Proceedings of Second Shri Chhatrapati Shivaji Maharaj QIP Conference on Engineering Innovations
Organized by Shri Chhatrapati Shivaji Maharaj College of Engineering, Ahmednagar
In Association with Novateur Publications JournalNX-ISSN No: 2581-4230
February, 22nd and 23rd, 2019

SITE SUITABILITY ANALYSIS FOR WATERSHED STRUCTURES IN KHOKAR NALA BY USING REMOTE SENSING AND GIS

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ABSTRACT

Water is a key component in determining the quality of our lives. Watershed is a natural hydrological unit. Watershed approach is holistic, linking upstream and downstream area. In KHOKAR NALA drainage basin, degradation rate is increasing and depletion of resources is occurred. There is loss of productive soil. Also there is reduced carrying capacity of streams. In present study, potential sites for watershed structure in KHOKAR NALA basin of Ahmednagar district, Maharashtra, India have been identified by using remote sensing and GIS techniques. Various thematic maps such as Land use/land cover, stream order, slope etc. are prepared using remote sensing application. The remote sensing data is operationally being utilized for mapping various resources. The need is to step ahead towards integrating these resources maps with their resources information and other socioeconomic data for general action plan. GIS can be used to manipulation of data, product generation, data management and data retrieval, etc. Remote sensing gives timely and accurate information on spatial distribution- land use, soil vegetation density, forest, geology water resources. The final map showing different categories of suitability sites for water harvesting structure such as Check dams, percolation tanks, farm ponds, contour bunding, and contour trenching have been suggested.

Key Word: Remote sensing, GIS, farm pond, water harvesting potential, Land use /Land cover

1. INTRODUCTION

Water is a key component in determining the quality of our lives. Watershed is a smaller unit of the river basin, lies within 4000 to 40000 hectare area. It is a natural geographical convenient basic unit in development and planning. It is an open physical system in term of input of precipitation and solar radiation and output of discharge and evaportranspiration. Assessing, managing and planning of water resources for sustainable use becomes and important issue in human life, especially in water scarcity regions. Topography of an area along with geological structures and lithology play an important role for watershed development. Thus, the term geomorphometry has been used in this report. Monsana (1962) has also adopted the term geomorphometry denoting the science dealing with the measurement of the form of the earth's crust. Geomorphometry supplies the quantitative values to geomorphologhy and hydrology. The Geographical Information System (GIS) has been adopted for Geomorphometric analysis of study of area. GIS is the data handling and analysis system based on set of data distributed spatially in two dimensions. Geographic data has three major component; geographic positions, properties(attributes), and time. The GIS software allow inputting, managing, analyzing and present geographical data by which can generate information.

Spatial map data (vector/raster) and attribute data get combined as they referenced in relative terms to a specific location on the earth's surface. Application of GIS makes the computation of the Geomorphometric parameters easy, less time consuming and more accurate. Integration of Remote Sensing and GIS technique provide reliable, accurate and update database on land and water resources, which is prerequisite for an integrated approach in identifying runoff potential zones and suitable sites for water harvesting structures.

Area of Investigation :
The Khokar Nala River is tributary of the Sina River is flowing through Ahmednagar district of MAHARASHTRA state. The study area lying between the latitudes 19°2'30"N to 19°7'30"Nand longitude 74°35'E to 74°45'E.The whole area can be obtained in single Toposheet nos. E4C12 , 47I/12. Covering the area of 38.47 sq.km acquired from survey of INDIA. The area is approachable through the road link.
Watershed area=38.47 sq. km

2. METHODOLOGY

The methodology adopted for the Geomorphometric study includes the geographical information system (GIS) technology and remote sensing (RS) techniques. The guidelines provided by the NNRMS core study material have been adopted for the computation of various Geomorphometric parameters.

Preparation of the base map: Top sheets have been scanned and glued by using TERRSET software to get the base map. After digitalization, the boundary of the watershed is delineated using the contour and drainage information in the base map.

