

Morphometric Analysis of a Basin Using Remote Sensing and GIS –A Review

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ABSTRACT: A GIS and Remote sensing based study has been undertaken to model the hydromorphological conditions which in turn help in appropriate planning and optimum utilization of land, water and land cover resource in the basin. Parameters evaluated with reference to erosion assessment such as stream order, stream length, bifurcation ratio, drainage density, stream frequency, texture ratio, elongation ratio, circularity ratio, and form factor ratio. The review related to Morphometric Analysis of a Basin Using Remote Sensing and GIS is discussed in the present paper.

KEYWORDS: Remote Sensing, GIS, Morphometric Analysis. River Basin.

I. INTRODUCTION

Geographical information system proves efficient tool in delineation of drainage basin pattern and its planning. Geographical information system and image processing techniques can be used for the identification of morphological features and analyzing properties of basin. The morphometric parameters of basin such as linear, areal and relief aspects for Sukhana Basin of Aurangabad District, Maharashtra state are evaluated. Parameters evaluated such as stream order, stream length, bifurcation ratio, drainage density, stream frequency, texture ratio, elongation ratio, circularity ratio, and form factor ratio. The morphometric parameters considered for analysis are stream length, bifurcation ratio, drainage density, stream frequency, texture ratio, form factor, circularity ratio, elongation ratio and compactness ratio.

A GIS and Remote sensing based study has been undertaken to model the hydromorphological conditions which in turn help in appropriate planning and optimum utilization of land, water and land cover resource in the basin. (Nooka Ratnam et al). Geographical information system (GIS) has emerged as an efficient tool in delineation of drainage pattern and ground water potential and its planning. GIS and image processing techniques can be employed for the identification of morphological features and analyzing properties of basin. (M.L.Waikar et al)

II. RESEARCH REVIEW

David Heesom and Lamine Mahdjoubi [1], have studied, effect of grid resolution and terrain characteristics on data from dtm. With objective of is to test the hypothesis that both the resolution of the gridded-data set and the characteristics of the terrain being modeled have an effect on the accuracy of any derived data. The accuracy for each of these quantities was calculated by comparing them with values obtained from a control model. This research concluded that by both increasing the resolution of the regular gridded-data sets and varying the characteristics of the terrain, the accuracy of any derived data is affected.

Sujata Biswas, S. et al., [2] have tried to use remote Sensing and Geographic Information System Based Approach for Watershed Conservation, for Murlu subwatershed in the Subarnarekha Basin! among nine subwatersheds forming a major portion of the Nayagram block in the Midnapore district of West Bengal State in eastern India was considered. This subwatershed was further divided into 44 micro watersheds with areas less than 10 km², which were prioritized based on morphometric parameters, it can be inferred that prioritization of microwatersheds is essential.

Ameek K. Thakkar and S.D. Dhiman [3], have carried out case study for morphometric Analysis And Prioritization of Miniwatersheds In Mohr Watershed, Gujarat Using Remote Sensing And Gis Techniques. The Mohr watershed has

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a dendritic drainage pattern. The highest bifurcation ratio among all the miniwatersheds is 9.5 which indicates a strong structural control on the drainage. The maximum value of circularity ratio is 0.1197 for the miniwatershed 5F2B5b3. The miniwatershed 5F2B5a2 has the maximum elongation ratio (0.66). The form factor values are in range of 0.29 to 0.34 which indicates that the Mohr watershed has moderately high peak flow for shorter duration. The compound parameter values are calculated and prioritization rating of eight miniwatersheds in Mohr watershed is carried out. The miniwatershed with the lowest compound parameter value is given the highest priority. The miniwatershed 5F2B5b2 has a minimum compound parameter value of 3.12 is likely to be subjected to maximum soil erosion hence it should be provided with immediate soil conservation measures.

Sahool N.T., et al., [4], have tried to estimate sediment yield from Geomorphological Parameters Based Watershed Sediment Yield Estimation. Eleven watersheds were selected. Out of which the data of ten watersheds were utilized for the development of models and the data of one watershed were utilized for validation of the models. Multiple regression models between sediment production rate (SPR) and scores of principal components were developed using principal component regression in Statistical Analysis System (SAS) environment. The average absolute deviation of predicted SPR was found within 10.55% and 5.43% for different percent ranges of runoff and ranges of rainfall. Hence the developed model can be used for better prediction of SPR for other similar ungauged watershed.

