WATERSHED PRIORITIZATION IN RELATION TO SOIL EROSION USING GEOSPATIAL TECHNIQUES IN MORPHOMETRIC ANALYSIS OF BAMA WATERSHED, MAHARASHTRA

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ABSTRACT

Land and water resources are depleting at global as well as in India as the population grows. The need of food, fiber and water is also increasing day by day to feed this ever-increasing population. Production process is impossible without natural resources, therefore conserved and utilized of land and water resources in an efficient manner is the only way for sustainable development of human being. Conservation of natural resources is a site specific, therefore effective site-specific planning is the most important parameter. In the current technical era Remote Sensing (RS) and Geographical Information System (GIS) plays a vital role for site specific planning of natural resources. Therefore, in the present study RS and GIS Tools are used for Morphometric Analysis of Bhama river basin of Pune district, Maharashtra, India. Digital Elevation Model (DEM) based watershed delineation and prioritization Bhama watershed was done by using Geospatial tools. The work outlines the significance of digital elevation model for assessment of drainage pattern and extraction of relative parameters. Basin has been divided into 11 sub-watersheds namely SW1 to SW11. It has been observed that the watershed's mean bifurcation ratio was 9.17, indicating a low mountainous region and a low drainage density of 3.2 km/km2, which very well fits the moderate soil texture, which signifies strong infiltration and minimal runoff owing to extensive forest cover. Lower peaks of longer duration with elongated watershed favor lower form factor ratio and elongation ratio of 0.25 and 0.57, respectively, which is helpful for preventing floods in downstream. The relatively low relief ratio of 0.018 correlates to modest erosion intensity. A modest roughness number of 2.28 is the result of low drainage density and relief. The stream order of watershed ranges from first to sixth order and have dendritic drainage pattern means homogeneity in texture and lack of structural control. It was considered as high priority for adopting conservation measure as well results were showing the appropriate measure structure locations for preventing the soil from getting eroded from the highly prioritized sub-watershed.

Keywords: - Bhama River Basin, Remote Sensing, GIS, Prioritization, Morphometric analysis

INTRODUCTION

The measuring and mathematical study of the configuration of the earth's surface, shape, and size of its landforms is known as morphological analysis. The use of quantitative analysis of morphometric characteristics in river basin evaluation, watershed prioritizing for soil and water conservation, and natural resource management at the watershed level has been discovered to be quite beneficial. Any hydrological research, such as groundwater potential evaluation, groundwater management, pedology, and environmental assessment, requires morphological analysis (Sreedevi et al., 2009).

Hydrologists and geomorphologists have discovered that some relationships exist between runoff characteristics and drainage basin system geographic and geomorphic properties. Physiographic properties of drainage basins, such as size, form, slope of drainage area, drainage density, size and length of contributories, and so on, can be linked to a variety of key hydrologic phenomena. For morphometric analysis, remote sensing techniques employing satellite pictures and aerial photography are useful. Satellite remote sensing is highly effective in assessing drainage morphometry since it can offer a synoptic picture of a vast area.

In a watershed management programme, particularly in case of large watersheds, it may not be possible to treat the entire area of the watershed with land treatment measures. Identification and selection of few areas or sub-watersheds having relatively more degradation problem, for development planning and implementation of conservation activities according to level of need and status of degradation, are required. These few selected areas or sub-watersheds within a large watershed are called the priority watersheds. In this process, collection of sufficient bio-physical and socio-economic information is required for integrated watershed management planning. After effectively prioritization of watersheds (sub-watersheds), a sub-watershed management plan for each priority sub-watershed is prepared in order to minimize natural and human-induced hazards and to conserve valuable resources (soil, water, biodiversity and socio-cultural aspects)

MATERIAL AND METHOD

STUDY AREA

The Bhama watershed is situated near pune city at altitude ranging from 1272 to 559. The Bhama basin is one of the sub-basins of Bhima river basin. The geographical location of research area is shown in fig 1. the total area by the basin under study is 397.71 km^2. The place is situated in the scenic area of Sahyadri's (western Ghats) The study area is situated along with the western margin of the Deccan Plateau, and on leeward side of the Western Ghat crown. The study area is surrounded by hilly regions on its west as well as in south side. the geographical location of study area extends between 18° 42' 33.5" N to 18° 59' 57.5" N latitudes and 73° 31' 40.5" E to 73° 56' 45.5" E longitudes

Study area situated on the lower site of the western ghat hence the climate of Pune is always moderate. The climate of the study area is tropical monsoon type. The climate shows the three distinct seasons summer winter and monsoon. All the seasons mainly persist for more or less four months duration.

There is a significant variation in temperature conditions in western Maharashtra throughout the year. Highest temperature recorded in the month of May which exceeds 38°C whereas in winter lowest temperature was recorded less than 15°C. Being benefitted of location in western ghat Monsoon starts in the area during June& receives up to the September end. Rest of the months are usually without spells and the months April and May sometimes gives torrential rainfall due to local climatic conditions. Avege annual rainfall recorded was 2700 m

