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Prioritization of Sub-watersheds in a Tropical River Basin, Northern Kerala, India using Geospatial Techniques

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Abstract: The prioritization of sub-watersheds using morphometric analysis for watershed development activities is gaining importance in recent years. The study area, a tropical river basin in Northern Kerala namely the Kadalundy River basin covers an area of 1266 km^2 and has been divided into 12 sub-watersheds. The linear, areal and relief parameters were delineated using Geographic Information System (GIS). The Shuttle Radar Topographic Mission (SRTM) data was used to prepare the shaded relief and slope map of the study area. The study reveals the Kadalundy River basin as a sixth order basin, having dendritic to sub-dendritic drainage pattern. Majority of the sub-watersheds have an elongated shape and the presence of structural controls on drainage development is identified in some areas. Three sub- watersheds belonging to very high priority class and needs immediate attention for soil conservation measures.

Keywords: *Tropical River Basin; Geospatial Techniques; Morphometric analysis; Prioritization*

1. Introduction

A river basin or a watershed is a natural integrator of all hydrological processes pertaining to its boundary. It may be considered as the logical physical unit for planning optimum development of soil and water. Conservation and management of both soil and water may have to be considered as integrated and not in isolation. Therefore, it is essential to have an integrated planning for development and management of a basin or watershed. The prioritization of watershed is essential for the proper planning and management of natural resources. According to the watershed atlas of AIS&LUS [1], the mean area of watersheds is less than 500 km^2 (±50%). Watersheds are further classified into sub-watershed (±30-50 km^2), mini watersheds (±10-30km^2) and micro watersheds (± 5- 10km^2) [2].

Morphometry is concerned with the quantitative measurement and generalization of land surface geometry. Morphometric analysis, one of the most important tools in hydraulic studies provides quantitative description of the basin geometry to understand inequalities in the rock hardness, structural controls, recent diastrophism, geological and geomorphic history of drainage basin [3]. Morphometric features of the erosional drainage basin have been classified into linear, areal and relief [3]. The Geographical Information System (GIS) and remote sensing are powerful tools for the delineation of morphometric parameters of sub-watersheds.

Digital Elevation Models (DEM) is becoming more important in hydrological modeling and in water resources management because they can provide many hydrological relevant parameters. The Shuttle Radar Topography Mission (SRTM) obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of Earth. SRTM consisted of a specially modified radar system that flew onboard the Space Shuttle Endeavour during an 11-day mission in February of 2000. Using SRTM data and GIS techniques is a speed, precision and inexpensive way for calculating morphometric analysis [4] [5] [6]. In the present study, an attempt has been made to prioritize the sub-watersheds of the Kadalundy River basin of the Northern Kerala through morphometric analysis using GIS and SRTM data.

1.1 Environmental settings

The Kadalundy River basin (KRB) is located in the Palghat and Malappuram districts of Kerala. The basin covers an area of 1226 km^2. It falls between east latitudes 10°55'41" and 11°11'12", and north longitudes 75°48'35" and 76°25'32" in the Survey of India (SOI) toposheet No 49M/16, 49N/13, 58A/8, 58A/4, 58B/1 and 58B/5 of 1:50,000 scale. In the present study, the Kadalundy River basin is divided into 12 sub-watersheds (Fig1 a). The altitude of the study area drops from 1376m to 20m. The climate of the study area is tropical to sub-tropical. The two monsoons, south west and north east have a good impact on the climate of the study area. The average rain fall is about 2793.3mm [7]. The average annual maximum temperature is 32.55°C and minimum is 20.2°C.

Physiographically the area is divided into four as high land (600-1800m), mid land (300-600m), low land (10-300m) and coastal plains (0-10m) [8] . The high land is mainly located in the eastern part of the study area and the topography slope towards the west.

Geologically the basin is underlined by charnockite and associated hornblende- biotite gneiss of Achaean age. In the western part of the study area these crystalline rocks are overlain by laterite. The coastal alluvium occupies the western coast of the basin.

