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Morphometric Analysis of Peddavagu Sub-watershed of Krishna River, Maddur Mandal, Mahabubnagar District, Telangana State

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ABSTRACT

The study of Morphometric investigation of Peddavagu sub-watershed of Krishna river basin of Maddur Mandal, Mahabubnagar District, Telangana. The watershed overspread an area of 230.77 sq.km in the Survey of India toposheet number 56H/9 on a scale of 1:50,000. The watershed area lies in the middle of latitudes $16^0$45'00" and $17^0$00'00" N and longitude $77^0$45'00" and $77^0$30'00"E. The effluent basin as been conducted based on the secondary basis. Watershed improvement and administration plans are further important for connecting exterior water and ground water resources in arid and semi-arid region. The growth of Morphometric methods was a main advance in the measurable explanation of the geometry of the drainage basin and its network which helpsin describing the drainage network. This Research was assumed to determine the drainage characteristic of Peddavagu sub-watershed. The SRTM data has been downloaded from GLCF website. The downloaded has been analyzed using Arc GIS software. The several linear parameters (stream order, stream number, stream length, stream length ratio, bifurcation ratio, drainage density, texture ratio, stream frequency) and shape factor(compactness coefficient, circulatory ratio, elongation ratio, form factor) of the drainage were computed. The total number of streams are 969 in that 665 are 1st order , 202 are 2nd order ,76 are 3rd order, 21 are 4th order, 4 are 5th order and 1 are 6th order streams. The streams have been formed dendritic drainage pattern. The distanceof the steam segment is maximum for first order stream and decreases as the stream order increases. The resultof drainage density shows the value 2.54 per Sq.km. Hence from the study it is clear that the Morphometric analysis based on GIS technique is very useful to recognize the main geo-hydrological features and for watershed development and management.

KEYWORDS: *Morphometric, Drainage basin, Watershed and Streams.*

INTRODUCTION

Morphometric features of a river basin reproduce its hydrological behaviour and are useful inestimating the hydrologic response of the basin. Quantitative Morphometric analysis helps understanding of the drainage development, surface run-off generation, infiltration capacity of the ground and groundwater potential. The watershed of the Peddavagu sub-watershed is an integral part of the Maddur mandal (Figure 1) and hence the Morphometric arrangement of the entire Peddavagu sub- watershed has been studied. Morph metric assessment of a river basin provides a quantitative analysis of the drainage system, which is an essential aspect of the characterization of basins Strahler (1964). This is most essential in any hydrological investigation like evaluation of groundwater potential, groundwater management, basin management and environmental assessment. Various hydrological phenomena can be correlated with the physiographic characteristics of a drainage basin such as size, shape, slope of the drainage area, drainage density, size and length of the contributories, etc. Rastogi and Sharma (1976). The morphometric evaluation can be performed through measurement of linear, aerial, relief, gradient of channel network and contributing ground slope of the basin Nautiyal (1994), Nag and Chakraborty (2003). Morphometric studies of various drainage basins have been carried out by using GIS and remote sensing technique for the estimation of morphometric parameters because the results obtained were reliable and accurate (Sarala. C 2013). Geographical information systems (GIS) have been used for assessing various basin parameters, providing flexible environment and powerful tool for determination, interpretation and analysis of spatial information related to river basins. Geology, relief and climate are the primary determinants of a running water ecosystem functioning at the basin scale John Wilson et al. (2012). Various Morphometric parameters such as drainage pattern, stream order, bifurcation ratio, drainage density and other linear aspects are studied using remote sensing technique and topographical map Mesa (2006). The Peddavagu sub-river Basin of Krishna River is flowing across the Maddur mandal the study area covers an area of 230.77sqkm. The Morphometric analysis of the area is carried out using the SOI toposheet no 56H/9. Particularly the area showing the litho logs found having with granite gneiss. And also six kimberlitic bodies are identified, three near Maddur and one each near Padiripadu. The first mention of the occurrence of Olivine Lamproites/Kimberlitic rocks in the Maddur – Narayanpet area was made in 1985 (G.S.I. 1985). However, a more detailed account of them was presented by Nayak et al. (1988), wherein they considered the occurrences at Maddur and Padiripadu to be Olivine Lamproites.

