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MORPHOMETRIC ANALYSIS OF BETTAHALASURU USING GIS AND REMOTE SENSING

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Abstract:

Remote sensing and Geographic Information System (GIS) techniques are being efficiently used in recent times as a tool in determining the quantitative description of basin geometry i.e., morphometric analysis. The morphometric parameters are computed using Arc GIS software. Hence, in the present study an attempt has been made to understand the hydrological process of the command area at the watershed level by drawing the inferences from morphometric analysis. The study area chosen for the present study is Bettahalasuru command area situated in Bangalore North lies geographically between13°10'8"N and 13°9'12"N latitude and 77°35'58"E and 77°37'35"E longitude and toposheet No:57 G/12. It covers an area of 3.8 Sqkm and perimeter of 7.89km. The inferences shows that the study area is coarse textured, with low stream frequency along with the elongated nature.

Key Words: Morphometric Analysis, Watershed, Bettahalasuru, Remote Sensing and GIS & Stream Frequency.

1. Introduction:

Watershed management is the process of formulating and carrying out a course of action involving manipulation of the natural system of watershed to achieve specified objectives. It implies the proper use of all land and water resources of a watershed for optimum production with minimum hazard to natural resources. Remote sensing and GIS techniques have emerged as powerful tools for watershed management programs.

Morphometry is the measurement and mathematical analysis of the configuration of the earth surface, shape and dimensions of its landforms (Clarke, 1966). The term morphometry is derived from the Greek word, where "morpho" means earth and "metry" means measurement, so together it is the measurement of earth features. Morphometric analysis provides quantitative description of the basin geometry to understand initial slope or inequalities in the rock hardness, structural controls, geological and geomorphic history of drainage basin (Strahler, 1964).

The quantitative morphometric analysis of the drainage basin is considered to be the most satisfactory method because it enables us:

- ✓ To understand the relationship between different aspects of the drainage pattern of the same drainage basin;
- ✓ For comparative evaluation of different drainage basins developed in various geologic and climatic regimes and
- ✓ To define certain useful parameters of drainage basins in numerical terms.

2. Objectives:

- ✓ To protect and enhance the water resource originating in the watershed.
- ✓ Morphometric analysis to express the characteristics in terms of numbers and ratios to enable easy comparison and analysis of catchment at watershed level.
- ✓ To prepare different thematic maps using SOI topomaps and remotely sensed data.

3. Scope of the Study:

- ✓ RS and GIS are being used as tools for planning and management of available natural resources within the watershed. Hence, in the present study an attempt has been made to use RS and GIS to estimate morphometry of the watershed.
- ✓ Morphometric analysis provides the physical characteristics of the watershed and also helps in derivation of parameters and ratios within the catchment.

4. Methodology:

- ✓ Collection of data.
- ✓ Preparation of different thematic maps.
- ✓ Morphometric analysis by using different morphometric parameters.

Collection of Data:

- ✓ Survey Of India (Soi) Topomap No. 57 G/12, On 1:50,000 Scale
- ✓ Indian Remote Sensing (Irs-1d, Liss Iii) Satellite in the form of FCC

Preparation of Different Thematic Maps:

In order to know the different natural resources, terrain conditions, etc. in the study area, different thematic maps are prepared.