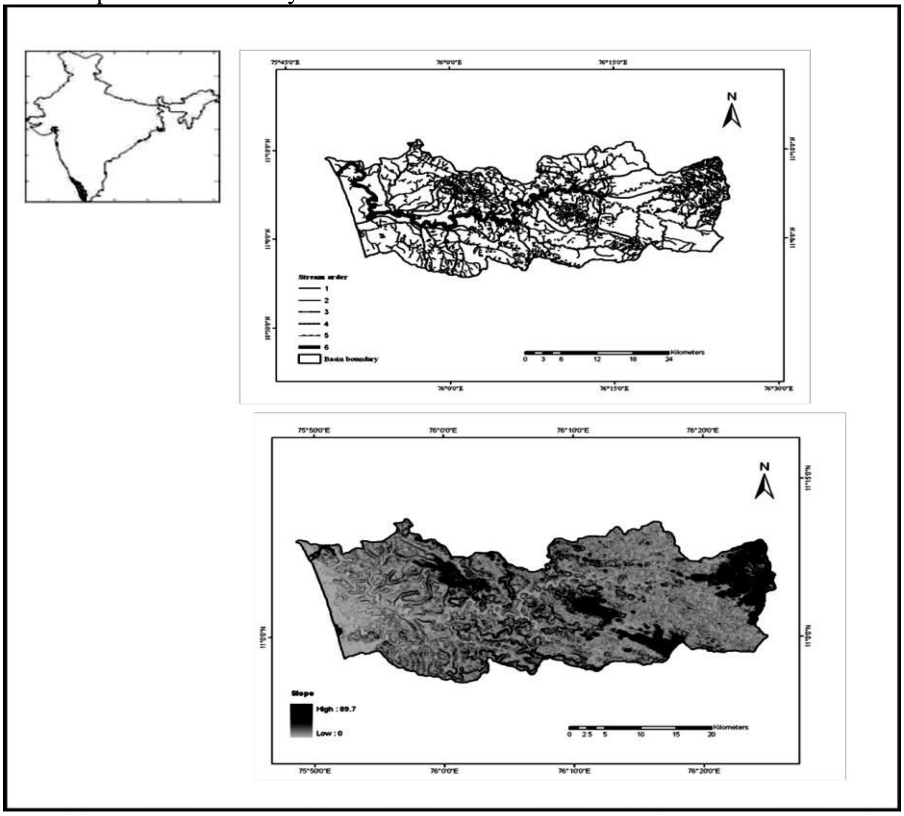

Figure. 1 a & b *Kadalundy River basin, drainage and its slope map*

2. Methodology

In the present study, the morphometric analysis and prioritization is done with the integrated use of GIS and remote sensing. The Survey of India (SOI) toposheets were used to prepare the base map. Drainage layer of the study area have been digitized and extracted from SOI map using Arc GIS software. It is often difficult and economically unfeasible to consider a big watershed as a single unit for the management. Division of watershed into smaller units and their evaluation is the best way to prioritize sub-watersheds for efficient management. In the present study, the Kadalundy River basin is divided into 12 sub-watersheds. The sub-watersheds were delineated on the basis of contour value, slope, relief and drainage flow direction. The stream ordering was carried out using the Strahler method [3]. Basin parameters such as area, perimeter, length and stream length were also calculated which were later used to calculate other parameters like bifurcation ratio, stream length ratio, stream frequency and drainage density. Drainage texture, elongation ratio, circularity ratio, form factor, compactness constant, length of overland flow and constant channel maintenance were evaluated with the help of established mathematical equations [3]. The SRTM DEM data having 90x 90m resolution was used to prepare the slope map of the present study area. The SRTM used in the study was projected using the WGS 84 horizontal datum to UTM projection (UTM 43 N). Derivation of relief aspects from SRTM data is a fast technique compare to the digitization of contours from the topographic maps. The prioritization rating of the 12 sub-watersheds were carried out by computing the compound parameter values. The sub-watershed with lowest compound value was given higher priority.

3. Results and discussion

The morphometric parameters were divided into three categories: linear, areal and relief aspects of the basin. In the present study morphometric analysis was carried out with the standard formula.