HISTORY OF THE STUDY AREA

The Peddavagu sub-watershed is one of the tributary of river Krishna which is flowing through Narayanpet and Mahabubnagar district. The watershed covers an area of 230.77 sq.km in the Survey of India toposheet number 56H/9 on a scale of 1:50,000. The watershed area lies between latitudes 16°45′00″ and 17°00′00″ N and longitude 77°45′00″ and 77°30′00″E. The streams have been formed dendritic drainage pattern. Topographically it's an rising and falling nature consisting of Hillocks, Valleys, shallow weathered. The normal annual rainfall in the Peddavagu-Sub watershed drainage spot is 230mm. As monsoon in India is from Jun to Sept. Due to the monsoon maximum water level increase is found during Dec to Jan. Geologically the area exposed with different rock types peninsular gneissic complex of Dharwar Super Group, which covers most of the area, comprises granites, gneisses and Olivine Lamproites/Kimberlitic rocks. The soils originate in the region is covered with Red top soil, Medium Black soils, and combine soils. The atmosphere is categorized in to three time of year at regular intervals in the region which is summer, winter, Rainy. All through summer the high temperaturegets up to 45°C and in winter fall up to 16°C whereas 70% rainfall come up in monsoon time. The mean normal annual rainfall of the district is 604 mm.

