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RESEARCH ARTICLE

Morphometric Studies on Part North Pennar Basin using Remote Sensing and Geographic Information System Techniques.

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Abstract

The morphometric analysis within the study area South-East Dry agroclimatic region of Karnataka the forest area are dominantly distributed within the forest area selected part of North Pennar Basin sub basin for morphometric analysis. Morphometric analysis includes for several drainage basin parameters include stream order, stream length, bifurcation ratio, drainage density, drainage frequency, form factor, elongation ratio, circularity ratio, texture ratio, length of overland flow and constant of channel maintenance are also calculated. Using GIS Software to analyse the within the sub basin morphometrical feature of selected sub basin.In The North Pennar Basin area is 43.12Sqkm The morphometric parameters ranges between Bifurcation Ratio (2.00 to 4.96), Drainage density (2.162), Drainage frequency (3.372), Circularity ratio (0.600), Texture Ratio (4.833), length of overland flow (0.231), Basin Length (12.4), Form factor (0.280).

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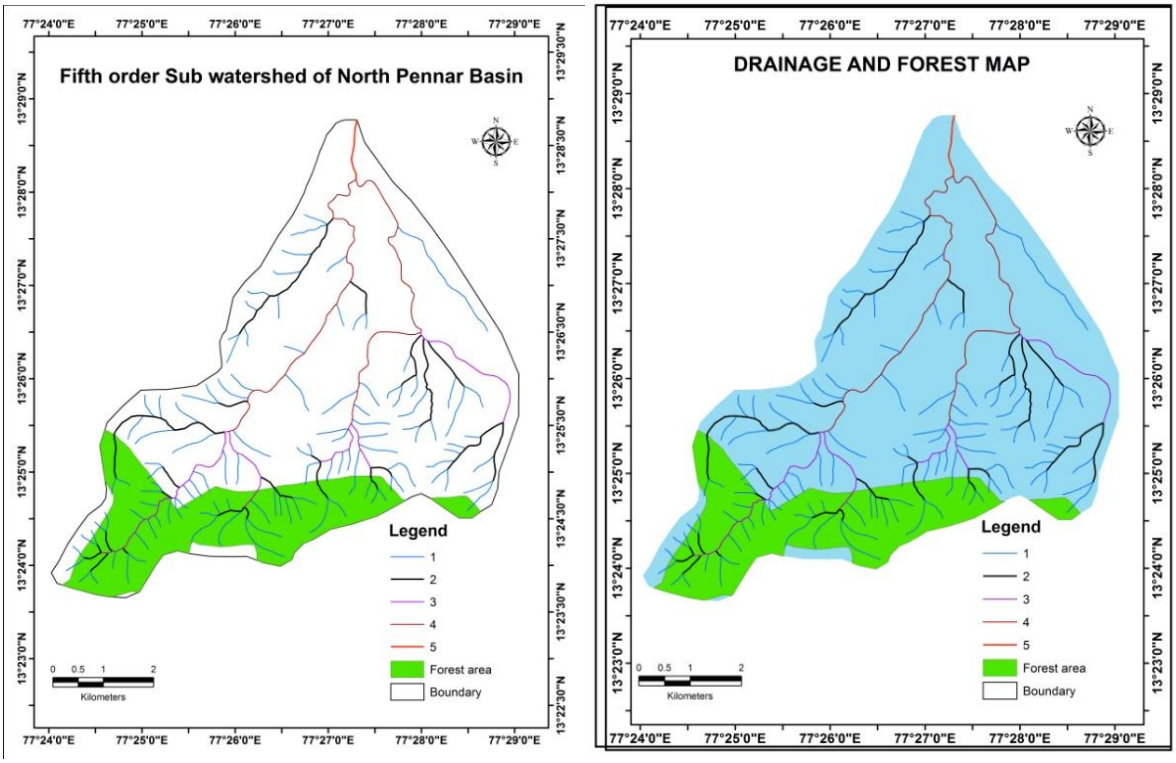
Introduction:-

The drainage basin analysis is important in any hydrological investigation like assessment of groundwater potential and groundwater management. 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 tributaries etc. The digitization of dendritic drainage pattern was carried out using Arc GIS 9.3 software, it is very useful to understand about in the dry agro climatic region (Forest area), using GIS software user-friendly to digitizing the drainage pattern of represented area. The Morphometrical analysis like linear and areal and relief aspect of the selected part of two sub watershed. Fluvial morphometry is the measurement and mathematical analysis of configuration of earth surface and of the dimension of its landforms originated due to fluvial processes. The morphometric analysis is carried out through measurement of linear, aerial and relief aspects of the basin and slope contribution (Nag and Chakraborty, 2003)

Material and Methods:-

The study area is situated in the South-Eastern dry agroclimatic zones of Karnataka and lies between the Longitude 77*27'30"E to 77*37'30" E and Latitude 12*35'0"N to 12*22'30"N The study area covers about 43.12 Sq.km of Kanakapura Taluk these areas covers by some part of forest. The North Pennar basin. The SOI Topo-sheet and Sub Watershed is used to delineate the boundary and morphometric analysis. The base map used for morphometric analysis carried out through GIS Mapping using SOI topographical sheet of the area scale of 1:50,000. The required GIS maps like location map, Drainage map, watershed map of the study area has been generated and morphometric spatial analysis tool is extensively used for calculation purpose.

