A Field Investigation of Chikhli Watershed with the Application of Gis and Remote Sensing, Durg (C.G.)

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***Abstract* - The objective of this paper is field investigation of the Chikhli watershed in Durg district, it is subdivision of Sheonath river basin. An applications of GPS and Remote Sensing; latitude, longitude and mean sea levels (MSL) values are taken. Path length of streams and sub-streams will be calculating by google earth for plotting contour map and slope directions was prepared with surfer 8 software. The catchment area (9.18 sq.km), Stream density (0.87/km), Drainage density (1.0643/km), Slope (4.14 radians), Length of stream and substream (9.77 km). The 4 soil samples are collected and two are investigated in post monsoon season, there permeability tests carried out in falling-head method, obtained result of runoff is 9569839.15 m^3/s by average rainfall, which flows off on the stream of watershed area. The quantity of runoff indicates capacity of reservoir area. This investigation of watershed concluding the quantity of runoff in post monsoon, facilitate to identify the condition of flood affected area and extract the solutions to civil engineers for the planning of constructing hydrological structures.**

Keywords- Chikhli, Watershed, Hydology.

I. INTRODUCTION

A *watershed* is basin like structure, that boundary line which more or less follows the highest ridgeline around the stream channels and meets at the bottom or lowest point of the land where water flows out of the watershed, the mouth of the waterway. Watershed is bounded by any hydrologic system and their shape is depending upon the topographical and geological feature of that particular area; this feature is also responsible for the patterns of stream runoff. Features of any watershed having that agencies facilitate to manage include water supply, drainage, storm water runoff, water rights, soil nature, geological formation and overall planning and utilization off watersheds. [2]

II. LOCATION AND TOPOGRAPHY OF THE STUDY AREA

The study area is located in division of Durg district in Chhattisgarh state, which is near to Howrah Mumbai mainline of South -Eastern Railway, and it is move across to Durg-Dhamdha road (SH-7). It falls in the survey of India Toposheet No. 64 G/8 A1 (scale 1:50,000) and bounded by the parallels Latitudes N21^{0}10’00” to N21^{0}15’00” and Longitudes E81^{0}15’00” to E81^{0}20’00”. It is about 317m above sea level. It is well developed urbanized features, surrounded by agriculture field, plateau and undulating plain are seen. The geographical area of Durg is 232 Sq.km. Sheonath is main river and bounded by Bemetara district in north, Balod district in south, Rajnandgaon district in the west and Raipur district in the East (Figure 1&2). [1]

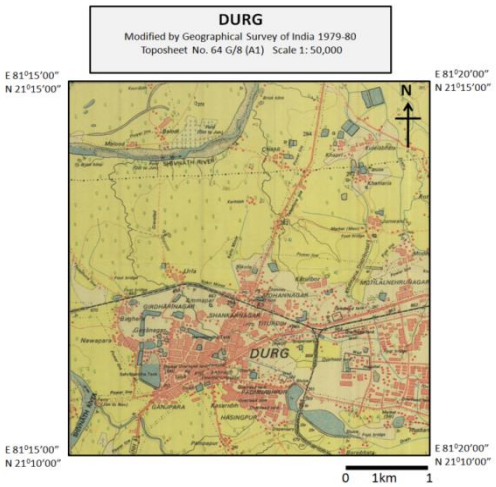

Figure 1 The survey of India Toposheet No. 64 G/8 is illustrated in this figure.

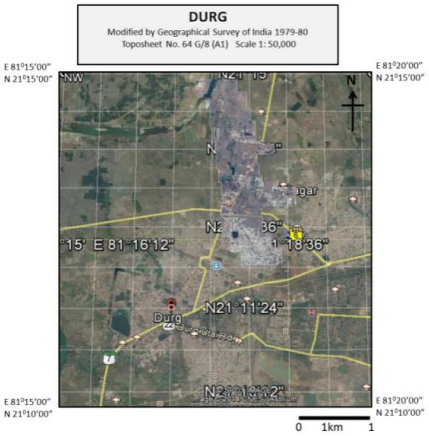

Figure 2 True colour satellite imagery of the study area (source CNES/Astrium Google earth map).

III. CLIMATE OF THE STUDY AREA

Chikhli has dry tropical weather, seasonal temperature variation are noticed. The summer season temperature are

usually reached peak in May/June and can be as high as 45^{0}C. The minimum rainfall occurs in this season. The monsoon season from July and August and September Maximum, Average and Minimum noticed rainfalls are 1477.2 mm, 1041.16 mm and 781.5 mm per year respectively. The average temperature of this season is 18^{0}C and in the end of October-November the temperature goes down 13^{0}C approximate in starting of January the average temperature is 28^{0}C. The vegetal cover of this area is Sagon, Tendu, Awala, Bahera, Harra, etc. Geologically recent to sub recent age alluvial deposits comprising gravel, sand, clay and laterite are also seen in that area. [1]

TABLE II COORDINATES AND ELEVATIONS DATA AND TRENDS OF SAMPLE LOCATION FROM CHIKHLI WATERSHED

Samples	C-1	C-2	C-3	C-4
Longitude	81^{0}17'25.08"	81^{0}17'39.19"	81^{0}17'55.30"	81^{0}18'06.50"
Latitude	21^{0}14'39.54"	21^{0}14'3.58"	21^{0}13'13.4"	21^{0}12'22.7"
M. S. L. (in m)	278	288	286	293
Trends of steam	N75^{0}W	N80^{0}W	N50^{0}W	N55^{0}W

Figure 3 (A) Field photograph from the study area, while tracking satellite and taking coordinates and altitude data from Global Positioning System (GPS) instrument "Garmin etrex vista HCx. (B & C) The pictures of sites from where soil sample are collected and (D) Using clinometer at site for taking trend along stream.

