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Prioritization Of Subwatersheds of Cauvery Region Based on Morphometric Analysis Using GIS

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ABSTRACT - Prioritization of watershed has picked up significance in watershed management. Morphometic analysis is been commonly applied to prioritize the watershed. The present study makes an effort to organize subwatersheds dependent on morphometric characteristics using GIS techniques in Part of Cauvery region. There are twenty three Subwatersheds under this. Various morphometric parameters namely Bifurcation ratio(Rb), Drainage density(Dd), Stream frequency(Ns), Texture ratio(T), Form factor(Rf), Circularity ratio(Rc), Elongation Ratio(Re), length of overland flow, shape factor(Bs), drainage texture, compactness ratio (Cc) has been determined for each subwatershed and allotted position on premise of relationship as to arrive at a computed value for final ranking of subwatershed. The morphometric parameters ranges between Rb (3.42-5.62), Dd (1.65-2.02), Fs (2.25-2.70), T (6.97-21.22), Rf (0.20-1.13), Rc (0.15-0.42), Re (0.51-1.19), Cc (1.53-2.51), Lof (0.24-0.30), Drainage Texture (8.85-27.06) and Bs (0.88-4.87).

Key words: GIS, DEM, Morphometric analysis, Subwatershed, Priority

I. INTRODUCTION

Drainage basin examination based on morphometric parameters is very fundamental for watershed planning since it gives an thought regarding the basin characteristics in terms of slope, topography, soil condition, runoff characteristics, surface water potential etc. Geographic Information System techniques strategies described by an exceptionally high exactness of mapping and measurement prove to be a adept tool in morphometric analysis. Morphometric is the measurement and mathematical analysis of the configuration of the Earth's surface, shape and dimension of its landforms (Clarke, 1996). Detailed morphometric analysis of a basin is of great help in understanding the influence of drainage morphometry on landforms and their characteristics. One of the advantages of quantitative analysis is that many of the basin parameters derived are in the form of ratios, and dimensionless numbers, thus providing an effective comparison irrespective of the scale (Krishnamurthy et al. 1996).Morphometric analysis of the watershed is considered to be the most satisfactory method because it enables (i) an understanding of the relationship of various aspects within a drainage basin (ii) a comparative evaluation to be made of different drainage basins developed in different geomorphological and topographical regimes and (iii) the definition of certain useful variables of drainage basins in numerical terms (Krishnamurthy et al. 1996).Prioritization of subwatershed based on morphometry of drainage basin using Remote sensing and GIS was attempted by Biswas et al.(1999)

II. MATERIALS AND METHODS

A Study Area

The Study area is located between 75^0 26' 1" E to 78^0 7'59" E and 11^0 25'23" to 13^0 26"1.5" N. It has been divided into twenty three subwatershed as (sbw1, sbw2, sbw3, sbw4, sbw5, sbw6, sbw7, sbw8, sbw9, sbw10, sbw11, sbw12, sbw13, sbw14, sbw15, sbw16, sbw17, sbw18, sbw19, sbw20, sbw21, sbw22, sbw23). Out of which the subwatersheds (sbw1, sbw2, sbw3, sbw4, sbw5, sbw6, sbw7, sbw9, sbw11, sbw13, sbw15, sbw18, sbw19) lies in Karnataka, subwatersheds (sbw10, sbw12) lies in tamil nadu, subwatersheds (sbw23) lies in karnataka kerala and tamil nadu, subwatersheds (sbw16 and sbw22) lies in kerala and Karnataka, subwatersheds (sbw8,sbw14,sbw17, sbw20, sbw21) lies in Karnataka and tamil nadu. The average mean daily temperature varies from 19.5 to 33.8^{0}C respectively. The impact of climate change is likely to have serious influence on agriculture and water sector.

B Methodology

By using SRTM DEM data, basin was delineated and the drainage network was extracted. Initially the sink or depression area in DEM has been filled to get rid of small imperfections in the data. Then on basis of relative slopes between pixels flow direction is determined. Flow

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accumulation grid has been prepared using this data. Stream order was generated using above data on the basis of drainage flow direction watershed was divided into twenty three subwatersheds designated as sbw1 to sbw23 as show in figure. Morphometric aspects such as Bifurcation ratio(Rb), Drainage density(Dd), Stream frequency(Ns), Texture ratio(T), Form factor(Rf), Circularity ratio(Rc), Elongation Ratio(Re), length of overland flow, shape factor(Bs), drainage texture, compactness ratio(Cc) is calculated using formulas and are shown in table 4. The total area(A), perimeter(P) of twenty three subwatersheds is calculated using Arc GIS and values are tabulated in table 2.