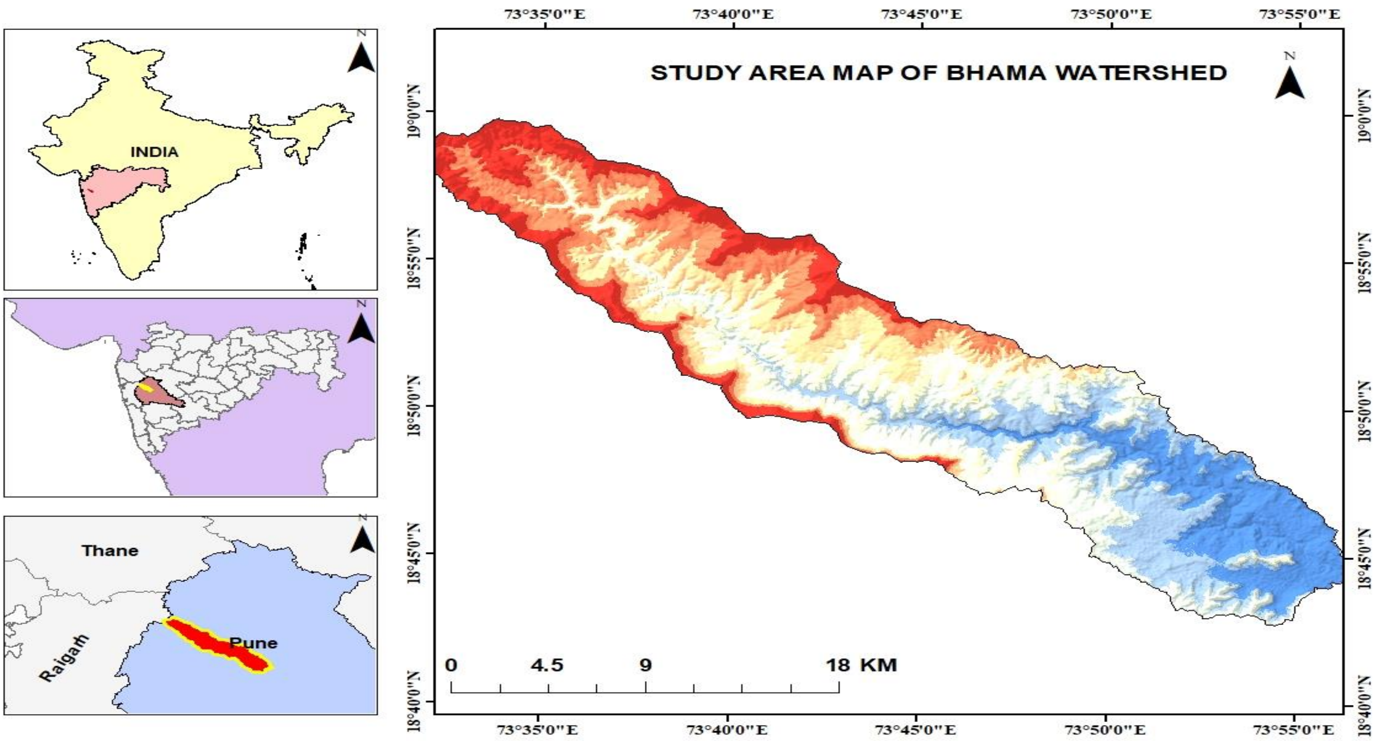

Figure 1 :- Study area location Map

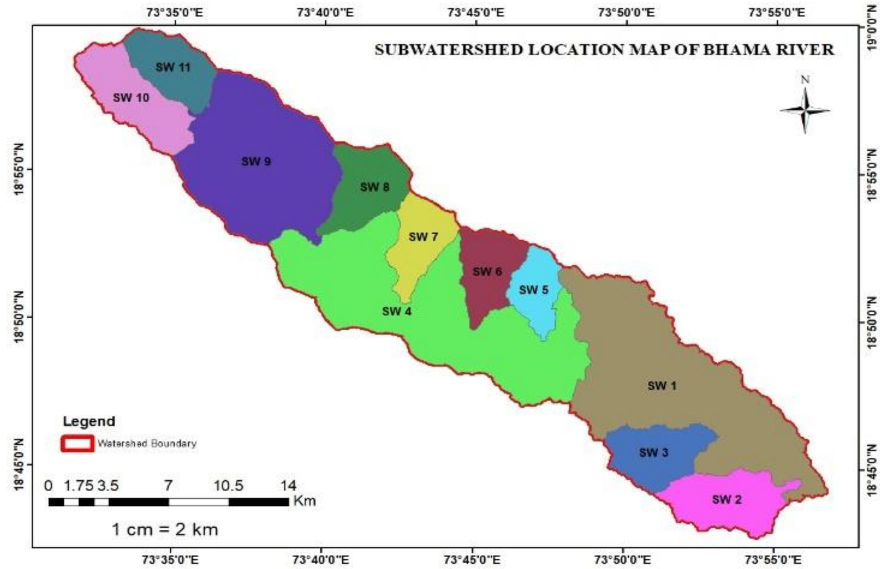

Figure 2 :- Sub-watershed location Map

DATABASE AND METHODOLOGY

The survey of India toposheet numbers 47 F/9, 47 F/13, 47 F/14, on scale of 1:50000 were used for present study. The toposheet maps were georeferenced on GIS platform with WGS 1984 datum and digitized the roads and villages.

The Strahler and Chow (1964) approach was used to organize the streams. The morphometric parameters were determined using the approach outlined in Table. The drainage map was created using the Geospatial tools using a 30 m 30 m resolution Digital Elevation Model (DEM) retrieved from NASA's USGS Earth Explorer Portal, which was initially created using the Shuttle Radar Topography Mission (SRTM) The stream order map was created using the basin's prepared drainage map using GIS Tools. The Stream Organize feature of the Spatial Analyst Hydrology tool in GIS Tools may be used to order streams. Using GIS Tools Editor tool, the stream sorting was done manually. At the same time, each stream segment was modified and the stream order was entered into the characteristics database. To modify the direction of flow and combine the stream segment, several tools such as clip and merge were employed. Figure shows a prepared stream order map of the research region. The stream order map was utilized for additional morphological analysis, such as manually counting the number of streams in each stream order and measuring the length of individual streams for further research. The Table lists several morphometric characteristics calculated for the research region, including linear, areal, and relief aspects.

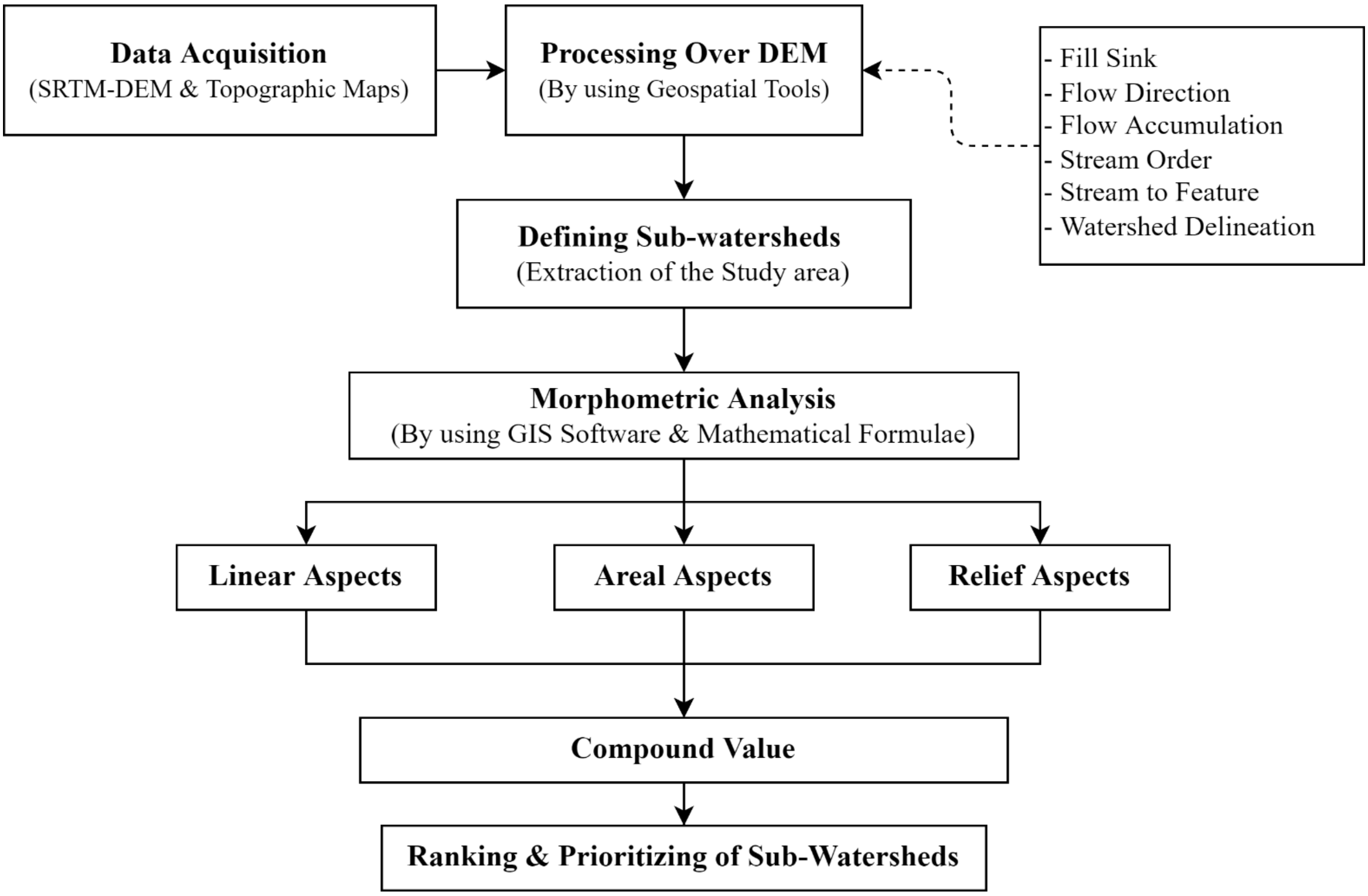

Figure 3: - Flowchart of methology

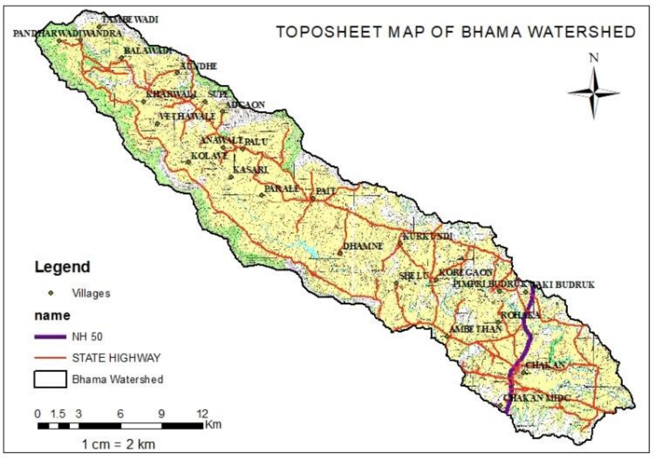

Figure 4 :- Toposheet Map

RESULT AND DISCUSSION

LINEAR ASPECTS

Linear aspects of drainage network are also referred as linear aspect of channel system. This includes the analysis of stream' order, stream length and length of overland flow, mainly.

Stream Order (Su)

The first step in morphometric study of a drainage basin based on hierarchy is stream order designation (Strahler, 1952). The Bhama River Basin was discovered to be a 6th order trunk stream. The Bhama river's maximum stream order frequency is found in first-order streams, then second-order streams, and finally third-order streams, before decreasing to the last highest order stream.

1st Order Stream (Suf)

The first order streams are the youngest streams in watershed. These streams are responsible to soil erosion in larger scale. In Bhama watershed have 4854 1st order streams

Stream Number (Nu)

Stream number is defined as the sum of order-wise stream segments. The inverse of stream order is stream number. The first, second, third, fourth, fifth, and sixth streams have stream numbers of 4854, 701, 178, 49, 6, and 1 correspondingly. Because the basin has a large number of first-order streams, it is responsible for the rapid removal of water after heavy rain.

Stream length (Lu)

Using SOI topographical sheets and GIS Tools in software, total stream lengths were determined. Hortons law states that geometric similarity is kept in increasing order watersheds (Strahler, 1964).

Stream Length Ratio (Lurm)

Horton (1945) determined the length ratio by dividing the man length of the order's segment (Lu) by the mean length of the next lower order's segment (Lu-1) which is constant across the basin's successive orders. When the stream length ratio rises from the lowest to the highest order, the basin has reached its mature geographic stage.

