International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 9, September 2017, pp. 271–278, Article ID: IJCIET_08_09_031
Available online at http://http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=8&IType=9
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

© **IAEME** Publication **Scopus** Indexed

A STUDY ON MORPHOMETRIC PARAMETER OF A WATERSHED FOR SUSTAINABLE WATER CONSERVATION

B N Suma, C V Srinivasa
Global Academy of Technology, Bangalore, Karnataka, India

ABSTRACT

Doddaballapur district comprises of about 12micro watershed which contains several mini watershed .The study area includes Bashettihalli mini watershed 77°33'0''E to 77°35'0''E latitude and 13°14'30''N to 13°17'30''N longitude. The study involves the morphological analysis, which includes the various methods of exploring the mathematical relationships between various stream attributes. There is a scarcity of waterin the study area hence in order to overcome the problem a detailed analysis of catchment characteristics is being presented in the paper. Hence for the study high resolution IRS LISS III image is used and its processed in Erdas imagine software for planning of watershed development. Different Morphometric analysis provides the explanation of physical characteristics of the watershed which are useful for the areas of land use planning, soil conservation, terrain elevation and soil erosion.

Key words: Remote sensing, GIS, Morphometry, conservation, watershed development.

Cite this Article: B N Suma, C V Srinivasa, A Study on Morphometric Parameter of a Watershed for Sustainable Water Conservation. *International Journal of Civil Engineering and Technology*, 8(9), 2017, pp. 271–278.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=9

1. INTRODUCTION

Quantification of the available water in a catchment is necessary for sustainable utilization of water resources. Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape, dimension of its landforms .The Morphometric analysis consists of linear, Aerial and relief aspects Morphometric parameters is of immense utility in quantitative analysis of river basin evaluation, watershed prioritization for soil and water conservation, and natural resources management at micro level.(P T Aravinda et.al.,)

Hence the study of the Remote sensing and GIS based drainage basin evaluation has been carried out for different basins for generation of precise and updated information for characterization of drainage basin parameters by this scientific tool. Using topographical maps or field surveys drainage morphometric parameters were extracted, from digital

topographical information which is called as digital elevation models (DEM), is more fast, precise, updated and inexpressive way of analysis of watershed (Prafull Singh *, et.al.)

The present study deals mainly with the geometry, more emphasis being placed on the evaluation of morphometric parameters such as stream order (Nu), stream length (Lu), bifurcation ratio (Rb), drainage density (D), stream frequency (Fs), texture ratio (T), elongation ratio (Re), circularity ratio (Rc),and form factor ratio (Rf) etc.

2. STUDY AREA

The study area consists of the Pennar river basin is one of the major North East Flowing rivers in Southern India. The catchment comprises of an area of about 9-10sq.km and is covered in the survey of India (SOI) toposheet numbers 57 G/7 and 57 G/11 on the scale 1:50,000. Topographical maps were rectified/referenced geographically and entire study area was delineated in GIS environment with the help of Arc-GIS 9.3 software.

The study area comprises of granite which occur as intrusive in the gneissic complex and vary in color, structure and texture. Doddaballapura receives scanty rainfall compared to other catchment areas in Karnataka. This is one of the reasons for water scarcity in the town as well as in villages surrounding Doddaballapura. Most of the underground water is often depleted due to low rainfall.

The soils in the watershed exhibits one of the oldest soils in the world as seen from organic carbon dating and also the Archean rocks. The soils in the watershed are deep red loams. They are derived from igneous rocks, principally granitic gneisses. The soils represent the running slopes, plains and undulating uplands with gently lowlands. The red soils are characterized by the light texture of sandy clay loam and clay loam, weak granular structure, porous, sticky and plastic, non-gravelly and subsoil with argillaceous clay.