Sreedevi P. D., et al., [5], have attempted Morphometric Analysis of a Watershed of South India Using SRTM Data and GIS. Shuttle Radar Topographic Mission (SRTM) data for preparing Digital Elevation Model (DEM), aspect grid and slope maps, Geographical information system (GIS) was used in evaluation of linear, areal and relief aspects of morphometric parameters. The study reveals that the elongated shape of the basin is mainly due to the guiding effect of thrusting and faulting. The lower order streams are mostly dominating the basin. The development of stream segments in the basin area is more or less affected by rainfall. The mean Rb of the entire basin is 3.89 which indicate that the drainage pattern is not much influenced by geological structures. Relief ratio indicates that the discharge capability of these watersheds is very high and the groundwater potential is meager. These studies are very useful for planning rainwater harvesting and watershed management.

M. Bagyaraj and B. Gurugnanam [8], have attempted significance of morphometry, integrating Remote Sensing data and techniques in addition to the conventional methods in a GIS platform. The Western Ghats are amongst the eighteen biodiversity hot-spots recognized globally (WCMC, 1992) and are known for their high levels of endemism. Kodaikkanal Hills are parts of Palani hills of Western Ghats. The study has demonstrated the potential use of remotely sensed data and Geographical Information Systems (GIS) in evaluation of linear, relief and areal morphometric parameters and to analyze their influence on the genesis and processes of landforms and characteristics of soil parameters like texture, drainage and land erosion conditions. Visual interpretation of satellite data in analysis of geological, landforms and land erosion characteristics in conjunction with drainage pattern facilitates effective delineation of distinct features to evaluate the influence of drainage morphometry.

Shakil Ahmad Romshoo et al., [9], have studied Geoinformatics for assessing the morphometric control on hydrological response at watershed scale in the Upper Indus Basin. Five watersheds (W1, W2, W3, W4 and W5) in the upper Indus basin were chosen for detailed studies to understand the influences of geomorphology, drainage basin morphometry and vegetation patterns on hydrology. From the morphometric analysis, it is evident that the hydrologic response of these watersheds changes significantly in response to spatial variations in morphometric parameters. Results indicate that W1, W2 and W5 contribute higher surface runoff than W3 and W4. Further, the topographic and land cover analyses reveal that W1, W2 and W5 generate quick runoff that may result in flooding over prolonged rainy spells. It is quite evident that these factors have significant impact on the hydrological response from the watersheds and can be used to predict flood peaks, sediment yield and water discharge from the ungauged watersheds.

Shagufta Akbari et al., [10] have estimated Geomorphology Parameters for Small Catchment using GIS study focuses on geomorphological studies of a small catchment Nima-Wira catchment situated in the Krishna river basin, Andhra Pradesh, India. Geomorphological characteristics of Nima- Wira catchment in the Krishna River Basin have been determined using GIS. The geomorphological parameter estimation has been of great importance great importance in understanding the hydrological behavior of the basin. In this study, in order to determine the geomorphological parameters required SRTM and Cartosat image were procured for year 2001 and 2009 respectively.

Sharad Chandra Dwivedi, [11], has studied Morphometric Analysis of Four Sub-Watersheds In Bah Area of Agra District Using Remote Sensing And Gis Techniques. Study carried out using Geo-coded FCC of bands 2, 3 and 4 of IRS 1D, LISS-III, SOI toposheets number 54 J/5 and 54 J/9 and GIS softwares – ArcGIS, Arcview and Dem

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software for preparation of DEM. The present study shows terrain exhibits dendritic to sub-dendritic drainage pattern, stream order ranges from third to fourth order; drainage density varies slightly and has very coarse to coarse texture in Pidhaura and Balarpur sub-watersheds and fine drainage texture in Batesar and Pariar sub-watersheds. The other parameters determined and discussed include bifurcation ratio, elongation ratio, stream frequency, number, length of overland flow and relief aspects of the watersheds. The mean bifurcation ratio depicts that the basin falls under normal basin category. The elongation ratio shows that Balarpur sub-watershed mark elongation pattern whereas Pidhaura, Batesar and Pariar sub watersheds possess circular shape.

