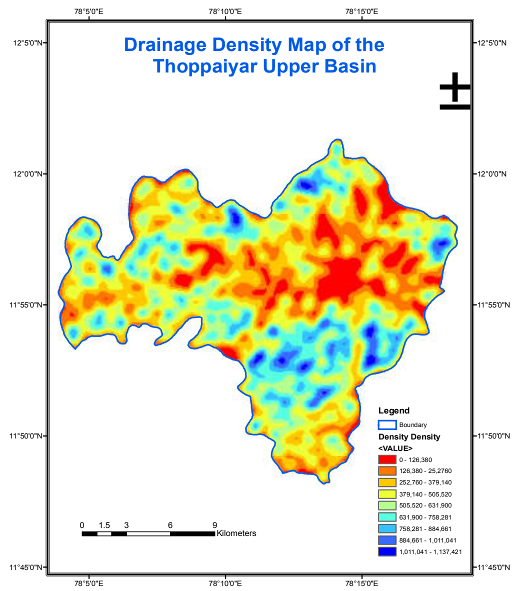

Fig. 5. The drainage density

length of streams of all orders per drainage area (Table 4). Langbein (1947) recognized the significance of D as a factor determining the time of travel by water and he also suggested a drainage density varying between 0.55 and 2.09 km/km^2 in humid region with an average density of 1.03 km / km^2. Density factor is related to climate, type of rocks, relief, infiltration capacity, vegetation cover, surface roughness and run-off intensity index. Of these only surface roughness has no significant correlation with drainage density. The amount and type of precipitation influences directly the quantity and character of surface run-off. An area with high precipitation such as thundershowers loses greater percentage of rainfall as run-off resulting in more surface drainage lines. Amount of vegetation and rainfall absorption capacity of soils, which influences the rate of surface run-off, affects the drainage texture of an area.

subsurface material, sparse vegetation and mountainous relief. Low drainage density leads to coarse drainage texture while high drainage density leads to fine drainage texture. The drainage density varies between 1.15 and 10.92 indicating low drainage density (Table 3). In the study area, the low drainage density indicates the region has highly permeable subsoil and thick vegetative cover. The drainage density map is shown in Fig. 5.

Stream frequency

Horton (1932) introduced stream frequency (Fs) or channel frequency which is the total number of stream segments of all orders per unit area (Table 3). Hypothetically, it is possible to have the basin of same drainage density differing in stream

Table 1. Methodology adopted for computations of morphometric parameters

SL. No	Morphometric Parameters	Formula	Reference
1	Stream Order	Hierarchial rank	Strahler (1964)
2	Stream Length (Lu)	Length of the stream	Horton (1945)
3	Mean Stream Length (Lsm)	Lsm=Lu/Nu Where, Lsm = Mean Stream Length Lu = Total Stream Length of order 'u' Nu = Total no. of stream segment of order 'u'	Strahler(1964)
4	Stream Length Ratio (RL)	RL = Lu/Lu-1 Where, RL = Stream Length Ratio Lu = Total Stream Length of order 'u' Lu-1 = Total stream Length of its next lower order	Horton (1945)
5	Bifurcation Ratio (Rb)	Rb=Nu/Nu+1 Where, Rb = Bifurcation Ratio Nu = Total no. of stream segment of order 'u' Nu+1 = Number of segment of the next higher order	Schumn (1956)
6	Mean bifurcation Ratio (Rbm)	Rbm = Average of bifurcation ratios of all orders	Strahler (1957)
7	Drainage density (D)	D=Lu/A Where, D = Drainage density Lu = Total Stream Length of all orders A = Area of the Basin (km^2)	Horton (1932)
8	Stream Frequency (Fs)	Fs= Nu/A Where, Fs = Stream Frequency Nu = Total no. of streams of all orders A = Area of the Basin (km^2)	Horton (1932)
9	Drainage Texture (Rt)	Rt= Nu/P Where, Rt = Drainage Texture Nu = Total no. of streams of all orders P = Perimeter (km)	Horton (1945)
10	Form Factor (Rf)	Rf = A/ Lb^2 Where, Rf = Form Factor A = Area of the Basin (km^2) Lb^2 = Square of Basin Length	Horton (1932)
11	Circularity Ratio (Rc)	Rc= 4*Pi*A/p^2 Where, Rc = Circularity Ratio Pi ='Pi' value i.e.3.14 A = Area of the Basin (km^2) P^2 = Square of the Perimeter	Miller (1953)
12	Elongation Ratio (Re)	Re = 2√A/Pi/Lb Where, Re = Elongation Ratio A = Area of the Basin (km^2) Pi = 'Pi' value i.e., 3.14 Lb = Basin Length	Schumn (1956)
13	Length of Overland flow (Lg)	Lg = 1/D * 2 Where, Lg = Length of Overland flow D = Drainage Density	Horton (1945)