III. RESULTS AND DISCUSSIONS

A Morphometric analysis

Designation ofStream order is the first step in morphometric analysis of a drainage basin, based on the hierarchic making of streams proposed by Strahler (1964). In the study area sbw1, sbw2, sbw3, sbw5, sbw6, sbw7, sbw8, sbw11, sbw13, sbw16, sbw18, sbw20, sbw21, sbw22 are of seventh order, sbw4,sbw10, sbw12, sbw17, sbw19, sbw23 are of sixth order where as sbw9, sbw14, sbw15 are of eighth order streams.The morphometric parameters were calculated its shows that Bifurcation ratio(Rb) ranges from 3.42 to 5.62 sbw14 have low Rb whereas sbw7 have high Rb. Drainage density (Dd) is low in sbw20 and high in sbw15 its value ranges from 1.65 to 2.02. Stream frequency (Ns) varies from 2.25 to 2.70 with sbw10 having low and sbw2 has high value. Texture ratio (T) ranges from 6.97 to 21.12 with low in sbw14 and high in sbw2. Form factor(Rf) is low in sbw17 and high in sbw22 it ranges from 0.20 to 1.13. Drainage Texture ranges from 8.85 to 27.06 with high in sbw2 and low in sbw10. Length of overland flow varies from 0.24 to 0.30. Basin shape(Bs) is low in sbw22 and high in sbw17 it ranges from 0.88 to 4.87. Compactness coefficient(Cc) show wide variation across the subwatershed it is more in sbw15 and less in sbw6 it varies from 1.53 to 2.51. Elongation ratio(Re) varies from 0.51 to 1.19 with sbw17 has low and sbw22 has high value. Circularity ratio(Rc) of subwatersheds ranges from 0.15 to 0.48 with low in sbw15 and high in sbw6.

