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MORPHOMETRIC ANALYSIS OF NAR RIVER BASIN, RAMPUR BAGHELAN BLOCK, SATNA DISTRICT (M.P.) USING REMOTE SENSING AND GIS TECHNIQUE

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Abstract

In the present paper, an attempt has been made to study the drainage morphometry of Nar river basin. A drainage map of the study area has been prepared with the help of Arc GIS 10.3.1 The present study deals mainly with the geometry, more emphasis being placed on the evaluation of morphometric parameters such as stream order (Nu), stream length (Lu), bifurcation ratio (Rb), drainage density (D), stream frequency (Fs), elongation ratio (Re), circularity ratio (Rc) and form factor ratio (Rf) etc.The Morphometry analysis is mathematical calculation of the parameter likes stream order, bifurcation ratio, and drainage density and so on. study area selected is Nar river basin which is located in Rampur Baghelan block of Satna district of Madhya Pradesh state and covered between Longitude 80°58'40.546"E to 81°8'53.944" E and Latitude between 24°37'56.971"N 24°22'52.068"N. Different Morphometric parameters were calculated by spatial and nonspatial analysis of drainage basin with the help of Arc GIS software. The drainage density (Dd) of study area is 1.65 km/sqkm2.This study would help the local people to utilize the resources for sustainable development of the basin area.

Introduction

Remote Sensing and GIS techniques are proved to be an efficient tool in the delineation, updating and morphometric analysis of drainage basin. Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape, dimension of its landforms (Clarke, 1966). The Morphometric analysis consists of linear, Aerial and relief aspects. Morphometric analysis brings out the basic characters on the geometrical and mechanical aspects of the river basin which in turn would be helpful in understanding the hydrology, sediment and evolution of landscapes in the basins (A.K. Bhardwaj, 2014). GIS techniques are now a day used for assessing various terrain and morphometric parameters of the drainage basins and watersheds, as they provide a flexible environment and a powerful tool for the manipulation and analysis of spatial information.

Study Area

The study area selected is a watershed of Nar River in Rampur Baghelan Block of Satna district of M.P. state, India. Basin located between Longitude 80°58'40.546"E to 81°8'53.944"E and between Latitude 24°37'56.971"N to 24°22'52.068"N N (Fig1).

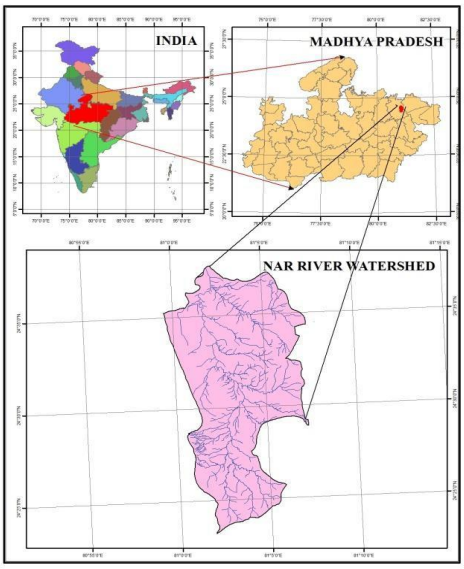

Figure 1. Location map of the Study area

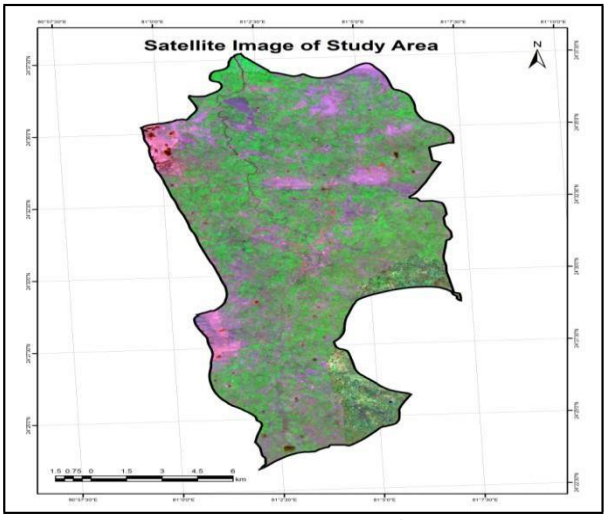

Figure 2. LISS III image of the Study area

Methodology

Brief methodology adopted for analysis is presented in figure 3. This work is based on map analysis carried out on morphometric parameter on toposheet No.63d/14 and 63h/2 and 63h/3 on scale 1:50,000 published by Survey of India. Satellite image of IRS LISS III is used for updation of drainage and terrain topography analysis. The toposheet is registered with the help of Arc GIS software which minimize errors during digitization. Basin drainage is digitized from toposheet and attributes are filled in each stream. Thereafter, the studied basins were demarcated through the insertion of watershed lines.