The similar condition of lithology and geologic structures, semi-arid regions have finer drainage density texture than humid regions. According to Nag (1998), low drainage density generally results in the areas of highly resistant or permeable subsoil material, dense vegetation and low relief. High drainage density is the resultant of weak or impermeable

frequency and basins of same stream frequency differing in drainage density. Tables 3 show Fs for all mini-watershed of the study area. It is noted that the Fs exhibits positive correlation with the drainage density values of the mini-watershed indicating the increase in stream population with respect to increase in drainage density.

Table 2. Orders, Numbers & Length of streams in different Mini-watershed

Sl.No	Mini-Water -shed	Stream Order (W)	No. of Streams (Nu)	Total length of streams (Lu) in Km	Cumulative length	Mean Stream Length (Lsm)	Stream Length Ratio (RL)
1	MW1	1	38	20.4	20.4	0.53	-
		2	7	74.34	94.74	10.62	3.64
		3	3	63.95	158.69	21.31	0.86
		4	1	1.07	159.76	1.07	0.01
			49	159.76			
2	MW2	1	53	26.75	26.75	0.5	-
		2	17	11.59	38.34	0.68	0.43
		3	4	4.13	42.47	1.03	0.35
		4	2	1.55	44.02	0.77	0.37
		5	1	2.16	46.18	2.16	1.39
			77	46.18			
3	MW3	1	137	66.2	66.2	0.48	-
		2	29	15.4	81.6	0.53	0.23
		3	5	7.04	88.64	1.4	0.45
		4	1	3.24	91.88	3.24	0.46
		5	1	6.01	97.89	6.01	1.85
			173	97.89			
4	MW4	1	54	3.07	3.07	0.05	-
		2	18	7.72	10.79	0.42	2.51
		3	4	6.17	16.96	1.54	0.79
		4	1	4.14	21.1	4.14	0.67
		5	1	0.41	21.51	0.41	0.09
			78	21.51			
5	MW5	1	22	12.35	12.35	0.56	-
		2	7	5.3	17.65	0.75	0.42
		3	2	1.97	19.62	0.98	0.37
			31	19.62			
6	MW6	1	33	1.76	1.76	0.05	-
		2	10	5.95	7.71	0.59	3.38
		3	2	5.04	12.75	2.52	0.84
			45	12.75			
7	MW7	1	37	16.7	16.7	0.45	-
		2	8	6.69	23.39	0.83	0.45
		3	5	12.15	35.54	2.43	1.87
		4	1	1.91	37.45	1.91	0.15
		5	1	0.9	38.35	0.9	0.47
			52	38.35			
8	MW8	1	31	21.12	21.12	0.68	-
		2	8	10.22	31.34	1.27	0.47
		3	2	4.55	35.89	2.27	0.44
			41	35.89			
9	MW9	1	31	16.55	16.55	0.53	-
		2	7	5.13	21.68	0.73	0.3
		3	2	6.84	28.52	3.42	0.01
			40	28.52			
10	MW10	1	51	31.19	31.19	0.61	-
		2	11	6.09	37.28	0.55	0.19
		3	3	8.57	45.85	2.85	1.4
		4	1	3.47	49.32	3.47	0.4
			66	49.32			
11	MW11	1	13	8.34	8.34	0.64	-
		2	3	0.55	8.89	0.18	0.06
		3	1	1.09	9.98	1.09	1.98
		4	2	7.28	17.26	3.64	6.67
		5	1	0.62	17.88	0.62	0.08
			20	17.88			
12	MW12	1	60	26.96	26.96	0.44	-
		2	14	7.74	34.7	0.55	0.28
		3	3	3.96	38.66	1.32	0.51
		4	1	5.42	44.08	5.42	1.36
			78	44.08			
13	MW13	1	37	15.63	15.63	0.42	-
		2	10	12.9	28.53	1.29	0.82
		3	3	5.56	34.09	1.85	0.43
			50	34.09			
14	MW14	1	43	23.8	23.8	0.55	-
		2	11	5.57	29.37	0.5	0.23
		3	4	1.17	30.54	0.29	0.21
		4	2	4.6	35.14	2.3	3.93
		5	1	2.34	37.48	2.34	0.35
			61	37.48			
15	MW15	1	32	15.19	15.19	0.47	-
		2	7	5.12	20.31	0.73	0.33
		3	1	1.84	22.15	1.84	0.35
			40	22.15			