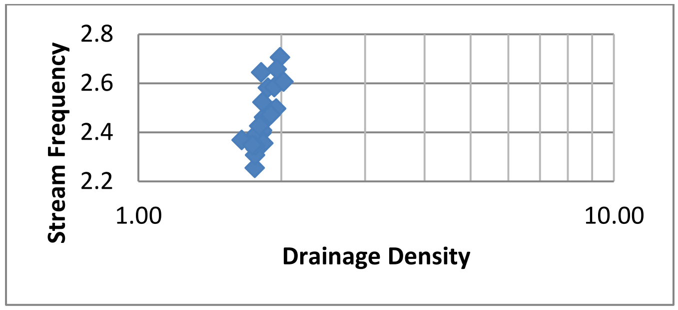

Figure 3 Regression of Drainage density on Stream frequency

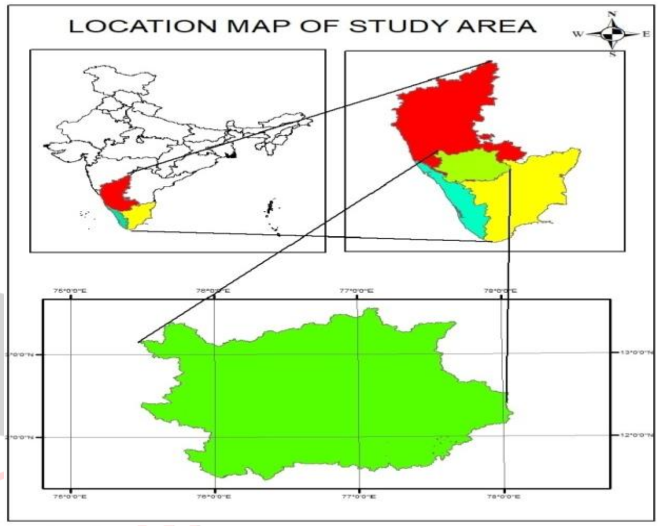

Figure 1 location map of study area

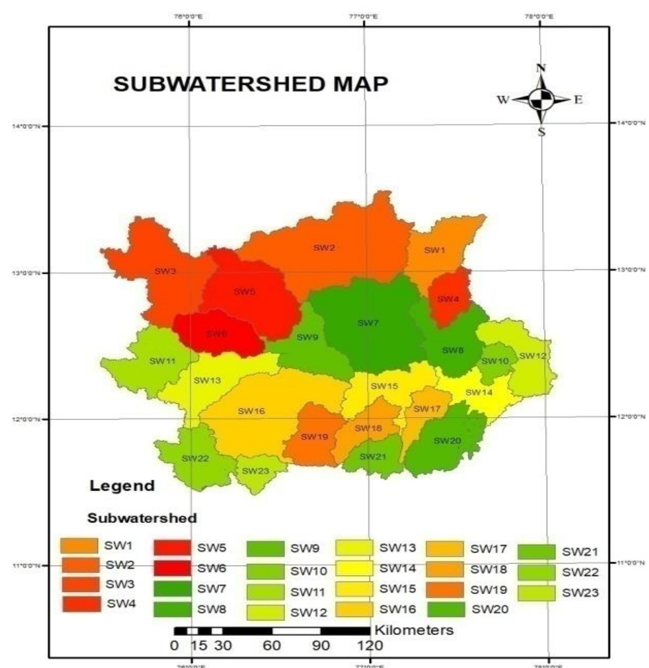

Figure 2 Subwatershed map

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	Morphometric Parameters	Methods	References
	Stream order (U)	Hierarchical order	Strahler,1964
	Stream length (Lu)	Length of the stream	Horton,1945
	Mean stream length (Lsm)	Lsm= Lu/Nu;where,Lu=Stream length of order'U'Nu=Total number of stream segments of order'U'	Horton,1945
	Stream length ratio (Rl)	Rl=Lu/Lu-1;whereLu=Total stream length of order'U',Lu-1=Stream length of next lower order	Horton,1945
	Bifurcation ratio (Rb)	Rb=Nu/Nu+1;where,Nu=Total number of stream segment of order'u';Nu+1=Number of segment of next higher order	Schumn,1956
	Drainage density (Dd) Drainage Texture	Dd=L/A where, L=Total length of streams ;A=Area of watershed Dt=N/P	Horton,1945
	Stream frequency (Fs)	Fs=N/A; where, N=Total number of streams ;A=Area of watershed	Horton,1945
	Texture ratio (T) Form factor (Rf) Circulatory ratio (Rc)	T= N1/P;where,N1=Total number of first Order streams ;P=Perimeter of watershed $Rf=A/(Lb)^2$;where,A=Area of watershed, Lb=Basin length $Rc=4\pi A/P^2$;where,A=Area of watershed, π=3.14,P=Perimeter of watershed	Horton,1945 Horton,1932 Miller,1953
	Elongation ratio (Re)	$Re=2\sqrt{(A/\pi)}/Lb$; where, A=Area of watershed, π=3.14,Lb=Basin length	Schumn,1956
	Length of overland flow (Lof)	Lof=1/2Dd;where,Dd=Drainage density	Horton,1945
	Constant of channel maintenance (Ccm)	C=1/Dd; where, Dd=Drainage density	Schumn,1956
	Compactness ratio (Cc)	$Cc=0.2821*P/A^2$;where, P=Perimeter of the basin(km), A=Area of the basin (km^2)	Horton,1945

Table 1: Formula adopted for computation of morphometric parameters for the study area

Table 2 : Subwatersheds of Cauvery Catchment

Subwatersheds	Area(km^2)	Perimeter(km)	Length(km)	Width(km)
Sbw1	1647.71	278.23	71.04	40.59
Sbw2	4893.82	489.03	76.54	98.01
Sbw3	2912.77	389.93	75.85	42.03
Sbw4	870.69	168.97	50.71	25.95
Sbw5	2668.08	319.65	81.1	47.4
Sbw6	1451.32	206.74	59.97	33.7
Sbw7	3787.47	379.16	84.29	65.78
Sbw8	1642.8	304.34	50.49	37.21
Sbw9	1526.64	285.9	68.06	38.69
Sbw10	529.53	134.78	34.17	22.99
Sbw11	1761.97	279.44	50.77	39.19
Sbw12	1488.17	272.03	58.39	27.86
Sbw13	1917.59	337.83	79.02	34.18
Sbw14	1154.2	296.77	54.96	35.52
Sbw15	1499.29	344.45	50.4	26.29
Sbw16	3775.96	423.22	92.21	60.18
Sbw17	788.63	199.57	62	25.91
Sbw18	1022.04	219.29	59.88	25.19
Sbw19	1199.12	209.31	50.54	27
Sbw20	1698.49	283.89	58.02	36.64
Sbw21	817	172.12	30.64	41.2
Sbw22	1473.54	270.11	36.11	42.04
Sbw23	610.22	148.72	31.96	28.8

Table 3: Linear Morphometric Characteristics of Subwatersheds in Study area

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Subwatershed	Stream order	No of Streams	Total length of Streams (km)	Cumulative Length(km)	Mean Stream Length(km)	Bifurcation Ratio	Length Ratio
Sbw1	1	3451	1525.81	1525.81	0.44		
	2	698	734.51	2260.32	1.05	4.94	2.38
	3	154	392.07	2652.39	2.55	4.53247	2.42
	4	32	188.35	2840.74	5.89	4.8125	2.31
	5	5	45.39	2886.13	9.08	6.4	1.54
	6	2	74.82	2960.95	37.41	2.5	4.12
	7	1	17.89	2978.84	17.89	2	0.48
Sbw2	1	10380	5068.12	5068.12	0.49		
	2	2255	2435.78	7503.90	1.08	4.60	2.21
	3	470	1126.43	8630.33	2.40	4.79787	2.22
	4	101	581.20	9211.53	5.75	4.65347	2.40
	5	22	298.33	9509.86	13.56	4.59091	2.36
	6	5	172.58	9682.44	34.52	4.4	2.55
	7	1	42.21	9724.65	42.21	5	1.22
Sbw3	1	5524	2769.59	2769.59	0.50		
	2	1130	1320.29	4089.88	1.17	4.89	2.33
	3	247	581.11	4670.99	2.35	4.5749	2.01
	4	60	342.00	5012.99	5.70	4.11667	2.42
	5	15	132.07	5145.06	8.80	4	1.54
	6	2	149.33	5294.39	74.67	7.5	8.48
	7	1	2.20	5296.59	2.20	2	0.03