Preparation of thematic maps: The base map and remote sensing data have been used to prepare different thematic maps ex. Drainage map, contour map, stream order map, etc.
Digital data inputting: Coordinate system for the study area was created with universal traverse Mercator (utm) projection for related zone. The top sheets have been geo-referenced with respect to the above zone. The watershed boundary, contours, drainage have been digitalized on the base map and the contour, and drainage maps have been generated. The satellite data (digital) was geo-referenced and rectified with the base map.
Generation of digital elevation model **:** The digitalized contour information has been used to obtain the DEM. The classified relief

map, the slope percentage map and aspect map have been obtained from DEM. The percentage slope map was further classified in nine classes.

3. GEOMORPHOMETRY:

R.E.Horton and A.E.Strahler first initiated first morphometric studies in the field of hydrology in the 1940's and 1950's. The main purpose of this work was to discover holistic stream properties from the measurement of various stream attributes. Morphometry is essentially quantitative, involving numerical variables their usefulness for comparisons and statistical analysis. Morphometry is the precise measurement of landforms and measurement of he shape or geometry of any natural form be it plant, animal, relief feature, is termed morphometry, (Strahler, 1969). In other words morphometry may be defined as the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimensions of its landforms (Dury,1970). The geomorphological and climatic characteristics of a basin govern its hydrological response to a considerable extent. The geomorphological characteristics of a basin represent its attributes, which may be employed in synthesizing its hydrological response. The importance of geomorphic factors like basin shape, relief, etc., cannot be overlooked in accurate prediction of runoff. Basin characteristics when measured and expressed in quantified geomorphic parameters with hydrologic characteristics of the basins, particularly the engaged once. Interpretation and quantitative evaluation of surface run-off, infiltration and susceptibility to erosion within the basin.

The geometric analysis of dendrite drainage of KHOKAR NALA basin deals with the computation of stream order, relief aspects, drainage density, slope and form factor etc.

Computation Of Morphometric Parameters

Various important morphometric parameters need for analyses are as follows:

a. Drainage network map: The drainage map was prepared by using GIS software. The drainage map shows dendaritic drainage pattern. The study area has fourth order drainage networks. Drainage in the study area is mostly taken care by the first order streams having maximum drainage length of 48.98 km. It is the number of stream segment of various orders. Horton's law of stream numbers states that the number of segments of each order is in inverse geometric sequence with order number.

***b. Stream Length*:** It is the length of each stream segment. Adding length of each stream for a given order, the total stream length of each order is computed. The total stream length divided by the number of stream segments of that order gives the mean stream length for that order.

c. Length Ratio: It is the ratio of mean stream lengths of any order and that of next order.

d. Relief Ratio: The total watershed relief divided by the maximum length of the watershed. It represents the overall steepness of drainage basin and is an indicator of the potential energy of the system to drain off.

e. Relative Relief: The ratio of the maximum watershed relief to the perimeter of the watershed.

f. Ruggedness Number: The drainage density times the maximum basin relief.

g. Elongation Ratio: The ratio of the diameter of circle with the same area as the watershed and the maximum length of the watershed. This ratio may be in the range of 0.6 and 1.0 are measured to depict the influence of basin shape and they represent the time taken for water from the remote parts of the catchment to reach the outlet. The value of elongation reaches one as shape of the basin approaches to a circle. Fan shaped i.e. nearly semicircular catchments give broad and low hydrographs.

h. Circulatory Ratio: The ratio of circumference of a circle of same area as the watershed to the perimeter of the watershed. Usually ranges between 0.6 to 0.7. It decreases for higher order basins because of large crenulations in their perimeter, which affect the denominator.

i. Basin Shape Factor: The ratio between the squares of the maximum length of the watershed to the area of the watershed.

j. *Confluence Ratio*: The ratio of the number of streams of a particular order to the number of streams of the number of streams of the next higher order. Bifurcation ratio is found to be one of the important geomorphologic characteristics.

k. Stream Frequency: It is the number of streams per unit area within the basin. It mainly depends on the Lithology of the basin and reflects the texture of the drainage network.

