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Geomorphological Analysis of Aralamallige Watershed, Bangalore Using Remote Sensing and GIS Approach

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Abstract: *The area selected for the present study was Aralamallige Watershed in Dodaballapur Taluk, Bangalore Rural District located between 77° 25'and 77 °35'32.6'' E longitude and 13 °15' 21.54'' and 13° 23'2.27''N Latitude. The catchment comprises of an area of about 138.45 sq.km. Remote sensing provides the base information's on the land use/land cover, soil, drainage and other aspects. GIS softwares were used for database creation and other analysis. Morphometric analysis was carried for the entire watershed to understand the hydrological process. Drainage density estimated to be 1.9km/sq km. The study demonstrated the use of remotely sensed data in conjugation with GIS for better management of natural resources within the watershed.*

Keywords: *Geomorpholgical, Aralamallige, Watershed, Sensing, GIS Approach*

1. INTRODUCTION

Geomorphologists and hydrologists often view streams as part of drainage basin. A drainage basin is the topographical region from which a stream receives runoff through flow and groundwater flow. Drainage basins are divided from each other by topographic barriers called a watershed. Lillesand, T.M. and R.W. Kiefer (1994).

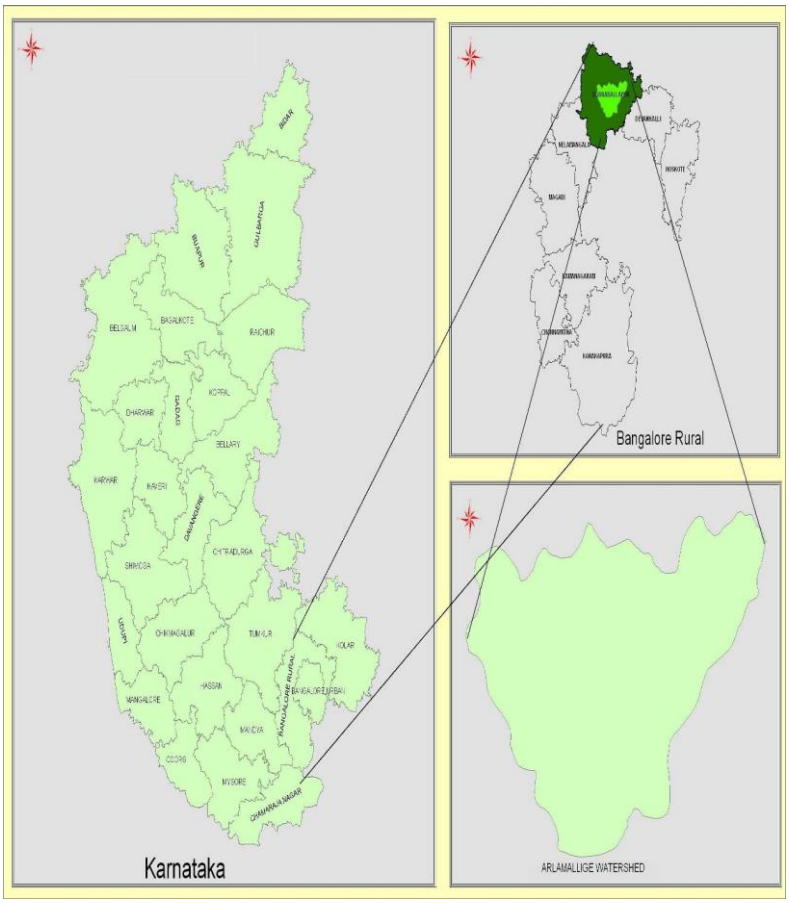
Horton and Strahler (1964) first initiated quantitative analysis in the field of hydrology early in 1940's and 1950's. Thereafter important contribution has been made by Strahler (1952, 1957), Morisawa (1959), Dilip G. Durbude(2001), Melton (1957), Schumn (1956) Akhouri Pramod Krishna, (1996), and Leopold and Miller (1956). Morphometry is defined as the measurement of geometric dimensions of a landform in a system. 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 basin. For Morphometric analysis the drainage details which were derived from Survey of India (SOI) topomaps on 1:50000 scale and updated with recently remote sensed data (IRS LISS III, Jan 2000). The dimensional parameters were estimated using Arc/Info and Arc/ View, ERADAS(8.5) GIS softwares.

Morphometric analysis was carried out to understand the physical characteristics of the watershed which is useful in further analysis like soil loss, land use planning, terrain elevation etc. The quantitative Morphometric analysis throws light on lithology and relative runoff.

