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Morphometry of upper Sarada River Basin Through Remote Sensing and Geographical Information System, Visakhapatnam, Andhra Pradesh, India

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Abstract:- A morphometry of Upper Sarada river basin has been analysied in this paper with Geographical Information System (GIS 10.4.1). This technique was used to found relevant encompasses size and shape of river basin and its drainage networks of Upper Sarada river basin. In this quantitative analysis has done based on Strahler's system of classification. Hence, we are using the SRTM–DEM data of 30 m resolution, USGS) the data which we downloaded that has been geo processed to analyze and evaluation of linear, slope, areal and relief aspects of various parameters in marpometry. The upper Sarada river basin drainage density is 0.69., whereas frequency vary. The R_b ranges from 0.66 to 4.26. then these veriations indicate structural disturbences and the low drainage densities could not affected to structural disturbances but the area is fully covered under dense vegetation cover. The Upper Sarada drainage basin occupies an area of 853.14 km2. The USRB slope varies from 1 to 10%, even the slope variations depend on the geology and erosion cycles. Therefore the mainstream length ratio is 9.3 it indicating that the USRB is extended with steep slopes and moderate relief. The morphometry of USRB estimated by applying universal methods and techniques viz.

Keywords:- *Morphometry of USRB, DEM, GIS, Upper Sarada River basin.*

I. INTRODUCTION

The morphometry is very useful to know the dimensions of any kind of physiographical features which are existing on the surface of the earth but here we have taken to study the upper Sarada river basin which mostly depends on seasonal rainfalls. In this basin, we would like to measure the basin sides channel slopes relief, area, and drainage network type and other variables of the study area. Later we might be correalate the mathematical parameaters which are defining cheractersticks of basin drainage and basin hydrology as in studies of sediment yield, are generally designated as morphometric analyses. Morphometric analysis is very useful to provide the quantitative depictions of any river basin (1). Different types of hydrological marvels associated with physiographic cheratersticks of drainage basin like size of the basin,shape of the basin, slope of the basin, drainage density, size and length of the contributories etc. (2,3). The morphometry has been analysed through measurement of linear, aerial, relief, slope of channel network (3). The morphometric analysis successfully measured with new technologies like RS and GIS (5,6,7). One of the earlier researchers Pioneer work on basin morphometry has been carried out by Horton (8,9,10,11), and. Remote Sensing and Geographical Information System are very useful to delineate the various thematic layers based on their theems hence we used the Arc Gis 10.4.1 software (Fig.2).

The data which is generated in geographical information system that should be used for elevation model of a landscape extent in upper Sarada river basin. The resolution of the image may vary with respect to the satellite sensors. The DEM downloaded from the USGS which is having 30 m resolution hence the DEM data has used to generate the stream network and other parameaters. The present paper describes the various morphometric parameters of Upper Sarada River Basin.

- *Study Area*

The upper Sarada basin is situated in Devarapalli, Chidikada, Chodavaram and K. Kotapadu mandals of Visakhapatnam district, and partly Vepada mandal of Vizianagaram District Andhra Pradesh, India. The upper Sarada river basin lies between 17°46'40" and 18°15'50" N latitudes and 82°52'45" and 83°07'10" E longitudes in the northern part of Andhra Pradesh, India. The top sheet numbers are 65o/1,2,3.on 1:50,000 Scale in (Fig. 1). The study area is covers 853.14 km^2. The study area is delineated river basin boundary and stream network of basin from SRTM (DEM 30 m resolution) data. the regional projection of this basin is (WGS 1984 UTM Zone 43N). The river originates from the Ananthagiri hill ranges at a height of 1500 m and runs towards the south and drain in to Bay of Bengal, The upper Sarada river is 53.99 Km long. The important tributaries of upper Sarada River basin are Mala Gedda (15.52 km), Isaka Gedda (4.18 km), Tenugupudi Gedda (5.0 km), Pindrangi chemanapalli Gedda (23.00 km) therefore there is Raiwada reservoir (130 Hectares) which is provide water for agriculture for the surrounded villages. The USRB and its surrondings are mostly climate type is tropical In winter, rainfall is less rainfall than in summer. The average annual temperature of upper Sarada River Basin is 28.2 °C. The average rainfall around 1104 mm. January is the driest month which is 0 mm of precipitation, With an average of 228 mm.