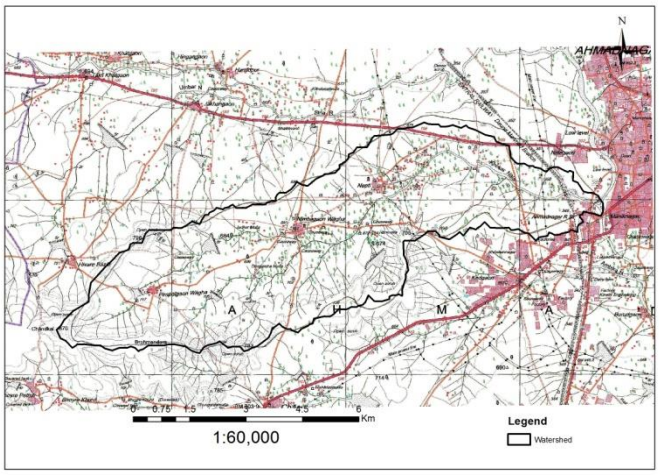

Figure 1: Location map of the area.

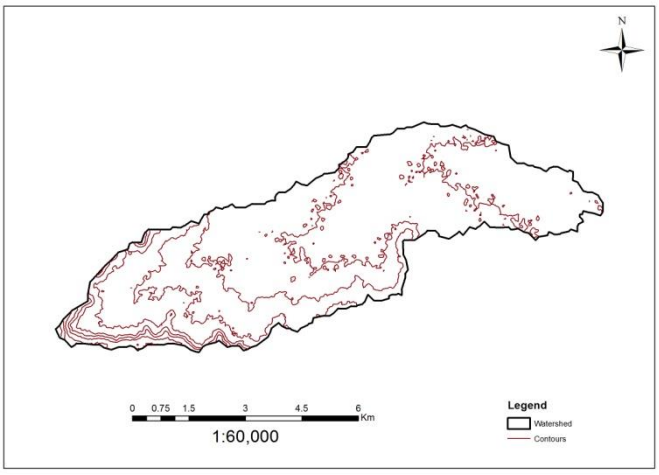

Figure 2: Contour map of the area.

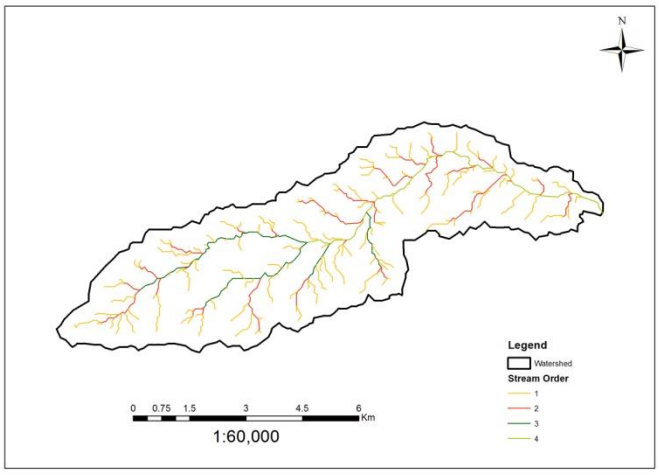

Figure 5: Stream Order Map of the area.