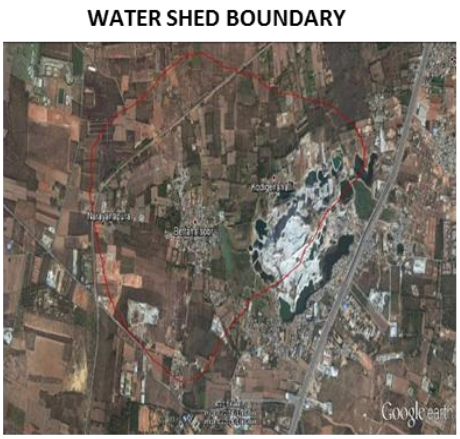

Figure 1: Watershed boundary

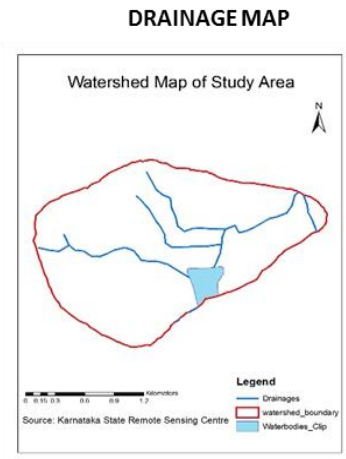

Figure 2: Drainage map

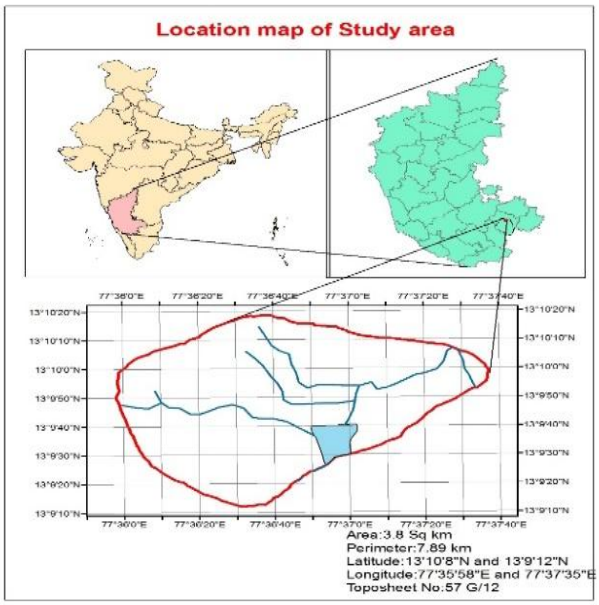

Figure 3: Location map

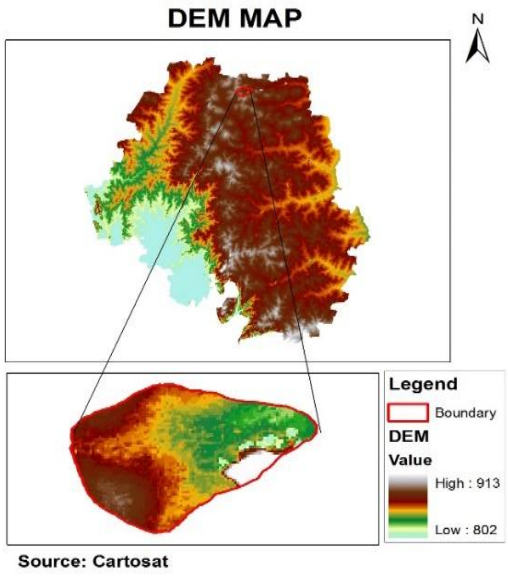

Figure 4: Dem map

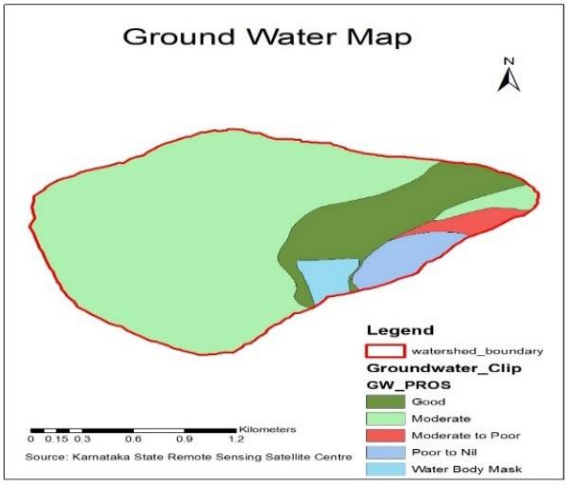

Figure 5: Ground water map

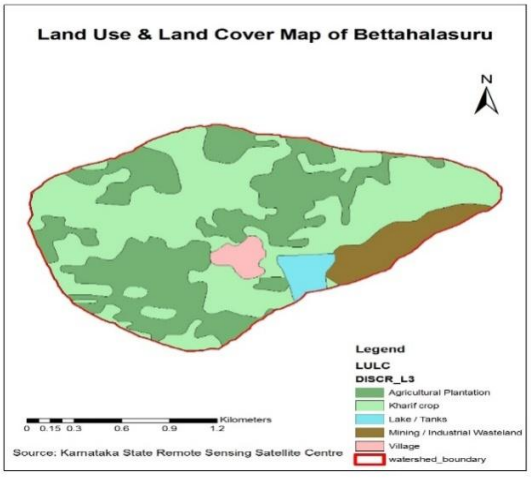

Figure 6: Land use & land cover map

Morphometric Analysis: Morphometric analysis of Bettahalasuru command area at the watershed level was carried out using GIS which is a suitable tool to study the morphological analysis. The entire catchment was

based on topography and drainage pattern. In that we have considered 1 watershed. The analysis was carried out through measurement of linear, aerial and relief aspects of watershed. The morphometric parameters were useful in understanding the hydrological processes of the drainage basin. Table 1.1 shows the formulae for various morphometric parameters.

Table 1: Formulae for various morphometric parameters

S.No	Morphometric Parameters	Formula
1	Stream order	Hierarchial rank
2	Stream length (Lu)	Length of the stream
3	Mean stream length	Lsm = Lu / Nu
4	Stream length ratio	RL = Lu / Lu – 1
5	Bifurcation ratio	Rb = Nu / Nu + 1
6	Mean bifurcation ratio	Rbm = Average of bifurcation ratios of all orders
7	Relief ratio	Rh = H / Lb
8	Drainage density	D = Lu / A
9	Stream frequency	Fs = Nu / A
10	Form factor	Rf = A / Lb
11	Circularity ratio	$Rc = (4 * Pi * A)^{1/2} / P^2$
12	Elongation ratio	Re = 2 (A/Pi)½ / Lb

