Morphometric Analysis of Gadwal Basin, Telangana State, India

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Abstract **- Geographical information system (GIS) & remote sensing has emerged as an efficient tool in delineation of morphometric analysis. GIS and image processing techniques can be employed for the identification of morphological features and analyzing properties of basin. The morphometric analysis of the drainage basin and channel network play an important role in understanding the geo-hydrological behavior of drainage basin and expresses the prevailing climate, geology, geomorphology, structural antecedents of the basin. Relief is typically defined as the difference in height between the high point and the low point on a landscape, in feet or in meters. It could also be defined more qualitatively: like "low relief plains" or "high relief rolling hills.**

The relationship among various drainage parameters and the aforesaid factors are well recognized by many workers. The drainage basin analysis is important in any hydrological investigation as assessment of groundwater potential, groundwater management, pedology and environmental assessment. Gadwal basin area is 83.75 sq km and four stream orders are there. Hydrologists and geomorphologists have recognized that certain relations are almost important between runoff characteristics, and geographic and geomorphic characteristics of drainage basin systems. Various important hydrologic phenomena can be correlated with the physiographic characteristics of drainage basins such as size, shape, slope of drainage area, drainage density, size and length of the contributories etc.

Index Terms **- Morphometric, Arc GIS, Remote Sensing, Drainage, Hydrology.**

INTRODUCTION

dimension of its landforms. Morphometric studies in the field of hydrology were first initiated. The morphometric parameters of basin can address linear, areal and relief aspects. The morphometric analysis of the drainage basin and channel network play an important role in understanding the geo-hydrological behavior of drainage basin and expresses the prevailing climate, geology, geomorphology, structural antecedents of the basin. Morphometric analysis of a drainage basin expresses fully the study area of dynamic balance that has been attained due to dealings between matter and energy. The development of stream segments in the basin area is affected by rainfall, groundwater discharge. The relationship among various drainage parameters and the aforesaid factors are well recognized by many workers. The drainage basin analysis is important in any hydrological investigation as assessment of groundwater potential, groundwater management, pedology and environmental assessment.

STUDY AREA

The study area is situated between 77°39’41.599” to 77°45’25.932” East longitudes and 16°12’23.804” to 16° 19’20.646” North latitudes forms part of survey of India toposheet numbers 56H/11, 56H/12, 56H/15, 56H/16. The total area covered is 83.75 Sq kms. The lithology of this belt consists of basic, intermediate and volcanics. Bands of iron formations, basic dykes, quartz veins, pegmatites, and hornblende within the schist belt. The major rock types are Granites and Gneisses, Amphibolites, Pink Granites, Epidote veins in and around dharur village to chinnachintharevula village.

DATA BASE AND METHODOLOGY

In the present study Remote Sensing data collected in digital form from NRSC (National Remote Sensing Center, Hyderabad) the image pass on IRS-1D LISS-IV data (24th January 2016) and Survey of India topographic map 56H/11, 12, 15 and 16 at scale 1:50,000 published by Survey of India (SOI) have been utilized. Geomorphological units and Stream Order, mapping with image interpretation techniques, digital image processing, exiting geology and geomorphology map using Arc GIS 10.8 and verified in field work with GCPs collection to understand the

distribution of the landforms, Stream Order and the lineaments.