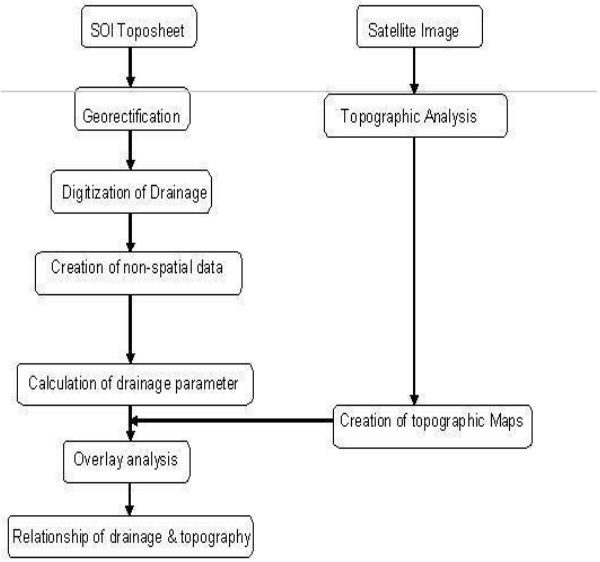

Figure 3. Methodology adopted for Drainage analysis (Agarwal Shyam Avtar et al, 2015)

Basin Morphometrics Parameter

The following basin parameters were calculated with the procedure and formula given is as follows:

Basin Area
Map scale x counted squares (Gregory and Walling, 1973)

Circulatory ratio-
$Rc = 4\pi A/P^2$ where Rc = Circulatory ratio, A =Basin area, P=Basin Parameter and π=Constant (Miller, 1953)

Bifurcation ratio Rb
$Rb = Nu/Nu + 1$ where Rb = Bifurcation ratio, Nu = Number of streams in the order U and Nu +1= umber of streams in the next higher order (Gregory and Walling, 1973)

Drainage density
DD = ΣL/A; where DD = Drainage density, ΣL = Sum of all stream lengths and A = Basin area (Horton, 1932)

Number of streams
ΣNu; where Nu is the stream number and Σ = Sum (Strahler, 1952)

Elongation ratio
$El = \frac{2\sqrt{A/\pi}}{L}$ where El = Elongation ratio, A = Basin area L = Basin length (Schumm, 1956)

Form factor
F = A/L2 where F = Form factor, A = Area of the basin and L = Length of the basin (Boyce and Clark, 1964)

Leminiscate ratio
K = L2/4A where L = Length of the basin and A = Area of the basin (Schumm, 1956).

Stream frequency
Sf = ΣNu /A where Sf = Stream frequency, Nu = Number of stream, A=Basin area (Horton 1945).

Linear Basin length
This is the straight line from the mouth of the basin to the farthest point on the basin perimeter. (Schumm, 1956).

Total stream length
This is the total length of all the tributaries and the principal drainage (Schumm, 1963).

Average stream length
Total stream length divide by total number of streams (Schumm, 1963).

Main stream length
This is the length of the principal drainage line (Schumm, 1963).

Result and Observations:

Calculated Stream parameter of Nar river basin and other Basin morphometric parameters are shown in table1 and Table 2 respectively with the help of drainage map (fig. 3) and stream frequency map (fig.4) of the study area.