Sbw4	1	1654	791.42	791.42	0.48		
	2	347	385.05	1176.47	1.11	4.77	2.32
	3	71	212.76	1389.23	3.00	4.88732	2.70
	4	18	98.71	1487.94	5.48	3.94444	1.83
	5	5	56.58	1544.52	11.32	3.6	2.06
	6	1	36.74	1581.26	36.74	5	3.25
Sbw5	1	5420	2553.86	2553.86	0.47		
	2	1154	1279.98	3833.84	1.11	4.70	2.35
	3	248	620.02	4453.86	2.50	4.65323	2.25
	4	49	233.96	4687.82	4.77	5.06122	1.91
	5	10	176.63	4864.45	17.66	4.9	3.70
	6	3	23.10	4887.55	7.70	3.33333	0.44
	7	1	112.40	4999.95	112.40	3	14.60
Sbw6	1	2727	1309.65	1309.65	0.48		
	2	580	649.07	1958.72	1.12	4.70	2.33
	3	125	285.08	2243.80	2.28	4.64	2.04
	4	32	180.90	2424.70	5.65	3.90625	2.48
	5	8	64.31	2489.01	8.04	4	1.42
	6	-	-	2489.01	-	-	-
	7	1	84.09	2573.10	84.09	-	-
Sbw7	1	7714	3734.21	3734.21	0.48		
	2	1636	1870.28	5604.49	1.14	4.72	2.36
	3	349	883.41	6487.90	2.53	4.687679	2.21
	4	70	459.70	6947.60	6.57	4.985714	2.59
	5	13	228.41	7176.01	17.57	5.384615	2.68
	6	1	38.81	7214.82	38.81	13	2.21
	7	1	105.93	7320.75	105.93	1	2.73
Sbw8	1	3187	1543.18	1543.18	0.48		
	2	668	762.07	2305.25	1.14	4.77	2.36
	3	145	361.44	2666.69	2.49	4.606897	2.18
	4	31	168.81	2835.50	5.45	4.677419	2.18
	5	7	81.32	2916.82	11.62	4.428571	2.13
	6	3	25.32	2942.14	8.44	2.333333	0.73
	7	1	79.57	3021.71	79.57	3	9.43
Sbw9	1	2987	1522.22	1522.22	0.51		
	2	629	745.43	2267.65	1.19	4.75	2.33
	3	141	339.12	2606.77	2.41	4.460993	2.03
	4	31	163.24	2770.01	5.27	4.548387	2.19
	5	5	85.03	2855.04	17.01	6.2	3.23
	6	1	6.23	2861.27	6.23	5	0.37
	7	2	6.91	2868.18	3.46	0.5	0.55
	8	1	69.83	2938.01	69.83	2	20.21
Sbw10	1	942	470.04	470.04	0.50		
	2	198	226.48	696.52	1.14	4.76	2.29

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	3	40	136.78	833.30	3.42	4.95	2.99
	4	10	52.82	886.12	5.28	4	1.54
	5	3	22.47	908.59	7.49	3.333333	1.42
	6	1	23.46	932.05	23.46	3	3.13
Sbw11	1	3333	1645.31	1645.31	0.49		
	2	728	773.62	2418.93	1.06	4.58	2.15
	3	167	384.06	2802.99	2.30	4.359281	2.16
	4	39	199.97	3002.96	5.13	4.282051	2.23
	5	10	101.83	3104.79	10.18	3.9	1.99
	6	2	79.73	3184.52	39.87	5	3.91
	7	1	1.83	3186.35	1.83	2	0.05

