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# Comparative Assessment Of Morphometric Parameters Using RS And GIS Techniques – A Case Study Of Mavinahole Watershed, Davanagere District

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***Abstract*—Analysis of drainage basin is at present being made mainly quantitatively. Also, the quantitative morphometric analysis, Earlier it has been well attempted by various Geomorphologist, like Horton. Quantitative studies have been carried out to correlate the geomorphic parameters with runoff and other hydrological characters. Remote sensing out plays conventional studies in various aspects of the earth because of its capability of giving more accurate, efficient timely data, in order to understand the dynamics of a watershed. An attempt has been made in this work to study drainage basin characteristics of Channagiri watersheds using IRS LISS III data. The linear, aerial aspects of the above basins are analyzed. The drainage basin characteristics are then compared with one another and with other climatic parameters.**

***Index Terms*— ASTER DEM Image, IRS LISS III Image, ArcView 3.2a, AutoCAD map 2000, ERDAS imagine 9.2, Linear Parameters, Relief Parameters.**

## I. INTRODUCTION

Morphometry is the measurement and mathematical analysis of the configuration of the Earth's surface, shape and dimensions of its landforms, this analysis can be achieved through measurement of linear, aerial and relief parameters of basin and slope contribution, surface tool is an extension in Arc View which can be used to find out the characterization of a polyline when elevation data set is available. Here, we present a geographic information system (GIS) based method of extracting stream power from a digital elevation model (DEM) intended to be a significant component of initial geomorphic and hydraulic assessment of stream channels. This method is physically based and objective and can be performed for any basin for which a reliable DEM exists, regardless of basin size or availability of other data. A crucial element of the analysis is extraction of actual channel gradient from the DEM using GIS - based tools.

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## II. Study Area

The study area, Mavinaholle watershed falls under Krishna River basin, Mavinaholle watershed is situated in Channagiri Taluk of Davanagere district and lies between longitude $75^0$ $83^1$ to $75^0$ $99^1$E, latitude $13^0$ $85^1$ to $14^0$ $13^1$N. The total geographical area of the watershed is 133.98 sq. Kms, Fig.1 represents the Rainfall data of the Davanagere district.

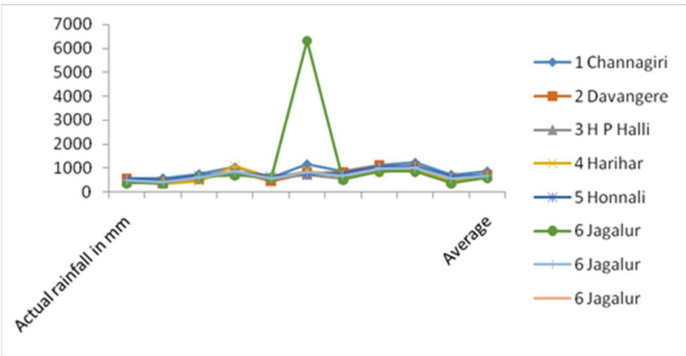



Figure 1. Graph shows the rainfall data

## III. Materials And Methadology

*Materials*

- Survey of India topographic (SOI) map NO 48 N/16 and 48 O/13 of 1: 50.000 scale.
- Satellite Images like ETM+LANDSAT, IRS LISS-3
- ASTER DEM images of 30m resolution
- In arc view software surface tools are used for analysis

*Software Used*

- ArcView 3.2a
- Arc map 9.2
- ERDAS imagine 9.2
- AutoCAD map 2000

*Surface Tool Parameters*

Surface tool is an extension in Arc View which can be used to find out the characterization of a polyline when elevation data set is available.