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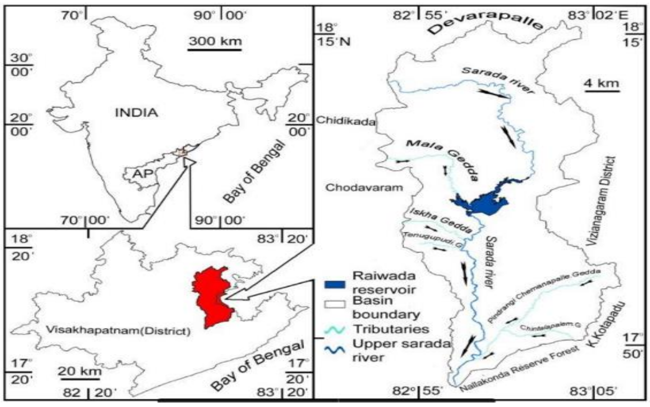
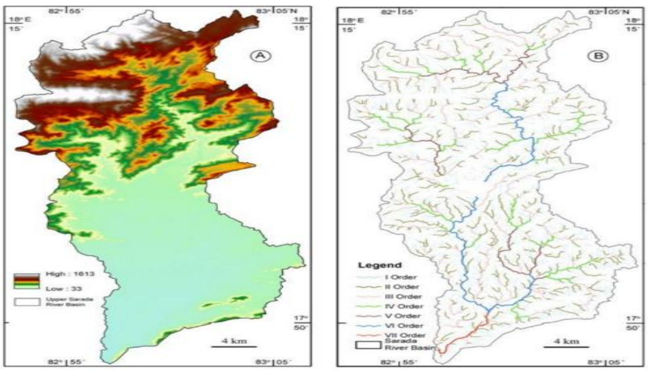


Fig 1:- Location Map of Upper Sarada River Basin (Study area)

II. METHODOLOGY

In this paper studying about Morphometry of upper Sarada river basin for the improvement water and soil conservation, the morphometric analysis studied with the help of digital elevation modal data (30 m resolution) (12,13) and topographical maps.(SOI) which is having 1: 50,000 scale. The drainage map of USRB has delineated (Fig.2 (A-D)with the help of Arc GIS 10.4.1 and some of the direct geometric characteristics such as area and perimeter of the basin, length and number of streams, stream order obtain from Arc GIS 10.4.1. The different morphometric parameters has taken to computed based on the formula suggested by (9,10) The value shown in table 1,2 and 3. The morphometric parameters are computed using ArcGIS 10.4.1 software. All the All morphometric distinctives are taken as a solitary parameter and we assigned knowledge based weightage by with regards to its role in soil erosion. All parameter has given a rank as per their role in the USRB. After the findings of USRB drainage results can understand about the characteristics of drainage basin help in understanding the reliable releated relief and slope possessions. When the any basin parameaters has been caliculated based on that earlier experts we have given a priority classification in 3 ways like the high, moderate and low priorities, when any basin may have high priority that indicates to renovation means to protect the basin from the floods and soil and water conservation.



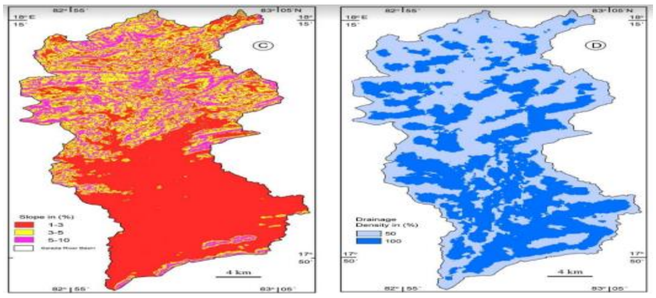


Fig 2:- (A-D) shown digital elevation modal, stream order, slope and drainage density map of study area

Su	Nu	R_b	N_{u-r}	Rb x Nu-r	R_{bwm}
I	1399				
II	328	4.26	1727	7357	3.22
III	95	3.45	423	1459	
IV	25	3.80	120	456	
V	6	4.16	31	129	
VI	2	3.00	8	24	
VII	3	0.66	5	3	
Total	1858	19.33	2314	9428	
Mean		2.76			

Table 1:- Stream order and stream numbers of Upper Sarada River Basin

Su	Lu	L_u/S_u	L_{ur}	L_{ur-r}	$L_{ur} \times L_{ur-r}$	L_{uwm}
I	716.5	0.51	-	-	-	1.23
II	363.8	1.1	0.2	1080	216	
III	195	2.0	1.9	559	1062	
IV	83	3.3	1.57	228	358	
V	43.7	7.3	2.21	127	281	
VI	5.3	2.7	0.36	49	18	
VII	9.3	3.1	1.14	15	17	
Total	1416.6			2058	1952	
Mean			1.05[a]			