3.1 Linear aspect

Linear aspects such as stream order, stream length, mean stream length, stream length ratio and bifurcation ratio are were determined and the results are given in table 1**.**

3.1.1 Stream order (Nu)

The ordering of the stream is carried out with the Strahler [3] method. The Kadalundy River basin is divided into 12 sub-watersheds, of which I and II sub-watersheds are of fifth order. III, IV, V, VI, VII, VIII, IX and X are of fourth order, the XI one is of third order and the XII is of sixth order. The Kadalundy River basin as a whole is a sixth order basin (fig 2).

From the table 1 A, it is observed that the first order streams have the maximum frequency and the frequency decreases as the order increases.

3.1.2Stream length (Lu)

Stream length is the total length of streams in a particular order. The number of streams of various orders was counted and their lengths from mouth to drainage divide are measured with the help of Arc GIS. The length of the streams has been calculated by using Horton's law [9]. The length of a stream is an indication of the underlying rock type of an area. If the rock formation is permeable, a few longer streams are formed and if the rock formation is less permeable a larger number of smaller streams are generally formed [10]. From table 1B it is clear that the total length of first order streams are maximum in all sub-watersheds. Usually the total length of streams decreases as the order increases. In the present study the sub-watersheds except I, VI and X show a deviation from this general observation. This change is due to flowing of streams from high altitude, change in rock type and probable uplift across the basin [11].

3.1.3 Mean stream length

It is a dimensional property obtained by dividing the total length of each stream order by the number of streams of that order. Generally the mean stream length increases with the increase in stream order. From table 1 B, it is observed that there is an anomaly in the case of sub-watersheds VI, VIII, X and XII, which is due to variation in topography and slope.

3.1.4 Bifurcation ratio (Rb)

The bifurcation ratio is defined as the ratio of the number of streams of any order to the number of streams of the next highest order [3]. It will be higher for elongated channels fed directly by large numbers of first order channels and lower for more intricately branching networks. The bifurcation ratio is a dimensionless number varying only between 3.0 and 5.0 for networks formed in homogenous rocks, but exceeding 10 where pronounced structural control encourages the development of elongated narrow drainage basins. Chow [12] reported ranges of bifurcation ratios from 3 to 5 for watersheds with drainage patterns not heavily influenced by geologic structures. The bifurcation ratio is also an indicative of the shape of the basin. An elongated basin has relatively high Rb, whereas a circular basin has a low Rb.

The bifurcation ratio is a useful measure of proneness of the drainage basin to flooding. If the bifurcation ratio is low, there is a higher chance of flooding, as the water will be concentrated in one channel rather than spreading out. Table 1A, shows that the mean bifurcation ratio of sub-watersheds in the present study area ranges from 3.345 to 5.422. The sub-watersheds V and IX have Rb greater than 5, which indicates the presence of structural controls on drainage development. The lower values of Rb in all other sub-watersheds and the total Kadalundy River basin indicate geomorphic control on the drainage development rather than structural control.

3.1.5 Stream length ratio (R_L)

It is the ratio of the mean length of a stream of a given order to the mean length of the next lower order stream in the same basin. The R_L has an important relationship with the surface flow discharge and erosional stage of the basin [9]. In the present study the stream length ratio of the sub-watersheds ranges from 0.165 to 5.227 and that of the Kadalundy River basin as a whole it ranges from 0.286 to 2.468.