- ID
- Surface Length
- Flat Length
- Length Ratio
- Min. Slope
- Max. Slope
- Avg. Slope
- Start Elevation
- End Elevation
- Low Point Elevation
- High Point Elevation
- Average Elevation
- Absolute Elevation Change

## IV. Results of ArcVview3.2a

Streams digitized from SOI toposheet overlaid on ASTER DEM. Total numbers of streams present in drainage streams are 349 numbers. Using Surface Tool extension linear and relief parameters obtained. The

TABLE.I. FORMULAE USED FOR COMPUTATION OF MORPHOMETRIC PARAMETERS

| Morphometric Parameters | Formula | Reference |
|---|---|---|
| Stream Order | Hierarchical rank | Strahler (1964) |
| Stream Length (Lu) | Length of the stream | Horton (1945) |
| Mean Stream Length (Lsm) | Lsm = Lu/Nu Stream Length Ratio (RL) Where, Lsm = Mean Stream Length Lu = Total stream length of order 'u' Nu= Total no. of stream segments of order 'u' | Strahler (1964) |
| Stream Length Ratio (RL) | RL= Lu/Lu- 1 Where, RL = Stream Length Ratio Lu = The total stream length of order 'u' Lu-l= The total stream length of its next lower order | Horton (1945) |
| Bifurcation Ratio (Rb) | Rb = Nu/Nu+ 1 Where, Rb = Bifurcation Ratio Nu = Total no. of stream segments of order 'u' Nu+l= Number of segments of the next higher order | Schumn(1956) |
| Mean bifurcation ratio ($Rb_m$) | Rbm = Average of bifurcation ratios of all orders | Strahler (1957) |
| Relief Ratio (Rh) | Rh = H/Lb Where, Rh=Relief Ratio H=Total relief (Relative relief) of the basin in Kilometer Lb= Basin length | Schumn(1956) |
| Drainage Density (D) | D-Lu/A Where, D=Drainage Density Lu=Total stream length of all orders A= Area of the Basin (km 2) | Horton (1932) |
| Stream Frequency (Fs) | Fs=Mu/A Where, Fs=Stream Frequency Nu=Total no. of streams of all orders A= Area of the Basin (km 2) | Horton (1932) |
| Drainage Texture (Rt) | Rt=Nu/P Where, Rt = Drainage Texture Nu=Total no. of streams of all orders P=Perimeter (km) | Horton (1945) |
| Form Factor (CRt) | $Rg=A/Lb^2$ Where, Rf=Form Factor A=Area of the Basin (km 2) Lb2=Square of Basin length | Horton (1932) |
| Circularity Ratio (Re) | Re=4*Pi*A/p2 Where, Re=Circularity Ratio Pi='Pi' value i.e. 3.14 A=Area of the Basin (km 2) P = Perimeter (km) | Miller (1953) |
| Elongation Ratio (Re) | Re=2v (A/Pi/Lb) Where, Re=Elongation Ratio A=Area of the Basin ($km^2$) Pi='Pi' value i.e. 3.14 Lb=Basin length | Schumn (1956) |
| Length of overland flow (Lg) | Lg=I/D*2 Where, Lg=Length of overland flow D=Drainage Density | Horton (1945) |
| Constant Channel Maintenance (C) | C=-I/D | Schumn (1956) |

results obtained are pruned to make a short table where are the linear parameters pertaining to selected streams are tabulated. Table 5.4 shows the result of linear parameters and Table 5.3 shows relief parameters.

The result present in Table 5.4 clearly shows that there are two types of length namely surface length and flat length. Flat length is actually what we measure on a toposheet or 2D surface. Whereas, surface length is actual flow length on the ground surface. Difference between the flat length and surface length varies from 0 to 1610.25m and 0 to 0.24m in the original Table (not included here). In Table5.4 the variation is from 24.31 to 1612.50 m and 0.002 to 0.24m.

TABLE.IIA . MORPHOMETRIC ANALYSIS OF MAVINAHOLE WATERSHED

| Name | Basin area sq (km) | Perimeter (km) | Basin length ($L_b$)(km) | Stream order Nu | | | | | Total No of Streams $\sum N_u$ (km) | Stream length in kms | | | | | Stream length $\sum L_u$ (km) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | I | II | III | IV | V | | I | II | III | IV | V | |
| Mavinaholle water shed | 133.98 | 69.427 | 24.56 | 261 | 68 | 15 | 4 | 1 | 349 | 130.37 | 59.82 | 21.23 | 13.07 | 26.43 | 250.94 |