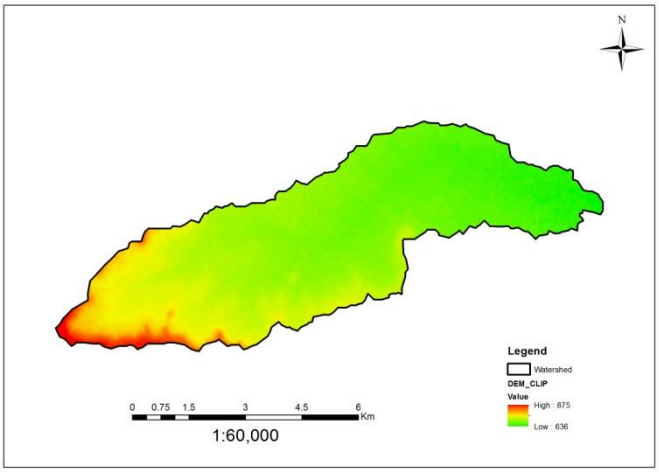

Figure 3: Digital Elevation Model

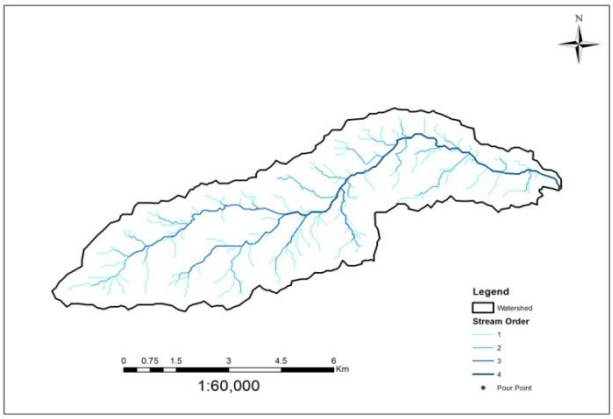

Figure 6: Drainage Map of the area.

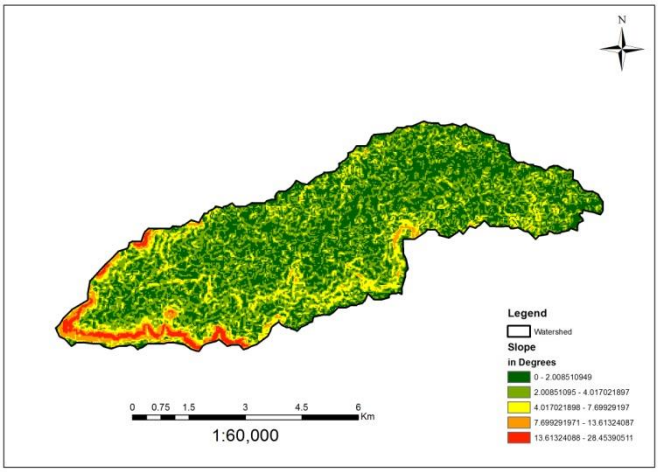

Figure 4: Slope Aspect Map

Geomorphometric Parameters of the area :

Stream Order	Stream Number	Stream length in Km.	Bifurcation ratio	Length ratio
1	135	48.912	3.84	-
2	35	20.849	8.75	1.64.
3	4	11.638	4	5.01
4	1	9.647	-	3.23

Total no. Of streams	:	135
Drainage area	:	88. 58 sq.km.
Elongation ratio	:	0.408
Drainage frequency	:	4.049
Form factor	:	0.200
Basin length	:	09.22 km.
Total relief	:	500 mts.
Ruggedness no.	:	0.98
Circulatory ratio	:	0.59
Relative relief	:	0.0177

4. RESULT

From the contour map and imageries it has been observed that the area has got high relief in upper part and moderately sloping ground. The Khokar Nala River is found to be in the youthful stage of its erosion, containing deep gorges, cascades. The contours are ranging from 636m to 875m.All the map obtained with the help of GIS software. TERRSET software is very useful to calculate the maps of area, from the analysed data of the respective river. The contour map, digital elevation model, slope aspect map, stream order and drainage order maps are obtained. From gromorphometry parameters we find Bifurcation ratio and length ratio which are useful in basin analysis for watershed management.

5. CONCLUSION

Integration of remote sensing and GIS allows reliable ,most accurate and most updated database on land water resources. It has been found to be very useful in deriving geomorphometric parameters. Some Geomorphometric parameters of Khokar Nala watershed shows that the watershed in elongated, having low drainage density, low ruggedness number, high relief and almost straight slopes allowing quick disposal of water indicating high rate of erosion but which is retarded due to hard rocks. It has been experienced that the manual estimation of the geomorphometric parameters is a tedious and cumbersome process and often discourages the field engineers from developing the regional methodologies for solving various hydrological problems of the basins. Watershed promotes economic and social development of community .It also generate employment and other income generation. Calculated parameters,

Achnolodgement :

The authors express their gratitude towards Dr.Uday Naik, Principal, Dr.V.V.P.College of Engineering, Ahemednagar. Maharashtra. for his constant encouragement and financial assistance. BCUD, SPPU, Pune for financial assistance for this research work. Author also express their gratitude to the Prof. U.R.Kawade, HOD, Deptt. of Civil Engineering for his support.

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