2. PHYSIOGRAPHY

The study area chosen was Aralamallige watershed, Doddaballapur taluk, Bangalore rural district. The study are stretches geographically from 77° 25' and 77 °35'32.6'' E longitude and 13 °15' 21.54'' and 13° 23'2.27''N Latitude. The catchment comprises of an area of about 138.45 sq.km and is covered in the survey of India (SOI) toposheet numbers 57 G/7 and 57 G/11. The maximum length of and width of the watershed is watershed is 16.77 km and 11.41 km respectively. Physiographically the study area falls in the southern maiden region, which is characterized by undulating landscape with rather broad based valleys. The highest relief is

formed at 940m above Mean sea level and lowest relief is obtained at 900m above MSL. The slope of the land is from northeast to southwest. The study area comprises of granite which occur as intrusive in the gneissic complex and vary in color, structure and texture. Ragi is an important grain crop of the taluk. Other crops include paddy, maize and cereals along wheat, jowar and millets. Area is rich in red loomy soils.



Location map of the study area

3. METHODOLOGY AND DATABASE

Drainage map prepared for the study area using Survey of India (SOI) topomaps on 1:50,000 scale was updated with remotely sensed data are updated for streams and water bodies such as tanks developed using satellite data. Overlaying of these details was carried out on the post monsoon image and the extent of surface water spread during rabi and kharif season were demarcated using the respective season satellite image. The drainage map was used for morphometric analysis to understand the watershed parameters and its hydrological behaviour. The drainage map of the study area is shown as(Fig 1.1)

4. DATABASE CREATION

The final thematic maps (spatial data) were scanned using A_0 scanner to create digital database. The scanned thematic maps were projected to polyconic projection using ERDAS IMAGINE (version 8.5) software. The thematic maps were digitised and labeled using Arc/Info (version 4.2) and Arc View GIS softwares. Thus the entire resource maps were converted into a set of digital layers. These layers were corrected by editing errors such as dangles, label of polygons, which were caused during digitisation (ESRI, 1989). Topology was established among the features of each theme by processes available in the software package (clean/build). All the data layers were transformed into real coordinate system in which the features of each data layer were identified with ground coordinates.

These individual layers were then converted in to shape files using ArcView software and further processed for coding of features and database creation. The database prepared was used for morphometric analysis.

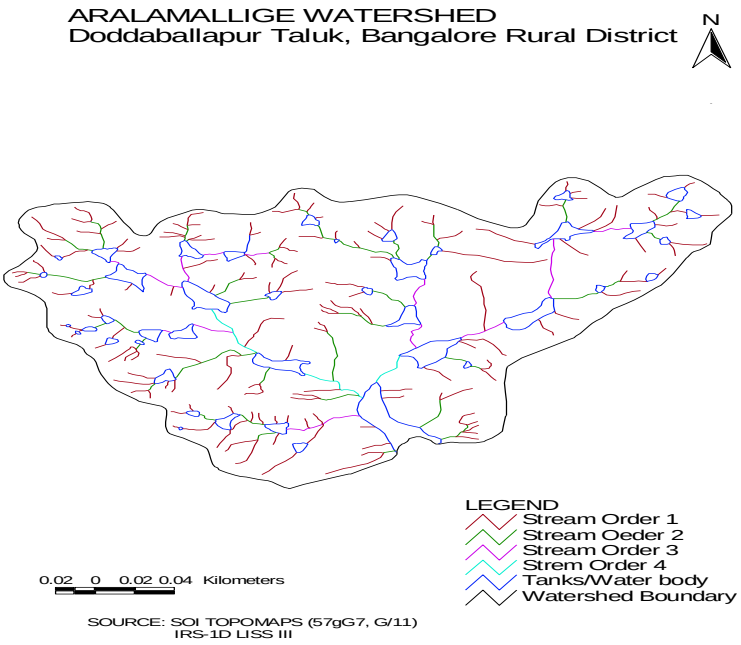
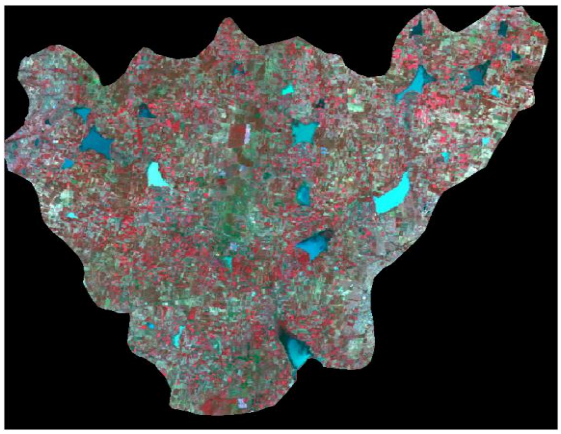