Table 1: *(A &B) Liner aspects of Kadalundy River basin* A

SW	A km^2	L Km	P km	Number of streams (Nu) of different stream order (u)							Rb					
				1	2	3	4	5	6	∑Nu	1/2	2/3	3/4	4/5	5/6	Rb
I	227.14	28.58	73.01	289	70	15	3	1	-	378	4.12	4.66	5.00	3	-	4.19
II	85.56	16.42	54.67	153	35	11	3	1	-	203	4.37	3.18	3.66	3	-	3.55
III	93.52	17.27	52.00	65	11	2	1	-	-	79	5.90	5.50	2.0	-	-	4.47
IV	37.98	10.35	32.16	67	17	4	1	-	-	89	3.94	4.25	4.00	-	-	4.06
V	129.52	20.76	62.91	144	27	5	1	-	-	177	5.33	5.40	5.00	-	-	5.24
VI	94.93	17.42	53.91	104	25	4	1	-	-	134	4.16	6.25	4.00	-	-	4.80
VII	35.83	10.01	31.75	61	17	4	1	-	-	83	3.58	4.25	4.00	-	-	3.94
VIII	27.70	8.65	27.15	44	10	3	1	-	-	58	4.4	3.33	3.00	-	-	3.57
IX	130.62	20.88	65.17	154	33	5	1	-	-	193	4.66	6.60	5.00	-	-	5.42
X	40.84	10.79	29.57	50	10	2	1	-	-	63	5.00	5.00	2.00	-	-	4.00
XI	78.51	15.64	39.99	44	9	5	-	-	-	58	4.88	1.80	-	-	-	3.34
XII	284.23	32.47	166.0	308	66	13	3	-	1	391	4.66	5.07	4.33	-	-	4.69
KRB	1266.18	75.88	211.5	1483	330	73	17	2	1	1906	4.494	4.52	4.29	8.5	2	4.76

B

SW	Total Stream Length in km (Lu)						Mean Stream Length in km (Lu/Nu)						Stream length Ratio (R_L)				
	1	2	3	4	5	6	1	2	3	4	5	6	2/1	3/2	4/3	5/4	6/5
I	169.74	56.33	37.85	29.28	19.65	-	0.58	0.80	2.52	9.76	19.65	-	0.33	0.67	0.77	0.67	-

II	81.35	25.49	16.63	9.32	21.69	-	0.53	0.72	1.51	3.109	21.69	-	0.31	0.65	0.56	2.32	-
III	54.05	15.28	4.08	17.56	-	-	0.83	1.39	2.04	17.56	-	-	0.28	0.26	4.30	-	-
IV	33.73	12.91	3.83	11.78	-	-	0.50	0.76	0.96	11.78	-	-	0.38	0.29	3.07	-	-
V	91.64	24.64	19.06	23.22	-	-	0.63	0.91	3.81	23.224	-	-	0.26	0.77	1.21	-	-
VI	64.81	22.59	18.84	4.11	-	-	0.62	0.90	4.71	4.112	-	-	0.34	0.83	0.21	-	-
VII	36.32	14.38	4.76	9.42	-	-	0.59	0.84	1.19	9.42	-	-	0.39	0.33	1.98	-	-
VIII	25.27	7.36	2.16	11.29			0.57	0.73	0.70	11.29	-	-	0.29	0.29	5.22	-	-
IX	101.88	23.55	35.38	20.15	-	-	0.66	0.71	7.07	20.15	-	-	0.23	1.50	0.57	-	-
X	32.21	11.40	11.23	3.68	-	-	0.64	1.14	5.61	3.68	-	-	0.35	0.98	0.32	-	-
XI	39.18	14.25	22.30	-	-	-	0.89	1.58	4.46	-	-	-	0.36	1.56	-	-	-
XII	188.44	61.28	30.05	4.944	-	102.09	0.612	0.929	2.312	1.648	-	102.09	0.32	0.49	0.16	-	-
KRB	748.91	289.58	206.21	144.79	41.34	102.09	0.50	0.8	2.82	8.52	20.68	102.10	0.39	0.71	0.70	0.29	2.47

3.2 Areal aspects

Form factor, elongation ratio, circularity ratio, shape factor, compactness coefficient, drainage density, stream frequency, drainage texture, constant of channel maintenance and length of overland flow are the areal aspects considered in this study and the results are given in table 2

3.2.1 Form factor (Ff)

Horton [13] proposed the form factor in order to express the shape of a basin quantitatively. It is defined as the ratio of the basin area (A) to square of the basin length (L) [13]. For a perfect circular basin the form factor is always less than 0.78. As the value of form factor becomes smaller, the basin will become more elongated. A circular watershed would result in runoff from various parts of the watershed reaching the outlet at the same time. An elliptical watershed having the outlet at one end of the major axis and having the same area as the circular watershed would cause the runoff to be spread out over time, thus producing a smaller flood peak than that of the circular watershed. The Ff value of the sub-watersheds ranges from 0.27 to 0.37, indicating elongated sub-watersheds. The Kadalundy basin as a whole has the Ff value of 0.219, which also indicate an elongated basin.

