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# Morphometric Analysis of Santra watershed Using G.I.S. and Remote Sensing, Santra Village, Block Patan, District-Durg, Chhattisgarh

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**ABSTRACT:** Morphometric analysis of Santra Nala watershed was carried out using Google Earth imagery, Survey of India Toposheet and QGIS 2.6.1 open-source software. Using QGIS 2.6.1 georeferencing, digitization and measurements were done. Measurements of Morphometric parameters of Santra Nala Watershed in three aspects these are linear, areal and relief. The results of computation were correlated with Google Earth Imagery and the synthesis of interpretation was translated to meaningful conclusions.

**KEYWORDS:** Watershed, Morphometric analysis, QGIS, Google Earth Imagery.

## I. INTRODUCTION

Watershed may be defined as a naturally occurring hydrologic unit bounded by natural boundaries and characterized by the similar physical, topographical, and climatic conditions. It is a land area from which water drains under gravity to a common drainage channel. Thus, a watershed is delineated area with well-defined topographic boundary and one water outlet. The soil and water conservation measures carried out on a watershed basis can play a prominent role in the strategy of comprehensive land and water management. Watershed management involves proper use of land and water resources of a watershed for optimum production with minimum hazards to natural resources (Biswas et al,1998).

The study of drainage network characteristic of a particular watershed may be carried out in two ways viz genetic approach and descriptive approach. The genetic approach involves the study of evolution of stream of a region of tectonics, lithology and structures. While the descriptive approach involves the study of forms characteristics and stream pattern (Singh, 1998). The drainage system refers to the origin and development of stream through time, while drainage pattern means spatial arrangements and forms of drainage system. The evolution of drainage system and development of related landforms in a region depends on the bedrock lithology and associated geological structures (Astra and SoulanKillis, 1992).Morphometric analysis of various watershed has been carried out using satellite data and arial photographs (Nautiyal, 1994; Agrawal,1998; Biswas et al,1998; Arun et al,2005; Thakkar and Dhiman,2007; Javed et al ,2009).

## II. STUDY AREA

The study area is confined between latitude 21°00'02"N to 21°05'02"N and longitude 81°25'01"E to 81°30'46"E. Santra watershed is situated in and around the Santra village in the PatanBlock of Durgdistrict, Chhattisgarh and covers an area of 43.107 km<sup>2</sup>.The maximum and minimum elevations in the study area deduced from Google Earth imagery are 315m and 296m above Mean Sea Level, respectively. The general slope of the watershed is from Northwest to Southeast. Main stream of the Santra watershed joins the Shivnath river along downstream side. The average annual rainfall of the area is 1047mm (CGWB Annual Report, 2019). There are some small water ponds and one check dam in the area, which primarily serve as a source of irrigation locally. Apart from these water tanks, there is a canal passing through the study area.