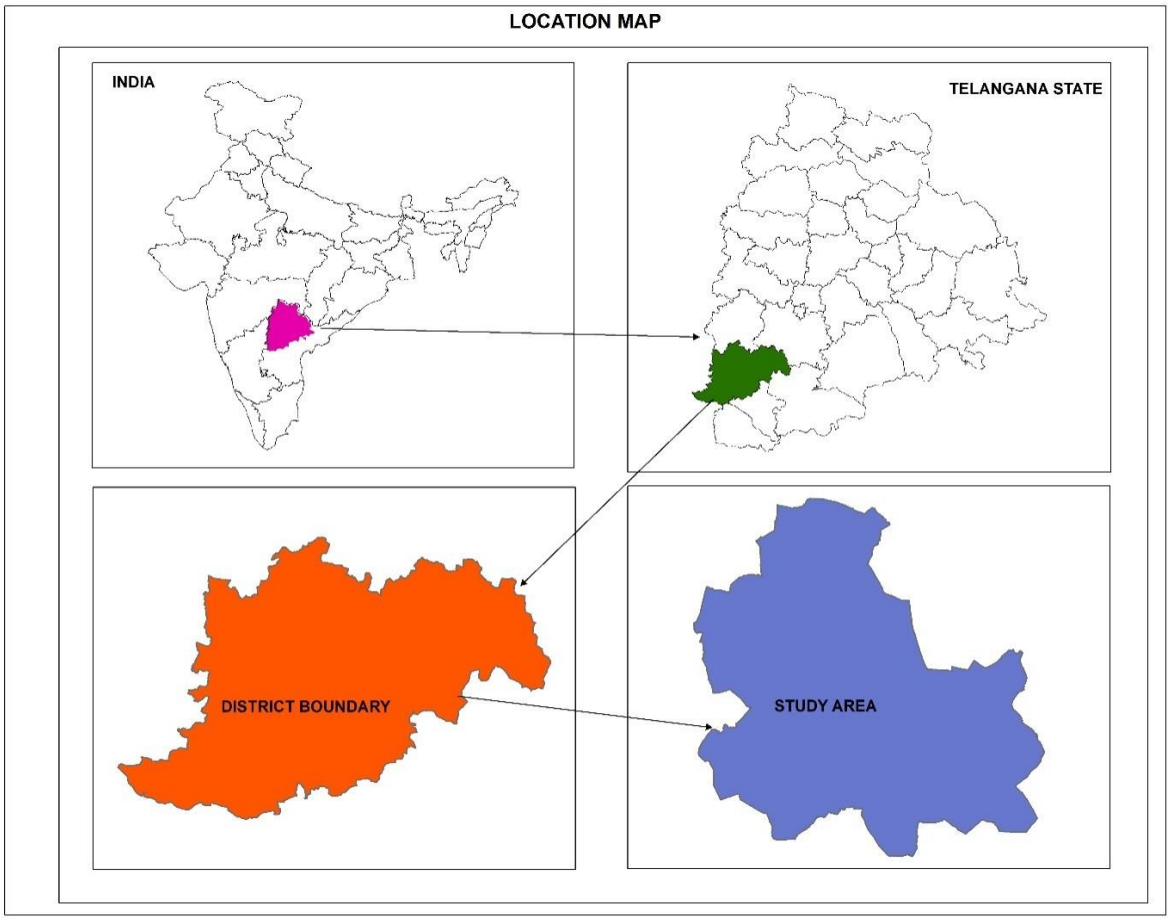
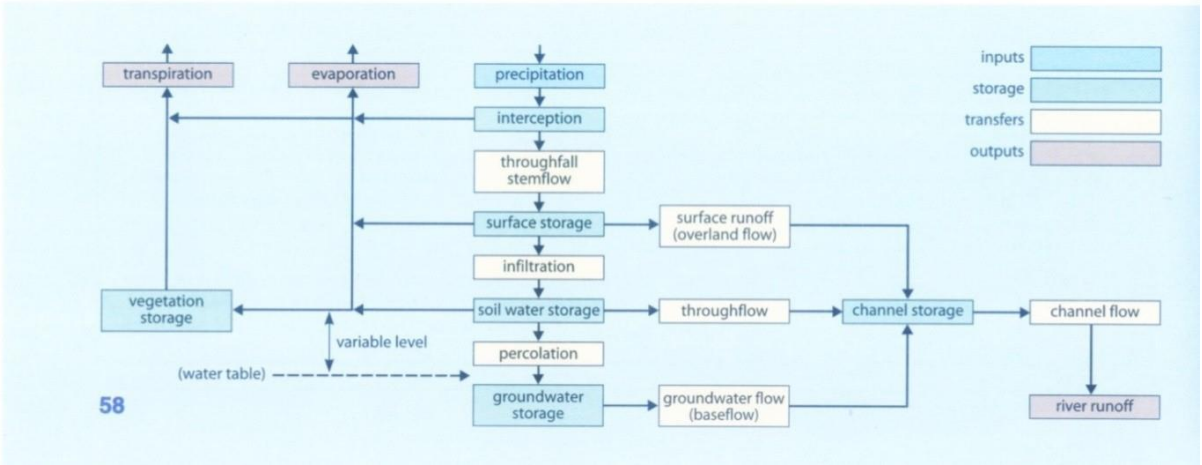


Figure 1: Location map of the study area (Maddur)

Drainage Basin Cycle:



METHODOLOGY

The Maddur mandal Drainage area was delineated through (SOI) Survey of India Toposheet and satellite imagery LISS-IV Topographic map NO.56H/9 OR E43×9 to scale 1:50,000. The study of Morphometric parameters is conducted with the help of

ASTER DEM. The ASTER DEM converts and imported into the ARC-GI software 10.3. The drainage map converted into geo- referencing UTM zone44 northern hemisphere. The drainage system was demarcated with the help of image by support with ARC GIS software. The drainage networks in the toposheets were recognized, which work like separating outline used for the overflow, the stream network was digitized. Stream ordering was done by fallowing Strahler (1964) technique and feature allocate in the direction of demarcated drainage amount of catchments area. The formulate "stream order" is a compute of the arrangement of a stream in the hierarchy of area. The present study area, the passage fragment of the drainage basin has been categorized according to Strahler's stream ordering classification. Based on Strahler calculation (1964), the 1st order streams exist individuals, which have no small river. second order streams survive those, that one have tributaries simply of first order streams, anywhere 2 second order channels join, portion of third order is created. When two third order subdivisions join, there fourth order way is formed. Whereas while two 4th order streams are joining, a segment of fifth order is formed and when two fifth order segments join, 6th Order is formed and so on. Morphometric analysis was established out for the Peddavagu sub-watershed of Krishna River, its flowing across the Maddur mandal drainage 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.