Panhalkar S.S., et al.[12] have described , Morphometric analysis and watershed development prioritization of Hiranyakeshi Basin in Maharashtra, India. The entire study region is divided into 19 sub-watersheds named as H-1 to H-19 by using ARCSWAT software. Various morphometric characteristics of the Hiranyakeshi basin have been assessed by applying GIS techniques and using SRTM data. Strahler's, Horton's and Schumm's methods have been employed to assess the fluvial characteristics of the study region. Each morphometric characteristic is considered as a single parameter and knowledge based weightage has been assigned by considering its role in soil erosion. The compound parameter values are calculated and the sub-watershed with lowest compound weight is given highest priority. The analysis reveals that H-1, H-2, H-3, H-5 and H-13 subbasins should be given high priority for watershed development as they are much more susceptible to soil erosion.

Rekha, V. B., et al., [13], have presented Morphometric Analysis and Micro-watershed Prioritization of Peruvanthanam Sub-watershed, the Manimala River Basin, Kerala, South India. A critical evaluation and assessment of morphometric parameters and prioritization of micro-watersheds based on water holding capacity of Peruvanthanam subwatershed have been achieved through measurement of linear, aerial and relief aspects of basins by using remote sensing and GIS techniques, and it necessitates preparation of a detailed drainage map. For prioritization, 9 micro-watersheds are delineated and parameters such as Rb, Dd, Fs, T, L of and C are calculated separately and prioritization has been done by using the Raster calculator option of Spatial analyst.

Danilo Godone and Gabriele Garnero [14] have studied, the role of morphometric parameters in Digital Terrain Models interpolation accuracy: a case study. The investigated dataset is a helicopter-borne laser scanner survey carried out on a mountain slope. It has been interpolated at various resolutions, and a percentage of the entire set has been employed to evaluate the interpolation accuracy. The analysis has highlighted, among the tested interpolators, the Natural Neighbour as the best one. The classification has drawn the attention to the total curvature and slope as the main factors affecting interpolation accuracy.

Jadhav Snehal , Md. Babar [15] have tried, the morphometric analysis of Domri river sub-basin is carried out in order to hydrological implication. For this purpose some basic parameters are measured including basin perimeter, basin length, elevation and other aerial parameters were calculated by using Arc Map (10.1) software. Total area of the sub-basin is 274.68 km². Geologically investigated area is covered by Deccan volcanic basalts which are Cretaceous to lower Eocene and Quaternary alluvium occurred along the gullies and both banks of the river. Quantitative analysis of drainage network shows that the dendritic to sub dendritic drainage pattern is developed in the sub-basin. Bifurcation ratio of Domri river sub-basin increases from 1st and 2nd order but decreases in 4th and 5th order stream because it is not affected by any structural control. Drainage texture in the investigated sub-basin indicates massive and resistant rocks cause coarse texture. Drainage morphometry is useful to signifying the construction sites for artificial recharging structures for implication of hydrology

Syed Ahmad Ali and Nazia Khan [16] have evaluated, Morphometric Parameters with Remote Sensing and GIS Based Approach. Detailed morphometric parameters of the Banas river basin has been carried out. The river Banas originating from the Khamnor hills of the Aravalli ranges (about 5 kms from Kumbalgarh) is one of the major rivers of the state which, in its entire course, flows through Rajasthan. It flows from Kumbalgarh towards the south upto Gogunda plateau and after cutting the Aravalli ranges at right angles, it flows through Nathdwara, Ra-jsamand and Railmagra. The total area of the Banas river basin is 702.55 km². Detailed drainage map was prepared from SOI (Survey of India) toposheets (45h/5 and 45h/9) and was updated using IRS-P6, LISS-III (Precision geocoded) data of 7th May, 2010 using ARC GIS software. For detailed study, Shuttle Radar Topographic Mission (SRTM) was used for delineating watershed boundary using SAGA GIS software. The GIS analysis techniques were used to evaluate linear and areal morphometric parameters of the basin. Drainage patterns are mainly dendritic to sub-dendritic with fifth order drainage. Banas river basin possess high drainage density which is indicative of less permeable material, sparse vegetative cover and moderate to high relief.