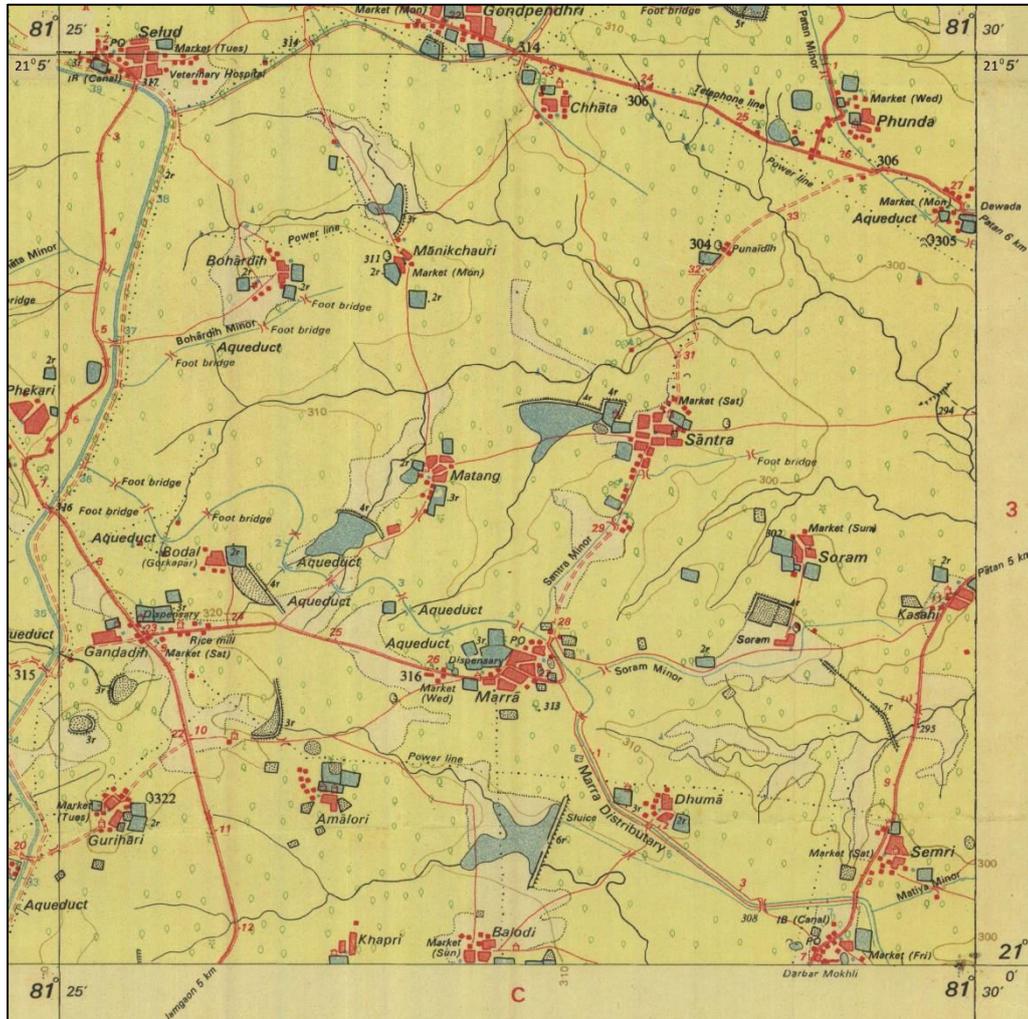


Figure – 1 A part of Toposheet No. 64-G/8 showing the location of Santra village and Santra watershed.

### III. GEOLOGY OF THE STUDY AREA

Geologically speaking, the Santra watershed contains the rocks of Chhattisgarh Supergroup of Mesoproterozoic age. They include a thick sequence of Chandi Formation comprising of stromatolitic limestone, sandstone & shale and top surface is covered by Laterite. Stromatolitic limestone & dolomite has a gradational contact with the underlying Gunderdehi shale.