3.2.2 Elongation ratio (Re)

Elongation ratio is the ratio between the diameter of the circle with the same area as the drainage basin and the maximum length of the basin. The values of Re generally vary from 0.6 to 0.1. Regions with very low relief usually have Re values very close to 1, whereas values in the range of 0.6 to 0.8 is generally associated with high relief and steep ground slope [3]. In the present study the Re values range from 0.586 to 0.686, indicating elongated sub-watersheds with high relief and steep slope.

3.2.3 Circularity ratio (Rc)

It is the ratio of the area of a drainage basin to the area of a circle having the same perimeter as that of the drainage basin [14]. It is a dimensionless parameter which provides a quantitative index of the shape of the basin. It is generally influenced by the geological structures, length, frequency and gradient of streams of various orders besides slope conditions and drainage design prevailing in the drainage basin. Table 2 shows that the circularity ratio of the present sub-watersheds ranges from 0.129 to 0.617. Sub-watersheds I, X and XI have Rc values greater than 5, which indicates that they are more or less circular and are characterized by high to moderate relief and structurally controlled drainage system. All other sub-watersheds and the Kadalundy basin as a whole have Rc values less than 5, indicating elongated shape of the basin.

3.2.4 Compactness coefficient (Cc)

The compactness coefficient is essentially the relationship of the shape of the drainage basin to a circle. A perfect circular basin has Cc values equal to 1. In the present study, the Cc values range from 1.273 to 2.779; this indicates that the basin is not a perfect circle.

3.2.5 Drainage density (Dd)

Drainage density (Dd) was defined by Horton [8] as the ratio of the total length of streams in a watershed over its contributing area. The drainage density is an important parameter as it is one of the factors that control the speed of run-off following a period of precipitation. The greater the drainage density, the faster the run-off. Thus flooding for a given quantity of rainfall is more likely in a region with a high drainage density. According to Horton the basins of low drainage density were the product runoff process dominated by infiltration and sub surface flow; whereas basins of high drainage density were the product of erosion and dissection by overland flow. Density factor is related to climate, type of rocks, relief, infiltration capacity, vegetation cover, surface roughness and run off intensity index. According to Nag [15], low drainage density generally results in the areas of highly resistant permeable subsoil material, dense vegetation and low relief. High drainage density is the resultant of weak or impermeable subsurface material, sparse vegetation and mountainous relief. Low drainage density leads to coarse drainage texture while high drainage density leads to fine drainage texture.

In the present study the drainage density of the sub-watersheds ranges from 0.965 to 1.811km/km^2, indicating a low drainage density. Hence the river basin has permeable subsoil and dense vegetation, which results in a coarse drainage texture.

3.2.6 Stream frequency (Fs)

Stream frequency is a measure of the topographic texture, expressed as the number of stream segments of all orders per unit area. It mainly depends upon the lithology of the basin and has a positive correlation with the drainage density. In the present study, the stream frequency of the whole river basin is 1.505 and that of the sub-watersheds ranges from 0.751 to 2.372.

3.2.7. Drainage texture (T)

Drainage texture is the total number of stream segments of all orders per perimeter of the basin. It is a measure of relative channel spacing in a fluvial-dissected terrain, which is greatly influenced by climate, vegetation, lithology, soil type, relief, and stage of development of a watershed [16]. Drainage texture is classified into four by Smith [16] as coarse (<4/km), intermediate (4-10/km), fine (10-15/km) and ultrafine (>15). In the present study the sub-watersheds II and VII have T values between 4 and 10; hence they have intermediate drainage texture. The remaining sub-watersheds and the Kadalundy River basin as a whole have a coarse drainage texture. A coarse drainage texture indicates the presence of permeable underlying material and results in high infiltration.

3.2.8. Constant of channel maintenance (C)

Constant of channel maintenance is the inverse of drainage density. It is also mentioned as the basin area required to support a linear length of channel. A high value of C (>0.5) indicates that the area is under the influence of structural disturbance and runoff condition is low. Table 2 shows that the C values of all the sub-watersheds in the present study is high, hence they have an influence on structural parameters and have high infiltration rate.