IV. METHODOLOGY

In the study of the work, applications of GPS and Remote Sensing are used. The soil sample taken in field area investigation, based on the post monsoon, latitude, longitude and mean sea levels (MSL) values are taken by the help of Global Positioning System (GPS : Garmin etrex vista HCx). Path length of streams and sub-streams will be calculating by google earth software and various points are taken for plotting contour map and it will be prepare with the help of surfer 8 software and their slope directions. The catchment basin will be plotting and area will be calculated by AutoCAD software. This contour map of field area helps civil engineering for the planning of constructing hydrological structures like reservoir, dams etc. and facilitate to identify the condition of flood affected area and extract the solutions.

A. SAMPLE COLLECTION

The investigation of study area has been carried out in post monsoon period. The total number of soil samples are 4 which are taken in project area. The locations of samples has been marked on the map (Figure 6). The true colour satellite imagery of the study area showing in figure 2 (source CNES/Astrium Google earth map). The general range of mean sea level along main stream is minimum at chikhali (275m) and maximum at katulbod (296m). (Figure 1.2).

The surface and vector contour has been prepared with the help of the coordinate values taken from the google earth map and prepared in surfer 8 software (Figure 4A,B and 5A,B)

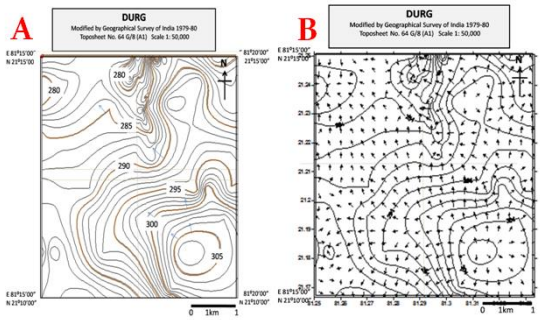

Figure 4 (A) Contour map (B) Vector map with elevation and flow direction of the study area, plotted with the help of surfer

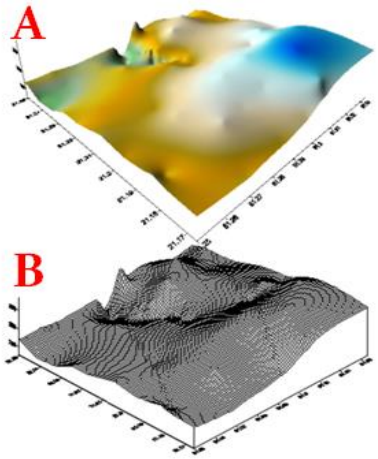

Figure 5 Isometric Surface and wire frame images are showing topographical features of the investigated area, prepared by surfer.

B. CHARACTERISTICS OF CHIKHLI WATERSHED

The basin characteristics such as the area, land-surface topography and other morphological properties vary only with respect to geological time and thus may be treated as constant. The calculated parameters are in Chikhli drainage basin or watershed are as given below. [3]

i). STREAM PATTERN: The pattern of stream in our investigation watercourse is **sub-parallel**, owing to the internal geologic structure and catchment topography which is indicating sedimentary low gradient topographical feature. In this terrain, 275m minimum and 307m highest elevation are observed; the higher one is near the SE quadrant and the inclination is showing towards NW direction in vector map. (Figure 4 A & B). [3]

ii). AREA: The catchment area is 9188811.3 Sq. m. or 9.18 Sq. km. .

iii). STREAM ORDER: The maximum order of this stream is 3 (three), total number is 8 (I=5, II=2 and III=1), total lenth of all the orders of stream measured in 9.77km.

iv). DRAINAGE DENSITY: **Dd = ∑L/A** Where, total no. of streams = 9.77 km , Area of basin = 9.18 Sq. km. **Dd** =1.0643/km.

v). STREAM DENSITY: **Ds = Ns/A** Where, No. of streams = 8, Area of streams = 9.18 Sq. km. **D_s** = 0.87