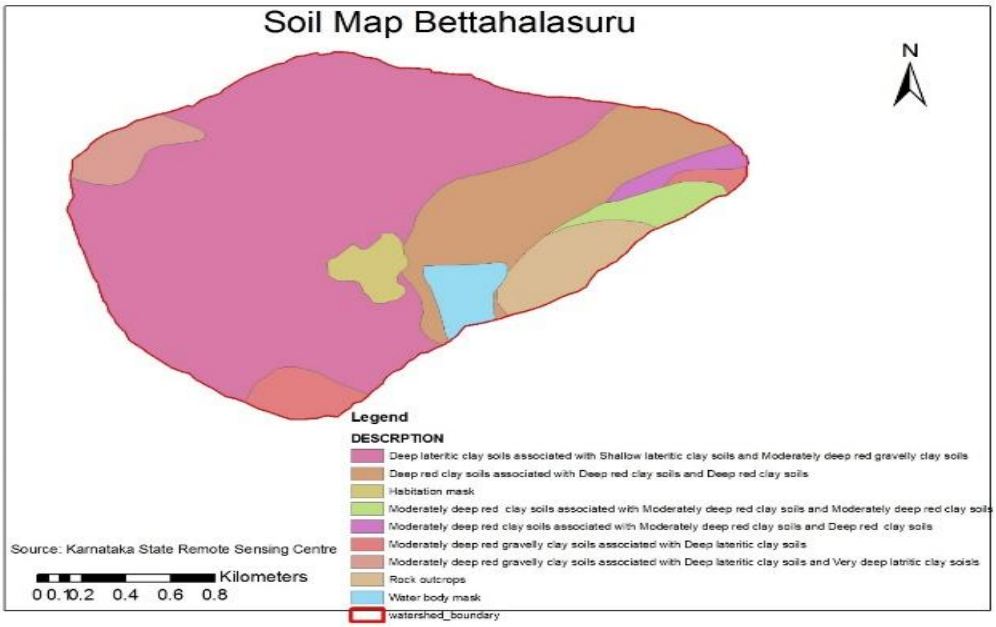

Figure 7: Soil map of Bettahalasuru

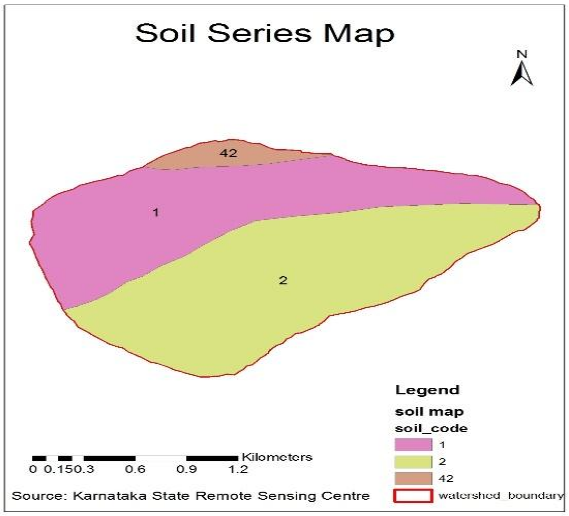

Figure 8: Soil series map of Bettahalasuru

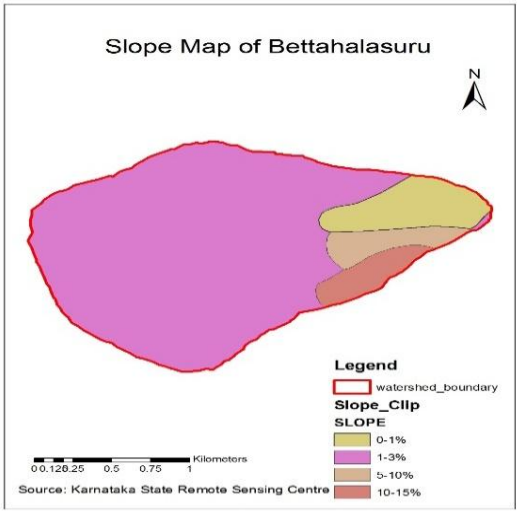

Figure 9: Slope map of Bettahalasuru

5. Results and Discussions:

Utilization of the Arc GIS software, along with some other associated extensions, has resulted in delineating watershed in Bettahalasuru Command Area (Fig 2). In the present study, the morphometric analysis has been carried out about parameters as stream order, stream length, bifurcation ratio, stream length ratio, basin length, drainage density, stream frequency, elongation ratio, circularity ratio, form factor, basin relief, relief ratio, channel gradient using mathematical formulae as given in Table 1. Morphometric characteristics and results of its parameters of watershed are summarized in Table 2 and Table 3.

Table 2: Morphometric characteristics of Bettahalasuru command area

Watershed	Area (Sq.km)	Perimeter (km)	Highest stream order	Stream Order		Stream Length (Km)	
				1	2	1	2
1	3.80	7.89	8	5	3	3.887	1.84

Table 3: Results of Morphometric parameters of Bettahalasuru command area

S.No	Watershed Parameters	Units	Watershed
1	Watershed area	km^2	3.80
2	Perimeter of the watershed	Km	7.89
3	Maximum length of the watershed	Km	3.325
4	Maximum width of the watershed	Km	2.723
5	Watershed highest stream order	No.	2
6	Cumulative stream segments	No.	8
7	Cumulative stream length	km	5.727
8	Length of overland flow	km	0.33
9	Drainage density	km/km^2	1.51
10	Constant of channel maintenance	km^2/km	0.66
11	Stream frequency	No/ km^2	1.58
12	Bifurcation ratio		1.67
13	Length ratio		0.79
14	Form factor		0.34
15	Shape factor		2.91
16	Circularity ratio		0.77
17	Elongation ratio		0.37
18	Compactness coefficient		1.14
19	Total watershed relief	km	0.111
20	Relief ratio		0.033
21	Relative relief		0.014
22	Ruggedness number		0.002

In order to check for the linearity, graph of stream order verses number of stream segments were plotted as shown in the Figures 10.