Table 2:- Stream length and stream length ratio in Upper Sarada River Basin

1	Strea orders (S_u) m	Stream rank	Strahler (1952)	I - VII
2	First stream (S_{uf})	$S_{uf} = N_1$ $N_u = N_1$? N_2 ? …N_n	Strahler (1952)	1399
3	Stream number (N_u)	$L_u = L_1$? $L_2…L_n$	Horton (1945)	1858
4	Stream length (L_u) Kms		Strahler (1964)	1446
5	Stream length ratio (L_{ur})		Strahler (1964)	0.2 - 2.21
6	Mean strea length ratio (L_{urm}) m		Horton (1945)	1.4
7	Weighted mean stream length ratio (L_{uwm})		Horton (1945)	1.23
8	Bifurcation ratio (R_b)		Strahler (1964)	0.66 - 4.26
9	Mean bifurcation ratio (R_{bm})		Strahler (1964)	2.76
10	Weighted mean bifurcation ratio (R_b)		Strahler (1953)	3.22
11	Main channel length (C_l) km.	GIS software analysis		9.3
12	Valley length (V_l) Kms	GIS software analysis		32.9
13	Minimum aerial distance (A_{dm}) Kms	GIS software analysis		29.6
14	Channel index (C_i)	$C_i = C_l / Adm$ (H and TS)	Miller (1968)	0.31
15	Valley index (Vi)	$Vi = V_l / Adm$ (TS)	Miller (1968)	1.11
16	Rho coefficient (q)	$q = {}_{Lur}/R_b$	Horton (1945)	0.38
17	Basin area (A) Sq Kms	GIS software analysis	Schumm (1956)	853.14 Sq.km
18	Basin length (L_b) Kms	GIS software analysis	Schumm (1956)	56.59 km
19	Drainage density (Dd)	$Dd = Lu\text{-}A$	Horton (1945)	1.69

Table 3:- Morpometric Analysis of Upper Sarada River Basin

III. RESULTS AND DISCUSSION

In this paper we examine about morphometry of upper Sarada river basin to findout the various types of parameters with the help of new technologies which are used lot in all the aspects of digitilizzation, hence we too assessd the strem network geometry of USRB such as barometry of basin, size of drainage basin,the the stream orders, shape and relief of th basin, moreover we carried out the parameaters bifirication ratio,stream length ratio, so on. (Table 3). The morphometry of of USRB has observed and the results shown below. The total USRB area is 853.14 km^2. We find out the denditric drainage system in USRB, The patteren of flow watercourses the dendtrick patteren mostly develops over the rocks which is having with uniform rock structure. Usually the river and its branches are largely depend upon the slope of the basin.

- Stream order (Su)

The stream order is very important to do the quantitative analysis for any drainage basin on the earth. Hence we got seven stream orders in USRB. the total streams are 1858, first stream total is 1399 and the following respectively 328,95, so on. The bifurcation ratio is maximum observed in the second stream and fifth stream order, we used 2,314 streams in the ratio, then finally the mean bifurcation ratio is 3.22 of USRB. The remaining parameters have shown in table 1 and 2.Horton was introduced in 1932. Stream ordering is a one of the widely applied methods for stream classification in a river basin. Stream ordering is defined as ameasure of the position of a stream in the hierarchy of tributaries (Leopold et al. 1964).Based on the Strahler (1964) system of stream ordering, According to the system, the upper Sarada River was found to be a 7th order drainage basin (Fig. 2 B). In the present parameter we have 7 seven stream orders among them the first order has maximum frequency appeared, (Table 1). usually the most of the first order streams located over the hilly region of the basin, the stream,Moreover in this basin demarcated a plenty of streams it indicates the USRB topography has been going to the erosion activity. The stream values are matched with the strahller (1964) which stream values are gradually decreased in proportional to the order increase. (Fig 2 .B)

- *Bifurcation ratio (Rb)*

The term bifurication ratio introduced by Horton in 1932, hence R_b denotes here the bifurcation ratio, is defined as the ratio of the number of streams of any given order to the number of streams in the next higher order in a drainage basin the Rb has shows small veriation of the range among the streams in different types of regions and environments. Except powerful controle of geological factors. The R_b for the Upper Sarada River Basin varies from 0.66 – 4.26 (Table 1) with a mean R_b of 2.76. The mean bifurcation ratio (R_{bm}) characteristically ranges between 1.0 to 5.0 for a basin when the influence of geological structures on the drainage network is negligible (Verstappen 1983). According to the quantitative analysis of morphometry it has showed that the R_b is uneven to the all orders because that might be the development of geological and lithological structures. The table has shows the low bifurcation ratio indicates poor geological disturbances so the drainage system haven't disturbed here the USRB has that total Rb is 19.33 and mean is 2.76. if the Rb value high that indicates the shape of the basin and elongated basin to have high Rb, the circulated basins have the low R_b.

- *Weighted mean bifurcation ratio (R_{bwm})*

The Rbwm is obtained by the multiplying of the Rb for each pair of order, according to the strahler and Schumm. The USRB has the Rbwm is 3.22.