Mean Stream Length (Lum)

The drainage network components and contributing watershed surface are related to mean stream length (Lum) (Strahler, 1964). It's calculated by dividing the overall length of an order's stream by the total number of segments.

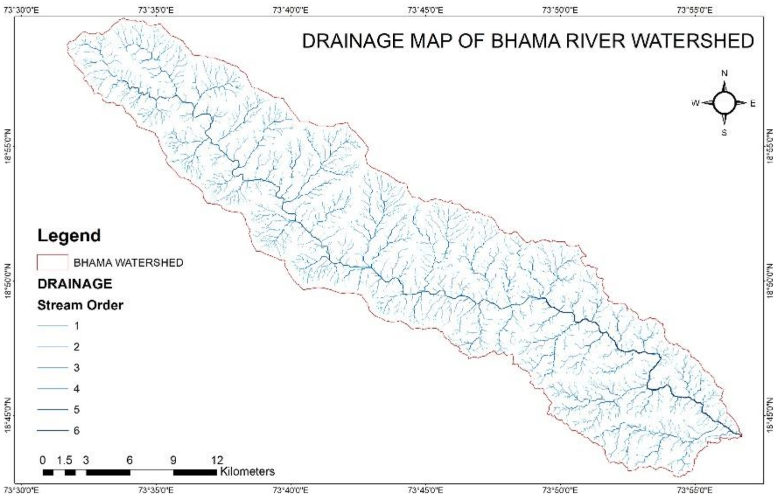

Figure 5: - Drainage Map of Bhama Watershed

Bifurcation ratio (Rb)

The number of stream segments of a given order (Nu) is divided by the number of streams in the next higher order (Nu+1) to compute the bifurcation ratio. The bifurcation ratio is a relief and dissertation index. A dimensionless feature is the bifurcation ratio. Lower bifurcation ratio values (less than 5) suggest that the watershed has less structural disturbances (Strahler, 1964) and that the drainage pattern has not been distorted (Nag 1998). A greater bifurcation ratio (>5) shows that the drainage pattern is under strong structural control, whereas lower values suggest that the watershed is not impacted by structural disturbance. The bifurcation ratio of 5.732 indicates that drainage pattern is influenced by geological structure.

Weighted mean Bifurcation ratio (Rbwm)

Strahler (1953) calculated the mean of the sum of the bifurcation ratios of each successive pair of orders to arrive at a more representative bifurcation ratio by multiplying the bifurcation ratio of each succeeding pair oforders by the total number of streams in this ratio. For this, the Rbwm value achieved is 5.7.

Length of main channel (Cl)

The length of the longest watercourse from the watershed's outflow point to the uppermost watershed boundary is known as the length of the main channel (Cl). Using GIS Tools, the length of the main channel (Cl) was calculated to be 75.88 km.

Channel Index (Ci) & Valley Index (Vi)

For determining valley length, channel length, and the shortest distance between the river's mouth and source (Adm). The channel index and valley index are computed using Adm. 1.48 and 1.45, respectively, are the calculated Channel Index (Ci) and Valley Index (Vi).

RHO coefficient

The RHO coefficient is determined by dividing the bifurcation ratio by the stream length ratio. The RHO coefficient determines the relationship between drainage density and basin physiographic development (Horton, 1945). Climate, biologic, anthropogenic, and geomorphologic factors all influence the RHO coefficient. For this research region, the RHO coefficient was calculated to be 0.77.

Table 1 : Linear aspect of Bhama River Basin

	LINEAR ASPECT													
			SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW9	SW 10	SW 11	Whole Basin
1	Stream Number (Nu)	1	109 1.00	214. 00	199. 00	109 4.00	10 8.0 0	157. 00	190. 00	245. 00	962. 00	343. 00	250. 00	4854.00
		2	169. 00	36.0 0	40.0 0	176. 00	19. 00	24.0 0	29.0 0	30.0 0	105. 00	44.0 0	27.0 0	701.00
		3	36.0 0	7.00	9.00	44.0 0	3.0 0	4.00	8.00	8.00	35.0 0	12.0 0	9.00	178.00
		4	9.00	2.00	2.00	12.0 0	1.0 0	2.00	2.00	2.00	8.00	4.00	1.00	49.00
		5	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00		6.00
		6												1.00

	Total		1306.00	260.00	251.00	1327.00	131.00	188.00	230.00	286.00	1111.00	404.00	287.00	5789.00
2	Stream Length (Lu)	1	173.84	37.51	34.72	168.49	21.26	25.19	27.96	31.54	120.43	45.24	29.51	768.71
		2	79.21	22.30	21.30	100.86	9.25	19.07	18.39	20.90	71.01	23.07	15.37	413.36
		3	42.66	11.28	8.51	35.87	6.50	6.50	7.47	10.28	25.70	7.41	8.20	174.19
		4	20.79	5.71	4.92	19.86	3.30	4.35	1.06	2.00	21.80	3.83	6.11	94.32
		5	20.82	2.30	3.10	20.03		2.57	4.35	5.13	11.33	5.41		30.25
		6												61.74
	Total		337.32	79.10	72.55	345.11	40.31	57.68	59.23	69.85	250.27	84.96	59.19	1542.56
3	Mean Stream Length (Lurm)	1	0.16	0.18	0.17	0.15	0.20	0.16	0.15	0.13	0.13	0.13	0.12	0.16
		2	0.47	0.62	0.53	0.57	0.49	0.79	0.63	0.70	0.68	0.52	0.57	0.59
		3	1.19	1.61	0.95	0.82	2.17	1.63	0.93	1.29	0.73	0.62	0.91	0.98
		4	2.31	2.86	2.46	1.66	3.30	2.18	0.53	1.00	2.73	0.96	6.11	1.92
		5	20.82	2.30	3.10	20.03		2.57	4.35	5.13	11.33	5.41		5.04
		6												61.74
4	Stream Length Ratio (Lur)	2/1	2.94	3.53	3.05	3.72	2.47	4.95	4.31	5.41	5.40	3.98	4.82	3.72
		3/2	2.53	2.60	1.78	1.42	4.45	2.05	1.47	1.84	1.09	1.18	1.60	1.66
		4/3	1.95	1.77	2.60	2.03	1.52	1.34	0.57	0.78	3.71	1.55	6.71	1.97
		5/4	9.01	0.81	1.26	12.10		1.18	8.21	5.13	4.16	5.65	0.00	2.62
		6/5	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		12.25
5	Mean Stream Length Ratio		4.11	2.18	2.17	4.82	2.82	2.38	3.64	3.29	3.59	3.09	4.38	4.44
6	Bifuegation Ratio (Rb)	1/2	6.46	5.94	4.98	6.22	5.68	6.54	6.55	8.17	9.16	7.80	9.26	6.92

		2/3	4.69	5.14	4.44	4.00	6.33	6.00	3.63	3.75	3.00	3.67	3.00	3.94
		3/4	4.00	3.50	4.50	3.67	3.00	2.00	4.00	4.00	4.38	3.00	9.00	3.63
		4/5	9.00	2.00	2.00	12.00		2.00	2.00	2.00	8.00	4.00		8.17
		5/6												6.00
7	Mean Bifurcation Ratio		6.04	4.15	3.98	6.47	5.01	4.14	4.04	4.48	6.13	4.62	7.09	5.73
8	Stream Length Used in Ratio	2+1	253.05	59.81	56.02	269.35	30.51	44.26	46.35	52.44	191.44	68.31	44.88	1182.07
		3+2	121.87	33.58	29.81	136.73	15.75	25.57	25.86	31.18	96.71	30.48	23.57	587.55
		4+3	63.45	16.99	13.43	55.73	9.80	10.85	8.53	12.28	47.50	11.24	14.31	268.51
		5+4	41.61	8.01	8.02	39.89	3.30	6.92	5.41	7.13	33.13	9.24	6.11	124.57
		6+5	20.82	2.30	3.10	20.03	0.00	2.57	4.35	5.13	11.33	5.41	0.00	91.99
	Total		500.80	120.69	110.38	521.73	59.36	90.17	90.50	108.16	380.11	124.68	88.87	2254.68
9	Weighted Mean Stream Length Ratio		3.10	2.78	2.44	3.44	2.70	3.26	3.17	3.58	3.82	3.02	3.94	3.26
10	No of Streams in Ratio	1												
		2	126	250	239	1270	127	181	219	275	1067	387	277	5555
		3	205	43	49	220	22	28	37	38	140	56	36	879
		4	45	9	11	56	4	6	10	10	43	16	10	227
		5	10	3	3	13	1	3	3	3	9	5	1	55
		6												7.00
	Total		1520	305	302	1559	154	218	269	326	1259	464	324	6723
11	Weighted Mean Bifurcation Ratio		6.16	5.72	4.84	5.86	5.67	6.28	6.00	7.47	8.30	7.09	8.53	6.43