Table 1: Morphometric Parameters for calculating methods

	Morphometric Parameters	**Methods**	**References**
Linear Parameters	Stream order (U)	Hierarchical rank	Strahler (1964)
	Stream length (Lu)	Length of the stream	Horton, 1945
	Mean stream length (Lsm)	Lsm = Lu/Nu where, Lu=Stream length of order'U' Nu=Total number of stream segments of order 'U'	Horton, 1945
	Stream length ratio (Rl)	Rl=Lu/Lu-1; where Lu=Total stream length oforder 'U', Lu-1=Stream length of next lower order.	Horton, 1945
	Bifurcation ratio (Rb)	Rb = Nu/ Nu+1; where, Nu=Total number of stream segment of order'u'; Nu+1=Number of segment of next higher order	Schumn,1956
Relief Parameters	Basin relief (Bh)	Vertical distance between the lowest and highestpoints of watershed	Schumn, 1956
	Relief ratio (Rh)	Rh=Bh/Lb; Where, Bh=Basin relief; Lb=Basinlength	Schumn, 1956
	Ruggedness number (Rn)	Rn = Bh × Dd Where, Bh =Basin relief; Dd=Drainage	Schumn, 1956

	Drainage density (Dd)	Dd = L/A where, L=Total length of streams;A=Area of watershed	Horton, 1945
	Stream frequency (Fs)	Fs = N/A where, N=Total number of streams;A=Area of watershed	Horton, 1945
Aerial Parameters	Stream frequency (Fs)	Fs = N/A where, N=Total number of streams;A=Area of watershed	Horton, 1945
	Texture ratio (T)	= N1/P where,N1=Total number of first order streams; P=Perimeter of watershed	Horton, 1945
	Form factor (Rf)	Rf=A/(Lb) 2 ;where, A=Area of watershed, Lb=Basin length	Horton, 1932
	Circulatory ratio (Rc)	Rc=4πA/P2 ;where, A=Area of watershed, π=3.14, P=Perimeter of watershed	Miller, 1953
	Elongation ratio (Re)	Re=2√(A/π)/Lb ;where, A=Area of watershed,π=3.14, Lb=Basin length	Schumn,1956
	Length of overland flow (Lof)	Lof = 1/2Dd where, Dd=Drainage density	Horton, 1945
	Constant channel	Lof = 1/Dd where, Dd=Drainage density	Horton, 1945