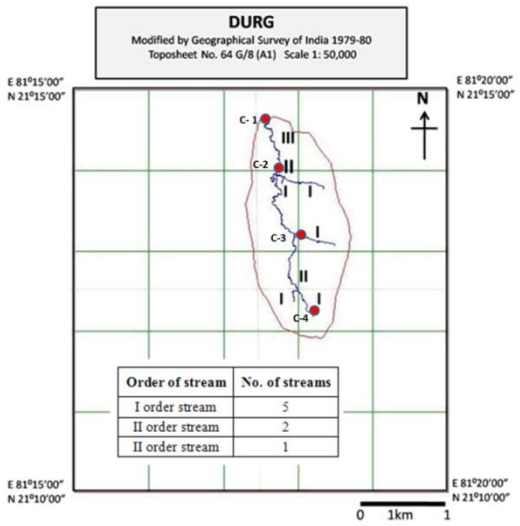

Figure 6 The sub-parallel drainage pattern of the investigated area depicting stream orders of the investigated stream and sample C-1, C-2, C-3 and C-4 (red spots).

vi). LENGTH: It is the length measured along the mainstream from the catchment outlet to the remotest point on the catchment boundary. The straight length between the starting and end of stream is 4.82 km.

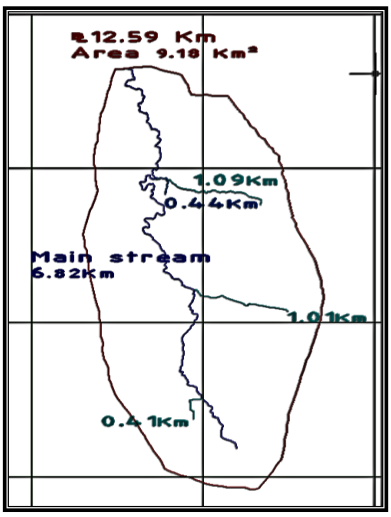

Figure 7 Calculated length of all streams, periphery and area are plotted in Chikhli watershed.

vii). SHAPE: The shape of the basin is quantitative measured by various factors.

viii). **Form factor R_f = A/L^2** (Where, Area of basin = 9188811.3 Sq. m. , Length of basin = 4.82×10^3), **R_f** = 0.396

ix). **Circularity ratio $R_c = 4\pi A/p^2$** (Where, area of basin = 9188811.3 Sq. m. , perimeter = 12599.7 m), **R_c** = 0.73

x). **Elongation ratio $R_e = D_e/L$** (Where, Area of basin = 9188811.3 Sq. m., Length of basin = 4.82×10^3) **$R_e = (2/L)\times\sqrt{A/\pi}$, R_e** = 0.7096

xi). **Compactness coefficient $C_c = P/\sqrt{(4\times\pi\times A)}$** (Where, Area of basin = 9188811.3 Sq. m. , perimeter = 12599.7 m), **C_c** =1.1725. It may be observed that the circularity ratio is nothing but the reciprocal of the square of the compactness coefficient. **$R_c = 1/C_c^2$,** 0.73 = 1/ 1.172

xii). RELIEF: The maximum basin relief H is the elevation difference between the basin outlet and the highest point on the basin perimeter usually expressed in meters. Here, elevation at the basin outlet is 275 and the highest point on the basin perimeter is 295. So the difference between this two points are 20m.

xiii). SLOPE: A simple way of obtaining slope is divide the difference between the basin outlet and the highest point on the basin perimeter by the distance between two points. Slope = 20/4.82 = 4.14

xiv). LIGHT COMPACTION TEST: Two samples of soils are tested their Light compaction test their optimum moisture content (OMC) is varies from 8.00 to 8.80 % and the results of falling head permeability is obtained coefficient of permeability **k** is varies 0.006 to 0.020 cm/sec. [4]

Figure 8 (A) Sieving of soil using 20mm and 4.75 mm IS sieve for preparation of sample. (B & C) Permeability testing by falling head method and Light compaction testing.

V. SUMMARY AND CONCLUSION

The study area Chikhli watershed is approximately extended in 9.18 km^2. This is very small watershed because it is less than 250 km^2. The internal geologic structure and catchment topography yield an erosion of the land is responsible for low gradient (4.14 radians), low stream density (0.87 km) and Drainage density (1.0643 km). Length of stream and sub-stream are calculated as 9.77 km. The 4 soil samples are collected and two samples of soils are tested their Light compaction test their optimum moisture content (OMC) is varies from 8.00 to 8.80 % and the results of falling head permeability is obtained coefficient of permeability **k** is varies 0.006 to 0.020 cm/sec. The average rainfall of Durg district is 1041.6 mm [1]

So, the rainfall volume on our study area is, 9571065.85 m^3/sec. The average permeability of study area is 0.0133

cm/sec. So the infiltrated water capacity of the subsoil of the study area is 1226.7 m^3/sec.

From the water budget equation except evaporation, transpiration etc. The runoff water has been calculated as,

Runoff = Precipitation – Infiltration = 9569839.15 m^3/sec.

So the runoff of Chikhli watershed Durg district (C.G.) calculated in post monsoon by average rainfall is **9569839.15 m^3/s** which flows off on the stream of our watershed area.

The quantity of runoff indicates capacity of reservoir constructed in that particular area. So, this investigation of watershed concluding the quantity of runoff in post monsoon so that it will help to determine the design the capacity of reservoir.

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