

Morphometric Analysis for Hydrogeological Studies in River Basin in Garoth Area, Mandsaur District, Madhya Pradesh, India

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Abstract

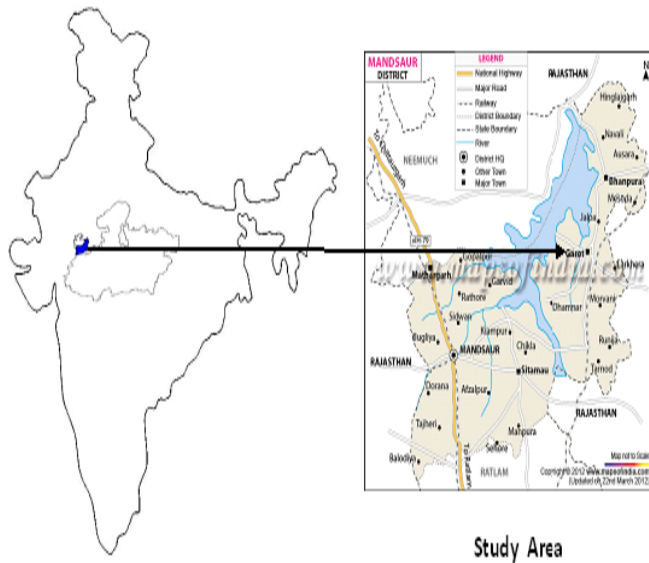
The study of Morphometric analysis of the Ansar and Rupaniya River basin of Garoth area located in Mandsaur District of Madhya Pradesh, India has been geometries to the conduction of water and sediment during the basin. Systematic explanation of the geometry of a drainage basin and its stream waterway requires quantity of linear, areal and relief aspects of the channel network and causative ground slopes. In the present study, the Morphometric analysis has been carried out about results as stream order, stream length, bifurcation ratio, stream length ratio, basin length, drainage density, stream frequency, elongation ratio, circularity ratio, form factor, basin relief, relief ratio, parameters specify a fairly good variation range and their significance has been discussed. The properties of the stream networks are highly important to study the landform making processes. These study are identifying and planning the groundwater potential zones.

Keywords:

Morphometry; channel network; ground slopes; ground water

Introduction

The Present study area is located in Ansar and Rupaniya River basin of Garoth area located in Mandsaur District of the Malwa plateau in state of Madhya Pradesh. The longitude is 75⁰ 35` to 75⁰ 40` E and latitude is 24⁰ 15` to 24⁰ 20` N (Survey of India topsheet No. 46 P/11 on the scale 1:50,000) (Fig. 1). Geomorphology is with the study of land forms and Reduce processes. The land forms are resulted due to erosional and depositional earth's relief features "The description of the land form was first attempted by Davis (1966) on the basis of genesis Rasel (1949) recognized different stages in the development of land forms.



Study Area

Fig: 1 Location Map of Garoth Area, Mandsaur District, M.P.

Geology of the area

The Geological Survey of India prepared the geological tectonic and others types of maps for the county. They have covered the present area by systematic geological mapping on the large scale in recent years.

The area is chiefly occupied by the middle trap flow locally known as “ Malwa Trap” Each flow has different sub-unit consisting of massive basalt, vesicular basalt Geological basalts (Cretaceous to Eocene).



Fig 2: Geological Map of Study Area.

Results and Discussion:

The study area part of Malwa plateau belonging to the Deccan volcanic provider Geomorphologically, the Deccan trap area is characterized by a flat topography with the few isolated low flat topped hills, valley and soil.

Morphometry relates basin and stream system geometries to the transmission of water and sediment in the basin. The regular explanation of the geometry of a drainage basin and its stream river requires quantity of linear, areal and relief aspects of the channel network and causative ground slopes. In the present study, the Morphometric analysis has been carried out about parameters as stream order, stream length, bifurcation ratio, stream length ratio, basin length, drainage density, stream frequency, elongation ratio, circularity ratio,

form factor, basin relief, relief ratio, channel gradient using numerical as given in Table 2.