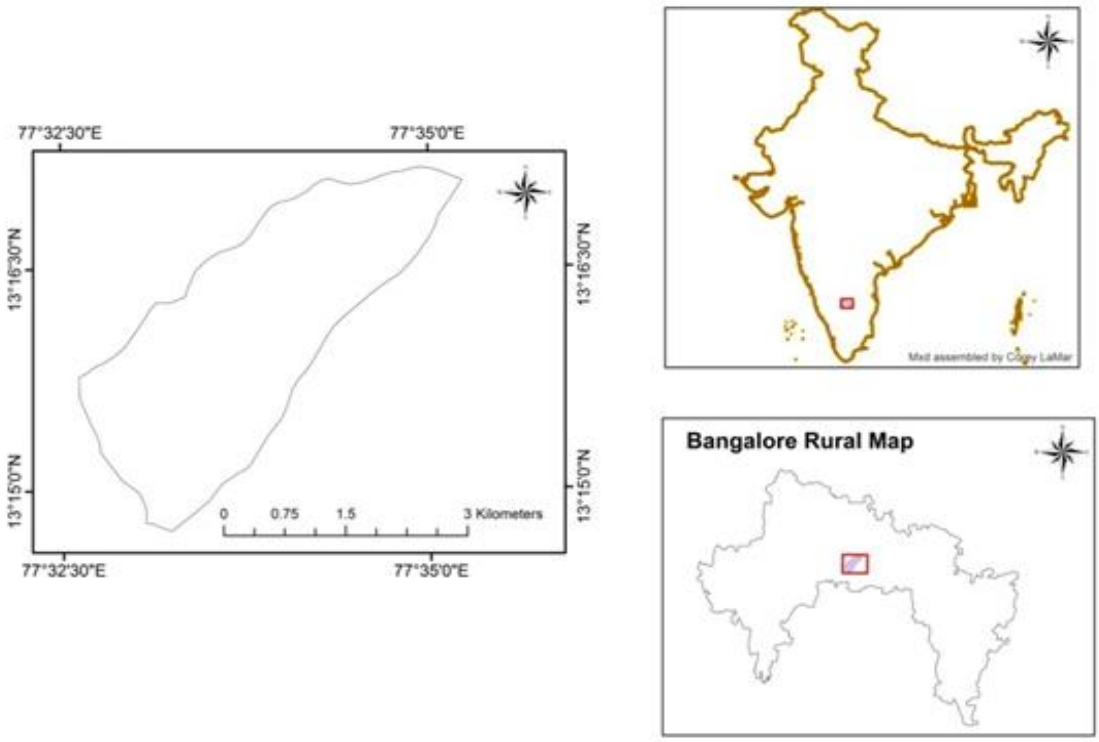

Figure 1

In this study, high resolution IRS LISS III image is used for planning of watershed development. Satellite images are one of the most powerful and important tools, it is an image of the whole or part of the earth taken using artificial satellites. Using Arc-GIS 9.3 software entire area was delineated, Arc-GIS is a geographic information system (GIS) for working with maps and geographic information. Erdas imagine 9.1 software was also used for the study area, Erdas imagine is an image processing software package that allows users to process both geospatial and other imagery as well as vector data. The study area map is as shown below Fig 1

3. METHODOLOGY

The morphometric characteristics at the watershed scale may contain important information regarding its formation and development. Because all hydrologic and geomorphic processes occur within the watershed. Morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect of the characterization of watersheds. Remote sensing and GIS techniques are used for assessing various terrains, morphometric parameters of drainage basins and watersheds, as they provide a flexible environment and a powerful tool for the manipulation and analysis of spatial information

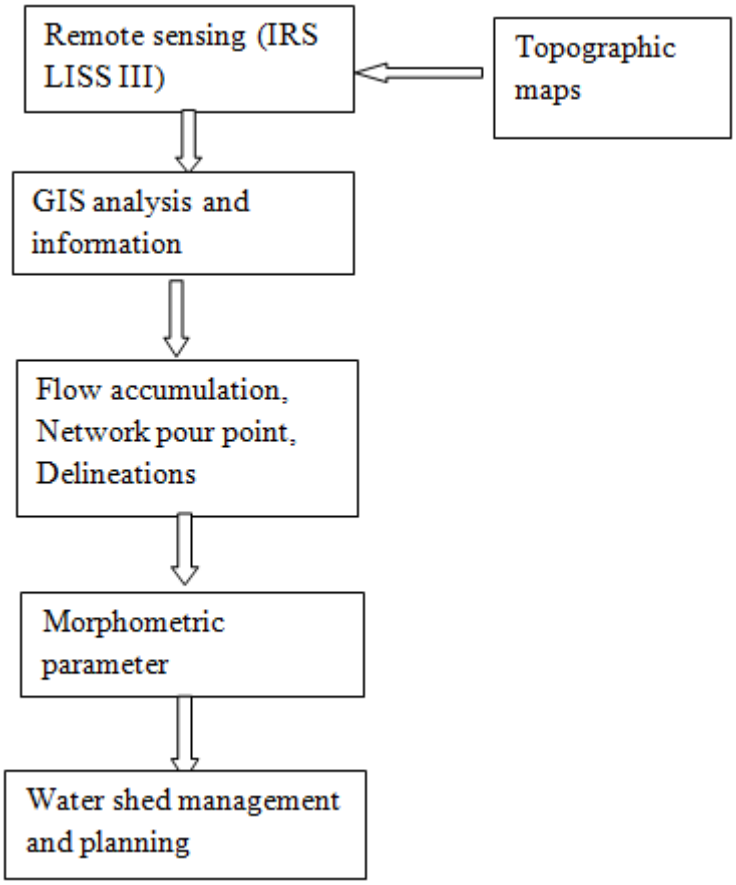

Figure 2

4. RESULT AND DISCUSSION

For morphometric analysis the drainage map from SOI on 1:50000 is used. The morphometric analysis was divided into 3 types as linear aspects, areal aspects and relief aspects.