Table. IIB

| Elevation (m) | | Basin relief (R) | Relief ratio (Rh) | Ruggedness number (Rn) |
|---|---|---|---|---|
| Hmax | Hmin | | | |
| 870 | 20 | 850 | 34.60 | 1591.2 |

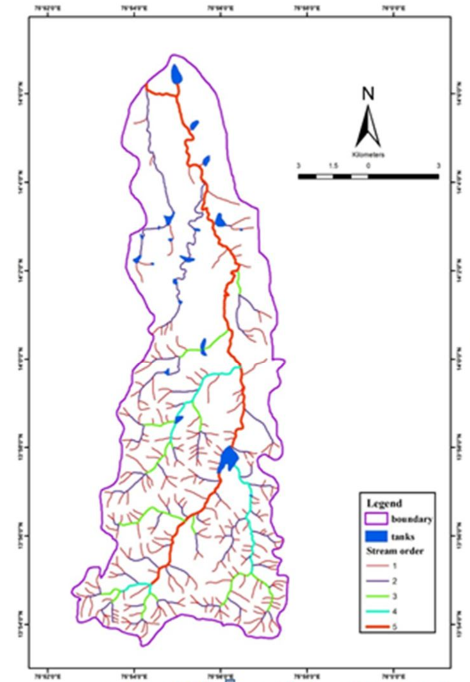
Table. IIC

| Name | Bifurcation Ratio ($R_b$) | | | | | Mean Bifurcation Ratio ($R_b$) | Stream Length Ratio (RI) | | | | | RHO Co-efficient RHO | Stream Frequency (Fs) | Drainage density (Dd) ($km^{-2}$) | Drainage Texture (T) | Elongation Ratio (Re) | Circulatory Ratio (Rc) | Form Factor (Rf) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I/II | II/III | III/IV | IV/V | V/VI | | II/I | III/II | IV/III | V/IV | | | | | | | | |
| Mavinaholle Watershed | 3.83 | 4.53 | 3.75 | 4 | - | 4.0275 | 0.46 | 0.35 | 0.62 | 2.02 | | 0.22 | 2.60 | 1.87 | 4.87 | 0.53 | 0.34 | 0.22 |

Surface length measured like this may give a better correlation when we plot them against order, for calculation of all the other parameters where length of the stream is involved, may give better results. The ratio between surface length and flat length is tabulated in Table 5.4 the ratio varies from 2496.64 to 26264.78m. As the surface length increases the ratio also increases. Where ever the stream length ratio values are high, it indicate steep slope.

Surface Tool in ArcView has also calculated the elevation in respect of starting point and the end point of every stream. Computation of this using SOI toposheet is not an easy task. Based on the elevation difference between the start elevation and end elevation values tabulated in Table 5.3, it is found that the difference between start point and end point varies from 687 to 938.86 and 606 to 852 respectively. Average elevation and the elevation range of individual streams area also calculated and are shown in the Table 5.3.

Slope values are obtained for all the streams in the study area. Slope values are expressed in percentage under average slope, minimum slope and maximum slope of each stream segment. The value of average slope, minimum slope and maximum slope varies from 213430.53 to 2626478.14m, 0 to 157781.92m and 1748983.35 to 69454220.77m. Slope of the line features can also be calculated in terms of degrees also based on the slope of the streams segment, surface runoff can be calculated. In such regions we can also asses' places of soil erosion and depositions. This also gives us an idea for suggesting suitable measures to stop soil erosion and consequences of soil deposition downstreams.we can also asses places of soil erosion and depositions. This also gives us an idea for




suggesting suitable measures to stop soil erosion and consequences of soil deposition downstream.