Morphometric Analysis of the Area

Horton (1945) and Strahler (1952) proposed the method count of stream which are followed in present text.

First order streams have no tributaries. second order no tributaries second order streams are resulted by joining two first order stream & third order stream in resulted by joining two second order stream and so on

Morphometric analyses is performed to elaborate quantitative data by different parameters to express basin characteristics.

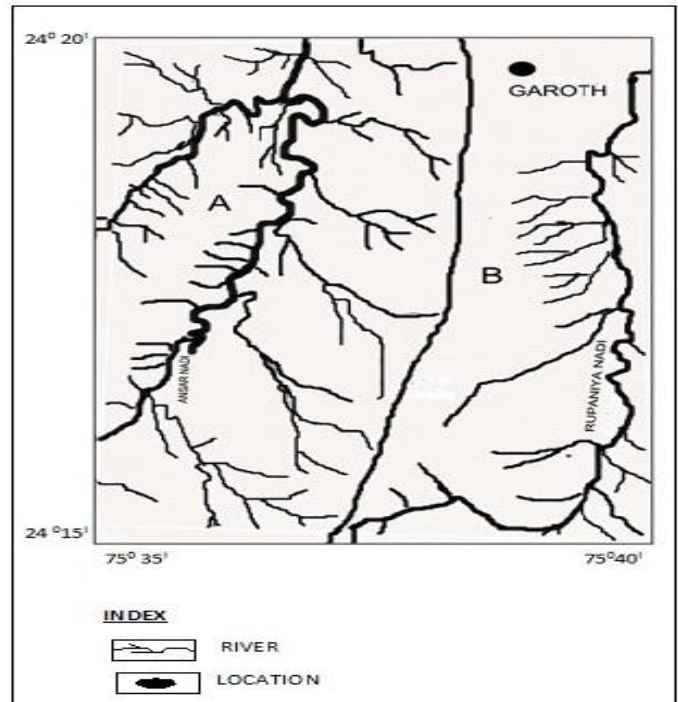


Fig 3: Drainage Map of Ansar and Rupaniya River Basin in Garoth area, Mandsaur District.

Table 1: Showing geomorphic variable of Sub Basin of the Gatoth area, Mandsaur district, M.P.

Basin	A	B
Number first order stream	71	31
Number second order stream	16	9
Number third order stream	3	0
Total Number of stream	90	40
Length first order stream	73	39
Length second order stream	33	13
Length third order stream	9	0
Total Length of stream	115	52
Area of basin	103.23	55.8
Basin perimeter	53	50
Highest elevation	426	429
Lowest elevation	408	421
Basin length	18.6	18.6
Width of basin	11.1	6

Table 2: Morphometric parameters of the drainage network of Ansar and Rupaniya River Basin

S NO.	Morphometric variables	Ansar and Rupaniya River Basin in Study Area, Sub-Basin	
		A	B
1	Bifurcation ratio	4.17 4 3	3.1 9 0
2	Drainage density	1.11	0.93
3	Circularity ratio	1.94	1.11
4	Form factor	0.29	0.16
5	Stream frequency	0.87	0.71
6	Elongation Ratio	0.01	0.02
7	Basin Relief	13	3
8	Relief Ratio	0.11	0.05

Linear Aspects

Stream links (The different drainage lines) and the nodes (the stream junction /confluences) characterize ‘linear aspects’ of the basin . the linear aspects include the stream order (U),Stream length(Lu), mean stream length (LSM), stream length ratio (RL) and bifurcation ratio (RL) and bifurcation ratio (Rb).

Stream Order(U)

Ranking of streams has been carried out based on the method proposed by Strahler (1964). The smallest fingertip tributaries are designated as order 1, where the two first order channels join, a channel segment of 2 nd order is formed and so forth. The trunk stream through which also discharge and sediments pass is therefore the stream segment of the highest order.