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Shanghong Zhang, et al., [17] have employed, DEM for flat region Extraction of watershed characteristics (stream position, stream length, watershed area, slope and others) using a digital elevation model (DEM) is an important prerequisite of hydrologic analysis. Detecting these surface hydrologic features in flat regions using a DEM is a known problem. Using a known stream network to improve DEM performance has been done in a variety of methods, many methods can improve calculation of watershed area, stream position and length, but there are strong impacts (e.g., slope) on subsequent terrain analysis from altering the DEM. To solve this problem, a new method, water depth gradient burning (WDGB), is proposed herein to extract watershed characteristics and subsequent terrain analysis in a flat region. WDGB can not only achieve watershed characteristics correctly in a flat region, but also have the least influence on the original DEM and the subsequent terrain analysis.

Nooka Ratnam et al., [18] have studied, Gis And Remote Sensing In Hydrogeomorphological Mapping And Integrated Agro Action Plan Development For Sustainable Land-Water Resource Management In Domaluru Watershed, Prakasam District, A.P., India. GIS modeling and integrated analysis of remote sensing data coupled with various spatio temporal parameters like, topography, drainage, soil, meteorological and land use / land cover helped in the generation of map output which can be directly used for agro action plan for the sustainable development of the Domaluru watershed.

Gundekar H.G., et al.[19] have studied, Morphometric study of the Dedhana river basin (Maharashtra). Morphometric parameters analysis has been carried out to determine drainage basin characteristics of the Dudhana river, a sub-tributary of the Godavari River using GIS. The catchment was divided into seven sub-basin for the analysis. Drainage pattern of the sub basins are dendrite and parallel. The basin is of seventh order stream and lower order stream mostly dominate the basin. The mean bifurcation ratio indicate that drainage pattern is not much influenced by geological structures.

P.D. Aher , et al. [20], have used remote sensing and GIS approach. Planning of watershed at micro-level is indispensable for sustainable development, particularly in the fragile semi-arid tropics. Geospatial–statistical techniques were used for identifying critical and priority sub-watersheds in water scarce region of India. A novel Weighted Sum Analysis technique was developed for ranking of each hydrological unit concerning the weightages obtained from morphometric parameters. Considering WSA approach, sub-watersheds were alienated into very high, high, medium, low and poor priority zones.

G P Obi Reddy, et al. [21] have carried out Geomorphological Analysis for Inventory of Degraded Lands in a River Basin of Basaltic Terrain Using Remote Sensing and GIS. Remote sensing data provides an opportunity for better observation and systematic analysis of terrain conditions following the synoptic and multi-spectral coverage. Geomorphological analysis reveals that various denudational and depositional landforms have been analysed and mapped.

Abhijit M.Zende, et al. [22] have done Prioritization of sub-watersheds in semi arid region, Western Maharashtra, India using Geographical Information System. Entire study area has been further divided into 9 sub-watersheds ranging in geographical area from 76 km² to 492 km² and has been taken up for prioritization based on morphometric analysis using Geographical information system (GIS) and remote sensing techniques.

M.L.Waikar and Aditya P. Nilawar. [23] carried out, Morphometric Analysis of a Drainage Basin of Charthana Using Geographical Information System. The morphometric parameters of basin are linear, areal and relief aspects. The study deals mainly with the geometry, more emphasis being placed on the evaluation of morphometric parameters.

Sridhar. P, et al. [24]has done Prioritisation of miniwatersheds based on Morphometric analysis using GIS. Eighteen miniwatersheds of Kadam watershed of Middle Godavari sub basin have been prioritized using GIS based on morphometric analysis. Ranks have been assigned to each parameter based on their value with highest value as I rank and the rank values of all parameters have been cumulated to obtain compound parameter. Priorities are arrived at based on compound parameter values. The miniwatershed with the lowest compound parameter value is given the highest priority and vice versa.

II. CONCLUSION

In this research review paper Morphometric Analysis of a Basin Using Remote Sensing and GIS is discussed in brief. Morphometric Analysis with reference to the site selection for conservation structures and also for planning of

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groundwater potential zones have been attempted various researchers . Morphometric analysis using high resolution satellite data with reference to erosion assessment which in turn require for planning of engineering conservation measures may be planned by using RS and GIS technique.

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