International Journal of Advances in Mechanical and Civil Engineering, ISSN: 2394-2827 Volume-4, Issue-6, Dec.-2017
http://iraj.in

WATERSHED PRIORITIZATION OF KUMARI AND KASAI RIVER BASINS OF PURULIA DISTRICT, WEST BENGAL

[1]MADHURIMA DAS, [2]GUPINATH BHANDARI

[1]Research Fellow, Department of Civil Engineering, Jadavpur University, Kolkata 700032, INDIA;
[2]Associate Professor, Department of Civil Engineering, Jadavpur University, Kolkata 700032, INDIA;
E-mail: [1]jumadhurima@gmail.com, [2]g.bhandari.ju@gmail.com

Abstract - The Land, water and soil are degraded and eroded with time due to improper natural resource management. In Present day, Watershed Prioritization is a significant and essential step for preventing the natural resource of watershed. Study on Drainage Morphometry and Watershed Prioritization have immense significance in Water resource management. The present study is profoundly concerned to watershed prioritization of Kasai and Kumari river Basins of Purulia District, West Bengal. The effectiveness of any water resource planning, conservation and management highly associated with Drainage Morphometric study and Watershed Prioritization of a Watershed. This analysis facilitate to planner, researcher to conduct the study on a watershed and implement a proper plan. The study has been emerged the analysis of drainage parameters such as linear, areal aspectsof Kumari and Kasai River basins using Remote Sensing and GIS, two advance effective tools.

The study has been investigated the Linear parameters of Drainage Morphometric analysis include stream number (Nu), stream length (Lu) bifurcation ratio (R_b), etc., Areal parameters comprise watershed perimeter (P), watershed area (A), drainage density (D_d), stream frequency (F_s), elongation ration(R_e), circulatory ratio (R_c) etc.

The result of the present GIS based Drainage Morphometric analysis and Prioritization has been revealed that Kasai- Patkol has comes under the high risk for soil erosion and need to give high priority for land conservation practices. The outcome of the present study may be useful for the social benefit and stakeholders at different levels may be benefitted.

Keywords - Morphometric Analysis, Watershed Pririotization , Remote Sensing, Geographical Information System (GIS)

I. INTRODUCTION

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms. Drainage pattern refers to spatial relationship among streams or rivers, which may be influenced in their erosion by inequalities of slope, soils, rock resistance, structure and geological history of a region.

In this study, Remote Sensing and GIS techniques can be used for detailed morphometric analysis and watershed prioritization studies. In the present study, morphometric analysis and prioritization of sub-watersheds have been carried out for four watersheds of Kumari and Kasai River Basin of Purulia District by using remote Sensing and GIS techniques.

II. STUDY AREA AND RELEVANT DATA

2.1 Description of the Study Area

The work has been conducted on four watersheds of Kumari and Kasai River Basins of Purulia District. The latitudinal extension of the study area is 23°28' 14" N to 22°59' 51"N and longitudinal extension is 22°52'40" E to 86°42'31"E . Location map of the study area has been shown in Fig.1.

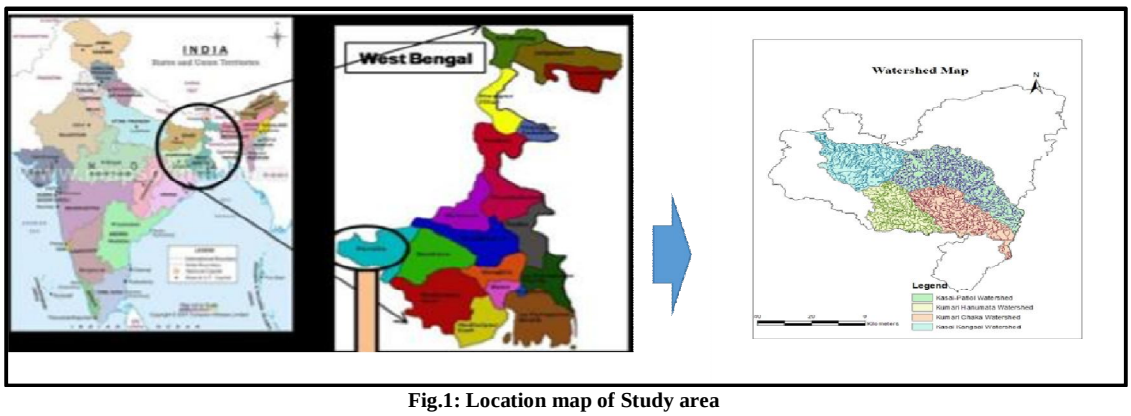

Fig.1: Location map of Study area

2.2 Relevant Data

In this study, Remote Sensing and Ancillary data such as IRS-P6, LISS III, SRTM DEM data, Toposheet Maps No. 73E, 73I and 73 J (Scale 1: 2,50,000), District Planning Map, have been used to prepare necessary maps which are associated with this study. The work has been carried out by the help of GIS software.