Table 1: Stream Parameter of Nar river Basin

Stream					
Order	I	II	III	IV	V
Number	269	59	13	4	1
Length(KM)	187.62	87.179	38.99	15.19	22.9
	I/II	II/III	III/IV	IV/V	
Bifurcation ratio	4.5	4.5	3.2	4	

Table 2: Basin morphometric parameters

S.No.	Parameters	Computed Values
1	Watershed Area	212.99 Sqkm
2	Watershed Perimeter	81 km
3	Circulatory Ratio	0.4
4	Mean Bifurcation Ration	4.05
5	Drainage Density	1.65km/sqkm
6	Number Of Streams	346
7	Elongation Ration	2.76
8	Form Factor	3.2
9	Stream Frequency	1.62
10	Watershed Length	33.08 km
11	Total Stream Length	351.879
12	Average Stream Length	1.01

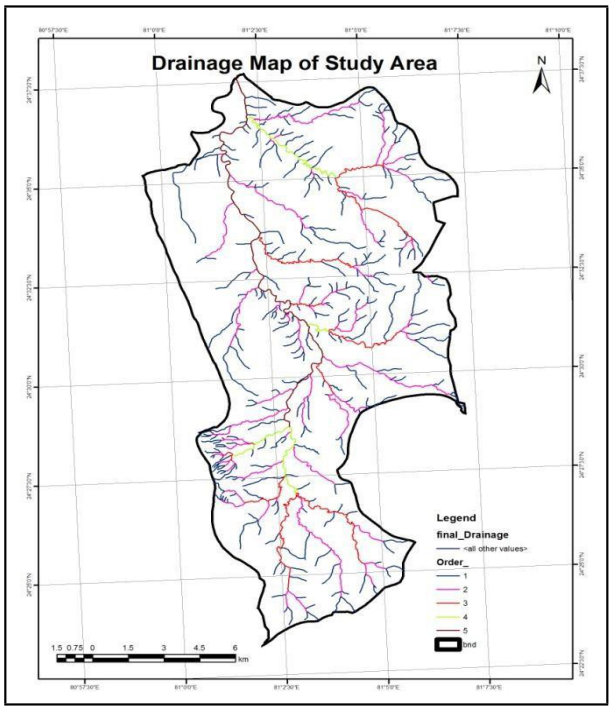

Figure 4: Map showing Stream order of Basin.

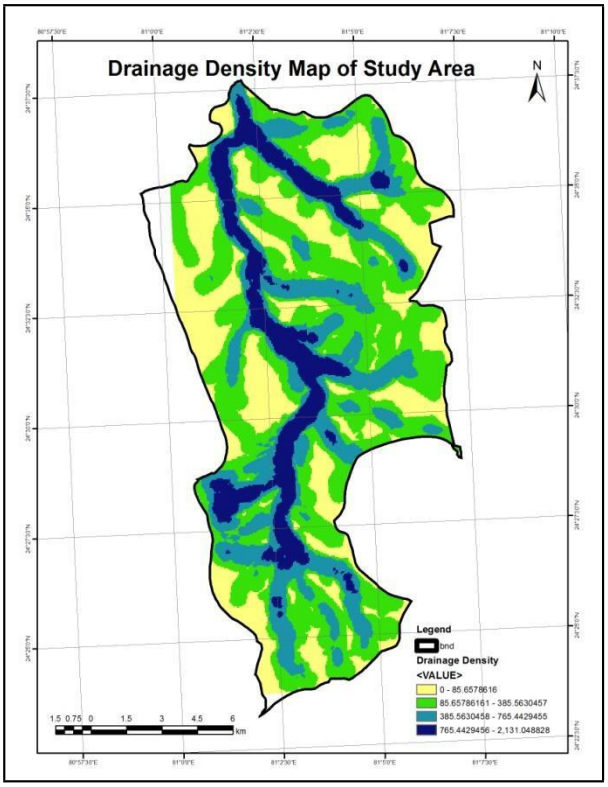

Figure 5: Map showing Stream Frequency of the Basin

Conclusion

From the quantitative study, it is seen that the basin forms the dendritic pattern of drainage. Mean bifurcation ratio is calculated for the watershed as 4.05.The quantitative analysis of Morphometric parameters such as drainage density, stream frequency bifurcation ratio etc. Drainage density reflects land use and affects the infiltration and the watershed response time between the precipitation and discharge. The study reveals the interrelationship between drainage properties and terrain topography of the respective area such as high drainage density area show elevated area and vice-versa. The drainage pattern is controlled by topography of the area which results flow of streams in dendritic drainage pattern.

Acknowledgments

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