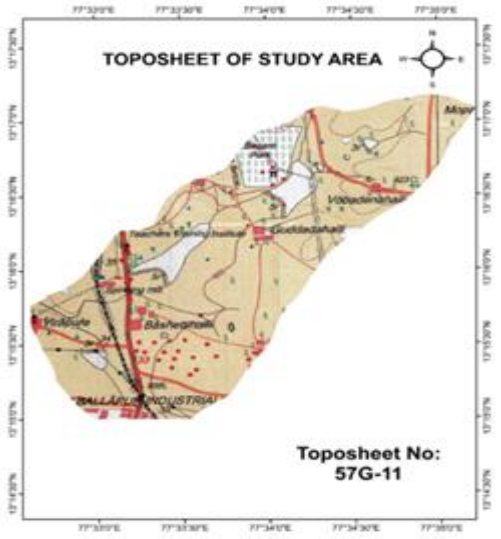

Figure 3

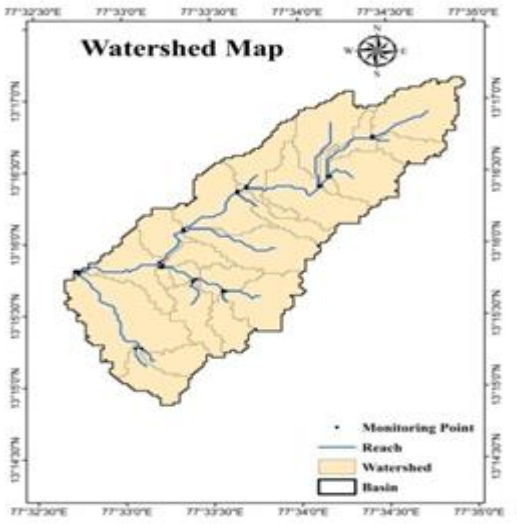

Figure 4

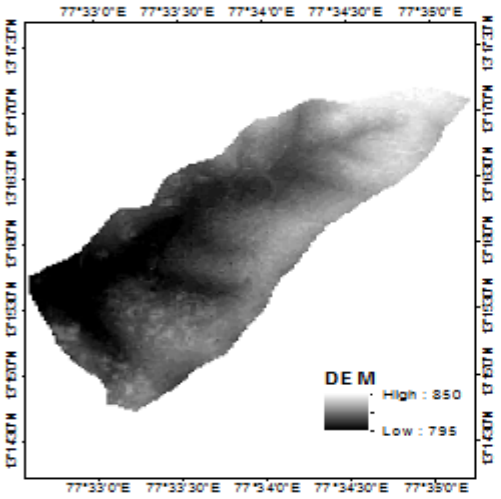

Figure 5

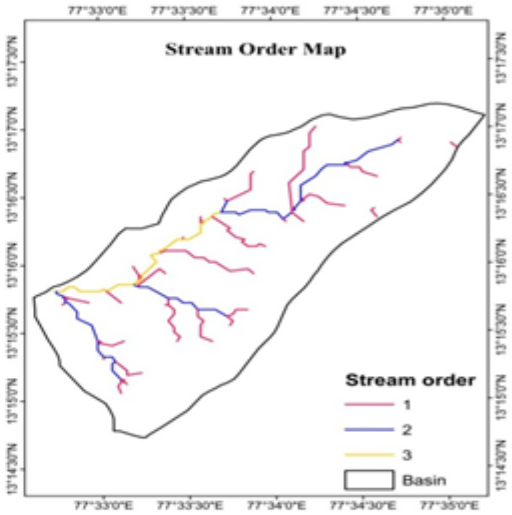

Figure 6

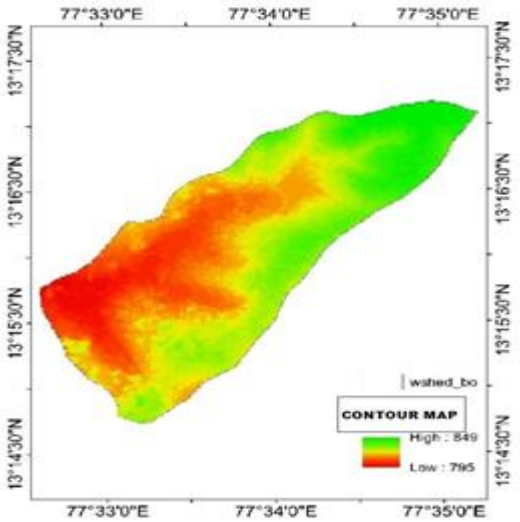

Figure 7

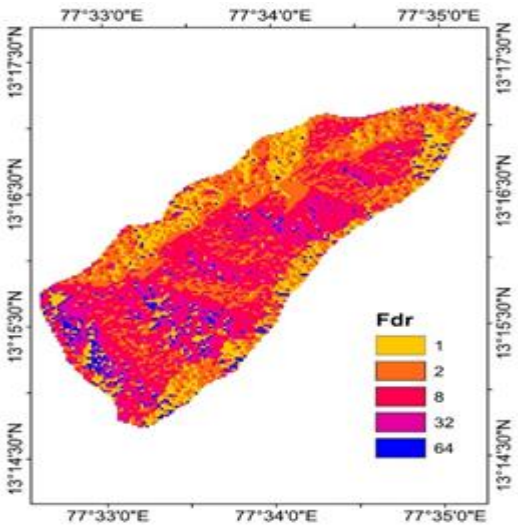

Figure 8

4.1. Stream Order

The concept of stream order is used to calculate other indicators of drainage character of a watershed.

Table 1 Shows the stream order assigned to watershed for the morphometric analysis.

Stream order	Number of streams	Total length of streams(meter)	Cumulative length(meter)	Mean stream length(meter)	Bifurcation ratio	Length ratio	Drainage density
1	51	9522.84	9522.84	186.72			
2	25	5511.68	15034.52	220.47	2.04	1.181	0.0019495821
3	17	2637.64	17672.16	155.16	1.471	0.703757719	
	93	17672.16			1.755	0.942239288	

Table 2 Different Morphometric parameters of Doddaballapura watershed

Sl no	Watershed Parameters	Units	Values
1	Watershed Area	Sq.m	9064587.205
2	Perimeter of the Watershed	M	14034.8
3	Watershed Stream Highest Order		3
4	Cumulative Stream segment		93
5	Cumulative stream length	M	17672.157
6	Length of overland flow	M	256.4652183
7	Drainage density	m/Sq.m	0.001949582
8	Constant of channel maintenance	Sq.m/m	512.9304366
9	Stream frequency	No/Sq.m	1.02597E-05
10	Bifurcation ratio		1.755294118
11	Length ratio		0.942239288
12	Circularity ratio		0.5783
13	Elongation ratio		0.76
14	Compactness coefficient		0.001548311
15	Total watershed relief	M	55
16	Relative Relief		0.06
17	Ruggedness number		28.211
18	Form Factor		0.5093

4.2. Bifurcation Ratio