3.2.9 Length of overland flow (Lo)

Length of overland flow is the length of water over the ground before it gets concentrated into definite stream channels which affect both hydrologic and physiographic development of drainage basins [9]. It mainly depends upon the relief and drainage density of the basin. From table 2, it is clear that sub-watersheds with high drainage density have low Lo values. The Lo values of the sub-watersheds range from 0.276 to 0.518.

Table 2 *Areal aspects in the Kadalundy River basin*

SW	Ff	Re	Rc	Cc	Dd	Fs	T	C (km)	Lo Km^2 Km^{-1}
I	0.278	0.594	0.535	1.367	1.377	1.664	2.291	0.726	0.363
II	0.317	0.635	0.323	1.759	1.693	2.372	4.016	0.591	0.295
III	0.313	0.631	0.434	1.517	0.973	0.845	0.822	1.028	0.514
IV	0.354	0.671	0.461	1.472	1.640	2.343	3.843	0.610	0.305
V	0.300	0.618	0.420	1.543	1.227	1.369	1.680	0.815	0.407
VI	0.313	0.631	0.410	1.561	1.163	1.411	1.641	0.860	0.430
VII	0.357	0.674	0.446	1.496	1.811	2.316	4.194	0.552	0.276
VIII	0.370	0.686	0.472	1.455	1.664	2.093	3.483	0.601	0.300
IX	0.299	0.617	0.386	1.609	1.385	1.500	2.078	0.722	0.361
X	0.351	0.668	0.587	1.305	1.433	1.543	2.211	0.698	0.349
XI	0.321	0.639	0.617	1.273	0.965	0.751	0.725	1.036	0.518
XII	0.270	0.586	0.129	2.779	1.361	1.376	1.873	0.735	0.367
KRB	0.219	0.529	0.356	1.677	1.212	1.505	1.824	0.825	0.413

3.3 Relief parameters

Basin relief, relief ratio and ruggedness number are the relief parameters considered in the present study. The results are shown in Table 3.

3.3.1 Basin relief (R)

Basin relief is the difference in elevation between the highest and lowest point in the basin. It controls the stream gradient and therefore influences flood patterns and the amount of sediments that can be transported. Hadley et.al. [17] showed that sediment load increases exponentially with basin relief. The maximum height of the Kadalundy River basin is 1376m and the minimum height is 20m, hence the relief of the basin is 1356m.

3.3.2 Relief ratio (Rr)

The relief ratio is the height- length ratio between basin relief and basin length. The Rr value of the sub-watersheds ranges from 0.068 to 0.006 and that of the Kadalundy River basin is 0.021. The high Rr value indicates hilly region and low value is the characteristic of valley and pedeplain [18]. The shaded relief of the study area derived from the SRTM DEM data is shown in fig.3.The shaded relief maps illustrate both the hill shading effects and topographic heights, and are used to visualize the geomorphic features.

3.3.3 Ruggedness number (Rn)

The ruggedness number is expressed as the product of basin relief and drainage density [19]. The Rn value of the sub-watersheds ranges from 2.45 to 0.17 and that of the Kadalundy River basin is 1.88. The high ruggedness value indicates areas of the basin which are more prone to soil erosion and have intrinsic structural complexity in association with relief and drainage density [20]. In the present case, sub-watersheds I and II have high Rn values, which suggest a high relief and drainage density.

3.3.4 Slope

Basin slope has a pronounced effect on the velocity of overland flow and watershed erosion potential. The slope map of the present study area derived from the SRTM DEM as shown in fig.4, shows that the slope of the Kadalundy River basin varies from 0° to >45°. The maximum slope is found in the eastern part of the study area.