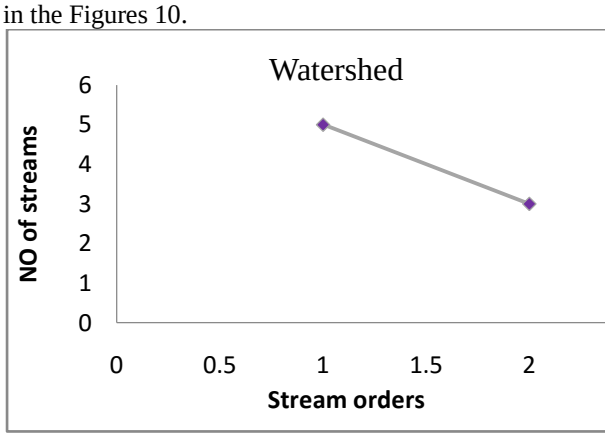

Figure 10: Regression of stream order on number of streams of watershed

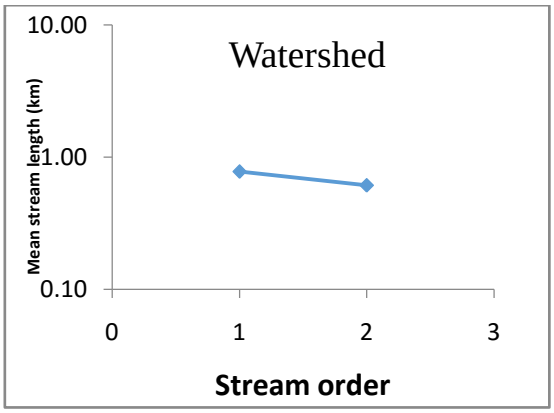

Figure 11: Regression of stream order on mean streams of watershed

Figsure11 shows the relationship between stream order and mean stream length as proposed by the Strahler's system of stream ordering. Generally it is observed that the mean stream length of any given order is greater than that of the lower order but less than that of the next higher order. But from this graphs it is seen that there is a variation in general observation. This deviation might be due to change in topographic elevation and structural disturbances like folds and joints.

6. Conclusion:

In the present study Bettahalasuru command area is often selected as a unit of morphometric investigation because of its topographic and hydrological unity. GIS software have resulted to be of immense utility in the quantitative analysis of the geo-morphometric aspects of the drainage basins. The study reveals that GIS based approach in evaluation of drainage morphometric parameters at river basin level is more appropriate than the conventional methods. The stream length has been computed based on the Horton's law for the watershed obtained parameters are as follows.

- ✓ In the present case the values of R_b is 1.67(in between 1- 5) for the watershed and hence suffered slight structural disturbances.
- ✓ The drainage density of the area varies from 1.24 to 2.49 km/km^2 indicating that the area is coarse texture.
- ✓ Stream frequency value for the watershed varies from 0-5 this indicates that the stream frequency is low.
- ✓ The circularity ratio varies is 0.77 for the watershed, which indicates the nature of topography.
- ✓ The elongation ratio ranges is 0.37 which indicates that the watershed is more elongated.
- ✓ The values of relief vary from 1.263 km to 1.006 km indicates that the watershed has enough slope for the runoff to occur from the remote point of the watershed to mouth.
- ✓ The relative relief ratios are ranging from 0.008 to 0.012. The high relative relief indicates that it is composed of resistant rock patches and low relief ratio indicates less resistant patch of rock.