The bifurcation ratio is a dimensionless property. Its values range between 3 and 5. Bifurcation ratio of streams is1.755294118indicate stream behaviour within the watershed. High value of bifurcation ratio of the catchment indicates elongated basin with low form factor indicates flow with longer duration.

4.3. Stream Length

The Length of the stream is an indication of the contributing area of the watershed. The length of the stream is an indication of the steepness of the drainage basin as well as the degree of drainage. Cumulative stream length of all steam segments of all stream orders, mean stream length for the basinare 17672.157 m.It is noticeable that total length of stream segments is maximum in first order stream and decreases as stream order increases. This change in stream

may indicate flowing of streams from moderate to steep slopes, low runoff and medium infiltration Fig 8 shows that there is a linear relationship between mean stream length and stream order. Table 2 shows the different morphometric parameters estimated for the entire watershed.

4.4. Stream Length Ratio

Horton (1945) postulated that, the length ratio tends to be constant throughout the successive order is 0.942239288.

4.5. Length of Overland Flow

The Length of overland flow is the average length of flow of water over the surface before it becomes concentrated in definite stream or channel and is calculated as 256.4652183mhence flow paths is associated with medium infiltration and average runoff.

4.6. Drainage Pattern

The drainage pattern for the present study area is Dendritic. The drainage pattern shows well integrated pattern formed by a main stream with its tributaries branching and re-branching freely in all direction and occurs on relatively homogeneous material such as granitic terrain. The Dendritic pattern of drainage indicates that the soil is semi pervious in nature.