Stream Length (Lu)

Stream length is Measured from the farthest drainage divide of the mouth of a river, based on the law proposed by Horton (1945) .Stream length is one of the significant features of the basin as it reveals surface run off characteristics. Streams of relatively smaller lengths indicate that they are associated with high slopes. longer lengths are indicative of flatter gradient usually. The total length of stream segments is highest in first order streams and decreases as the stream order increases in the present case.

Stream Length Ratio(RL)

Stream length ratio (RL) is the ratio of the mean length of the one order to the next order of the stream segment. Total stream length of a given order is inversely related to stream order. is inversely

related to stream order, i.e., total stream length decreases from the lower order to the successively higher orders.

Bifurcation Ratio (Rb)

According to Schumm (1956), the term bifurcation ratio may be defined as the ratio of the number of the stream segments of given order to the number of segments of the next higher orders.

Bifurcation ratio shows a small range of variation for different regions or for different environments except where the powerful geological control dominates (Strahler (1957))

$$R_b = \frac{N_u}{N_{u+1}}$$

Where, R_b = Bifurcation ratio, N_u = Number of channel segment of particular order, N_{u+1} = Number of channel segment of Next higher order.

The bifurcation ratio of sub basin of the study area varies from 0 to 9 with average value 4.65. The relatively lower value of mean bifurcation ratio also suggests the geological heterogeneity, higher permeability and lesser structural control in the area.

Areal Aspects

Area of a basin (a) and perimeter (p) are the important parameters in quantitative geomorphology. The basin is defined as the total area projected upon a horizontal plane perimeter is length the boundary of the basin

areal aspects include different morphometric parameters. like drainage density (D), stream frequency (FS) form factor (Rf), circulatory / ratio (Rc), elongation ratio (Re) and length to the over land flow (Lg). The values of these parameters were calculated and results have been given in table.

Drainage Density (Dd)

Drainage density is defined as the ratio of total length of streams of all orders within the basin to the basin area of per unit area, which is expressed in terms of km/sq, it indicates the closeness of spacing of channels. Thus providing a qualitative measure of the average length of stream channels for the whole basin (Horton,1932).

$$D_d = \frac{L}{A}$$

Where, D_d = Drainage density in 1 Km, L = Sum of total length of stream of all order, A = Total area of drainage basin in sq. km.

The Drainage density of sub basin of the study area varies from 0.93 to 1.11 with average value 1.02. The D_d of the Ansar and Rupaniya drainage basin is moderate indicates clearly that the basin has permeable subsurface material, good vegetation cover and medium relief, causing more infiltration of water and recharging groundwater aquifers.

Stream Frequency (Fs)

The total number of stream segments of all orders per unit area is known as stream frequency (Horton 1932)

$S_f = N / A$, Where, S_f = Stream Frequency, N = Sum of all stream basin, A = Total area of drainage in Km^2 .

The stream frequency of sub basin of with average value 0.79. The stream frequency shows positive correlation with the drainage density. Lesser the drainage density and stream frequency in a basin, the runoff is slower, and therefore, flooding is less likely in basins with a low to moderate drainage density and stream frequency.

Form Factor (Rf)

Form factor (Rf) may be defined as the ratio of the area of the basin to the square of basin length (Horton, 1932) it is the quantitative expression of drainage basin outline form smaller the value of form factor, more elongated will be the basin.

$F = A / L^2$, Where, F = Form Factor, A = Drainage area of drainage basin, L = Basin length

The form factor of sub basin of the study area varies from 0.16 to 0.29 with average value 0.22.

Circularity Ratio (Rc)

Miller (1953) defined a dimensionless circularity ratio (Rc) as the ratio of basin area

to the area of a circle having the same perimeter as the basin.

$R_c = A_u / A_c$, Where, R_c = Circularity Ratio, A_u = Area of Basin, A_c = Area of circle with same perimeter as of the basin.

The circularity ratio of sub basin of the study area varies from 1.11 to 1.94 with average value of 1.52. Such drainage systems are partially controlled by the structural disturbances

Elongation Ratio (Re)

Elongation ratio (Re) is the ratio between the diameter of the circle of the same area as the drainage basin and the maximum length of the basin.