Fig .2 Drainage map of Mavinaholle watershed

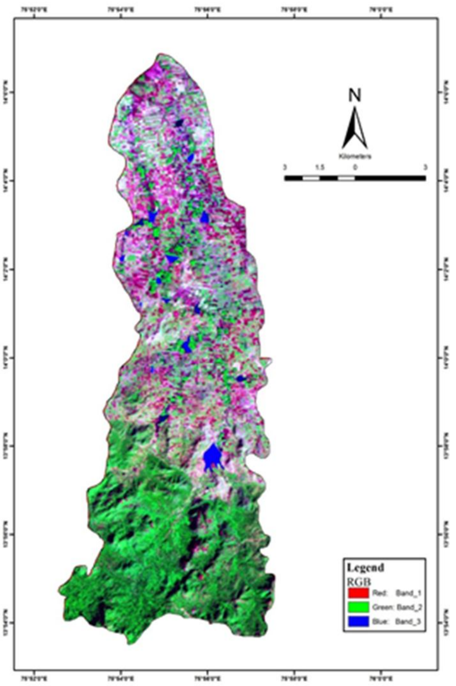



Fig.3 IRS LISS-III Image of Mavinaholle watershed

TABLE. III. RELIEF PARAMETERS DERIVED FROM THE SURFACE TOOLS OF ARCVIEW 3.2A

| FDID | Avg-slope (%) | Min-slope (%) | Max-slope (%) | Start elevation (m) | End elevation (m) | Average elevation (m) | Elevation range (m) | Abs-elev-change (m) |
|---|---|---|---|---|---|---|---|---|
| 1 | 2626478.14 | 99607.46 | 6945420.79 | 938.87 | 786.15 | 858.68 | 152.72 | 152.72 |
| 2 | 666087.47 | 0 | 2884048.23 | 786.40 | 754.81 | 768.86 | 35.40 | 31.60 |
| 6 | 556826.19 | 0 | 2162925.43 | 789.81 | 755.19 | 778.68 | 43.26 | 34.62 |
| 37 | 956725.94 | 0 | 4293442.65 | 775.09 | 732.00 | 753.81 | 43.96 | 43.09 |
| 40 | 1561083.07 | 47229.44 | 4829698.39 | 817.38 | 728.24 | 770.06 | 89.14 | 89.14 |
| 46 | 1400394.10 | 32556.07 | 5989136.04 | 893.36 | 845.24 | 875.80 | 53.72 | 48.12 |
| 54 | 828623.98 | 0 | 4006813.11 | 773.57 | 743.09 | 755.80 | 30.48 | 30.48 |
| 63 | 213430.53 | 0 | 2277106.59 | 736.39 | 728.30 | 730.91 | 9.59 | 8.09 |
| 87 | 705503.15 | 15573.91 | 3253530.09 | 846.74 | 819.58 | 831.13 | 27.35 | 27.16 |
| 93 | 1265420.73 | 0 | 4441337.16 | 924.39 | 812.38 | 862.51 | 112.39 | 112.01 |

TABLE. IV LINEAR PARAMETERS DERIVED FROM SURFACE TOOL OF ARC VIEW 3.2A

| FDID | Stream length (m) | Surface length (m) | Flat length (m) | Length ratio (m) |
|---|---|---|---|---|
| 1 | 725 | 173.61 | 0.01 | 26264.78 |
| 2 | 1004 | 65.42 | 0.01 | 7081.70 |
| 6 | 1491 | 79.57 | 0.01 | 5802.22 |
| 37 | 563 | 52.06 | 0.01 | 10101.65 |
| 40 | 741 | 106.55 | 0.01 | 15610.83 |
| 46 | 632 | 80.31 | 0.01 | 14003.94 |
| 54 | 609 | 47.72 | 0.01 | 8553.15 |
| 63 | 1745 | 39.77 | 0.02 | 2496.65 |
| 87 | 937 | 61.09 | 0.01 | 7055.03 |
| 93 | 1056 | 129.92 | 0.01 | 13477.33 |

## V. CONCLUSIONS

Morphometric parameters of a basin such as linear, areal and relief aspects are normally calculated manually. Calculation of these parameters manually is time consuming and some of the parameters are not possible to calculate. Even if they are calculated they will not be accurate, for example, a stream length what we calculate is a 2D parameters, actually it is 3D parameters. The length measured is 2D is always less than the 3D length. Therefore, for accurate measurement of some of parameters Surface Tool extension available in ArcView 3.2a is used, for comparative analysis.

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