12	Rho Coefficient (Lur/Rb)		0.46	0.59	0.61	0.60	0.44	0.76	0.66	0.66	0.59	0.51	0.52	0.54
			0.54	0.51	0.40	0.36	0.70	0.34	0.41	0.49	0.36	0.32	0.53	0.42
			0.49	0.51	0.58	0.55	0.51	0.67	0.14	0.19	0.85	0.52	0.75	0.54
			1.00	0.40	0.63	1.01		0.59	4.10	2.57	0.52	1.41		0.32
														2.04
13	Mean Rho		0.62	0.50	0.56	0.63	0.55	0.59	1.33	0.98	0.58	0.69	0.60	0.77
14	Main Channel Length (Cl) Km		30.60	9.50	7.77	26.19	7.73	7.77	8.75	7.98	20.47	10.63	7.87	75.88
15	Valley Length (Vl) Km		29.80	8.86	6.68	25.56	7.09	7.04	7.45	7.04	19.17	9.65	7.10	74.65
16	Maximum Aerial Distance(Adm)		20.87	8.70	6.49	20.18	6.05	6.30	6.90	6.70	12.30	8.70	6.30	51.20
17	Channel Index(Ci)		1.47	1.09	1.20	1.30	1.28	1.23	1.27	1.19	1.66	1.22	1.25	1.48
18	Valley index		1.43	1.02	1.03	1.27	1.1	1.12	1.08	1.05	1.56	1.11	1.13	1.46

Areal aspect

Drainage density (Dd), Stream frequency (Fs), Drainage Texture (Rt), Form Factor (RF), Elongation ratio (Re), Circularity ratio (Rc), Length of overland flow (Lg), Constant of channel maintenance (C), Lemniscate (k), Infiltration Number (If), and Basin perimeter (P) were calculated for the drainage basin (watershed) and the results are shown in Table 4.

Length of basin (Lb)

The longest dimension of a basin parallel to the main drainage line is called basin length (Schumm, 1956). According to Schumm (1956), the distance is 39.25 kilometers.

Basin area (A)

The area is just as important as the other metric, which is the overall length of the stream. The basin area, which is 396.71 km2, was calculated using GIS Tools in software.

Basin Perimeter (P)

The basin perimeter is the outermost edge of the basin that encloses the area. The size and shape of a watershed are determined by the basin perimeter. Using GIS Tools , the basin perimeter is calculated and found to be 132.09 km.

Length area relation (Lar)

Lar = 1.4* A0.6 formula proposed by Hack (1957) gives the relation between the stream length and basin area

Lemniscate's (k)

Chorely (1967) uses a Lemniscate value to determine the slope of the basin. It is calculated using the formula k= Lb2/4*A, where Lb is the basin length in kilometers and A is the basin area in square kilometers. k is determined to be 3.88 in the computed value.

Form factor (Ff)

The dimensionless form factor, often known as an index, is used to express the various basin shapes (Horton, 1932). The form factor ranges from 0.1 to 0.8. A higher form factor number indicates a circular basin, while a lower value indicates an elongated basin. The shape factor ranges from 0.78 to >0.78 for elongated basins and >0.78 for circular basins. The form factor value for the Bhama river basin is 0.38, indicating that the basin is elongated.

Elongation ratio (Re)

The diameter of a circle with the same area as the basin divided by the maximum basin length is known as the elongation ratio (Schumm, 1956). Strahler claims that the elongation ratio varies from 0.6 to 1.0 across a wide range of climatic and geology types. The elongation ratio is used to classify the slope of a watershed: elongated (0.5-0.7), less elongated (0.7-0.8), oval (0.8-0.9), and circular (0.5-0.7). (0.9-0.10). Bhama river basin's elongated ratio is 0.69, indicating that the basin is elongated.

Texture ratio (Rt)

The texture ratio (Rt= NI/P) is the proportion of first-order streams to the basin's perimeter, and it is affected by lithology, terrain relief, and infiltration capacity. Texture ratio is a significant measure in morphometric analysis since it is affected by infiltration capacity, terrain relief, and lithology. This basin's texture ratio was discovered to be 22.527.

Circulatory ratio (Rc)

Circularity ratio is a dimensionless characteristic that measures the degree of circulation across the basin. Circularity ranges from 0 to 1, with a value near to 1. The circulatory ratio is computed by dividing the surface area of the watershed by the surface area of a circle with the same perimeter as the watershed. The circulatory ratio of the basin fluctuates between 0.4 and 0.6, according to Miller (1953), indicating that the basin is elongated and made up of extremely permeable geological components. The circulation ratio of the basin is 0.4, indicating that it is of the elongated type.

Drainage texture (Dt)

The drainage texture is computed by dividing all stream segments by the area's circumference (Horton, 1945). Smith (1950) defined five drainage texture classifications: extremely fine (>8), fine (6 to 8), moderate (4 to 6), coarse (2 to 4), and very coarse (2). The drainage texture of the basin is assessed to be 28.63, indicating an extremely fine texture.

Compactness coefficient (Cc)

The compactness coefficient (Cc) is computed by dividing the watershed's perimeter by the circumference of a circular region equal to the watershed's area (Gravelius 1994). The slope, but not the area of the watershed, determines the compactness coefficient. The basin's Cc was discovered to be 1.21.

Fitness ratio (Rf)

The fitness ratio is the length of the main channel divided by the perimeter of the watershed. The fitness ratio is a topographic fitness metric (Melton 1957). Bhama basin has a fitness ratio of 0.35.

Wandering ratio (Rw)

The wandering ratio (Rw) is the ratio of the length of the main stream to the length of the valley (Smart & Surkan 1967). The valley length is the straight-line distance between the basin outflow and the ridge's remost point. The wandering ratio was determined to be 1.24 in this investigation.

Watershed Eccentricity (τ)

τ = [(|Lcm2 -Wcm2|)] is the expression for watershed eccentricity. Watershed eccentricity, Lcm = Straight length from the watershed mouth to the watershed's center of mass, and Wcm = Watershed's width at the center of mass and perpendicular to Lcm The eccentricity of the watershed is a one-dimensional characteristic. The watershed eccentricity is calculated to be 0.42 for the specified watershed.

Centre of Gravity of watershed (Gc)

The length from the watershed's outflow to a point on the stream closest to the center of the watershed is used to determine the watershed's Center of Gravity (Gc). The watershed's center of gravity was determined using Geospatial Tools, and it is located at latitude 18.99N and longitudes 74.75E.

Sinuosity Index (Si)

Sinuosity describes the channel layout of a drainage basin. Sinuosity is the ratio of channel length to down valley distance. The Sinuosity value ranges from 1 to 4 and beyond. Geomorphologists, Hydrologists, and Geologists all utilize the Sinuosity Index. Hydraulic, topographic, and standard sinuosity indexes were calculated and found to be 16.66 percent, 83.33 percent, and 1.05 percent, respectively.

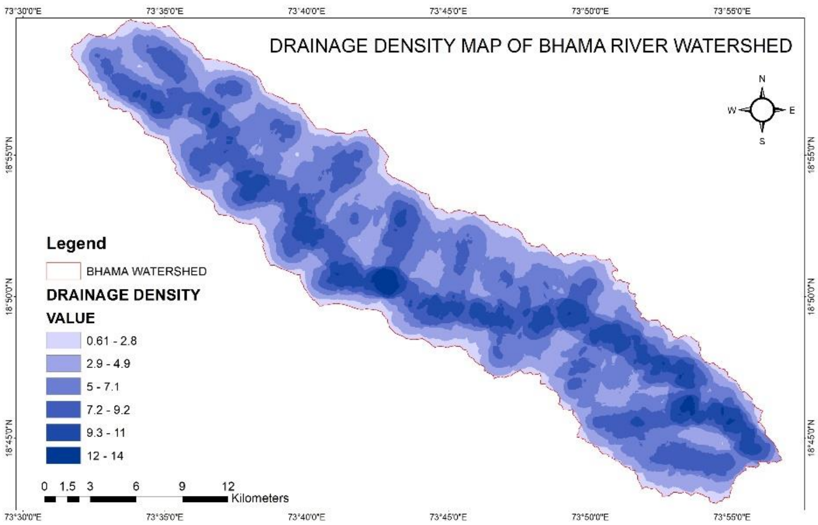

Figure 6: - Drainage Density Map of Bhama Watershed

Stream frequency (Fs)

Stream frequency refers to the number of stream segments per unit area. The frequency of a stream is also known as the frequency of a channel (Horton 1932). The watershed's stream frequency was discovered to be 4.283.

Drainage Density (Dd)

Drainage density refers to the length of a stream per unit area in a watershed (Horton, 1952). Using the spatial analyst tool in Geospatial Tools, the drainage density was determined. Dd is classified as extremely coarse (less than 2), coarse (2-4), moderate (4-6), fine (6-8) or very fine (>8). The basin's Dd was discovered to be 2.49, indicating a coarse drainage basin.