- *Stream number (N_u)*

The stream orders are obtaining from the CartoSat-1 DEM (30 m resolution) and counted separate. In the present basin we recognised 186 stream segments so it is large runoff pattern lies in this, so the morphometry analysis is used to develop the watershed management and to identify the runoff zone, groundwater recharge zone and storage. Hence the high-ranking order value of strems indicate unexpected burst of rainfall and it leads to floods in the basin. (Fig 2.B)

- *Stream length (L_u)*

Usually, the first order stream segments are maximum in proportional to increasing stream order but here is whenever the streams are shown the small value that indicates the steep slopes and fine texture of basin. If the values are high indicates to the of low gradients, but the stream length is calculated from the river mouth to the drainage with ArcGis10.4.1 based on Hortons law. The total stream length of the USRB is 853.14km2.

- *Mean stream length (L_{um})*

The mean stream length getting by the divided by the total length of stream and an order by the total sum of segments. The mean stream length values are not uniform in all the basins but uneven distribution depends on the topographical conditions and their sizes. In USRB L_{sm} is 1.4 according to Horton 1945, based on the size and surface conditions of the basin.

- *Stream length ratio (L_{urm})*

The stream ratios are not uniform because of the streams lengths also vary which are existing in the basic. Similarly the stream length ratio also not even it has significance changes occurred, on the other hand these values are not even due to the might be the gradient of the basin and topography. hence Lurm denotes the mean stream length, according to Horton he has taken the following the ratio of the mean (L_{ur}) segments of order (S_o) segments of the next lower order (L_{u-1}), on the other hand the changes of length ratio from one order to other indicates to development of the basin in the late youth stage of geomorphic development.

- *Basin length (L_b)*

L_b denotes here basin length this is the longest length of the basin from the origin of the water to the point of confluence (Gregory andWalling 1973). The Upper Sarada River Basin originates from the from the Ananthagiri hill ranges at an altitude of 1500 m above mean sealevel and enter into the Bay of bengal. The basin length fixes the shape of the basin. When the basin has maximum length that denotes as elongated basin. L_b of USRB is 56.59 km (Table 3). Channel index (C_i) and valley index (V_i) To the determination of bend and curvey nature of basin we generate the rivers in Arc Gis later divided in to numerous segments to identify. (Table 3).

- *Basin area (A)*

The USRB collects water from the various streams from the uplands to the plain area, according to Morphometry A states the basin area, the river basin is an important to determine the stream length, the USRb is computed with Arc Gis 10.4.1 that is 853.14 km^2 (Table 3).

- *R_{ho} coefficient (q)*

The R_{ho} coefficient is another parameter in Morphometry, the letter "q" denotes R_{ho} coefficient, it determines the drainage density of any basin that leads to develop watershed to storage capacity of watershed. On other hand the R_{ho} determines the denudation process of the basin. Anthropogenic factors. The R_{ho} value of USRB is 0.38.

- *Drainage density (D_d)*

Dd denotes the drainage density according to Chorely, it is important indicator to determine the measurement of landscape dissection and runoff potential. It studied about the total stream length in a USRB is 1.69km^2.

- *Slope*

It is also one of the vital feature of Morphometry and important in hydrological study, most of the streams in the basin is flowing towards the downward, here in the, Most of the basin is placed in the southern part based on the ground truth it flows towards down based on the slope, The slope map shows the most of the northern part of the Basin is higher slope gradient is lies. The USRB slopes vary from 1 to 10 degree whatever we seen in some of the studies the factors influence on the basin such as climattemorphogenic process. (Fig.2C). Usually steep angle hill effects in quick runoff with possible top soil loss or erosion cause of corrosion, attrition and destruction.

- *Drainage Flow direction*

The DEM has been generated by using of Cartoset dataset which is having 30 mt resolution. Even the water can be flows depending on the gradient slope of the basi which is having 1-10 degree. The USRB direction of flow in between 1–128. The elevation of water flow of this basin has caluculated among the centers distance. Moreover the basin water flow direction determined by the basin, but here we fiond out that the water flow direction towards the easterward of this basin as well as on the side of southern part of the basin towards western flow direction.

IV. CONCLUSION

The present paper emphasised the connotation of quantitative morphometry in study area such as stream order due to that it has belongs to the seventh order drainage basin, moreover in this study we delineate 7 stream orders. The another morphometry of this basin is bifurication ratio which is occurs between 0.66-4.26 is uneven due to the geological and lithological variations of the basin. Followed by weighted mean bifurication ratio that is around 3.22, the total streams in the basin is 1858, where as stream length (), mean stream length ratio, basin length (56.59 km), basin area (853.14 km^2), q is 0.38 of the basin, Dd is 1.69 km^2. The very significant morphometric is slope which is influence direct impact on drainage of any basin (Fig.2C), moreover the drainage flow too depend on the slope (1-128) which is caliculated using the DEM data by geographical information system.

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