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QUANTITATIVE APPRISAL OF AREAL PARAMETERS IN MORPHOMETRIC STUDY OF MALATTAR RIVER BASIN

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ABSTRACT

The morphology of river channel is the function of number of geomorphic processes and its associated environmental conditions. The morphometric evaluation of drainage data provides a quantitative explanation of basin geometry and is used to reveal the geomorphic and geological history of each drainage basin. The present article makes an attempt to study the areal aspect of Malattar River Basin to derive the morphometric and hydrologic properties of the basin. The measurement of various areal morphometric parameters namely .stream frequency, drainage density, form factor, circulatory ratio, elongation ratio and constant of channel maintenance has been taken out and analyzed and are then compared with drainage basin geology and inferences have been derived.

KEYWORDS: Morphology, Geology, Drainage, Areal aspect, Parameters

INTRODUCTION

The main purpose of stream morphology is to discover holistic stream properties from the measurement of various stream attributes. The morphology of river channel is the function of number of geomorphic processes and its associated environmental conditions.

Morphometry is the measurement and mathematical analysis of configuration of the earth surface, shape and dimension of its landforms in a given drainage basin (Clarke 1966). The morphometric evaluation of drainage data provides a quantitative explanation of basin geometry and is used to reveal the geomorphic and geological history of each drainage basin. The study of morphometric properties of drainage basin becomes more imperative because of their significance in development of land forms and understanding the hydrological properties of the basin.

Morphometric study primarily involves computer characterisation and analysis of linear and areal aspects of drainage basin. With the wider availability of contour maps after areal analysis became an the important aspect that have gained significance due to the advancement of mathematical, statistical and computer applications in morphometry. Areal relationships provide useful data on the characteristics of streams as regards the basin, including the collection of rainfall and concentration of runoff, the interaction of climate and geology, and the area necessary to maintain measured units of channel length.

The present article makes an attempt to study the areal aspect of drainage basin by taking a case study from the Palar Basin of Eastern Ghats, so as to derive the morphometric and hydrologic properties of the basin.

AREA CHOSEN

The area considered for the present study is Malattar Basin, a tributary basin of River Palar. Malattar basin lies between 12°50’N to 13°10’N latitudinally and 78°20’E to 78°45’E longitudinally (Figure 1)covering an area of about 1008.38 sq. kms. The river basin occupies the areas of Chittoor district in Andhra Pradesh, Vellore and North Arcot districts in Tamilnadu. With regard to the terrain geology of the region, the upper basin of the river is characterized with sheet rocks trending towards North-Eastern part while; lower Malattar is mainly composed of alluvial tracts as a result of deposition of the sediments at the foot hill region.

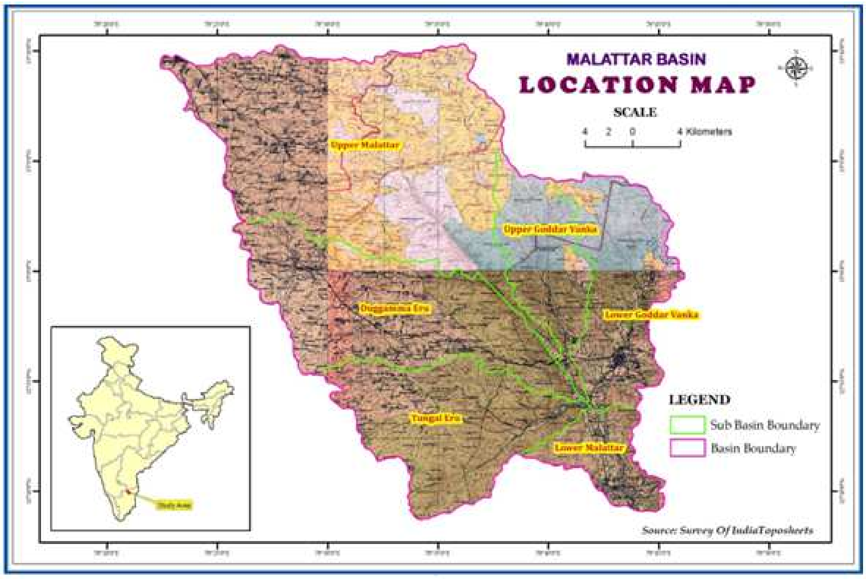

Figure 1

METHODOLOGY

The entire river network has been captured from Survey of India toposheet of 1:50,000 scale. To study the areal morphometric character of river Malattar, a quantitative analysis with the help of ArcGIS 9.3 have been carried out. Subsequently, the basin has been delineated and demarcated into several sub basins. Based upon the shape and length of drainage network several parameters from the aerial aspects have been applied and are then compared with drainage basin geology and inferences have been derived.

RESULTS AND DISCUSSIONS

For the detailed analysis of morphometry of Malattar basin, it is divided into 6 sub basins namely, Upper Malattar, Duggamma Eru, Upper Goddar Vanka, Lower Goddar Vanka, Tungal Eru and Lower Malattar. The measurement of various areal morphometric parameters namely, stream frequency, drainage density, form factor, circulatory ratio, elongation ratio and constant of channel maintenance has been taken out and analysed. Also an attempt has been made to study the morphometry of sub basins individually and for basin as a whole.

Drainage Density

Drainage density is defined as the total length of stream orders per drainage area. It is the ratio of total channel segment lengths cumulated for all orders within a basin area, which is expressed in terms of miles/sq.mile or km/sq.km. The drainage density indicates the closeness of spacing of channels (Horton1932).