Sbw12	1	2741	1383.29	1383.29	0.50		
	2	595	666.09	2049.38	1.12	4.61	2.22
	3	126	350.61	2399.99	2.78	4.722222	2.49
	4	34	190.14	2590.13	5.59	3.705882	2.01
	5	8	61.16	2651.29	7.65	4.25	1.37
	6	1	78.31	2729.60	78.31	8	10.24
Sbw13	1	3527	1700.23	1700.23	0.48		
	2	743	891.56	2591.79	1.20	4.75	2.49
	3	158	392.42	2984.21	2.48	4.702532	2.07
	4	32	192.69	3176.90	6.02	4.9375	2.42
	5	7	82.95	3259.85	11.85	4.571429	1.97
	6	2	73.13	3332.98	36.57	3.5	3.09
	7	1	57.92	3390.90	57.92	2	1.58
Sbw14	1	2070	1006.79	1006.79	0.49		
	2	453	482.92	1489.71	1.07	4.57	2.19
	3	107	294.86	1784.57	2.76	4.233645	2.58
	4	22	123.74	1908.31	5.62	4.863636	2.04
	5	4	23.79	1932.10	5.95	5.5	1.06
	6	3	16.60	1948.70	5.53	1.333333	0.93
	7	2	2.30	1951.00	1.15	1.5	0.21
	8	1	81.24	2032.24	81.24	2	70.64
Sbw15	1	3058	1561.79	1561.79	0.51		
	2	663	742.96	2304.75	1.12	4.61	2.19
	3	144	385.86	2690.61	2.68	4.604167	2.39
	4	30	174.25	2864.86	5.81	4.8	2.17
	5	5	54.58	2919.44	10.92	6	1.88
	6	2	19.85	2939.29	9.93	2.5	0.91
	7	3	4.22	2943.51	1.41	0.666667	0.14
	8	1	87.74	3031.25	87.74	3	62.37
Sbw16	1	7043	3332.77	3332.77	0.47		
	2	1422	1686.87	5019.64	1.19	4.95	2.51
	3	313	857.69	5877.33	2.74	4.543131	2.31
	4	62	379.52	6256.85	6.12	5.048387	2.23
	5	13	160.94	6417.79	12.38	4.769231	2.02
	6	5	96.44	6514.23	19.29	2.6	1.56
	7	1	148.88	6663.11	148.88	5	7.72
Sbw17	1	1524	712.10	712.10	0.47		
	2	313	354.64	1066.74	1.13	4.87	2.42
	3	61	182.01	1248.75	2.98	5.131148	2.63
	4	11	84.16	1332.91	7.65	5.545455	2.56
	5	3	69.69	1402.60	23.23	3.666667	3.04
	6	1	15.63	1418.23	15.63	3	0.67
Sbw18	1	2026	979.29	979.29	0.48		
	2	412	487.35	1466.64	1.18	4.92	2.45
	3	85	259.17	1725.81	3.05	4.847059	2.58
	4	21	132.34	1858.15	6.30	4.047619	2.07
	5	5	70.34	1928.49	14.07	4.2	2.23
	6	1	15.63	1944.12	15.63	5	1.11
	7	1	48.80	1992.92	48.80	1	3.12
Sbw19	1	2523	1200.63	1200.63	0.48		
	2	516	554.26	1754.89	1.07	4.89	2.26
	3	113	331.75	2086.64	2.94	4.566372	2.73
	4	26	135.09	2221.73	5.20	4.346154	1.77
	5	6	68.05	2289.78	11.34	4.333333	2.18
	6	1	57.32	2347.10	57.32	6	5.05
Sbw20	1	3133	1380.40	1380.40	0.44		

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	2	688	674.88	2055.28	0.98	4.55	2.23
	3	152	392.53	2447.81	2.58	4.526316	2.63
	4	36	180.81	2628.62	5.02	4.222222	1.94
	5	10	98.72	2727.34	9.87	3.6	1.97
	6	2	56.65	2783.99	28.33	5	2.87
	7	1	20.58	2804.57	20.58	2	0.73

Table 3 Continued

Subwatershed	Stream order	No of Streams	Total length of Streams (km)	Cumulative Length(km)	Mean Stream Length(km)	Bifurcation Ratio	Length Ratio
Sbw21	1	1507	713.80	713.80	0.47		
	2	320	358.52	1072.32	1.12	4.71	2.37
	3	65	182.34	1254.66	2.81	4.923077	2.50
	4	18	87.66	1342.32	4.87	3.611111	1.74
	5	4	58.36	1400.68	14.59	4.5	3.00
	6	2	19.76	1420.44	9.88	2	0.68
	7	1	1.94	1422.38	1.94	2	0.20
Sbw22	1	2830	1444.39	1444.39	0.51		
	2	624	695.85	2140.24	1.12	4.54	2.18
	3	145	334.33	2474.57	2.31	4.303448	2.07
	4	29	177.77	2652.34	6.13	5	2.66
	5	9	86.24	2738.58	9.58	3.222222	1.56
	6	3	44.65	2783.23	14.88	3	1.55
	7	1	16.16	2799.39	16.16	3	1.09
Sbw23	1	1179	549.56	549.56	0.47		
	2	282	295.89	845.45	1.05	4.18	2.25
	3	63	129.54	974.99	2.06	4.47619	1.96
	4	11	78.68	1053.67	7.15	5.727273	3.48
	5	3	34.90	1088.57	11.63	3.666667	1.63
	6	1	24.69	1113.26	24.69	3	2.12