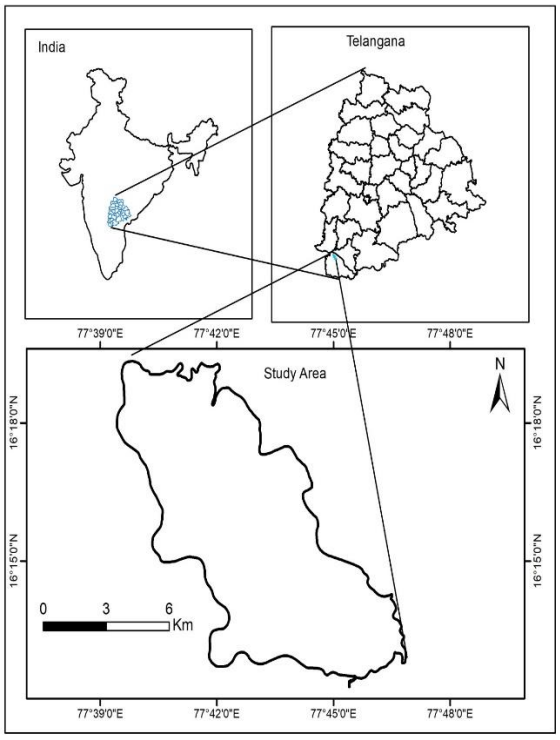

Figure 1: Location map of the study area

The several Morphometric parameters such as linear aspects, aerial and relief aspects of the drainage basin computed the input parameters for the present study such as area, perimeter, elevation, stream length etc. And also categorized about some factor computed in the present study area by GIS customs consist of stream order, stream length, bifurcation ratio, drainage density, stream frequency, form factor, circulatory ratio, elongation ratio, relief ratio and ruggedness number.

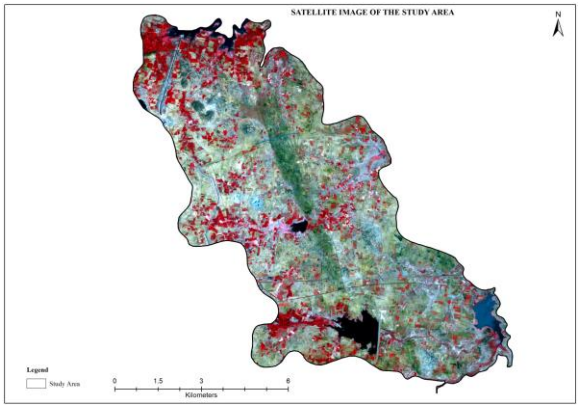

Figure 2: LISS IV Satellite Imagery of the study area

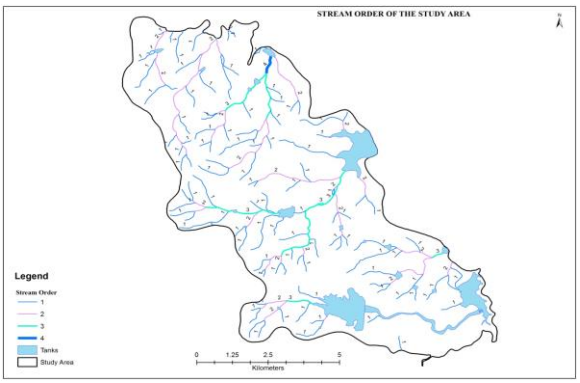

Figure 3: Stream order map of the study area

RESULT AND DISCUSSION

The present study has been carried out for Morphometric analysis of the study area this process is done by applicability of Horton's laws of stream numbers and lengths of streams of each order. The basin Morphometric analysis can deals about the three parameters those are Linear, Aerial and Relief aspects reveal about the Morphometric of the basin Rabindra N. Tiwari and Vikash K. Kushwaha (2021). The drainage pattern in the study is dendritic to sub-dendritic .All orders of stream numbers are different from First order to fourth order, The total number of streams are 150 in that 112 are 1st order, 29 are 2nd order, 08 are 3rd order, 01 are 4th order. Drainage and stream order map of the study area showing the results.

1. Linear Aspects: 1. Stream order (U), 2. Stream Length (Lu), 3. Stream number (Nu), 4. Stream Length Ratio (RL), 5. Mean Stream Length (Lsm), 6. Bifurcation ratio

2. Aerial Aspects: 1. Basin area, 2. Drainage density (Dd), 3. Basin length, 4. Stream frequency (Fs), 5. Form factor (Ff), 6. Circularity ratio (Rc), 7. Elongation ratio (Rc), 8. Length ofoverland flow (Lof).

3. Relief Aspects: 1. Basin relief, 2. Relief ratio (Rh), 3. Ruggedness number (Rn)

1 Linear Aspect:

The Linear aspects of Morphometric analysis indicate about the channel network pattern of the drainage system whereas also topographical feature of the drainage basin segments are also investigate. These

are discussing about the Stream order, Stream number, Stream length, Stream length ratio, Mean stream length ratio and Bifurcation ratio.

1.1 Stream Order (U):

Horton's introduced the concept of stream order in the year of 1932.For the stream classification at the river basin; stream ordering is a widely applied. In the hierarchy of tribunals Leopold, the stream ordering is defined as a position of stream. In the view of Strahler system of stream ordering – the stream of drainage area have been demarcated. According to the Strahler system my study area is close to the 4th order and also demarcated of stream ordering. The figures for all the parameters related to Morphometric are described in table. The first order streams on the South side began at the highest elevation of 370 m. The number of streams decrease as the stream order has increase; the first stream order has no tributaries. The smallest tributaries of the stream order are selected as the 1 st order, 2nd order streams started where the two first order streams meet, similarly a 3 rd order structure is formed where the two second order streams meet. As the number of stream order increases the water flowing rate percentage decreases and the infiltration capacity increases.