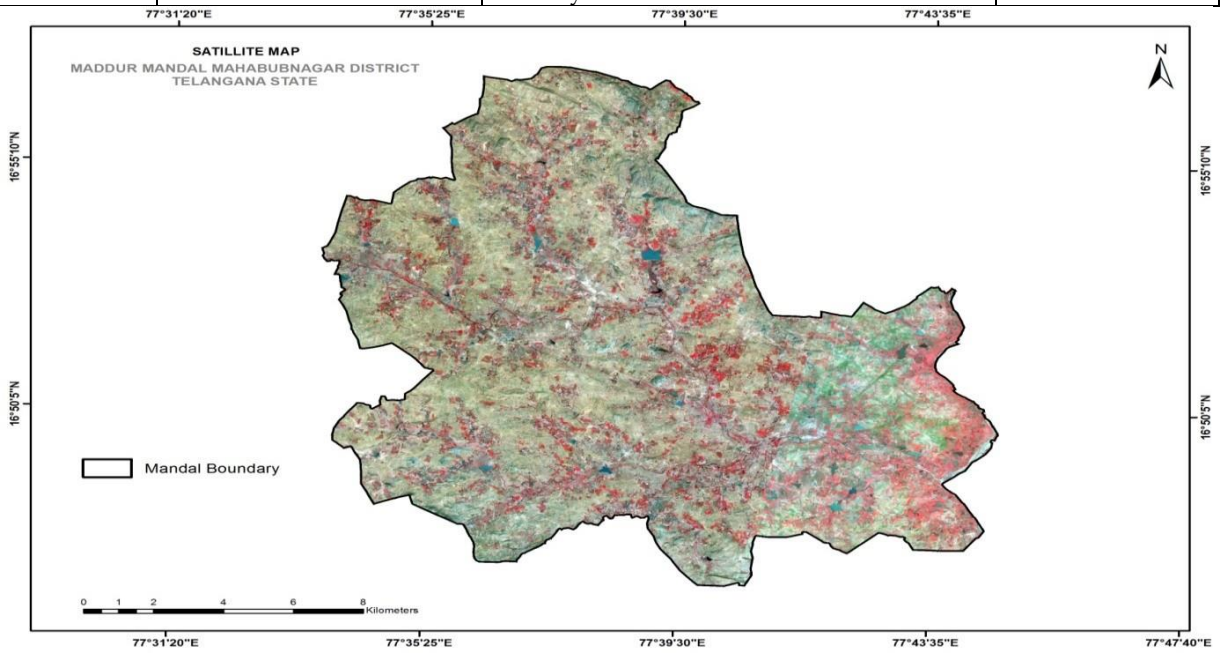


Figure 2: Imagery LISS-IV map of the area

RESULTS AND DISCUSSION

The Peddavagu sub-watershed drainage map is toposheet number is SOI 56H/9 scanned copy digitized through ARC-GIS software. The present study has been carried out for Morphometric analysis of the study area this processes is done by applicability of Horton's

laws ofstream 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 and it is subjective by the common topography of the area and also it can consist rocks it gives information of drainage texture of the nature. All orders of stream numbers are different from First order to Sixth order, The total number of streams are 969 in that 665 are 1st order , 202 are 2nd order ,76 are 3rd order, 21 are 4th order, 4 are 5th order and 1 are 6 th order streams. 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 of overland 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:

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 6th 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 north side began at the highest elevation of 570m.

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 (U):

The word stream number is simply seen along the way with the letter (Nu). My study area Peddavagu sub-watershed has a total of 969 streams; the sixth 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 574 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 andtopography of the area.