$E = 2 / L \sqrt{A / \pi}$, Where, E = Elongation Ratio, A = Area of Basin, L = Length of basin.

The value of Re in the study area was found to be 0.01 indicating relatively moderate relief of the terrain and elongated shape of the drainage basin.

Relief Aspects

Relief aspect of drainage basin relate to the these dimensional features of the basin involving area volume and altitude of vertical diamention of landforms wherein different morphometric methods are used to analyse terrain characteristics.

Relief Ratio

Relief is the maximum vertical distance between the lowest and the highest points of a basin relief in as important factor in understanding the denudational characteristics of the basin.

$R_h = H/L$, Where, R_h = Relief Ratio, H = Basin Relief, L = Horizontal Distance along longest dimension of basin.

The relief ratio of sub basin of the study area form 0.05 to 0.11 with average value of 0.8 that indicates moderate relief and steep to moderate slope.

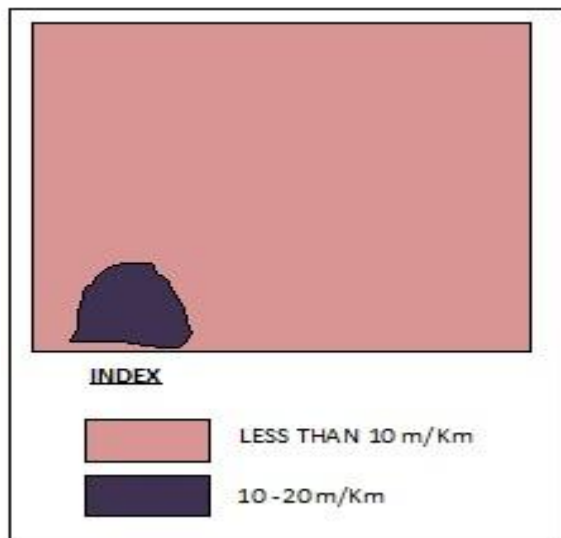


Fig 4: Map Showing Slope and Relief

Basin Relief

According to Schumm (1963) The relief ratio is the dimension less height length ratio equal to the tangent of the angle formed by two planes intersecting at the mouth of the basin one representing the horizontal the other passing through the highest point of the basin.

$H = H_1 - H_2$, Where, H = Basin relief, H_1 = Highest point of basin, H_2 = Lowest point of basin.

The Basin Relief of sub basin of the study area varies from 3 to 13 with average value 8. It has been observed that a high degree of correlation exists among relief and drainage frequency and stream channel slopes.

Groundwater Prospect Map

Groundwater potential is a resource of invaluable value that has been used by humans over centuries without paying any watchful consideration to control it. Though it exists in almost every geological formation, but it exists more in certain aquifers discontinuous with porosity and fractures. The potential and quality of it in an area depends upon geological, geomorphological and socio-economic factors popular in the area. Quantitative morphometric analysis taken in relationship with geological, lithological and topographical setting are extremely helpful in investigating hydrogeological state of an area and identifying the Bardiya Amra, Bovirkhera, Kachaliya and Lakhakhri village in the ground water rich zones.

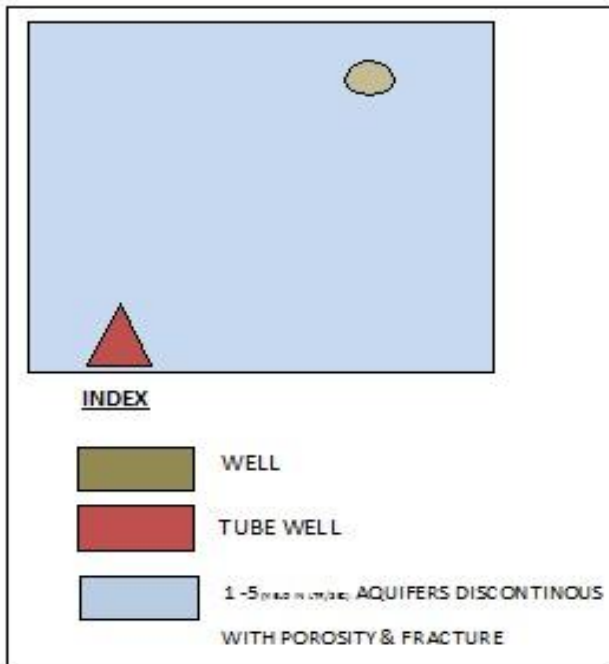


Fig 5: Map Showing the Groundwater Potential Zones.