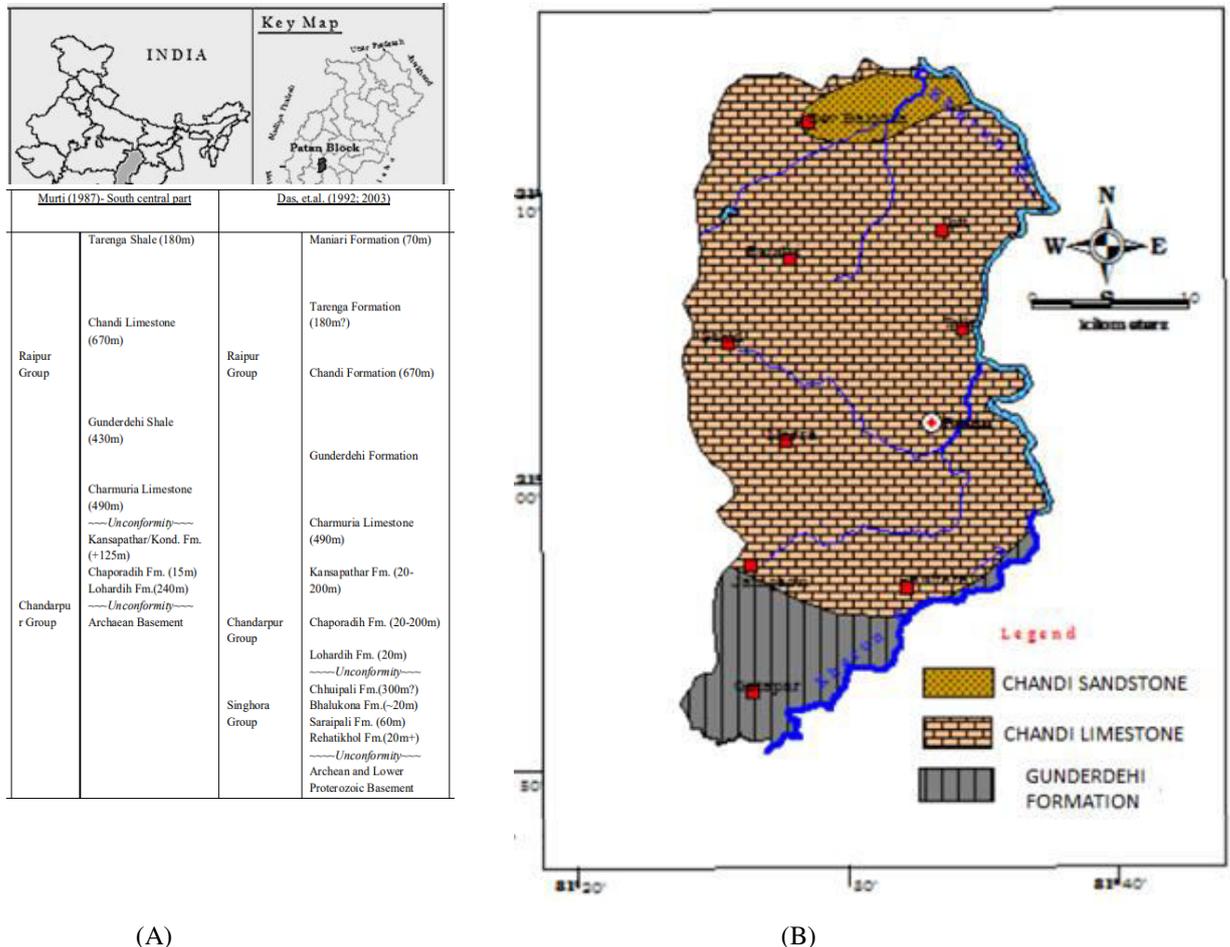


Figure – 2 (A) Stratigraphic succession of Chhattisgarh Supergroup after Murty(1987) and Das et al(1992,2003) and (B) Location map and geological map of Patan (modified after CGWB Report -2017)

#### IV. DATA AND METHODOLOGY

Survey of India (SOI) Toposheet No. 64G/8 of 1:50,000 scale and Google Earth data acquired on 11<sup>th</sup> January, 2020 were used for the present study. The image was geometrically corrected with respect to the SOI toposheets. The watershed boundary was delineated from satellite image referring the toposheets. The drainage pattern, watershed boundary was digitized on the Survey of India toposheet and True color Google Earth imagery using QGIS open-source software, elevation profile is created by Google Earth Pro and wireframe map, surface contour map, topographic maps created through Surfer 8 software.

The drainage parameters like the numbers and length of the streams of different orders, drainage area, watershed perimeter, maximum watershed length and other parameters were determined from the digitized map of the watershed.

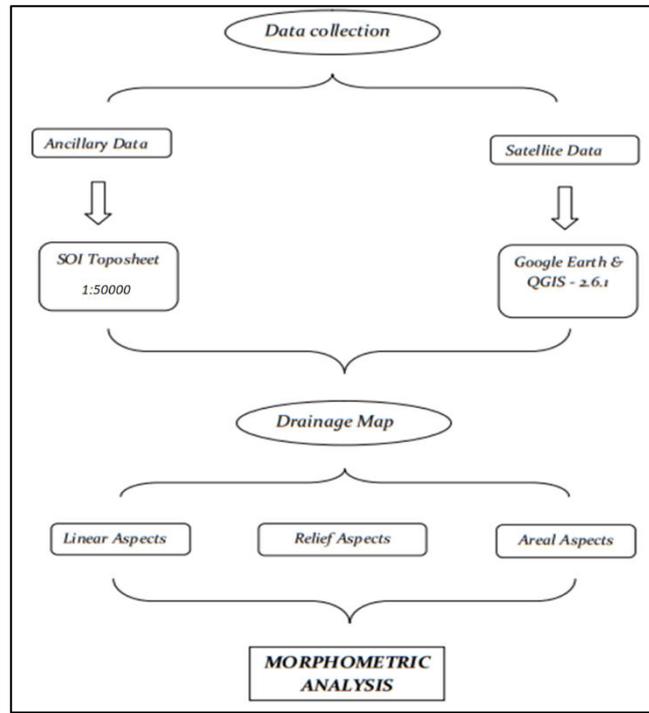


Figure – 3 Flow diagram of methodology followed in the present work.