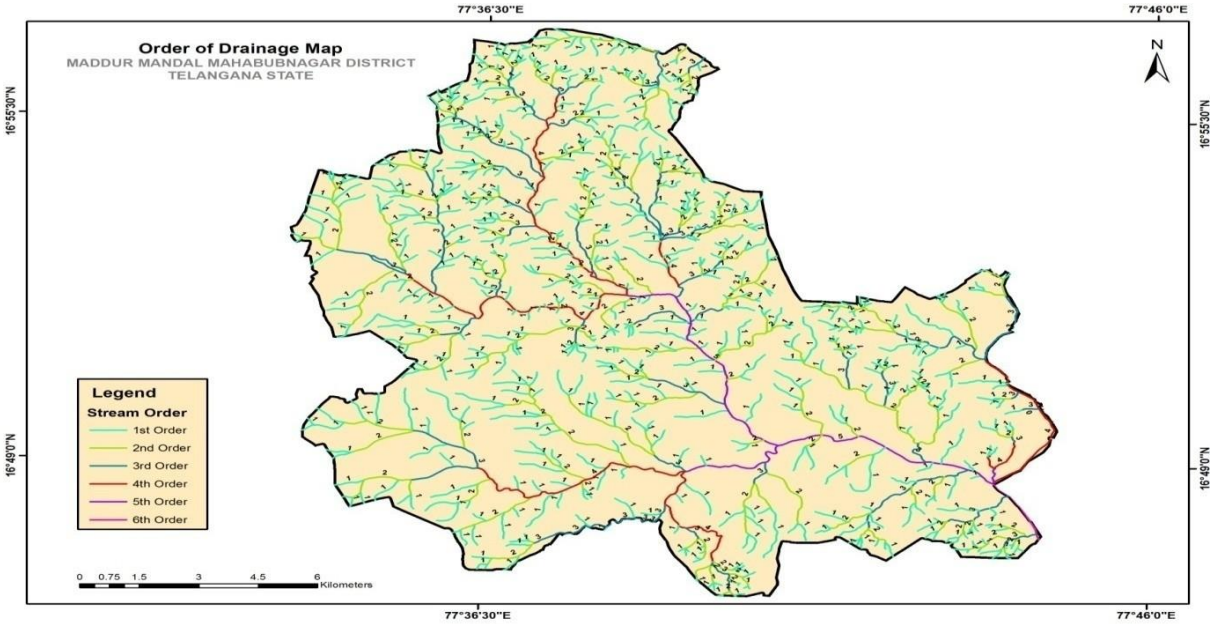


Figure 3: Stream order pattern in the drainage basin of study area

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 Peddavagu drainage area values varies from 3.29 to 4 with a mean Rb value is 3.61. 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 2.29 to 3.

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 a 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 of watershed covers an area of 230.77 sq.km

2.2 Drainage density:

To analysis the Morphomettric 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 futures 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 Peddavagu sub-watershed drainage density is 2.54 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 watershed.

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 Peddavagu sub-watershed drainage area meets at the point of junction of source. The junction point is southeastern parts of the study area. The basin length of the Peddavagu sub-watershed is 17.18.

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 Peddavagu sub-watershed value of Re is 0.99. 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 watershed and the circle of a area the same circumference as the parameter of the watershed. According to Miller (1953). Circularity ratio results show the various landscape texture. 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 70.45. 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 Peddavagu sub-watershed of drainage area is 26.77

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 0.004 to 0.64 the mean value is 0.12, 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). 6th order stream values having higher than the remaining values of Peddavagu sub-watershed of Krishna river.

1st order streams 0.004, 2nd order stream 0.008, 3rd order stream 0.018, 4th order stream 0.034 5th order stream 0.074, 6th order stream 0.64.

Table 2: Morphometric Parameters of the Peddavagu sub-watershed

S. No	Morphometric Parameters Values	S. No	Morphometric Parameters Values
1	Area of the drainage area in Sqkm 230	9	Circularity ratio 70.45
2	Perimeter in km 82	10	Elongation ratio 0.99
3	Axial length in km 17.18	11	Form factor 26.77
4	Breadth in km 14.92	12	Texture Ratio 8.10
5	Drainage density 2.54	13	Maximum watershed relief 570.00
6	Constant channel maintenance 0.39	14	Relief ratio 0.87
7	Stream Frequency 4.21	15	Relative relief 0.05
8	Length of overland flow in Km 1.27	16	Ruggedness number 1285.57

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 Peddavagu sub-watershed value is 0.87. 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 watershed 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)

Table 3: Stream parameters of Peddavagu sub-watershed

Stream order (U)	No. of streams(Nu)	Length of Streams (Lu)	Mean stream length (Lsm)	Bifurcation ratio (Rb)	Stream length ratio(RL)
1	665	305	0.459	3.292079208	2.292079208
2	202	143	0.708	2.657894737	1.657894737
3	76	70	0.921	3.619047619	2.619047619
4	21	37	1.762	5.25	4.25
5	4	17	4.250		
6	1	2	2.000	4	3