Landuse and Cropping Pattern

landuse are generally used interchangeably, their actual meanings are quite distinct. Landuse refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or others. Delineating and mapping land cover is important for global monitoring studies, resource management and planning activities. Identification of land cover establishes the baseline from which monitoring activities can be performed and provides the ground cover information for baseline in the maps.

The land use categories of the study area have been urban settlements, grass & scrubland and

arable land unirrigated. The study area is covered by river/water body, forest/plantation, Fellow/open land and crop land.

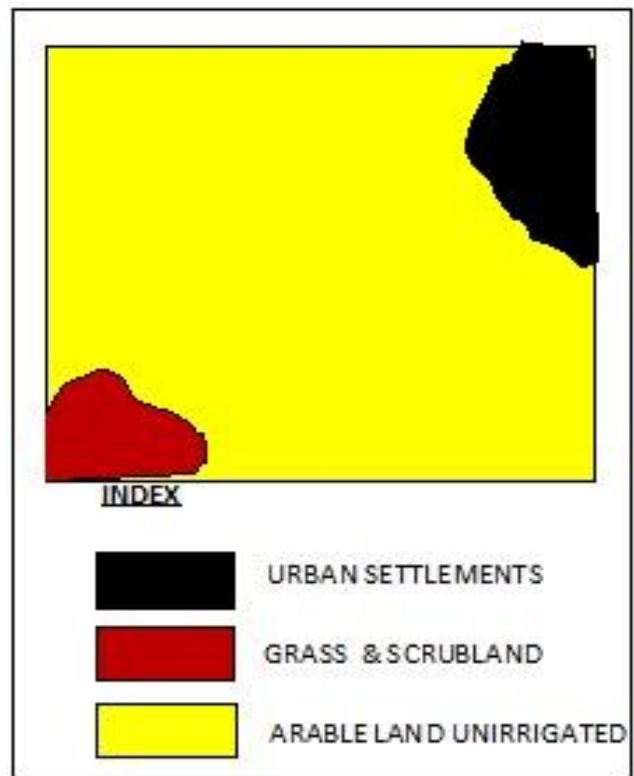


Fig 6: Landuse and Cropping pattern Map.

Conclusion

The Morphometric analysis of the study drainage basin indicates that there are streams of three orders that decrease in number as the order increases. The Bifurcation Ratio ranges from 0 to 9 with a mean value of 4.65. This range suggests that the drainage of the study is mainly governed by lithological characters. The impact of geological structures is rather insignificant. The Drainage density is an reflection of the nature of river basin. It

represented by total length of stream per Km. The drainage density of the present area has been calculated to be ranging from 0.93/km to 1.11/km with a average value of 1.02/km. This low value of drainage density points out that the study area is rather a flat area. The computation of stream frequency of the present area indicates a moderate development of streams. The Elongation Ratio in the Sub-Basin A, B, ranges with in values from 0.01 and 0.02 reflecting that the area is characterized by low relief. The circulatory ratio for the study area has been determined as revealing variation from 1.11 and 1.94 suggesting that the area under invocation is characterized by the presence of a more or less circulatory basin.

The geomorphic analysis of the present study area reveals dendritic to sub-dendritic drainage pattern that is more feasible for demarcation Bardiya Amra, Bovirkhera, Kachaliya and Lakhakhri village in the ground water potential sites.

Acknowledgment

Deep appreciation is expressed to S. N. Sharma, for kind inspiration and valuable suggestions to improve the manuscript. Sincere thanks are due to Dr. V.P. Tiwari and Dr. Vinita Kulshrestha for very generous assistance.

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