Infiltration Number (If)

If=Dd*Fs, the infiltration number is equal to the product of drainage density (Dd) and stream frequency (Fs). A greater infiltration number indicates a lesser infiltration capacity and more runoff (Horton1964). The infiltration number (If) for the basin is 10.66, indicating that the basin has a lesser infiltration capability and more runoff.

Drainage pattern (Dp)

The drainage pattern (Dp) is useful for determining the stage of erosion. Slope, lithology, and structure all have an impact on drainage patterns. Dendritic and radial patterns may be found in the research region. Howard (1967) made a connection between drainage patterns and geological data.

Length of Overland flow (Lg)

Overland flow length (Lg) is half the reciprocal of drainage density. Lower relief is indicated by a longer duration of overland flow, and vice versa. Low value (0.2), moderate value (0.2-0.3), and high value (>0.3) are the three categories for length of overland flow values. A lower Lg value suggests greater relief, more runoff, and less infiltration, whereas a higher Lg value indicates a gentle slope, more infiltration, and less runoff. The length of the overland flow (Lg) is 0.2, which indicates moderate to high relief, runoff, and infiltration.

Constant of Channel Maintenance (C)

Constant of Channel Maintenance (C=1/Dd) is the inverse of drainage density. Constant channel maintenance of watershed is computed to be 0.4

Table 2 : Aerial aspect of Bhama River Basin

AREAL ASPECTS													
		SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	Whole Basin
19	Length from W's Center to Mouth of W's (Lcm) Kms	11.04	4.37	3.75	9.17	3.16	3.85	3.84	4.08	6.17	3.54	3.18	24.98
20	Width of W's at the Center of Mass (Wcm) Kms	5.20	3.34	3.44	6.82	2.94	2.84	2.85	3.78	7.95	2.80	3.21	8.70
21	Basin Length (Lb) Kms	17.19	7.58	6.86	17.10	5.34	6.36	6.22	6.97	14.63	7.74	6.53	39.25
22	Lb in Meters	17188.39	7575.63	6862.53	17103.97	5335.57	6359.32	6216.76	6965.69	14631.17	7739.26	6534.73	39252.43

23	Mean Basin Width (Wb)	5.39	2.89	2.68	5.37	2.22	2.53	2.49	2.71	4.77	2.94	2.58	10.11
24	AREA	92.70	21.91	18.41	91.90	11.82	16.10	15.47	18.90	69.81	22.75	16.89	396.71
25	PERIMETER	73.49	25.48	21.02	12.66	16.61	19.31	19.00	20.48	45.43	23.81	17.64	132.09
26	Relative Perimeter (Pr)	1.26	0.86	0.88	7.26	0.71	0.83	0.81	0.92	1.54	0.96	0.96	3.00
27	Length Area Relation (Lar)	21.20	8.92	8.04	21.09	6.16	7.42	7.24	8.17	17.88	9.13	7.63	50.72
28	Lemniscate's (k)	3.19	2.62	2.56	3.18	2.41	2.51	2.50	2.57	3.07	2.63	2.53	3.88
29	Form Factor Ratio (Rf)	0.31	0.38	0.39	0.31	0.42	0.40	0.40	0.39	0.33	0.38	0.40	0.26
30	Shape Factor Ratio (Rs)	3.19	2.62	2.56	3.18	2.41	2.51	2.50	2.57	3.07	2.63	2.53	3.88
31	Elongation Ratio (Re)	0.63	0.70	0.71	0.63	0.73	0.71	0.71	0.70	0.64	0.70	0.71	0.57
32	Ellipticity Index (Ie)	7.52	2.81	1.90	5.58	3.34	2.42	2.82	2.06	4.13	3.21	2.34	11.03
33	Texture Ratio (Rt)	14.85	8.40	9.47	86.41	6.50	8.13	10.00	11.96	21.18	14.41	14.17	36.75
34	Circularity Ratio (Rc)	0.22	0.42	0.52	7.21	0.54	0.54	0.54	0.57	0.43	0.50	0.68	0.29
35	Circularity Ration (Rcn)	1.26	0.86	0.88	7.26	0.71	0.83	0.81	0.92	1.54	0.96	0.96	3.00
36	Drainage Texture (Dt)	17.77	10.20	11.94	104.82	7.89	9.74	12.11	13.96	24.46	16.97	16.27	43.83
37	Compactness Coefficient (Cc)	0.00	0.02	0.02	0.00	0.03	0.02	0.02	0.02	0.00	0.01	0.02	0.00
38	Fitness	0.42	0.37	0.37	2.07	0.47	0.40	0.46	0.39	0.45	0.45	0.45	0.57

	Ratio (Rf)												
39	Wandering Ratio (Rw)	1.78	1.25	1.13	1.53	1.45	1.22	1.41	1.15	1.40	1.37	1.20	1.93
40	Watershed Eccentricity (τ)	1.87	0.84	0.43	0.90	0.39	0.92	0.90	0.41	0.81	0.77	0.14	2.69
41	Centre of Gravity OF the Watershed (Gc)	73.51 E & 18.47 N	73.53 E & 18.43 N	73.51 E & 18.45 N	73.43 E & 18.50 N	73.47 E & 18.51 N	73.45 E & 18.51 N	73.4 3E & 18.5 2N	73.41 E & 18.54 N	73.37 E & 18.55 N	73.33E & 18.57N	73.34E & 18.58 N	73.3 4E & 18.5 8N
42	Hydraulic Sinuosity Index (Hsi) %	2.70	7.53	16.10	2.50	9.51	10.78	16.7 7	13.47	6.68	10.18	11.21	1.64
43	Topographi c Sinuosity Index (Tsi) %	97.30	92.47	83.90	97.50	90.49	89.22	83.2 3	86.53	93.32	89.82	88.79	98.3 6
44	Standard Sinuosity Index (Ssi)	1.03	1.07	1.16	1.02	1.09	1.10	1.17	1.13	1.07	1.10	1.11	1.02
45	Longest Dimension Parallel to the Principal Drainage Line (Clp) Kms	29.80	8.86	6.68	25.56	7.09	7.04	7.45	7.04	19.17	9.65	7.10	74.6 5
46	Stream Frequency (Fs)	14.09	11.87	13.63	14.44	11.08	11.68	14.8 7	15.13	15.91	17.76	16.99	14.5 9
47	Drainage Density (Dd) Km / Kms2	3.64	3.61	3.94	3.76	3.41	3.58	3.83	3.70	3.59	3.73	3.50	3.89
48	Constant of Channel Maintenanc e (Kms2 / Km)	0.27	0.28	0.25	0.27	0.29	0.28	0.26	0.27	0.28	0.27	0.29	0.26

49	Drainage Intensity (Di)	3.87	3.29	3.46	3.85	3.25	3.26	3.88	4.09	4.44	4.76	4.85	3.75
50	Infiltration Number (If)	51.27	42.84	53.73	54.22	37.80	41.83	56.9 2	55.93	57.05	66.32	59.55	56.7 4
51	Drainage Pattern (Dp)												
52	Length of Overland Flow (Lg) Kms	0.14	0.14	0.13	0.13	0.15	0.14	0.13	0.14	0.14	0.13	0.14	0.13

Relief aspect

Relief refers to the relative height of points on surface and lines with respect to the horizontal base of reference. Relief expresses the magnitude of the vertical dimension of the landform.

Maximum basin relief (H)

The elevation difference between the highest point in the catchment and the catchment outflow is known as maximum basin relief (H). The relief of the basin is 396 meters, indicating that the basin has undulating topography with high kinetic energy of water, resulting in significant soil erosion.

Relief ratio (Rhl)

The total relief of a river basin is the difference in elevation between the highest and lowest points in the watershed on the valley floor. The relief ratio is the proportion of a basin's overall relief to its longest dimension parallel to the main drainage line (Schumm, 1956). The river basin relief ratio was determined to be 0.0063 in this research region.

Relative relief (Rhp)

The formula published by Melton (1957) for calculating relative relief is Rhp= H*100/P, where P is the perimeter in meters and H is the total basin relief.

Absolute relief (Ra)

The difference between a specific site and sea level is known as absolute relief. Using Geospatial Tools, the absolute relief is estimated and determined to be 898 m.

Channel gradient (Cg)

The Channel Gradient (Cg) m/Kms is computed using Broscoe's (1959) formula: Cg = H / (/2) * Clp, where H is the total basin relief and Clp is the longest dimension parallel to the Principal drainage line (Clp) Kms. The research area's channel gradient is determined to be 3.37.

Ruggedness Number (Rn)

The ruggedness number is used to determine the unevenness or roughness of the surface (Rn). The roughness number is the product of basin relief and drainage density (Strahler, 1968). The slope steepness and length are commonly combined to get the ruggedness number. The study area has a toughness rating of 0.986.

Melton Ruggedness number (MRn)

The Melton Ruggedness number is a slope index that provides a unique depiction of the relief ruggedness within a watershed (MRn). The MRn for the research area is 10.28.