SOI Toposheets→ GIS Software → Digitisation Drainage →Morphometry Clculation → Condition of Sub-Watershed → Creating Drainage patterns



Map 1.1:- Drainage Map

Morphometry:-

Remote Sensing and GIS techniques have been proved to be efficient tools to use the delineation, updating and morphometric analysis of drainage basin. The rpresent study incorporates a morphometric analysis of two sub-basins of South-East dry agroclimatic region of Karnataka these watersheds are selected for within the forest area forest areas are covered in these Sub watersheds using remote sensing and GIS techniques. The morphometric parameters of the sub-basins are classified under linear, areal and relief aspects. While the mean bifurcation ratio values suggest that the geological features are not disturbing. The geographic and geomorphic characteristics of a drainage basin are important for hydrological investigations involving the assessment of groundwater potential, watershed management and environmental assessment. The correlation between physiographic characteristics of drainage basins such as size, shape, slope of drainage area, drainage density, size and length of the tributaries, etc., to various hydrologic phenomena has been reported by Rastogi and Sharma (1976).

Table 1.1: Methods of calculating morphometric parameters

	Morphometric Parameters	Methods	References
LINEAR	Stream order (U)	Hierarchical order	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 of order '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
ARIAL	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
	Texture ratio (T)	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)	$Rc=4\pi A/P2$; where, A=Area of watershed, π=3.14, P=Perimeter of watershed	Miller, 1953
	Elongation ratio (Re)	$Re=2\sqrt{(A/\pi)}/Lb$; 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 of channel maintenance (C)	C = 1/Dd; where, Dd=Drainage density	Schumn,1956
	Compactness ratio (Cc)	$Cc=0.2821*P/A^2$;where, P=Perimeter of the basin(km), A=Area of the basin (km^2)	Horton, 1945

Morphometric Parameters:-

Linear Aspects:-

The linear aspects of morphometric analysis of basin include stream order, stream length, mean stream length, stream length ratio and bifurcation ratio.

Stream Order (Nu):-

There are four different system of ordering streams that are available (Horton, 1945; Strahler, 1964). Sub-basin of North PennarBasinshows First order 114, second order 23, third order 5, fourth order 2, Fifth order 1 numbersdrainages presents in the Sub-basin of North Pennar Basin of Fifth order drainage basin table (1.1) Map (1.1).

Stream length (Lu):-

The stream length ratio can be defined as the ratio of the mean stream length of a given order to the mean stream length of next lower order and has an important relationship with surface flow and discharge (Horton, 1945).and Sub-basin of North Pennar Basin are showing sixth and fifth order basin.

Mean stream length (Lu/Nu):-

Mean stream length of a stream channel system is a dimension less property reveling the characteristic of the size of the component of the drainage network and its contributing basin setLu=∑Lu/Nu,→Where ∑Lu = Total length of the order,→Nu = Number stream of that orderand Sub-basin of North Pennar Basin shows First order 0.42, second order 0.83, third order 2.20, fourth order 7.00, Fifth order 1.00 numbers mean stream length ratio (km) presents in the Sub-basin of North Pennar Basin of Fifth order drainage basin table (1.2) Map (1.1).

tream Length ratio (RL):-
The stream length (Lu) has been computed based on the law proposed by Horton. Stream length is one of the most significant hydrological features of the basin as it reveals surface runoff characteristics. Stream length ratio (RL) is ratio of the mean length of the one order to the next lower order of the stream segment. The number of first to fifth order is total stream length of the study area is 7.950 km.

Bifurcation Ratio (Rb):-
Bifurcation shows a small range of variation for different regions or for different environments except where full geological control dominants (Strahler, 1957).Rb = Nu/Nu+1 where, Rb= Bifurcation Ratio, Nu = number of Segments of the given order Segments. Nu+1= Number segments of the next higher order.Sub-basin of North Pennar Basin shows First order 4.96, second order 4.60, third order 2.50, fourth order 2.00 observed in the Sub-basin of North Pennar Basin of Fifth order drainage basin table (1.3) Map (1.1).