1.2 Stream number (Nu):

The word stream number is simply seen along the way with the letter (Nu). My study area has a total of 150 streams; the fourth order is the largest order. The first order streams have possibility when it rains heavily, the chances of flash floods are high to the down side of streams Chitra et al. (2011).

1.3 Stream Length (Lu):

According to Horton's law the stream length has been measured. Total length of Lu of all orders indicated in table 1. First order stream lengths are longer than all other stream order, stream lengths decreases as stream order increases. The length of the streams is measured by Horton's formula Lu has been digitized by using various steps through topography of the area with the help of Arc GIS. The total stream length of all orders 126.43 km.

1.4 Mean Stream Length (Lsm):

The mean stream length (Lsm) shows the quality properties of mechanism of drainage system and its related basin surface (Strahler 1964). As the serial number of order in any drainage increases, so do the mean stream length value also increased. Krishna River is a difference from 0.459 to 2 km with the mean Lsm values is 1.68. The Lsm is a special farm related to the length of drainage network and also it is related to the surface (Strahler 1964). The mean stream values are different from one basin to another basin it is depends on the basis of size and topography of the area.

1.5 Bifurcation ratio:

The number of streams of the next higher order call the bifurcation ratio, the drainage nature of bifurcation ratio of the number of streams are given in order of ratio.(Rb) The bifurcation ratio of the study area values varies from 3.86 to 8 with a mean Rb value is 3.6. Where the powerful geological structure exist the Rb values are vary in each environment. The Morphometric investigation results reveal the Rb is not same for all orders. The Rb values refers the low gradient structural disorder and also do not have been distorted high values of Rb indicates low permeability of the basin and structural complexity. The bifurcation ratio of drainage network is introduced by (Strahler 1952). Rb values conducted through following formula Rb= Nu/Nu+1.

1.6 Stream length ratio (RL):

The ratio between the two stream lengths all lengths of any given stream order to the total number of stream of next higher of drainage network. The RL is dependent on study area topography and also slope of the area. It is showing important great correlation of the surface and discharge of flow rate existing basin erosional stage Wilson et at (2012). The values of stream length ratio varied from 0.741 to 0.875.

2. Aerial Aspects:

The areal aspects parameters directly refer an area of region and also indicate about the size, shape topography of the area. Area (A) Perimeter (P) is most significantly parameters to discuss about the quantitative aspects of the area. The areal aspects parameters continue with the Basin area, Drainage density (Dd), Basin length (Lb), Stream frequency (Fs), Elongation ratio (Re), Circularity ratio (Rc), Form factor (Rf), Length of overland flow (Lof).

2.1 Basin area:

Drainage basin forms some kind of land activities fill with the rainwater and snowmelt. Filled water entering into the downhill to the water body. The basin water flow through the river, streams, channel network to sea body. The study area covers an area 83.75 sq.km

2.2 Drainage density:

To analysis the Morphometric drainage area, the drainage density is one of the most important parameter densities. The total stream length in a given basin and area of the basin is defined as drainage area (Strahler1964). The drainage density is related to various features of the topography those are climate and physical characteristic of the drainage basin. A high drainage is affected on infiltration and permeability of a drainage basin. Drainage density was firstly described by (Robert E. Horton 1945). The study area drainage density is 0.001 it is indicates the lower order streams are mostly dominating the basin. The formula of drainage density is Dd = L/A Where, L= Total length of stream, A= Area of the study area.

2.3 Bain length (Lb):

The basin from the highest area specific catchment to the point of confluence is called length of basin (BL). Based on the Basin Length, the basin length calculation has been given by various workers as George and Walling (1973). The basin length determined the position of the basin. The study area meets at the point of junction of source. The junction point is eastern parts of the study area. The basin length of the study area is 17.37 km.