Fig 1.1. *Drainage map of the study area*

IRS – 1D, LISS III IMAGE (20-1-2000) Aralamallige watershed



Survey of India Topomap (57 G) showing the study area

5. RESULTS AND ANALYSIS

From the quantitative study, it is seen that the watershed is of dendritic nature. High bifurcation ratio values are characteristic of the watershed that has suffered less structural disturbance, and the drainage density pattern has been distorted because of the structural disturbances. The bifurcation ratio is indicative of the shape of the basin also. An elongated basin is likely to have a high R_b whereas circular basin is likely to have low R_b. The values of R_b in the present case indicate that watershed has suffered less structural disturbance and the watershed may be regarded as very elongated. Drainage density reflects land use and affects the infiltration and the basin response time between the precipitation and discharge. For the present study the drainage density was evaluated to be 1.9km/Sq.km. which indicates that the area is coarse in nature.

The circulatory ratio for the watershed indicates nature of topography. Its low, medium and high values in the area correlated with youth, mature and old stage of cycle of tributary watershed of the region. The elongation ratio is 0.79 which indicates that the watershed is less elongated the stream frequency obtained for the study area is 1.25 no. /sq km, hence it is classified under the class of low drainage density, leading to higher bifurcation ratio in to the soil. The study area covers a area of 138.45sqkm and has an length and width of 16.77 km and 11.41 km respectively.

The perimeter of the watershed is 57.44km. The highest stream order and the number of tanks are4 and 43 in number respectively. The length of the stream is an indication of the steepness of the drainage basin as well as degree of drainage. The cumulative stream lengthis 274.45km which indicates that the study area has steep well drained areas. Thus this factor defines defines the efficiency of the drainage network. Circulatory ratio is the ratio between the area of watershed to thr area of circle having same circumference as the perimeter of the watershed. It is the significant ratio that indicates the stage of dissection in the study region. In the present study circulatory ratio is 0.52 km/Sq.km which indicates that the watershed is mature. The length ratio of watershed is 2.27 No/sq km which tends to be constant throughout the successive order of the steream. The steram frequency is the total number of streams in a drainage basin divided by area of the drainage basin. In the present study the stream frequency calculated was 0.52 No/sq km. The inverse of drainage density is the constant of channel maintenance. It indicates the number of sq km of watershed required to sustain one linear km of the channel and its value in the present study is 0.52 km/sq km. The relief ratio increases overall the sharpness of the watershed and it is an indicator of intensity process operating as the shape of the watershed. Here in the present watershed relief ratio was estimated to be 0.0023km and overall relief was estimated to be 0.04km.(Table 1 & 2)

Table1. *Different Morphometric characteristics of Aralamillage watershed*

Stream Order	No. of Segments	Total Length (Km)	Bifurcation ratio (R_b)	Mean Length (Km)	Cumulative Length (Km)	Length Ratio	Drainage Density (Km/Sq.Km)
1	134	121.68	4.3	0.90	121.68		1.9
2	31	56.93	5.1	1.83	178.61	2.03	
3	6	52.25	3	7.4	230.86	4.04	
4	2	43.29	2	21.79	274.15	2.94	
Total	173	274.45					

Table2. *Watershed parameters*

S.No.	Parameters	Unit	Value
1	Watershed area	Sq.km	138.45
2	Maximum length of watershed	Km.	16.77
3	Maximum width of watershed	Km.	11.41
4	Perimeter of watershed	Km.	57.44
5	Highest stream order	No.	4
6	Number of tanks	No.	43
7	Cumulative stream length	Km.	274.45
8	Drainage density	Km/sq.km	1.9
9	Form factor	-	0.49
10	Compactness coefficient	-	1.37
11	Circulatory ratio(Re)	-	0.52
12	Elongation ratio	-	0.79
13	Constant of channel maintenance	Km/sq.km	0.5 2
14	Stream frequency	No/sq.km	1.2 6
15	Length ratio	-	2.27
16	Basin relief(H)	m.	4.0
17	Relief ratio	km	0.0023
18	Bifurcation ratio	-	3.6

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