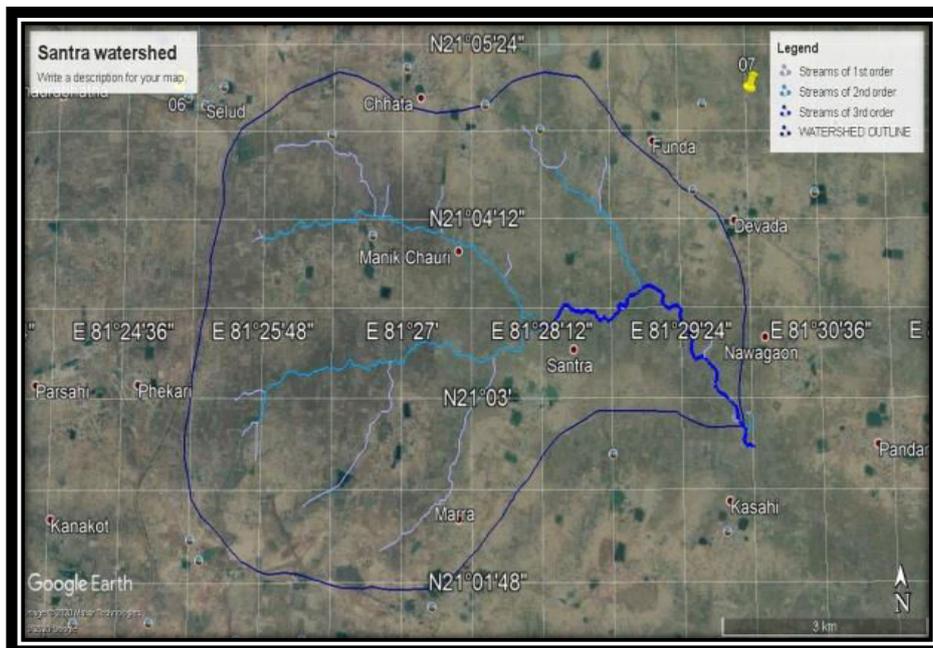


Figure – 4 GoogleEarth image of Santra watershed

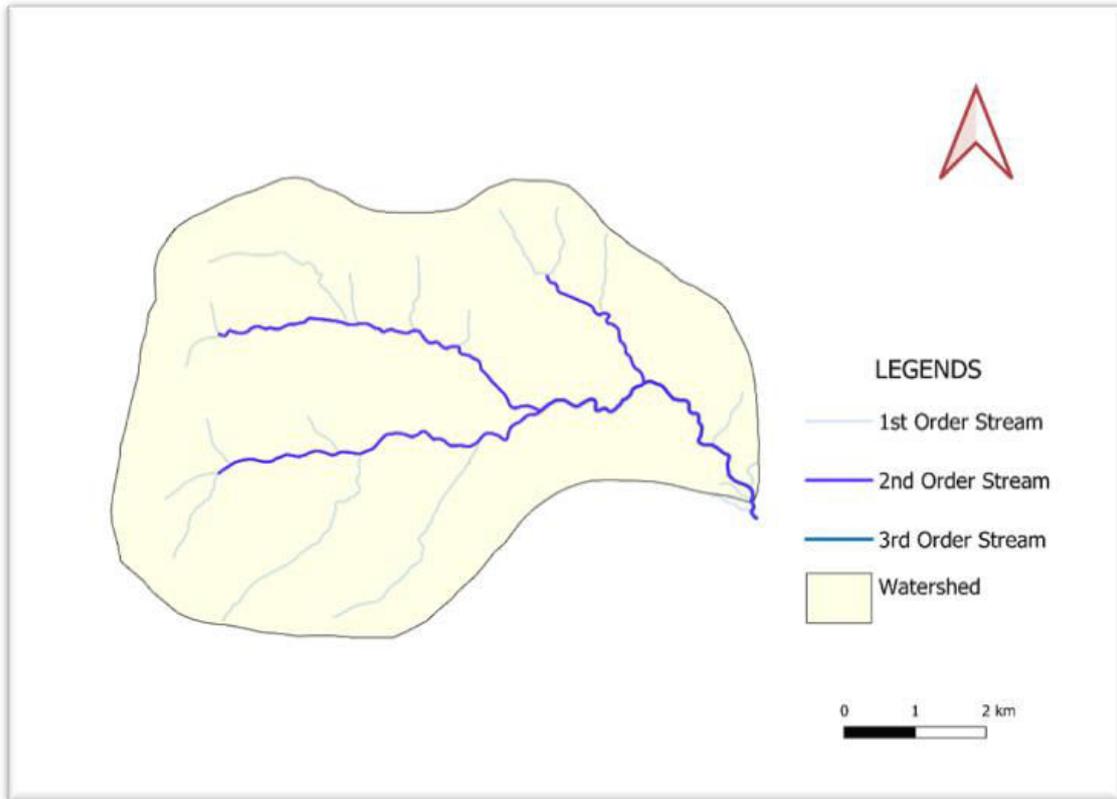


Figure –5 Digitized image of Santra watershed prepared by using QGIS 2.6.1 Brighton

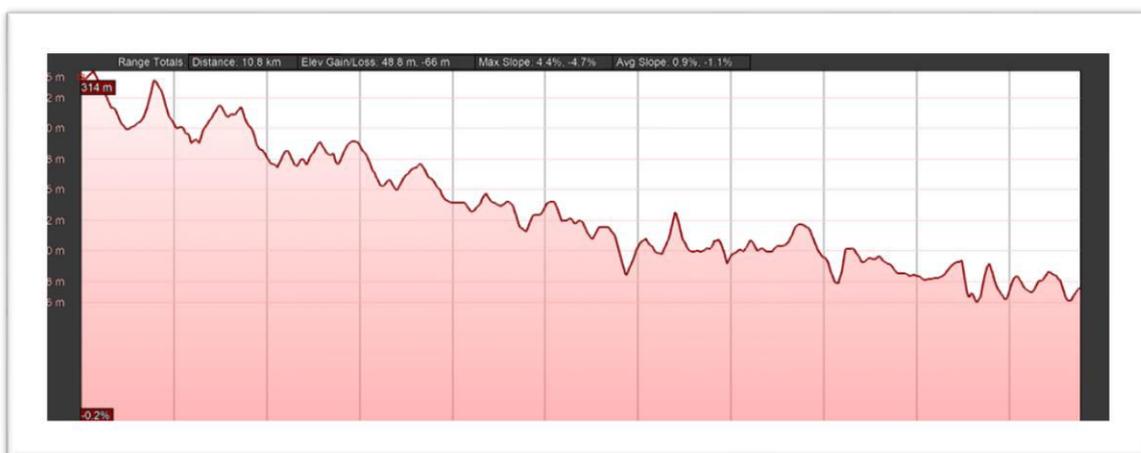


Figure 6 – Elevation profile of the main river of the Santra watershed (Prepared by Google Earth Pro).

## V. RESULT AND DISCUSSION

### MORPHOMETRIC ANALYSIS

The first step in the Morphometric analysis is the designation of stream order. For the Santra watershed the stream ordering has been done based on hierarchy of streams proposed by Strahler (1964). The Santra watershed has been designated as 3<sup>rd</sup> order basin. The Morphometric analysis is discussed below.



**LINEAR PARAMETERS**

**Bifurcation Ratio (R<sub>b</sub>)**

The ratio between the number of stream segments of a given order to the number of segments (N<sub>u</sub>) of next higher order (N<sub>u+1</sub>) is termed as bifurcation ratio.

$$R_b = N_u / (N_{u+1})$$

The bifurcation ratio is not same from one order to the next order because of possibility of changes in the watershed geometry and lithology, but tend to be consistent throughout the series the mean bifurcation ratio (R<sub>b</sub>) of the watershed area is found to be 4.5 (Table 1), higher bifurcation ratio indicates the control of geological structures on the drainage system, whereas the lower value suggest less structural disturbance on drainage system.