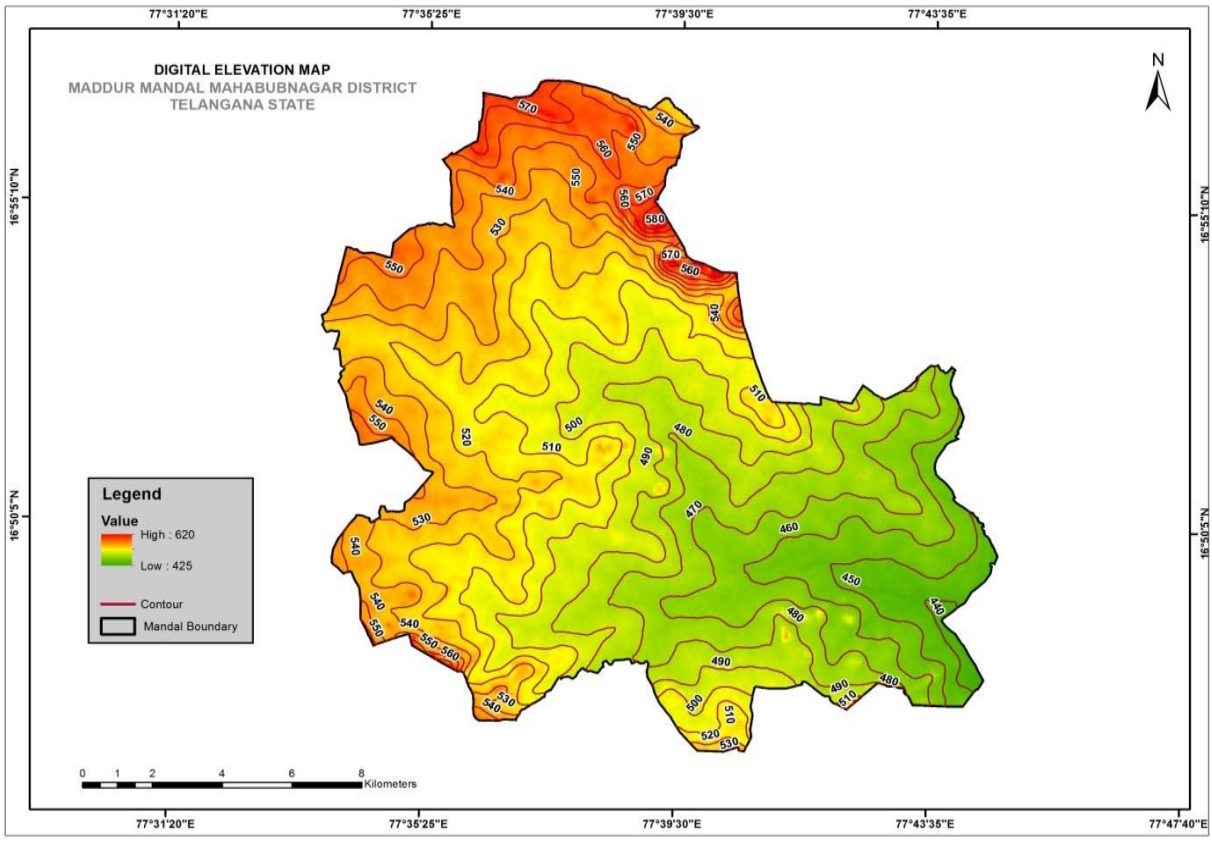


Figure 4: Digital Elevation Model (DEM) of the Study Area

CONCLUSION

The Peddavagu sub-watershed of Krishna river sub surface having a less permeability due to shallow basement geological conditions. The present study has been conducted with the help of ARC-GIS software. The Peddavagu sub-watershed Krishna river is flowing through the Maddur mandal drainage area occupy 230.77 sq.km , the study area stream order varying from 1-6th orders. It is mainly covered by 1st order streams. The first order streams lengths are maximum in study area. The drainage density value of Peddavagu sub-watershed is 2.54 this values shows the good potential area. Especially SE parts of study area having low-lying area. Shallow basement will occurring while two types of geological formations are originated those are granite gneiss and Olivine Lamproites/Kimberlitic rocks. Contour elevations of the river basin varies from 570m to 440m slope direction is towards southeast side of the basin. Drainage density is the most reliable character for Morphometric analysis of basin. The Dd value of the Peddavagu sub-watershed 2.54 .the area having below 5 value shows good potential for determination of recharge structure the stream frequency is also main important parameter. It is associated with the natural and physical activities of the area. The value Fs is 4.21 indicate about the good yielding function. The drainage density was very course in texture. The study area indicate moderate and high relief, low run off and low infiltration, with early mature stage of erosion development are part of relief ratio, Ruggedness and visual interpretation of DEM indicated relief.

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