III. METHODOLOGY

The present study mainly concerned to evaluate morphometric characteristics of river basin and Prioritazation watersheds of Kumari and Kasai River basins with geospatial techniques. To do the Survey of India (SOI) toposheets of 73E, 73I and 73 J with 1: 2,50000 scale have been used as reference map. Watershed boundaries of Purulia district, West Bengal have been delineated using Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) using Geographical Information System (GIS) software after detail study of topographical map to obtain correct result. Various morphometric parameter analysis including linear aspects of the drainage network such as stream order, bifurcation ratio, stream length of the basin, etc. have been computed. Similarly, areal aspects of the drainage basin such as drainage density, stream frequency, elongation ration, circulatory ratio, form factor, etc. have been computed using ArcGIS software and Excel file. The morphometric parameters for the delineated watershed area were calculated in GIS environment based on the formula suggested by Strahler, Horton, Schumm, Miller etc.
Mean Biffurcation Ratio, Drainage Density, Stream Frequensy (Fs), Form Factor (Rf), Circulatory Ratio (Rc), Elongation Ratio(Rc), are also termed as erosion risk assessment parameters and have been used for prioritizing watersheds. Some morphometric parameters like, drainage density, stream frequency, bifurcation ratio, drainage texture, length of overland flow have a direct relationship with erodibility, higher the value, more is erodibility. Shape parameters such as elongation ratio, compactness coefficient, circularity ratio, and basin shape and form factor have an inverse relationship with erodibility [Akram Javed et al., 2009] lower the value more is the erodibility. After the ranking has been done based on every single parameter, the ranking values for all the linear and shape parameters of each watersheds have been added up for each of the watersheds to arrive at compound value. Based on average value of these parameters, the sub-watersheds having the least rating value was assigned highest priority, next higher value was assigned second priority and so on. The morphometric parameters linear aspect such as Stream order,stream Number and Stream Length, Bifurcation Ratio have been taken from Strahler (1964); Horton (1945); Strahler (1957) respectively. The areal aspect such as Basin Area and Basin Length, Drainage Density and Stream Frequency, Elongation Ratio and Form Factor, Circulatory Ratio, has been taken from Schumm (1956), Horton (1945), Schumm(1956), (Miller, 1935).

IV. RESULT AND DISCUSSION:

The morphometric parameters can be broadly classified into the two categories: (1) Linear aspects of channel; (2) Areal aspects of the basin; In this study, Drainage morphometric analysis and Prioritization of Kasai and Kumari River Basins have been discussed in this section.

4.1 Linear Aspects of the Channel

4.1.1 Stream Order and Stream Number

Stream Ordering is an initial step in analysis of drainage basin. It is not only the index , it is approximate index of the amount of stream flow. The concept of Stream ordering was first founded by Horton (1945), but it has modified by Strahler (1952). Generally Stream decrease geometrically with stream orders. The exponential negative relationship between stream order and number of stream confirm that the terrain is complex and it is subject of compact bed-rook (Nag, 1998).
In the present study, the stream ordering has been done based on the proposed Hierarchical Rank method of Strahler (1964) using SOI toposheet and Satellite Image in ArcGIS 9.2 software. In this study, it is observed that the maximum stream frequency shown in first order stream. the stream order of the watersheds varies from 1st order to 6th order. The change in the stream order indicates that the streams are flowing from high altitude.

4.1.2 Stream Length

Stream length is a most significant parameter of Morphometric analysis of Watershed. The length of the computed streams of different order from SOI toposheet and satellite Image have been calculated with the help of ArcGIS 9.2 software based on proposed theory of Horton (1945). The stream length has been decrease with increase stream order which indicate that geometrical similarity is preserved generally in watershed of increasing order. Stream lengh has been decrease as the stream order increase expects Kasai-Patlol.

4.1.3 Bifurcation Ratio (Rb)

Bifurcation ratio is related to the branching pattern of a drainage network . The bifurcation ratio is the ratio of the number of the stream segments of given order to the number of streams in the next higher order. Horton (1945) considered the bifurcation ratio as index of relief and dissertation. Strahler (1957) demonstrated that bifurcation shows a small range of variation for different regions or for different environment except where the powerful geological control dominates. In this study, it is observed that Bifurcation Ratio is not same from one order to its next order, it reveals that these irregularities depend on the geological and lithological development of the watershed. The lower value of Rb indicates that it have suffered less structural disturbances. In the present study, the higher values of Rb indicates strong structural control on the drainage pattern, while the lower values indicative of watershed that are not affect by structural disturbances. Bifurcation

ratio is mainly controlled by the basin shape and is not only influences the landscape and morphometry but also controls the surface run off.