Stream Order (N)	Stream Number (N <sub>u</sub> )	Stream length (L <sub>u</sub> )	Mean Stream length (L <sub>u1</sub> )	Stream length ratio (R <sub>L</sub> )	Bifurcation Ratio (R <sub>b</sub> )
1	20	14.91	0.74	-	
2	4	14	3.5	0.93	5
3	1	5.39	5.39	0.38	4

**TABLE -1: -Linear Data Table of Santra Watershed**

**AREAL PARAMETERS**

**Drainage Density (D<sub>d</sub>)**

It gives the mean length of stream within a basin per unit area and is obtained by dividing total stream length (ΣL) by the total basin area (A<sub>u</sub>)

$$D_d = \Sigma L / A_u$$

The drainage density for this watershed is found to be 11.43 km which indicates that there is approximately 11.43km length of the stream in 1 km<sup>2</sup> area. The indirect conclusions that can be drawn from this value is that the bedrock is found to be moderately pervious and also major amount of water runs off.

**Drainage Texture (T)**

Drainage texture may be defined as the total number of stream segments of all order in a basin per perimeter of the basin. Drainage texture depends on the underlying litho-logy, infiltration capacity and relief aspect of the terrain and on natural factors such as climate, rainfall, vegetation, rock and soil type, relief and stage of development. (Smith, 1950) has classified drainage texture into 5 different classes i.e., very coarse (<2), coarse (2 to 4), moderate (4 to 6), fine (6 to 8) and very fine (>8).

$$T = D_d * F_s$$

Very fine drainage texture represents erosion rates and lesser chances for groundwater recharge due to higher slope. Drainage texture of the Santra watershed is 1.72 that is indicating very coarse drainage.

**Stream Frequency (F<sub>s</sub>)**

Stream frequency can be defined as the number of stream segments per unit area.

$$F_s = N_s / A_u$$

Where N<sub>s</sub> = Total number of streams in the basin.

This characteristic of any watershed denotes the number of streams present in unit area. The stream frequency for this drainage basin is found to be 1.72 km<sup>-2</sup>, which indicates the presence of impervious rocks or hard stratum.

**Form Factor (R<sub>f</sub>)**

It is ratio of the basin area (A<sub>u</sub>) to the square of the basin length (L<sub>b</sub>)

$$R_f = A_u / (L_b)^2$$

Where, A<sub>u</sub> = Area of basin (km<sup>2</sup>)

L<sub>b</sub> = Maximum length of the basin (km)

The basin length used here is measured from the mouth to the farthest point on the perimeter of the basin. The form factor (R<sub>f</sub>) for this watershed is found to be 0.5 Basins with low form factor are elongated while with high form factor are circular. This basin is found to be an elongated basin.

**Elongation ratio (R<sub>e</sub>)**

Elongation ratio (R<sub>e</sub>) may be defined as the ratio of diameter of a circle of the same area as the basin to the maximum basin length. The value of R<sub>e</sub> varies from 0 (in highly elongated shape) to unity i.e., 1.0 (in the circular shape).

$$R_e = 1.128 \sqrt{A_u} / L_b$$

Elongation ratio of Santra watershed is 0.80 that is less elongated to oval shape of basin.

Area (A <sub>u</sub> )	Drainage Density (D <sub>d</sub> )	Stream Frequency (F <sub>s</sub> )	Drainage Texture (T)	Elongation Ratio (R <sub>e</sub> )
43.107	11.43	1.72	1.72	0.80

**Table -2: - Areal Data Table of Santra Watershed**

**RELIEF ASPECTS**

**Basin Relief (R)**

Basin relief is a parameter that determines the stream gradient and influences flood pattern and volume of sediment that can be transported (Hadley and Schumm, 1961).

$$R = H-h$$

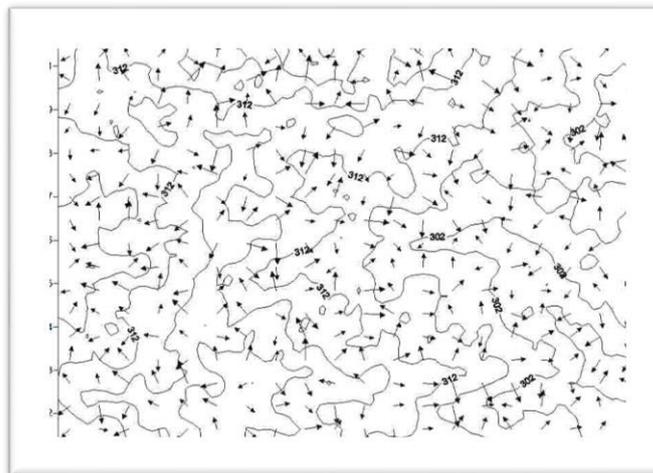
The basin relief of Santra watershed is 22 m.