4.7. Elongation Ratio

The study area has elongation ratio of 0.7 .Strahler states the ratio (0.6-1) over a wide variety of climatic and geologic types. Values of 1 are found in typical regions of low relief, while values from 0.6-0.8 are generally associated with strong relief and steep ground slopes. The Table 3 shows the watershed shapes ratio and its interface.

Table 3 Watershed shape ratio

WATERSHED	SHAPE RATIO
Circular	0.9
Oval	0.8-0.9
Less elongated	0.7-0.8
Elongated	0.5-0.7
More elongated	0.5

4.8. Drainage Density

The drainage density 0.001949 km/Sq.km. for the study area and hence it can infer that the area is very coarser watershed. The drainage density obtained for the study area is low indicating that the area has highly resistant or highly permeable sub-soil material and also it can infer that the area is very coarser watershed. D d values for the sub -basins are below 3 which indicate that the fissured and jointed rock strata are relatively permeable, a characteristic feature of coarse drainage

Table 4 Watershed texture based on drainage density

DRAINAGE DENSITY(km/Sq.km)	TEXTURES
<1.24	Very coarse
1.24-2.49	Coarse
2.49-3.73	Moderate
3.73-4.97	Fine
>4.97	Very fine

4.9. Constant of Channel Maintenance

The 'C' value of the study area is 0.00051293 Sq. Km/Km. It not only depends on rock type permeability, climatic regime, vegetation, relief but also as the duration of erosion and climatic history. The constant is extremely low in areas of close dissection.

4.10. Stream Frequency

Table 2 shows the stream frequency for No. of streams/Sq.km and the inference can be drawn for the study area. The study area has low stream frequency as its value is in the range of 1.02m/sq.km indicates high permeability rate of subsurface formation

Table 5 Stream frequency pattern based on number of streams / Sq.km

Stream frequency	Number of streams/Sq.km
Low	0-5
Moderate	5-10
Moderate high	10-15
High	15-20
Very high	20-25

4.11. Basin Relief

The difference in elevation between the remotest point and discharge point is obtained from the available contour map. The highest relief is formed at the western tip of the watershed where an elevation of 849m above mean sea level. The lowest relief was obtained at an elevation of 795 m above mean sea level. The overall relief calculated for the watershed was 0.055km.

4.12. Relief Ratio

Relief ratio is defined as the total watershed relief to the maximum length of the basin. The relief ratio for the watershed is obtained as 0.055km.

4.13. Relative Relief

Relative relief is defined as the ratio of the maximum watershed relief to the perimeter of the watershed. It is calculated as0.06

4.14. Ruggedness Number

Strahler (1958) defined ruggedness number is the product of the basin-relief and drainage density and usually combines slope steepness with its length. High values of the Ruggedness number in the watershed are because both the variables like relief and drainage density are enlarged. Ruggedness number is calculated as 28.11.

5. CONCLUSIONS

From the above discussion, it is concluded that the catchment area has good drainage characteristics for conservation of water. Hence suitable water conservation practice can be adopted in the basin. It is useful for natural water resource management for sustainable water shed development programme.

REFERENCES

[1] P T Aravinda1, H B Balakrishna2 (2013)'' Morphometric analysis of vrisha bhavathi watershed using remote sensing and gis"ijret: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308

[2] Prafull Singh, et.al(2014).,"Hydrological inferences from watershed analysis for water resource management using remotesensing and GIS techniques'' The Egyptian Journal of Remote Sensing and Space Sciences (2014) 17, 111–121

[3] Aparna Pa*, et.al.(2015),Quantitative Analysis of Geomorphology and Flow Pattern Analysis of Muvattupuzha River Basin Using Geographic Information System" 2214-241X © 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license Aquatic Procedia 4 (2015) 609 – 616

[4] M.L.Waikar1 and Aditya P. Nilawar2(2014) "Morphometric Analysis of a Drainage Basin Using Geographical Information System: A Case study**"** *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e- ISSN: 2278-1684, p-ISSN : 2320–334X PP 71-77*

[5] B. Ramyaa Sree and SS. Asadi A Remote Sensing and G IS Based Critical Evaluation of Change Detection Study in Thimmaipally Watershed for Land Resources Management, International Journal of Civil Engineering and Technology , 8(4), 2017, pp. 2110-2124.

[6] Thanappan Subash, Kushnappa B.K, Dhanasekaran A and Afiya A , Changes on Physio - Chemical Properties of Soil in Agricultural Land in Ambo-Guder Watershed, Ambo, Ethiopia – A Case Study . International Journal of Civil Engineering and Technology , 8(5), 2017, pp. 667–675.