2.4 Stream frequency (Fs):

In the view of Horton (1945) the stream of frequency and the drainage basin has been analyzed. The system of drainage basin and its stream of frequency described as the ratio of the whole number of streams of every order to the basin of whole area. Parameters of Fs are an important aspect to show the various stages prospect growth. The originate of Fs is interlinking of with the various activities those are natural and structural control of the basin, rainfall, soil permeability and vegetation cover. The value of Fs is 4.21 formula of Stream frequency is Fs= £Nu/A Where, £Nu= total number of stream segments of all order A= Area of the basin.

2.5 Elongation ratio (Re):

The main important areal properties of the basin are Elongation ratio. It is very essential, the diameters of a circle to the area, the same area basin comes at the maximum level of drainage. The Re is depending on these diameters. It is also depends on the physical and geological conditions of the basin. The study area value of Re is 1.0157. The act of Elongation ratio parameter is conducted about the basin lengthening, slope and shape of the drainage area.

2.6 Circularity ratio (Rc):

Circularity ratio is the ratio between the area of the study area and the circle of area the same circumference as the parameter of the study area. According to Miller (1953). Circularity ratio results show the various landscape textures. It is having three stages based physical characteristics drainage basin. Low circularity ratio indicates youth stage, life cycle of the tributary of drainage basin area. The analysis results of circularity ratio showing the value of 0.33. It is commonly affected by lithological aspects of the basin. The Rc value is calculated by using the formula Rc= 4A/P2.

2.7 Form factor (Rf):

According to Horton (1932) it is defined as the ratio between area of watershed and square of watershed length form factor and Rc both are the similarly having the close one to another. The form factor value of study area of drainage area is 0.2712.

2.8 Length of overland flow (Lof):

The length of overland flow depends mainly on the basis of drainage density and landform of the basin. The average value of various orders of priority ranges are 0.003 to 0.42 the mean value is 0.14, the length of overland flow is a length of water flow path over the ground earlier it may get concentrated to the certain stream channel segments. Lof measure from the stream spacing and degree of dissection of drainage density (Chorley 1969). 4th order stream values having higher than the remaining values of study area of Krishna River. 1st order streams 0.2121, 2nd order stream 0.0418, 3rd order stream 0.0256, 4th order stream 0.6724.

Table: 1 Morphometric Parameters of the Study area

Mean stream Length	842.92
Drainage Density	0.001
Stream Frequency	0.0000017
Texture Ratio	0.0027
Elongation Ratio	1.0157
Circulatory Ratio	0.334494476
Form factor ratio	0.271211
Length of overland flow	2000
Channel maintenance or constant of channel maintenance	1000

Table: 2 Stream order Parameters of the Study area

Stream Order (U)	Number of Streams (Nu)	Length of streams (Lu)	Stream length Ratio (RL)	Bifurcation Ratio (Rb)
1	112	83062	0.741	3.862
2	29	30185	0.724	3.625
3	8	12519	0.875	8
4	1	672		

3. Relief Aspects:

The relief aspects of the area it shows relief ratio and ruggedness number of area. The longest basin length measured along the main drainage basin called relief ration (RR).

3.1 Relief ratio (Rh):

The relief ratio is covering and maintenance of the drainage basin. It is differences between highest and lowest elevation of the basin. The relief ratio is describing the grade of a river. The estimate results between the source of the river and the river confluence both are divided by the length of the stream. It is a special case of the slope. According to Schumm the relief ratio of study area value is 44.43. The following formula of relief ratio by Schumm H-h/L Where, H=highest elevation of the basin, h=Lowest elevation of the basin, L=Longest axis of the basin.

3.2 Basin relief:

Basin relief is an important factor for understanding the Denudational character of the area. Relief is the maximum and minimum elevation of watershed. Basin should be the study area for the better understanding study area.

3.3 Ruggedness number:

The drainage density (Dd) and product of maximum basin relief (H) both are comes under same parameters and same unit. The slope gradating and length expressing the extent of the instability of land surface, it is referred by the ruggedness. It is the specific area of research area basin has rugged topography is structurally complexity, soil erosion are showing. (Strahler, 1957).

Basin Relief	Relief ratio	Ruggedness Number
123	44.43285	0.000123

CONCLUSION

The aerial aspects of the drainage basin such as drainage density (D), stream frequency (Fs), were calculated. The drainage density of the study area confirms to drainage morphometry and geohydrological conditions suitable for better surface permeabilities. On the whole, the data suggests good prospects for infiltration measures, presuming that such measures are in line with local hydrogeological conditions.

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