**Relief Ratio (R<sub>r</sub>)**

Relief ratio is a dimensionless ratio between basin relief and basin length and widely accepted as an effective measure of gradient aspects of the watershed (Schumm, 1956; Vittala et al., 2004).

$$R_r = R/L_b$$

The relief ratio of Santra watershed is 2.38



**Figure 7- Surface contour map of the Santra watershed**

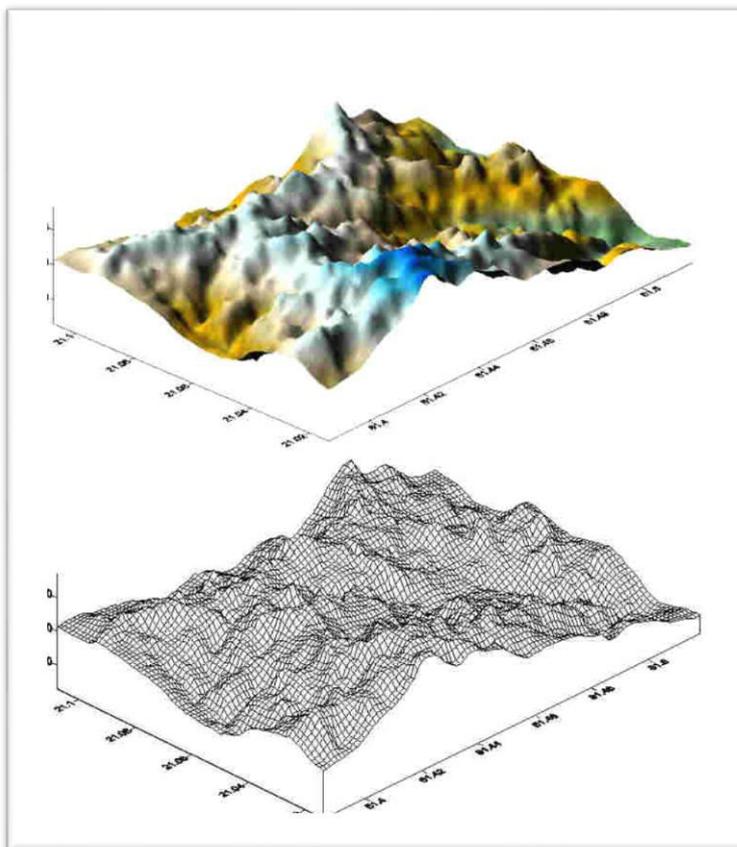


Figure 8- DEM and Wireframe map of the Santra watershed prepared using Surfer-8

## VI. CONCLUSION

The morphometric analysis of the drainage network of the Santra watershed exhibits the sub-dendritic pattern and signifies the homogeneity in texture and lack of structural control. Santra watershed is having gentle slope from Northwest to Southeast. Here 1<sup>st</sup> & 2<sup>nd</sup> order streams are not useful for constructing check dams because these streams are situated on plain terrains and volume of water discharge through river tributaries in the basin is less due to rainy season river of large number of streams of lower order present in Santra watershed.

## VII. ACKNOWLEDGEMENT

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## REFERENCES

1. Agarwal. C.S. (1998)- Study of drainage pattern through areal data in Naugarh area of Varanasi District, Uttar-Pradesh Jour. Ind. Soc. Remote Sensing. Volume 26(4). P. 169-175
2. Arun P.S., Jana, R. and Nathawat, M.S. (2005) – A rule based physiographic characterization of a drought prone watershed applying Remote Sensing and GIS. Jour. Ind. Soc. Remote Sensing. Volume 33(2). P. 189-201.
3. Astra, T. and Soulanellis, N. (1992) – Contribution of digital analysis techniques on Landsat-5 TM imageries for drainage delineation. A case study from the Olympus Mountain, West Macedonia, Greece. Proc. 18<sup>th</sup> Annual Conference Remote Sensing Society, University of Dundee. P. 163-172.