***Table 3** Relief aspects in the Kadalundy River basin*

SW	Elevation (m)		Basin relief (R)(m)	L (km)	Rr	Rn (km)
	Max 'H'	Min 'h'				
I	1376	40	1336	19.56	0.068	1.84
II	1376	20	1356	21.29	0.063	2.45
III	800	20	780	21.21	0.036	0.75
IV	160	40	120	18.46	0.006	0.19
V	160	20	140	15.10	0.009	0.17
VI	440	20	420	14.28	0.029	0.48
VII	800	20	780	11.67	0.066	1.12
VIII	360	20	340	10.79	0.031	0.32
IX	460	20	440	10.04	0.043	0.61
X	120	20	100	11.31	0.008	0.17
XI	100	20	80	13.62	0.058	0.94
XII	600	20	580	44.61	0.013	0.78
KRB	1376	20	1356	64.52	0.021	1.88

4. Prioritization of sub-watersheds

Classification of watersheds on the basis of their priority is an important step in the watershed management programmes. In the present study, the 12 sub-watersheds of the Kadalundy River basin are classified on the basis of the priority of their morphometric parameters. The linear parameters have a positive relationship with erodability; hence linear parameters with highest value is ranked as 1, whereas the shape factor has an inverse relation with erodability, so the shape factors with lowest value is ranked as 1 [21]. The compound value for each sub-watershed is calculated by taking the average of ranking value of each and the prioritisation rating is given in Table 4. The sub-watersheds were then categorised into four classes as very high (<5.5), high (5.5-6), moderate (6-6.6) and low (>6.5) priority on the basis of the range of their compound values. Thus the sub-watersheds I, VI and XII have very high priority, sub-watershed III has high priority and the sub-watersheds II, IV, V and VII have moderate priority. The sub-watersheds VIII, IX, X and XI belong to the low priority class. The final prioritised map of the study area is given in fig.2.

***Table 4** Prioritization of sub-watersheds using morphometric parameters*

SW	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Ff	2	7	5	10	4	6	11	12	3	9	8	1
Re	2	7	5	10	4	6	11	12	3	9	8	1
Rc	10	2	6	8	5	4	7	9	3	11	12	1
Cc	3	11	7	5	8	9	6	4	10	2	1	12
Rb	6	11	5	7	2	3	9	10	1	8	12	4
Dd	7	2	11	4	9	10	1	3	6	5	12	8
T	5	1	11	2	10	8	3	4	7	6	12	9
Fs	5	2	11	3	9	10	1	4	7	6	12	8
Lo	6	11	2	9	4	3	12	10	7	8	1	5
C	6	11	2	9	4	3	12	10	7	8	1	5
Compound value	5.2	6.5	6.5	6.7	5.9	6.2	7.3	7.8	6.5	7.2	7.9	5.4
Final priority	**1**	**5**	**5**	**6**	**3**	**4**	**8**	**9**	**2**	**7**	**10**	**2**

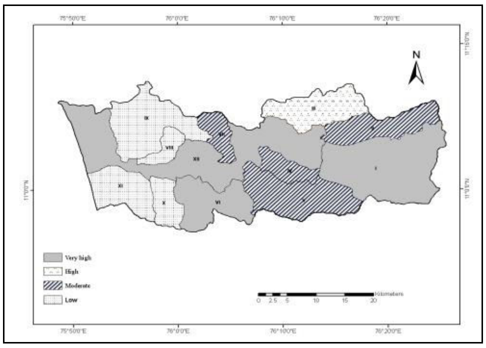

***Figure 2**. Final Sub- watershed wise prioritization of Kadalundy river basin*

5. Conclusions

The morphometric analysis of the Kadalundy River basin reveals it as a sixth order basin. The basin has dendritic to sub dendritic drainage pattern with an intermediate drainage texture in the sub-watersheds II and VII and a coarse texture in others, indicating high infiltration rate in majority of the study area. The high values of bifurcation ratio in the V and IX sub-watersheds indicate the presence of structural control on the drainage development, whereas the Kadalundy basin as a whole have geomorphic control, rather than structural one. The analysis of the shape parameters reveals an elongated nature to the Kadalundy basin, hence having smaller flood risk than a circular basin.

The low drainage density of the study area indicates the presence of permeable sub soil and dense vegetation. The SRTM data seems to be a faster technique for the preparation of slope map and the slope of the river basin ranges from 0 to 89.7°. The prioritization study shows that the sub-watersheds I, VI and XII falls in the very high priority class. As they have high rate of erodability they need immediate attention in soil conservation measures before any watershed development programme. The sub-watershed III falls in the high and the sub-watersheds II, IV, V and VII fall in moderate priority class. The sub-watersheds VIII, IX, X and XI have low priority.

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