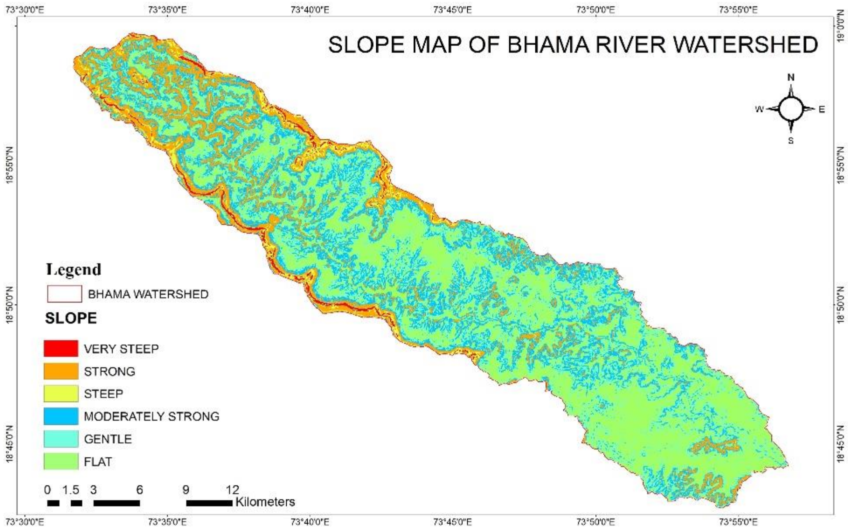

Figure 7: - Slope Map of Bhama Watershed

Gradient ratio (Rg) :-

The indicator of the channel slope which enables the assessment of runoff volume (Sreedevi, 2004). The Rg for the study area is 0.0061.

Gradient & channel slope (Sgc)

The gradient stated as a change between its vertical intervals (Vei) reduced to unity and its horizontal counterpart is the steepness of slope (Hoe). The formula Sgc= Vei/Hoe is used to compute the gradient.

Slope analysis (Sa)

Slope analysis (Sa) is calculated by using Geospatial Tools. It is the average slope in the degree. It is found to be 0.01422 for the study area.

Average slope of overall basin (S)

The average slope was used to investigate the erodibility of a watershed (Wenthworth 1930). When the slope % is higher, erosion is higher. The slope of the watershed is 1.422 percent when calculated using the method S = (Z * (Ctl/H)) / (10 * A).

Mean slope of overall basin (Θs)

The formula s = (Ctl * Cin) /A is used to calculate the mean slope of the basin, where s is the overall slope, Ctl is the total length of the contour in the watershed, A is the area of the watershed, and Cin is the contour interval. The Bhama river basin's mean slope has been calculated to be 0.063.

Table 3 : Relief aspect of Bhama River Basin

Relief aspect													
		SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW1 0	SW1 1	Whole
53	Height of Basin Mouth (z) m	559	566	576	599	603	624	642	650	647	682	681	559
54	Maximum Height of the Basin (Z) m	777	680	711	1110	819	967	1164	1226	1272	1097	1134	1272
55	Total Basin Relief (H) m	218	114	135	511	216	343	522	576	625	415	453	713
56	H in kilometer	0.22	0.11	0.14	0.51	0.22	0.34	0.52	0.58	0.63	0.42	0.45	0.71
57	Relief Ratio (Rhl)	0.01	0.01	0.02	0.02	0.03	0.05	0.07	0.08	0.03	0.04	0.06	0.01
58	Absolute Relief (Ra) m	777	680	711	1110	819	967	1164	1226	1272	1097	1134	1272
59	Relative Relief Ratio (Rhp)	0.30	0.45	0.64	4.04	1.30	1.78	2.75	2.81	1.38	1.74	2.57	0.54
60	Dissection Index (Dis)	0.28	0.17	0.19	0.46	0.26	0.35	0.45	0.47	0.49	0.38	0.40	0.56
61	Channel Gradient (Cg) m / Kms	4.66	8.20	12.87	12.73	19.40	31.03	44.63	52.11	20.77	27.39	40.64	6.08
62	Gradient Ratio (Rg)	0.01	0.02	0.02	0.03	0.04	0.05	0.08	0.08	0.04	0.05	0.07	0.02
63	Watershed Slope (Sw)	0.01	0.02	0.02	0.03	0.04	0.05	0.08	0.08	0.04	0.05	0.07	0.02
64	Ruggedness Number (Rn)	0.79	0.41	0.53	1.92	0.74	1.23	2.00	2.13	2.24	1.55	1.59	2.77
65	Melton Ruggedness Number(MR n)	22.6 4	24.35	31.46	53.30	62.83	85.48	132.7 2	132.4 9	74.80	87.01	110.2 3	35.80
66	Total Contour Length (Ctl) Kms	688. 41	187.4 6	90.82	1184. 77	110.5 2	145.3 7	187.9 6	332.3 0	1264. 11	499.4 6	331.3 7	

67	Contour Interval (Cin) m	10M	10M	10M	10M	10M	10M	10M	10M	10M	10M	10M	
68	Slope Analysis (Sa)	0.03	0.05	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.06	0.05	0.00
69	Average Slope (S) %	2.65	5.10	2.60	2.80	3.55	2.55	2.71	3.74	3.69	5.80	4.91	0.00
70	Mean Slope of Overall Basin (Θs)	0.74	0.86	0.49	1.29	0.94	0.90	1.21	1.76	1.81	2.20	1.96	0.00
71	Relative Height (h/H)	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table
72	Relative Area (a/A)	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table	IN Hypsometric table
73	Surface Area of Relief (Rsa) Sq Kms	92.70	21.91	18.41	91.90	11.82	16.10	15.47	18.90	69.81	22.75	16.89	396.71
74	Composite Profile area (Acp) sq.km.	92.70	21.91	18.41	91.90	11.82	16.10	15.47	18.90	69.81	22.75	16.89	396.71

Hypsometry :-

Hypsometric analysis describes the distribution of elevation data across an area of land surface. The elevation distribution across a land surface is described through hypsometric analysis. It's a useful tool for assessing and comparing the geomorphic evolution of different landforms, regardless of the factors that may have caused it. Tectonics and/or climate, as well as lithological variation, are key determinants of landscape evolution. In present study we hypsometric curves of 11 sub watersheds of Bhama River The hypsometric integral has been employed as a morphometric parameter to determine the link between watershed area and hypsometric analysis. These factors were statistically analyzed by categorizing them into distinct classes using the natural breaks method. This reveals substantial connections between the number of watersheds in respective classes and the total area occupied by respective hypsometric and area classes for hypsometric integral classes and area classes.

Table 4: - Hypsometric Data of Bhama River

SW1								
Value	**AREA KM2**	**MIN**	**MAX**	**RANGE**	**a**	**a/A**	**h**	**h/H**
1	26.27	559	600	41	92.70	1.00	41	0.20
2	46.16	601	650	49	66.43	0.72	90	0.43
3	18.78	651	700	49	20.27	0.22	139	0.67
4	1.48	701	746	45	1.49	0.02	184	0.89
5	0.01	754	777	23	0.01	0.00	207	1.00
SW2								
1	3.17	566	600	34	21.92	1.00	34	0.30
2	14.16	601	650	49	18.75	0.86	83	0.74
3	4.59	651	680	29	4.59	0.21	112	1.00