16	MW16	1	47	21.63	21.63	0.46	-
		2	11	9.68	31.31	0.88	4.47
		3	2	3.6	34.91	1.8	0.37
			60	34.91			
17	MW17	1	56	26.05	26.05	0.46	-
		2	14	9.17	35.22	0.65	0.35
		3	8	7.75	42.97	0.96	0.84
		4	1	1.72	44.69	1.72	0.22
			79	44.69			
18	MW18	1	28	14.13	14.13	0.5	-
		2	7	5.94	20.07	0.84	0.42
		3	2	2.5	22.57	1.25	0.42
			37	22.57			
19	MW19	1	37	17.47	17.47	0.47	-
		2	9	6.52	23.99	0.72	0.37
		3	2	2.6	26.59	1.3	0.39
			48	26.59			
20	MW20	1	40	20.31	20.31	0.5	-
		2	11	8.48	28.79	0.77	0.41
		3	2	1.25	30.04	0.62	0.14
		4	1	5.04	35.08	5.04	4.03
			54	35.08			

Table 3. Morphometric Analysis of Different Mini-Watershed

Sl.No	Mini-Watershed	Area (A) (Sq.km)	Total no. Of streams (Nu)	Total length of Streams (in kms) (Lu)	Stream Frequency Nu/A	Drainage Density Lu/A	Length of over land flow(Lg)
1	MW1	14.62	49	159.76	3.35	10.92	0.04
2	MW2	12.87	77	46.18	5.98	3.58	0.13
3	MW3	24.62	173	97.89	7.02	3.97	0.12
4	MW4	13.51	78	21.51	5.77	1.59	0.31
5	MW5	10.08	31	19.62	3.07	1.94	0.25
6	MW6	11.03	45	12.75	4.07	1.15	0.43
7	MW7	19.76	52	38.35	2.63	1.94	0.25
8	MW8	14.33	41	35.89	2.86	2.5	0.2
9	MW9	8.63	40	28.52	4.63	3.3	0.15
10	MW10	23.48	66	49.32	2.81	2.1	0.23
11	MW11	9.16	20	17.88	2.18	1.95	0.25
12	MW12	13.11	78	44.08	5.94	3.36	0.14
13	MW13	13.49	50	34.09	3.7	2.52	0.19
14	MW14	12.81	61	37.48	4.76	2.92	0.17
15	MW15	8.98	40	22.15	4.45	2.46	0.20
16	MW16	12.72	60	34.91	4.71	2.74	0.18
17	MW17	15.88	79	44.69	4.97	2.81	0.17
18	MW18	8.03	37	22.57	4.6	2.81	0.17
19	MW19	9.71	48	26.59	4.94	2.73	0.18
20	MW20	11.61	54	35.08	4.65	3.02	0.16
		268.43	1179	829.31			