The drainage density in the sub basins of Malattar ranges from 2.29 to 2.79 except for Upper Goddar Vanka which is 3.01.The similar conditions of lithology and geologic structures, semi arid regions have finer drainage texture and hence high drainage density for Upper Goddar Vanka sub basin. This high density presents that the region has weak or impermeable sub surface material, sparse vegetation and mountainous relief (Strahler, 1964). Rest of the five sub basins may be considered as moderately drained (Table 1).

Stream Frequency (Fs)

The total number of stream segments of all orders per unit area is known as stream frequency (Horton 1932).In the present analysis it is noted that the values of Fs vary from 3.12 in Lower Malattar to 4.89 in Upper Goddar Vanka (Table 1). It is also possible to see that the drainage density values of the sub basins exhibits positive correlation with stream frequency suggesting that there is an increase in stream population in the Malattar basin and sub basins with respect to increasing drainage density.

Drainage Texture

It is an important factor in the drainage morphometric analysis which is depending on the underlying rock lithology, infiltration capacity and relief aspect of the terrain. Drainage texture refers to the relative spacing of drainage lines. According to Horton (1945), infiltration capacity is the single important factor which influences the drainage density and stream frequency. Permeability thus influences authentically on drainage texture into very course (<2), course (2-4), moderate (4-6), fine (6-8) and very fine (>8).

In the present study, the value of drainage texture ranges from 4.12 in lower Malattar sub basin to 12.97 in upper Malattar sub basin.

Constant of Channel Maintenance

Schumm (1956) has used the inverse of drainage density as a property termed constant of channel maintenance. Specifically, constant of channel maintenance represents the number of square feet or square kilometer required to sustain one linear foot of channel. For lower Malattar sub basin, the value of constant of channel maintenance is 0.44 to a sq.km. of the surface (Table 1). It indicates that an average of 0.44sq.km.of surface is required to support each linear km. length of the channel. Rest of the sub basins have channel maintenance values ranging from 0.33 to 0.39.

Form Factor

Quantitative expression of drainage basin outline form was made by Horton (1932) through form factor ratio (Rf), which is the dimensionless ratio of basin area to the square of basin length. Basin shape may be indexed by simple dimensionless of the basic measurements of area, perimeter and length (Singh, 1998). Basin with high form factors experience larger peak flows of shorter duration, whereas elongated basin with low form factors experience lower peak flows of longer duration. In the Malattar basin region, the form factor for upper Goddar Vanka sub basin (0.18) and Upper Malattar sub basin (0.19) shows very low value (Table 2).

Table 1: Values of Areal Morphometric Aspects

Sub Basins	Drainage Density	Stream Frequency	Drainage Texture	Constant Of Channel Maintainance
Upper Malattar	2.77	3.87	12.97	0.361
Duggamma Eru	2.57	3.83	9.41	0.389
Upper Goddar Vanka	3.01	4.89	7.56	0.332
Lower Goddar Vanka	2.54	3.58	7.21	0.394
Tungal Eru	2.79	3.89	6.45	0.358
Lower Malattar	2.29	3.12	4.12	0.437
Malattar Basin	2.71	3.69	**8.85**	0.369

Circularity Ratio

It is the ratio of the area of the basin to the area of the circle having the same circumference as the perimeter of the basin (Miller, 1953). It is influenced by length, frequency of streams of various orders, gradient, lithology and the drainage pattern prevailing in the basin. In the present investigation the circulatory ratio lies between 0.4 t0 0.5 for Lower Goddar Vanka (0.41), Tungal Eru (0.41) and Lower Malattar (0.44) sub basins (Table 2).

Elongation Ratio

Elongation ratio is defined as the ratio between the diameter of a circle of the same area as the basin and the maximum basin length (Schumm 1956). Values of Re generally vary from 0.6 to 1.0 over a wide variety of climatic and geologic types. Re values close to in the range 0.6 to 0.8 are usually associated with high relief and steep ground slope (Strahler, 1964). In the present study area of Malattar basin elongation ratio value ranges from 0.36 to 0.66 for different sub basins (Table 2).

CONCLUSIONS

Upper Goddar Vanka sub-basin exhibits high drainage density as well as stream frequency pointing out the conclusion that that the region has weak or impermeable sub surface material, sparse vegetation and mountainous relief. It is also possible to see that the drainage density values of the sub-basins exhibits positive correlation with stream frequency.

Table 2: Values of Basin Configuration

Sub Basins	Area (Km^2)	Form Factor	Circularity Ratio	Elogation Ratio
Upper Malattar	383.441	-	0.37	0.528
Duggamma Eru	207.339	0.207	0.36	0.51
Upper Goddar Vanka	86.048	0.18	0.348	0.47
Lower Goddar Vanka	124.48	0.308	0.41	0.63
Tungal Eru	160.068	0.332	0.47	0.65
Lower Malattar	49.97	0.34	0.44	0.66
Malattar Basin	1008.38		0.4	0.57

With regard to the study of drainage texture, very fine texture is observed at Upper Malattar and Duggamma Eru which may be due to the presence of impervious character of charnockite and granatoid gneiss as underlying rocks. In the case of channel maintainence, except lower Malattar sub-basin, most parts of Malattar basin lies in between elevated topography. In the Malattar basin region the basin configuration pertaining to the form factor, circularity and elongation ratio shows that upper Goddar Vanka sub basin and Upper Malattar sub basin have more elongated basin whereas rest of the sub basins have moderate elongated basin with moderate slope and short duration flow, as well as an early stage of topographical maturity with high relief and structurally controlled drainage system. It also indicates that basin having elongated in shape tent to have low discharge of runoff and highly permeability of subsoil condition.

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