7. References:

1. Nageswara rao. K, Swarna latha.p,et.al (2010): Morphometric Analysis of Gostani River Basin in Andhra Pradesh State, India Using Spatial Information Technology.
2. Jai m.paul and m. inayathulla(sep-oct 2012):Morphometric Analysis and Prioritization of Hebbal Valley in Bangalore.
3. Improving watershed management in developing countries: a framework for prioritising sites and practices Carlos Perez and Henry Tschinkel.
4. Rafiq Ahmad Hajam et al, (2013), Application of Morphometric Analysis for Geo-Hydrological Studies Using Geo-Spatial Technology –A Case Study of Vishav Drainage Basin.
5. Ajoy Das, Milan Mondal, Bhaskar Das, Asim Ratan Ghosh,(2012), Analysis of drainage morphometry and watershed prioritization.
6. Koshak.N, Dawod.G,(2011), A GIS morphometric analysis of hydrological catchments within Makkah Metropolitan area, Saudi Arabia.
7. Mesa LM (2006) Morphometric analysis of a subtropical Andean basin (Tucumam, Argentina). Environmental Geology 50: 1235-1242.
8. Obi Reddy GP, Maji AK, Gajbhiye KS (2002) GIS for morphometric analysis of drainage basins. Geological Survey of India 11: 9-14.
9. Pareta K, Pareta U (2011) Quantitative Morphometric Analysis of a Watershed of Yamuna Basin, India using ASTER (DEM) Data and GIS. International Journal of Geomatics and Geosciences 2: 251-265.
10. Rafiq Ahmad Hajam, Aadil Hamid and Sami Ullah Bhat-A Case Study of Vishav Drainage Basin.
11. Agarwal, C.S. (1998) Study of drainage pattern through aerial data in Nahagarh area of varansi district, U.P. Jour. Indian Soc. Remote Sensing, v.26(4), pp.169–175.CrossRefGoogle Scholar
12. Das, A.K. and Mukhrjee, S. (2005) Drainage morphometry using satellite data and GIS in Raigad district, Maharashtra. Jour. Geol. Soc. India, v.65, pp.577–586.Google Scholar
13. Gangalakunta, P., Et Al. (2004) Drainage morphometry and its influence on landform characteristics in a basaltic terrain, Central India–a remote sensing and GIS apparoach. Internat. Jour. Appl. Earth and Geoinformation, v.6, pp.1–16.CrossRefGoogle Scholar
14. Horton, R.E. (1932) Drainage basin characteristics. Trans. Amer. Geophys. Union, v.13, pp.350–360.CrossRefGoogle Scholar
15. Horton, R.E. (1945) Erosional development of stream and their drainage basin. Hydrogeological approach to quantitative morphology. Bull. Geol. Soc. Amer., v.56, pp.275–370.CrossRefGoogle Scholar
16. Langbein, W.B. (1947) Topographic characteristic of Drainage Basin. U.S. Geol. Surv.Water-Supply Paper 986 (C) pp.157–159.
17. Rudraiah M, Govindaiah S, Srinivas Vittala S. Morphometry using Remote Sensing and GIS Techniques in the Sub-Basins of Kagna River Basin, Gulburga District, Karnataka. India J Indian Soc Remote Sens. 2008; 36:351–60. Crossref.
18. Mayilvaganan MK, Mohana P, Naidu KB. Delineating groundwater potential zones in urinjapuram watershed using geospatial techniques. Indian Journal of Science and Technology. 2011 Nov; 4(11):1470–76.

19. Sen Gupta D, Dwivedi L, Tripathi SK, Ghosh P, Awasthi A. Groundwater potential mapping of Sihu river watershed area of Mahoba district, U.P. using remote sensing and GIS. International Journal of Applied Research. 2015; 1(10):241–48.
20. Morphometric Analysis using Remote Sensing and GIS Techniques in the Bagain River Basin, Bundelkhand Region, India (PDF Download Available). Available from: https://www.researchgate.net/publication/316245223_Morphometric_Analysis_using_Remote_Sensing_and_GIS_Techniques_in_the_Bagain_River_Basin_Bundelkhand_Region_India [accessed Dec 08 2017].