Table 4. Bifurcation Ratios in Different Mini-Watershed

Sl.No	Name of Mini Watershed	(Stream Orders) W=1/2	W= 2/3	W= 3/4	W=4/5	Mean bifurcation ratio(Rbm)
1	MW1	5.428	2.333	3	-	3.587
2	MW2	3.117	4.25	2	2	2.841
3	MW3	4.724	5.8	5	1	4.131
4	MW4	3	4.5	4	1	3.125
5	MW5	3.142	3.5	-	-	3.321
6	MW6	3.3	5	-	-	4.15
7	MW7	4.625	1.6	5	1	3.056
8	MW8	3.75	4	-	-	3.875
9	MW9	4.428	3.5	-	-	3.964
10	MW10	4.636	3.666	3	-	3.767
11	MW11	4.333	3	0.5	2	2.458
12	MW12	4.285	4.666	3	-	3.983
13	MW13	3.7	3.333	-	-	3.516
14	MW14	3.909	2.75	2	1	2.414
15	MW15	4.571	7	-	-	5.454
16	MW16	4.272	5.5	-	-	4.886
17	MW17	4	1.75	8	-	4.583
18	MW18	4	3.5	-	-	3.75
19	MW19	4.111	4.5	-	-	4.305
20	MW20	3.636	5.5	2	-	3.712

Table 5. Shape Parameters of Different Mini-Watershed

Sl. No	Mini-Water Shed	Area (A) (Sq.km)	Perimeter (P) (km)	Basin length (km)	Width of the basin(km)	Elongation Ratio	Form factor	Texture Ratio(Rt)	Circularity Ratio(Rc)
1	MW1	14.62	17.23	6.23	3.47	0.69	0.37	2.84	0.61
2	MW2	12.87	19.49	5.96	2.09	0.67	0.36	3.95	0.42
3	MW3	24.62	33.22	9.60	3.76	0.58	0.26	5.2	0.28
4	MW4	13.51	17.91	6.16	3.14	0.67	0.35	4.35	0.52
5	MW5	10.08	14.58	5.19	2.67	0.69	0.37	2.12	0.59
6	MW6	11.03	15.87	5.30	3.52	0.70	0.39	2.83	0.55
7	MW7	19.76	24.74	6.14	3.17	0.81	0.52	2.1	0.41
8	MW8	14.33	16.32	6.45	3.98	0.66	0.34	2.51	0.67
9	MW9	8.63	17.73	5.48	1.25	0.60	0.28	2.25	0.34
10	MW10	23.48	25.44	9.76	3.97	0.56	0.24	2.59	0.45
11	MW11	9.16	14.29	5.14	2.33	0.66	0.34	1.39	0.56
12	MW12	13.11	16.75	4.81	3.16	0.84	0.56	4.65	0.58
13	MW13	13.49	18.04	6.86	2	0.60	0.28	2.77	0.52
14	MW14	12.81	16.79	5.38	3.93	0.75	0.44	3.63	0.57
15	MW15	8.98	15.04	5.19	2.3	0.65	0.33	2.65	0.49
16	MW16	12.72	18.62	5.12	2.91	0.78	0.48	3.22	0.46
17	MW17	15.88	17.34	6.56	3.46	0.68	0.36	4.55	0.66
18	MW18	8.03	13.87	4.82	2.26	0.66	0.34	2.66	0.52
19	MW19	9.71	15.2	4.26	2.91	0.82	0.53	3.15	0.52
20	MW20	11.61	19.47	8.15	1.35	0.47	0.17	2.77	0.38

Drainage texture

Drainage texture (Rt) is one of the important concepts of geomorphology which means that the relative spacing of drainage lines. Drainage lines are numerous over impermeable areas than permeable areas. According to Horton (1945), Rt is the total number of stream segments of all orders per perimeter of that area. He recognized infiltration capacity as the single important factor which influences Rt and considered drainage texture which includes drainage density and stream frequency. Smith (1950) has classified drainage density into five different textures. The drainage texture less than 2 indicates very coarse, between 2 and 4 is related to coarse, between 4 and 6 is moderate, between 6 and 8 is fineand greater than 8 is very fine drainage texture. The drainage texture various between 1.39 to 5.2 (Table 5) MW11 indicate very coarse Rt and MW3 show moderate Rt.

Form factor

According to Horton (1932), form factor (Rf) may be defined, as the ratio of basin area to square of the basin length (Table 5). The value of Form factor (Rf) is always less than 0.7854, which is for a perfectly circular basin (Strahler, 1964). The form factor values of the watersheds in the study area range between 0.17and 0.53. Basins of low form factor are elongated and have flatter peak flows for longer duration, while the basins with high form factors are circular and have high peak flows for shorter duration.