4. Biswas, S., Sudhakar, S. and Desai, V.R. (1998) – Prioritization of sub-watersheds based on Morphometric analysis of drainage basin: A Remote Sensing and GIS approach. *Jour. Ind. Soc. Remote Sensing*. Volume 27(3). P. 155-166.
5. Burley, T.M. (1996) – Land use or land utilization. *Prof. Geographer*. Volume 13 No. 6. P. 18-20.
6. Chakarvarti, S.C. (1973) – The geology of manganese ore deposits of Kandri-Mansar area, north-eastern part of Nagpur District Maharashtra. *Bull. Geological Survey of India. Series A. Economic geology No. 22 Part III*.
7. Clawson, Marion and Stewart, Charles, L. (1965) – Land use information. A critical survey of US Statistics including possibilities for greater uniformity. Baltimore, Md. The Johns Hopkins Press for Resources for the Future, Inc P. 402.
8. Das, D. P., Kundu, A., Das, N., Dutta, D. R., Kumaran, K., Ramamurthy, S., Thanavelu, C. and Rajaiya, V. (1992) Lithostratigraphy and sedimentation of Chhattisgarh Basin. *Indian Min.*, v.46, pp.271-288.
9. Ground water resources and development potential of Durg District, Chhattisgarh report 2019, Central Ground Water Board.
10. [http://cgwb.gov.in/AQM/NAQUIM\\_REPORT/Chhattisgarh/Patan%20Block,%20Durg%20District.pdf](http://cgwb.gov.in/AQM/NAQUIM_REPORT/Chhattisgarh/Patan%20Block,%20Durg%20District.pdf).
11. Javed, A., Khanday, M.Y. and Ahmad, R. (2009) – Prioritization of sub-watersheds based on Morphometric and Land use analysis in Guna District Madhya-Pradesh: A Remote Sensing and GIS based approach. *Jour. Ind. Soc. Remote Sensing*. Volume 2(37). P. 261-274.
12. Murty, K. S., (1987) Stratigraphy and sedimentation in Chattisgarh Basin. In. Radhakrishna, B.P. (Ed.), *Purana Basins of Peninsular India (Middle to Late Proterozoic)*. *Mem. Geol. Soc. Ind.*, No. 6, pp.239-260.
13. Nautiyal, M.D. (1994)- Morphometric analysis of drainage basin, District Dehradun, Utter-Pradesh. *Jour. Ind. Soc. Remote Sensing*. Volume- 22(4). P. 252-262.
14. Pandey, Shiv N. *Principles and Applications of Photogeology*, Wiley Eastern Limited, India. 1987.
15. Singh, Chanchal and Shrivastava P.K. (2017) Study of hydrogeological Properties of Durg Block, Durg District, Chhattisgarh, India. *IOSR Journal of Applied Geology and Geophysics*.
16. Singh, Prafull & Thakur, Jay Krishna & Singh, Umesh. (2013). Morphometric analysis of Morar River Basin, Madhya Pradesh, India, using remote sensing and GIS techniques. *Environmental earth sciences*.
17. Singh, Savindra (2007), *Fundamentals of Geomorphology*; 5<sup>th</sup> Edition, Pragya Pustak Bhawan Publishing.
18. Singh, S. (1998)- Drainage system and patterns. *Physical geography*. Prayag Pustak Bhawan, Allahabad, India. P. 225-244.
19. Strahler, A.N. (1964) – Quantitative geomorphology of drainage basins and channel networks. In *Handbook of Applied Hydrology*, V.T. Chow Ed. Section II, McGraw Hill New York. P. 440-476.
20. Sukristiyanti, S., Maria R. and Lestiana H. (2018)- Watershed-based Morphometric Analysis: A Review; IOP Conf. Series: Earth and Environmental Science 118.
21. Thakkar, K.A. and Dhiman, S.D. (2007)- Morphometric analysis and prioritization of mini watershed in Mohr watershed, Gujrat, using Remote Sensing and GIS techniques. *Jour. Ind. Soc. Remote Sensing*. Volume 35(4). P. 313-321.
22. Thornbury William D. (1986)- *Principles of Geomorphology*, Third Wiley Eastern Edition.



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