SW3								
1	0.88	576	600	24	18.42	1.00	24	0.18
2	14.42	601	648	47	17.54	0.95	71	0.54
3	3.11	649	700	51	3.12	0.17	122	0.92
4	0.01	701	711	10	0.01	0.00	132	1.00
SW4								
1	20.48	599	650	51	91.91	1.00	51	0.10
2	46.65	651	700	49	71.43	0.78	100	0.20
3	15.36	701	750	49	24.78	0.27	149	0.30
4	3.39	751	800	49	9.42	0.10	198	0.40
5	1.33	801	850	49	6.03	0.07	247	0.49
6	1.31	851	900	49	4.70	0.05	296	0.59
7	1.15	901	950	49	3.39	0.04	345	0.69
8	1.35	951	1000	49	2.24	0.02	394	0.79
9	0.63	1001	1050	49	0.89	0.01	443	0.88
10	0.24	1051	1100	49	0.26	0.00	492	0.98
11	0.01	1101	1110	9	0.01	0.00	501	1.00
SW5								
1	2.23	603	650	47	11.82	1.00	47	0.23
2	6.30	651	700	49	9.59	0.81	96	0.47
3	2.61	701	750	49	3.29	0.28	145	0.71
4	0.68	751	798	47	0.68	0.06	192	0.94
5	0.00	807	819	12	0.00	0.00	204	1.00
SW6								
1	0.70	624	650	26	16.11	1.00	26	0.08
2	7.02	651	700	49	15.41	0.96	75	0.22
3	5.62	701	750	49	8.39	0.52	124	0.37
4	2.44	751	800	49	2.77	0.17	173	0.52
5	0.15	801	850	49	0.33	0.02	222	0.66
6	0.11	851	900	49	0.18	0.01	271	0.81
7	0.06	901	949	48	0.07	0.00	319	0.96
8	0.01	952	967	15	0.01	0.00	334	1.00
SW7								
1	4.16	642	700	58	15.48	1.00	58	0.12
2	6.73	701	750	49	11.32	0.73	107	0.22
3	2.50	751	800	49	4.59	0.30	156	0.32
4	0.63	801	850	49	2.09	0.14	205	0.41
5	0.63	851	900	49	1.46	0.09	254	0.51
6	0.41	901	950	49	0.83	0.05	303	0.61
7	0.21	951	1000	49	0.42	0.03	352	0.71
8	0.14	1001	1050	49	0.21	0.01	401	0.81
9	0.05	1052	1099	47	0.07	0.00	448	0.91
10	0.02	1102	1149	47	0.02	0.00	495	1.00
11	0.00	1164	1164	0	0.00	0.00	495	1.00
SW8								
1	1.61	650	700	50	18.90	1.00	50	0.09
2	5.76	701	750	49	17.29	0.91	99	0.18
3	6.39	751	800	49	11.53	0.61	148	0.26
4	1.91	801	850	49	5.14	0.27	197	0.35
5	0.85	851	900	49	3.23	0.17	246	0.44
6	0.69	901	950	49	2.37	0.13	295	0.52
7	0.49	951	1000	49	1.68	0.09	344	0.61
8	0.47	1001	1050	49	1.19	0.06	393	0.70
9	0.42	1051	1100	49	0.72	0.04	442	0.78
10	0.18	1101	1150	49	0.30	0.02	491	0.87
11	0.10	1151	1200	49	0.12	0.01	540	0.96

12	0.02	1201	1226	25	0.02	0.00	565	1.00
SW9								
1	13.77	647	700	53	69.81	1.00	53	0.09
2	27.89	701	750	49	56.05	0.80	102	0.17
3	14.23	751	800	49	28.16	0.40	151	0.25
4	4.95	801	850	49	13.92	0.20	200	0.33
5	1.93	851	900	49	8.98	0.13	249	0.41
6	1.59	901	950	49	7.04	0.10	298	0.49
7	1.59	951	1000	49	5.46	0.08	347	0.57
8	2.44	1001	1050	49	3.87	0.06	396	0.65
9	0.85	1051	1100	49	1.43	0.02	445	0.73
10	0.37	1101	1150	49	0.58	0.01	494	0.81
11	0.15	1151	1200	49	0.22	0.00	543	0.89
12	0.05	1201	1250	49	0.06	0.00	592	0.97
13	0.01	1251	1272	21	0.01		613	1.00
SW10								
1	0.21	682	700	18	22.75	1.00	18	0.04
2	2.34	701	750	49	22.55	0.99	67	0.16
3	8.58	751	800	49	20.21	0.89	116	0.29
4	5.14	801	850	49	11.63	0.51	165	0.41
5	1.96	851	900	49	6.49	0.29	214	0.53
6	1.31	901	950	49	4.53	0.20	263	0.65
7	1.23	951	1000	49	3.22	0.14	312	0.77
8	0.91	1001	1050	49	1.99	0.09	361	0.89
9	1.08	1051	1097	46	1.08	0.05	407	1.00
SW 11								
1	0.72	681	700	19	16.89	1.00	19	0.04
2	2.24	701	750	49	16.16	0.96	68	0.15
3	4.56	751	800	49	13.92	0.82	117	0.26
4	4.75	801	850	49	9.37	0.55	166	0.37
5	2.15	851	900	49	4.62	0.27	215	0.48
6	0.85	901	950	49	2.46	0.15	264	0.59
7	0.56	951	1000	49	1.61	0.10	313	0.70
8	0.34	1001	1050	49	1.06	0.06	362	0.82
9	0.56	1051	1100	49	0.72	0.04	411	0.93
10	0.16	1101	1134	33	0.16	0.01	444	1.00
Whole Basin								
1	30.60	559	600	41	396.63	1.00	41	0.06
2	98.79	601	650	49	366.03	0.92	90	0.13
3	106.08	651	700	49	267.23	0.67	139	0.20
4	69.94	701	750	49	161.16	0.41	188	0.27
5	42.69	751	800	49	91.22	0.23	237	0.34
6	18.81	801	850	49	48.52	0.12	286	0.41
7	8.99	851	900	49	29.72	0.07	335	0.48
8	6.09	901	950	49	20.73	0.05	384	0.55
9	5.43	951	1000	49	14.64	0.04	433	0.62
10	4.89	1001	1050	49	9.21	0.02	482	0.69
11	3.22	1051	1100	49	4.32	0.01	531	0.76
12	0.74	1101	1150	49	1.10	0.00	580	0.83
13	0.27	1151	1200	49	0.36	0.00	629	0.90
14	0.08	1201	1250	49	0.10	0.00	678	0.97
15	0.01	1251	1272	21	0.01	0.00	699	1.00