Circularity ratio

It is the ratio of the area of the basin to the area of a circle having the same circumference as the perimeter of the basin (Miller 1953) (Table 5). The circularity ratio (Rc) is influenced by the length and frequency of streams, geological structures, landuse/land cover, climate, relief and slope of the basin. The circulatory ratio range between 0.28 to 0.6

Elongation ratio

Schumm (1956) defined elongation ratio (Re) as the ratio between the diameter of the circle of the same area as the drainage basin and the maximum length of the basin. A circular basin is more efficient in the discharge of run-off than an elongnated basin (Singh, 1997). The values of Re generally vary from 0.6 to 1.0 over a wide variety of climatic and geologic types. Values close to 1.0 are typical of regions of very low relief, whereas values in the range 0.6 – 0.8 are usually associated with high relief and steep ground slope (Strahler, 1964). These values can be grouped into four categories namely (a) circular (>0.9), (b) oval (0.9 to 0.8), (c) Less elongnated (<0.7). The Re of mini-watershed of the study area varies from 0.47 to 0.84 (Table 5).

Length of overland flow

It is the length of water over the ground before it gets concentrated into definite stream channels (Horton, 1945) (Table 3). This factor basically relates inversely to the average slope of the channel and is quite synonymous with the length of sheet flow to a large degree. The length of overland flow (Lg) approximately equals, to half of the reciprocal of drainage density (Horton 1945).

CONCLUSION

The totally 50 lineaments present in the area of investigation. The prominent direction of the lineaments in NNE to SSW and NNW to SSE. The major trend line towards on the NNE to SSW. The Thoppaiyar upper watershed has five orders of drainage and the total length of the drainage is 829.31km and numbers about 1179. The major land uses are dry crop, wet crop, plantation, degraded forest land, water body and remaining are barren land, settlement and transport. The Irugur series of soil is prevalent in the area and turn off zone is present on the upland hills. The slope of the study area ranges from 4.94% to 84.11%. sloped towards direction of NW and SE. The yercaud to madras tectonic block is of considerable importance to study area. The major rock types encountered is charnockite. Intension of narrow hills and dykes noticed. The dykes are traced in the SW to NE intruded into tensional fractures developed by the deformation of rocks. The water level rises in month of October, November, December is due to the varying thickness of weathering and forming of “D” group soil. The rainfall and water level analysis correlation has shown that rise of 1m column of water the monthly rainfall required in 60mm to150mm in July, August, September and October. Remote sensing and GIS have proved to be efficient tool in drainage delineation and updating in the present study and these updated drainage have been used for the morphmetric analysis. The morph metric analysis of the drainage networks of all 20 mini-watersheds exhibits the radial of dendritic drainage pattern and the variation in stream length ratio might be due to changes on slope and topography. It is also concluded from the study that the mature stage of streams in 5th mini-watershed and late youth stage of geomorphic development in remaining mini-watersheds.The variation in values of bifurcation ratio among the mini-watersheds is described to the difference in topography and Geometric development. Normally, if the bifurcation ratio (Rb) is low, the mini-watershed produces a sharp peak of discharge, and if Rb is high, the mini-watershed yields a low but extended peak flow. The stream frequencies for all mini-watersheds of the study exhibits positive correlation with the drainage density valves indicating the increase in stream population with respect to increase in drainage density. In generally, low drainage density is favored in regions of highly resistant or sub-soil materials, under dense vegetative cover and where relief is low. High drainage density is favored in regions of impermeable sub surface materials, sparse vegetation and mountainous relief. Elongation ratio, Circulatory ratio and Form factor shows that 14th mini watershed possesses similarly square shape, while the remaining marks elongated pattern. The form factors computed indicate that the basin will have moderately high and short duration flow peaks. The high gradient of slope, permeable resistant rocks and vegetative covering will also affect the peak flows and the runoff generated. The drainage texture is very coarse to moderate in the study area. There is a need for comparative evolution of morphometric parameters, their control and influence on the rainfall-runoff relation and behavior of stream flows. The detailed morphometric analysis finally concludes that mini-watershed 13, 14, 15, 17, 18, 20 of Thoppaiyar upper watershed is having better scope for artificial recharge scheme and deep ground water exploration.

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