B Priortization of subwatersheds

Morphometric aspects such as Bifurcation ratio(Rb), Drainage density(Dd), Stream frequency(Ns), Texture ratio(T), Form factor(Rf), Circularity ratio(Rc), Elongation Ratio(Re), length of overland flow, Basin Shape(Bs), drainage texture, compactness ratio(Cc) are also termed as erosin risk assessment parameters and have been used for prioritizing subwatersheds (Biswas et al 1999). The parameters such as Bifurcation ratio(Rb), Drainage density(Dd), Drainage Texture, Stream frequency(Ns), Texture ratio(T),have a direct relationship with erodibility higher values of all these have been rated as rank 1 second largest is rated as rank 2 and so on with the least ranked last. Parameters such as Form factor(Rf), Circularity ratio(Rc), Elongation Ratio(Re), Basin Shape(Bs) have inverse relationship with the erodibility higher the value less is erosion lower the value high is erodibility. In this manner least estimations of this is appraised as rank 1 and second least been rated as rank 2 and so on and the highest values is given last rank.after the ranking has been done based on every single parameters of each subwatershed were added up for each of the twenty three subwatersheds to arrive at compound value. Based on the average value of these parameters. Subwatershed with least rating was assigned highest rank next value was assigned second rank and so on and the subwatershed with highest compound value was assigned last rank. Hence on basis of morphometric analysis subwatershed 2 is considered highly erosive and given first priority and the subwatershed 22 is given the last priority. The subwatershed were further grouped into three classes as High (5-9.99), Medium(9.99-14.99), Low(14.99-20) based on the compound values.

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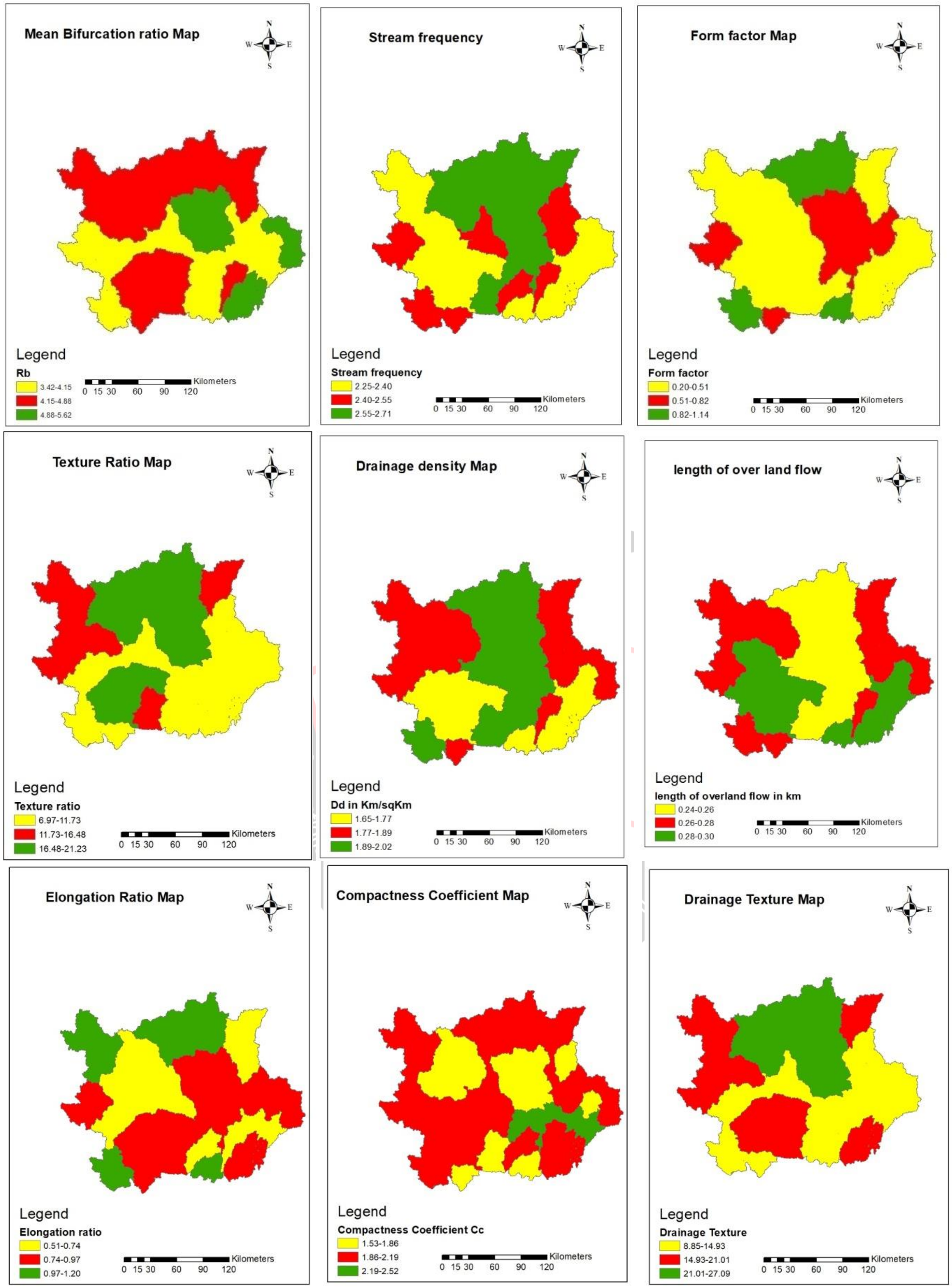

Figure 4 Spatial Analysis of Morphometric Parameters

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Table 4 :Results of Morphometric Analysis