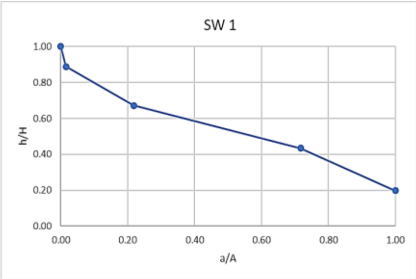

Chart -1: Hypsometric curve of SW1

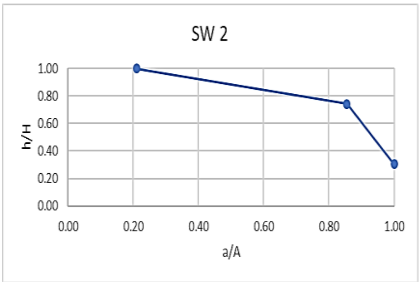

Chart -2: Hypsometric curve of SW2

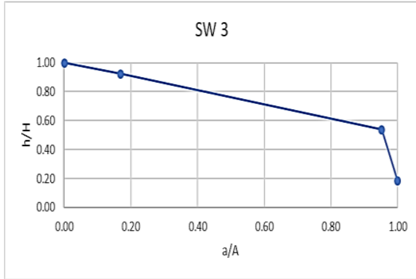

Chart -3: Hypsometric curve of SW3

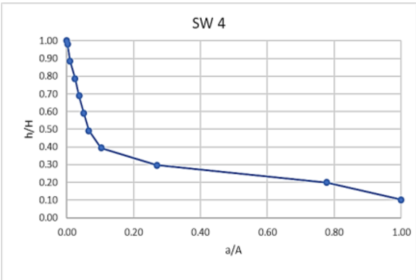

Chart -4: Hypsometric curve of SW4

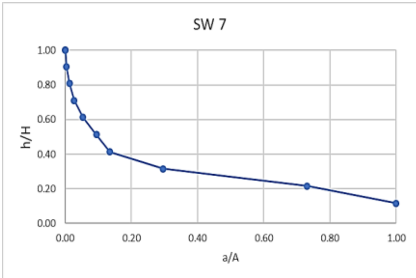

Chart -5: Hypsometric curve of SW5

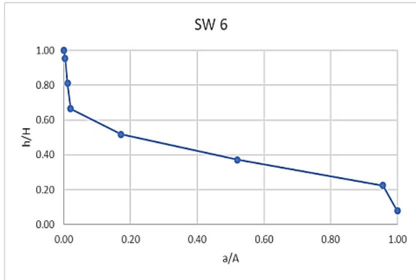

Chart -6: Hypsometric curve of SW6

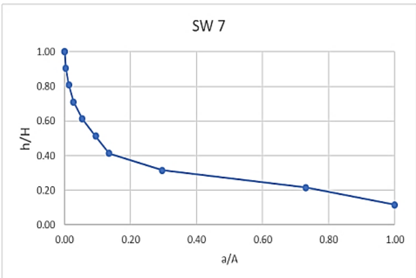

Chart -7: Hypsometric curve of SW7

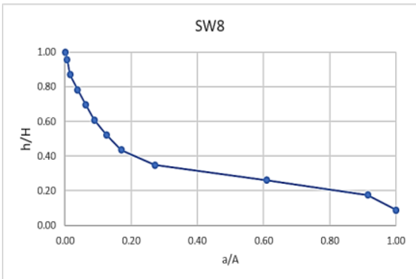

Chart -8: Hypsometric curve of SW8

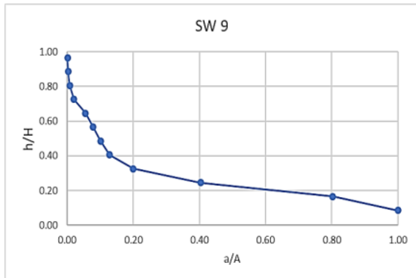

Chart -9: Hypsometric curve of SW9

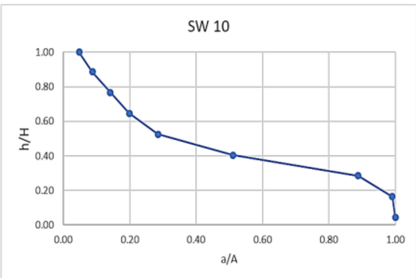

Chart -10: Hypsometric curve of SW10

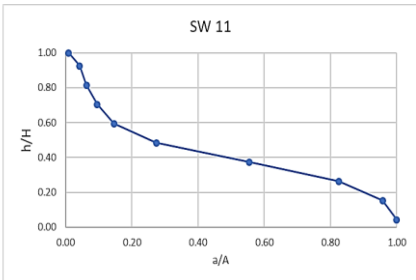

Chart -11: Hypsometric curve of SW11

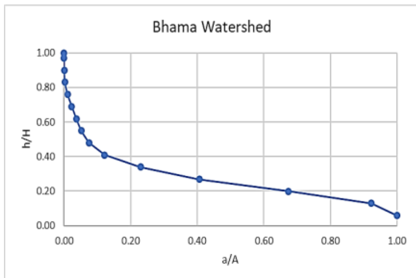

Chart -12: Hypsometric curve of Bhama Watershed

The above Hypsometric Curves Concluded that the drainage network of SW1, SW5, SW10, SW11 is in maturity stage, in SW2 and SW3 the drainage network is in young stage SW6, SW8 is in between maturity and old stage and SW4, SW7, SW9 drainage network is in old stage . the Hypsometric curve of whole Bhama watershed shows that the drainage network of watershed is in old stage this means that the soil erosion in watershed is not going to increase by means of drainage of basin.

Prioritization:-

In a watershed management programme, particularly in case of large watersheds, it may not be possible to treat the entire area of the watershed with land treatment measures. Identification and selection of few areas or sub-watersheds having relatively more degradation problem, for development planning and implementation of conservation activities according to level of need and status of degradation, are required. These few selected areas or sub-watersheds within a large watershed are called the priority watersheds.

In this process, Morphometric analysis used for prioritization of micro-watersheds by studying different linear and aerial parameters of the watershed even without the availability of soil maps. After effectively prioritization of watersheds (sub-watersheds), a sub-watershed management plan for each priority sub-watershed is prepared in order to minimize natural and human-induced hazards and to conserve valuable resources (soil, water, biodiversity and socio-cultural aspects). And finally, various integrated watershed management activities in the selected priority watershed (sub-watershed) is implemented

The various morphometric parameters such as area, perimeter, stream order, stream length, stream number, bifurcation ratio, drainage density, stream frequency, drainage texture, length of basin, form factor, circulatory ratio, elongation ratio, length of overland flow, compactness coefficient, shape factor, texture ratio is computed. The linear parameters such as drainage density, stream frequency, bifurcation ratio, drainage texture, length of overland flow have a direct relationship with erodibility. Higher the value, more is the erodibility. Hence for prioritization of sub-watersheds, the highest value of linear parameters is rated as rank 1, second highest value is rated as rank 2 and so on, and the least value is rated last in rank. Shape parameters such as elongation ratio, compactness coefficient, circularity ratio, basin shape and form factor have an inverse relationship with erodibility. Lower the value, more is the erodibility. Thus, the lowest value of shape parameters is rated as rank 1, next lower value was rated as rank 2 and so on and the highest value is rated last in rank. Hence, the ranking of the micro watersheds is determined by assigning the highest priority/rank based on highest value in case of linear parameters and lowest value in case of shape parameters.

The prioritization is carried out by assigning ranks to the individual indicators and a compound value (Cp) is calculated. Watersheds with highest Cp are of low priority while those with lowest Cp are of high priority. Thus, an index of high, medium and low priority is produced

Table 4: - Prioritization of Bhama Watershed

Parameters	SW 1		SW 2		SW 3		SW 4		SW 5		SW 6		SW 7		SW 8		SW 9		SW 10		SW 11	
Bifurcation Ratio (Rb)	6.04	4	4.15	8	3.98	11	6.47	2	5.01	5	4.14	9	4.04	10	4.48	7	6.13	3	4.62	6	7.09	1
stream frequency (Fs)	14.09	11	11.87	8	13.63	7	14.44	6	11.08	10	11.68	9	14.87	5	15.13	4	15.91	3	17.76	1	16.99	2
Drainage Texture (Dt)	17.77	10	10.20	8	11.94	7	104.82	1	7.89	11	9.74	9	12.11	6	13.96	5	24.46	2	16.97	3	16.27	4
Form Factor (Rf)	0.31	11	0.38	4	0.39	6	0.31	1	0.42	10	0.40	8	0.40	9	0.39	5	0.33	2	0.38	3	0.40	7
Circulatory Ratio (Rc)	0.22	11	0.42	1	0.52	4	7.21	10	0.54	5	0.54	7	0.54	6	0.57	8	0.43	2	0.50	3	0.68	9
Elongation Ratio (Re)	0.63	11	0.70	4	0.71	6	0.63	1	0.73	10	0.71	8	0.71	9	0.70	5	0.64	2	0.70	3	0.71	7
Compactness Coefficient (Cc)	0.0024	11	0.02	4	0.02	7	0.00	1	0.03	10	0.02	8	0.02	9	0.02	5	0.00	2	0.01	3	0.02	6
Shape Factor (Rs)	3.19		2.62		2.56		3.18		2.41		2.51		2.50		2.57		3.07		2.63		2.53	
Length of Overland Flow (Lg)	0.14	1	0.14	6	0.13	11	0.13	9	0.15	2	0.14	4	0.13	10	0.14	7	0.14	5	0.13	8	0.14	3
Drainage Density (Dd)	3.64	1	3.61	7	3.94	2	3.76	4	3.41	11	3.58	9	3.83	3	3.70	6	3.59	8	3.73	5	3.50	10
Stream Length Ratio (Lur)	4.11	1	2.18	10	2.17	11	4.82	2	2.82	8	2.38	9	3.64	4	3.29	6	3.59	5	3.09	7	4.38	3
Drainage Intensity (Di)	3.87	1	3.29	9	3.46	8	3.85	7	3.25	11	3.26	10	3.88	6	4.09	5	4.44	4	4.76	3	4.85	2
Infiltration No (If)	51.27	11	42.84	8	53.73	7	54.22	6	37.80	10	41.83	9	56.92	4	55.93	5	57.05	3	66.32	1	59.55	2
Ruggedness No (Rl)	0.79	1	0.41	11	0.53	10	1.92	5	0.74	9	1.23	8	2.00	4	2.13	3	2.24	2	1.55	7	1.59	6
Relief Ratio (Rhl)	0.01	1	0.01	1	0.02	9	0.02	1	0.0	8	0.0	5	0.0	3	0.08	2	0.03	7	0.0	6	0.0	4

				1				0	3		5		7						4		6	
Relative Relief Ratio (Rhp)	0.30	1	0.45	11	0.64	10	4.04	2	1.30	9	1.78	6	2.75	4	2.81	3	1.38	8	1.74	7	2.57	5
RHO Coefficient	0.62	1	0.59	7	0.61	5	0.60	6	0.44	11	0.76	2	0.66	4	0.66	3	0.59	8	0.51	10	0.52	9
Lamniscate (K)	3.19	11	2.62	7	2.56	5	3.18	10	2.41	1	2.51	3	2.50	2	2.57	6	3.07	9	2.63	8	2.53	4
Compound parameter (Cp)	5.94		7.3		7.41		4.9		8.3		7.2		5.8		5.00		4.4		4.9		4.94	
Ranking	7		9		10		4		11		8		6		5		1		2		3	
Final priority	**MEDIUM**		**LOW**		**LOW**		**MEDIUM**		**LOW**		**LOW**		**MEDIUM**		**MEDIUM**		**HIGH**		**HIGH**		**HIGH**	

CONCLUSION

The morphometric characteristics of different sub watersheds shows their relative characteristics with respect to hydrologic response of watershed it has been observed that the watershed's mean bifurcation ratio was LOW Mountainous Region and a LOW drainage density which very well fits the moderate soil texture, which signifies strong infiltration and minimal runoff owing to extensive forest cover. Lower peaks of longer duration with elongated watershed favor lower form factor ratio and elongation ratio which is helpful for preventing floods in downstream. The relatively low relief ratio correlates to modest erosion intensity. A modest roughness number is the result of low drainage density and relief . Low, Medium and high priority the prioritization analysis revels that the SW9, SW10, SW11 Are the zones having Lowest compound score and were considered under high priority which clearly indicates that maximum soil erosion and hence these may be taken for conservation structures firstly. Medium prioritized zone is shown for SW1, SW4, SW7, SW8. And SW2, SW3, SW5, SW6 these watersheds have low compound score so assigned Low Priority for this compound score

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