4.2 Areal Aspect:

4.2.1 Basin area:

Basin area is an important parameter of areal aspect of the morphometric analysis. There is a relationship between Basin area and total stream length. The basin area of four watershedshave been computed using ArcGIS-10.

4.2.2 Drainage Density:

Drainage density is defined as the total length of streams of all orders per drainage area. It is measured by dividing the total length of the streams of all orders by area of the basin. Drainage Density depend on climate, relief, rock type, landscape, infiltration, vegetation cover etc.Low drainage density is a subject of Area with very resistant or permeable subsoil material, low relief and dense vegetation weak or impermeable subsurface material, mountainous relief and sparse.

4.2.3 Stream Frequency

Stream frequency is the total number of stream segments of all orders per unit area. It is the ratio of the total number of stream segments by area of the basin. the stream frequency and drainage density is positively correlated.

4.2.4 Elongation Ratio

The elongation ratio is the ratio of the diameter of a circle of the same area as the drainage basin to the maximum length of the basin (Schumm, 1956). The range of the elongation ratio is .6 to 1.0 . Lower value indicates the strong relief and the value nearly 1 associated with low relief.

4.2.5 Form Factor

Form factor as the ratio of the area of the basin to the square of the basin length (Schumm, 1956). Zero value indicates highly elongated shape and one indicates circular shape of the basin. The basin became circular when the value of form factor is greater than .78. The smaller value of form factor indicates the basin is elongated.

4.2.6 Circulatory ratio

The dimensionless ratio of area of basin (Au) to the area of the circle having the same perimeter of the same basin (Miller, 1935).The value near One means more circular shape of the basin. Runoff is stays more time in circular basin than elongated basin.

V. WATERSHED PRIORTIZATION

The compound parameter values of four watersheds of Kasai and Kumari river basins have been calculated and prioritization rating is shown in Table 1. Watershed Kasai-Patlol with a compound parameter value of 2.75 receives the highest priority (one). The sub-watershed Kumari-Chaka with a compound parameter value of 3 receives the highest priority followed byKumari-Hanumata and Kasai-Kangsai. Highest priority indicates the greater degree of erosion in the particular watershed and it becomes potential area for applying soil conservative measure.

Watershed Prioritization										
Watersheds	Mean Bifurcation Ratio	Drainage Density	Stream Frequency (Fs)	Texture Ratio (Rt)	Form Factor (Rf)	Circulatory Ratio (Rc)	Elongation Ratio (Rc)	Length of Overland Flow (Lg)	Compound	Final Priority
Kumari-Hanumata	5	1	1	3	7	7	7	7	4.75	3
Kumari-Chaka	3	5	5	5	1	1	1	3	3.00	2
Kasai- Patlol	1	3	3	1	3	3	3	5	2.75	1
Kasai-Kangsai	7	7	7	7	5	5	5	1	5.50	4

Table.1 Watershed Prioritization

ACKNOWLEDGEMENT

The authors would like to extend the heartiest thanks to the University Grant Commission (UGC), Government of India, for funding the research work; also extending the heartiest thanks to Department of Civil Engineering, Jadavpur University, for providing the golden opportunity to work on this problem. The authors are also thankful to Survey of india, National Remote Sensing Centre (NRSC), Government of India, National Aeronautics & Space Administration (NASA), United States Federal Government, for providing the data to carry out the Research Work. The authors would like to extent the thanks to 'UGC-BSR Research Fellowship in Science for Meritorious Students', 2012-2013 for funding.

CONCLUSION

Watershed prioritization is one of the most important aspects of water resource planning. The present study demonstrates the utility of remote sensing and GIS techniques in morphometric analysis and prioritizing watersheds based on morphometric analysis. Results of prioritization of watersheds show that watersheds Kasai-Patlol and Kumari-

Chaka are more susceptible to soil erosion. Therefore, immediate attention towards soil conservation measures is required in these sub watersheds to preserve the land from further erosion and to alleviate natural hazards.

REFERENCE

[1] Singh,N., Tiwari,P., Guru,P.K., khalkho,D., (2014).Morphometric analysis for prioritization of watershed using GIS technique, International Journal of Agricultural Engineering, 7(1), 69-73.

[2] Gajbhiye,S., Sharma, S.K., Meshram,Chandrashekhar (2014). Prioritization of Watershed through Sediment Yield Index Using RS and GIS Approach, International Journal of u- and e- Service, Science and Technology, 7 (6), 47-60.

[3] Mishra,S.S.,Nagarajan,R.,(2010)Morphometric analysis and p rioritization of sub-watersheds using
GIS and Remote Sensing techniques: a case study of Odisha, International Journal of Geomatics and Geosciences, 1(3), 501-510.

[4] Paul, J.M., Inayathulla, M.,(2012). Morphometric Analysis and Prioritization of Hebbal Valley in Bangalore, IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE), 2(6), 31-37.

★★★