Sub watershed	Bifurcation ratio mean	Drainage density	Stream frequency	Texture ratio	Form factor	Circularity ratio	Elongation ratio	Compactness coefficient	Length of overland flow	Drainage texture	Basin shape
Sbw1	4.196	1.8133693	2.64380201	12.4	0.325503	0.2665278	0.6439359	1.93699583	0.2757298	15.609387	3.07216830
Sbw2	4.672	1.9871286	2.70422696	21.22	0.835355	0.2570198	1.0315747	1.97249852	0.2516193	27.061734	1.19709584
Sbw3	4.511	1.8184031	2.39600106	14.16	0.5062849	0.2406149	0.8030871	2.03863151	0.2749665	17.898084	1.97517225
Sbw4	4.438	1.8229909	2.40728618	9.78	0.3385917	0.38303106	0.65675493	1.61578289	0.2742745	12.404568	2.95340948
Sbw5	4.273	1.87398804	2.58050733	16.95	0.4056552	0.32797374	0.71885904	1.74614565	0.2668106	21.539183	2.46514722
Sbw6	4.31	1.77293774	2.39299396	13.19	0.4035478	0.42648503	0.71698936	1.53125705	0.2820178	16.798877	2.47802062
Sbw7	5.62	1.9328866	2.58325478	20.34	0.5330857	0.33089775	0.82406927	1.73841353	0.2586804	25.804409	1.87587072
Sbw8	3.96	1.83936572	2.46043341	10.47	0.6444273	0.22276977	0.90604997	2.11871172	0.2718328	13.281198	1.55176534
Sbw9	3.92	1.92449431	2.48716135	10.44	0.3295738	0.23458377	0.64795008	2.06467176	0.2598085	13.280867	3.03422129
Sbw10	4.008	1.76014579	2.25482975	6.98	0.4535243	0.36612493	0.7600908	1.65266697	0.2840673	8.8588811	2.20495326
Sbw11	4.018	1.80840196	2.42909925	11.92	0.6835718	0.28340728	0.93316247	1.87842776	0.2764872	15.316347	1.46290396
Sbw12	5.05	1.83419905	2.35524167	10.07	0.4364913	0.2525856	0.74568081	1.98973715	0.2725985	12.884608	2.29099639
Sbw13	4.075	1.76831335	2.33105095	10.44	0.3071013	0.21103232	0.62546934	2.17683502	0.2827553	13.231507	3.25625415
Sbw14	3.42	1.76073471	2.30635938	6.97	0.3821093	0.16460034	0.69768435	2.46481678	0.2839723	8.9699093	2.61705215
Sbw15	3.73	2.02179031	2.60523314	8.87	0.5902344	0.1587168	0.86711651	2.51008569	0.2473055	11.339817	1.69424194
Sbw16	4.481	1.7646135	2.34615833	16.61	0.4440903	0.26477968	0.75214373	1.94337974	0.2833481	20.932375	2.25179400
Sbw17	4.44	1.7983465	2.42572563	7.63	0.2051586	0.24869807	0.5112227	2.00522814	0.2780331	9.5856090	4.87427564
Sbw18	4	1.94994325	2.49598842	9.23	0.2850302	0.26694382	0.60258363	1.93548612	0.2564177	11.632997	3.50829165
Sbw19	4.82	1.95735206	2.65611448	12.05	0.4694530	0.34377345	0.77332359	1.70554756	0.2554471	15.216664	2.13013843
Sbw20	5.21	1.65121373	2.36798568	11.03	0.5045538	0.26469909	0.80171303	1.94367558	0.3028075	14.167459	1.98194890
Sbw21	3.62	1.74097919	2.34638923	8.75	0.8702510	0.34637698	1.05290076	1.69912562	0.2871947	11.137578	1.14909375
Sbw22	3.84	1.89977198	2.47092037	10.48	1.1300741	0.25367066	1.19982705	1.98547708	0.2631894	13.479693	0.88489766
Sbw23	4.2	1.82435843	2.52204123	7.92	0.5974105	0.3465272	0.8723718	1.69875731	0.2740689	10.348305	1.67389072

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Table 5: Priorities of Sub watersheds and their ranks