Drainage density:-
It may be considered as one of the methods of measurement of basin area. According to Horton, Drainage Density is defined ratio of total length of all stream segments in a given drainage basin to the total area of that basin. It is expressed by a formula DD=∑L/A Where, ∑L = Total length, A = Total area. In the study area drainage density has calculated, drainage density ranges between 2.162sqkms in sub basin of North pennar basin Map (1.1).

Stream frequency / Channel frequency:-
The total number of stream segments of all orders per unit area is known as stream frequency (Horton, 1932). Hopefully, it is possible to have basins of same drainage density differing stream frequency and basins of the same stream frequency differing in drainage density. The Stream frequency in North Pennar basin shows 3.3 Map (1.1).

Drainage texture or Texture ratio:-
Drainage texture is the total number of stream segments of all orders per perimeter of that area (Horton, 1945).The texture ratio in the study area North Pennar basin The values of texture ratio of the study area 4.8 Map (1.1).

Aerial aspects:-

Form factor (Rf):-
Form factor (Ff) is defined as the ratio of the basin area to the square of the basin length (Chow, 2010). The value of form factor would always be greater than 0.78 for a perfectly circular basin. Smaller the value of form factor, more elongated will be the basin. The form factor in the study area noted that 0.280 in North Pennar basin.

Circularity ratio (Rc):-
Circularity Ratio is the ratio of the area of a basin to the area of circle having the same circumference as the perimeter of the basin (Miller, 1953).The circularity ratio show in the study area part Sub watershed of North Pennar Basin circularity ratio its shows 0.600 Map (1.1).

Elongation ratio (Re):-
Schumm (1956) defined elongation ratio as the ratio of diameter of a circle of the same area as the drainage basin and the maximum length of the basin. The formula used to calculate Elongation Ratio is
Re= (2/Lb)*(A/3.14*0.5)
Elongation ratio shows North Pennar basin 0.597 the study area results indicate that 0.597 (<0.7) the represented basin is elongated area. Map (1.1).

Compactness constant (Cc):-
Compactness ratio is defined as the ratio between the area of the basin and the perimeter of the basin. Cc=0.2821*P/A2. The study area Cc observed 0.236 in Sub basin of North Pennar basin.

Length of Overland Flow (Lof):-
The Length of Overland Flow (Lg) is the length of water over the ground surface before it gets concentrated into definite stream channel (Horton, 1945). Length of overland flow North pennar basin shows 0.231 Map (1.1).

Constant of Channel Maintenance (Ccm):-

Constant of channel maintenance, as the inverse of drainage density observed in Sub basin of North Pennar basin 0.462Map (1.1).

Discussion and Conclusion:-

The different values of morphometric parameters derived from different sources will affect the outcome of the basin and influence the main channel. Modern technologies like ArcGIS 10.2 Software, high spatial resolution data can be effectively used towards morphometric parameters analysis towards fast processes and the high resolution data resemble the manual outcome (Dikpal & Prasad, 2015). The morphometric analysis of the drainage network of the watershed show trellis and dendric patterns. In the Sub-basin of North Pennar Basin of Fifth order drainage basin, drainage density ranges between 2.162sqkms in sub basin of North Pennar basin and in the study area forest area dominantly distributed in the Southern part and Northern part of the study area, Elongation ratio shows Sub basin of North Pennar basin 0.661In the study area results indicate that 0.661 (<0.7) the represented. Morphometric parameters of the sub watershed describe in the table (1.3).

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Table 1.2:- Calculation of different Morphometric parameters of fifth order sub watershed of North Pennar Basin.

				Stream Orders					Total no of streams in Km
Sub-basins of	Sub-basin Area (Km2)	Perimeter (Km.)	Basin Length (Lb in km)	I	II	III	IV	V	
North Pennar Basin	43	30	12.4	114	23	5	2	1	145

Mean Stream Length (LSM) in km				
I	II	III	IV	V
0.42	0.83	2.20	7.00	1.00

Stream Length Ratio in (km)					
I	II	III	IV	V	Total Stream Length
	1.962	2.663	3.182	0.143	7.950

Table 1.3:- Calculation of different Morphometric parameters of fifth order sub watershed of North Pennar Basin.

Bifurcation Ratio				
I	II	III	IV	V
4.96	4.60	2.50	2.00	

SI.No	Shape Parameters	Area
1	Drainage Density (Km/Sq Km.)	2.162
2	Drainage frequency (Streams/ Sq km.)	3.372
3	Circularity Ratio (Rc)	0.600
4	Texture Ratio (T)	4.833
5	Length ofoverland flow(Lg)	0.231
6	Basin Length(Lb in km)	12.4
7	Form factor Ff	0.280
8	Elongation Ratio (Re)	0.597
9	Compactness constant (Cc)	0.236
10	Constant of Channal Maintenance (C)	0.462

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