Subwatershed	Bifurcation ratio	Drainage Density	Stream Frequency	Texture Ratio	Form Factor	Circularity Ratio	Elongation Ratio	Compactness Coefficient	Length of overland flow	Drainage Texture	Basin Shape	Compound Parameter	Final Rank
Sbw1	13	14	3	7	4	13	4	11	14	7	20	10	5
Sbw2	5	2	1	1	21	10	21	14	2	1	3	7.36363	1
Sbw3	6	13	15	5	15	6	15	18	13	5	9	10.9090	8
Sbw4	9	12	14	16	6	22	6	2	12	16	18	12.0909	13
Sbw5	11	8	6	3	9	16	9	8	8	3	15	8.72727	4
Sbw6	10	17	16	6	8	23	8	1	17	6	16	11.6363	10
Sbw7	1	5	5	2	16	17	16	7	5	2	8	7.63636	2
Sbw8	18	9	11	12	19	4	19	20	9	12	5	12.5454	15
Sbw9	19	6	9	13	5	5	5	19	6	13	19	10.8181	7
Sbw10	16	21	23	22	12	21	12	3	21	23	12	16.9090	22
Sbw11	15	15	12	9	20	15	20	9	15	8	4	12.9090	16
Sbw12	3	10	18	15	10	8	10	16	10	15	14	11.7272	11
Sbw13	14	18	21	14	3	3	3	21	18	14	21	13.6363	20
Sbw14	23	20	22	23	7	2	7	22	20	22	17	16.8181	21
Sbw15	21	1	4	18	17	1	17	23	1	18	7	11.6363	9
Sbw16	7	19	20	4	11	12	11	12	19	4	13	12	12
Sbw17	8	16	13	21	1	7	1	17	16	21	23	13.0909	17
Sbw18	17	4	8	17	2	14	2	10	4	17	22	10.6363	6
Sbw19	4	3	2	8	13	18	13	6	3	9	11	8.18181	3
Sbw20	2	23	17	10	14	11	14	13	23	10	10	13.3636	19
Sbw21	22	22	19	19	22	19	22	5	22	19	2	17.5454	23
Sbw22	20	7	10	11	23	9	23	15	7	11	1	12.4545	14
Sbw23	12	11	7	20	18	20	18	4	11	20	6	13.3636	18

IV. CONCLUSIONS

Stream frequency(Ns) for present study is low demonstrating relatively a low runoff. The length of overland flow(lof) for majority of the subwatersheds in the present study is more than 0.25 hence they have longer flowpaths associated with more infiltration and reduced runoff. Higher value of form factor(Rf) indicates wider basin and lower value indicates narrow basin. Drainage density varies from1.65 km/km^2 to 2.02 km/km^2 indicating all the subwatershed fall under coarse texture. Circularity ratio ranges between 0.15 to 0.42 when it is closer to 1 the basin is more likely to be circular. We can also conclude that in case of non availability of soil maps this type of study could be used in selecting area for soil conservation measure. The priority have been shown in figure 5.

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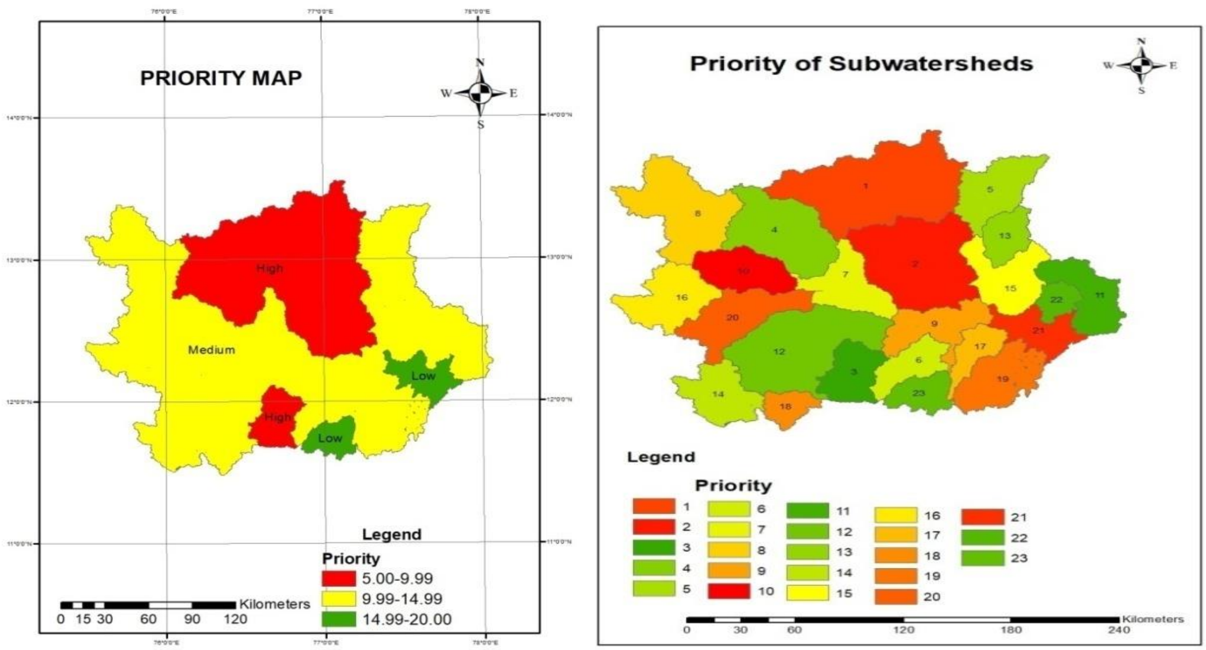

Figure 5 Priority Map

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