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REVIEW PAPER ON STUDY OF WATERSHED CHARACTERISTICS USING GEOSPATIAL TECHNOLOGY

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Abstract -*Water is one of the vital needs of all living beings. Humans need water in many daily activities like drinking, washing, bathing, cooking etc. If the quality of water is not good then it becomes unfit for drinking and other activities. The quality of water usually described according to its physical, chemical and biological characteristics. Hence it becomes necessary to find the suitability of water for drinking, irrigation and Industry purpose. The groundwater quality based on Sodium percent, Sodium Absorption Ratio and Residual Sodium Carbonate will help to identify the suitability of water for irrigation purpose. Rapid industrialization and use of chemical fertilizers and pesticides in agriculture are causing deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from water borne diseases. Parameters that may be tested include temperature, pH, turbidity, salinity, nitrates, TDS, Cations, Anions and phosphates.*

Key Words:MORPHOMETIC PARAMETERS, PRIORITIZATION, SUB WATERSHEDS, GIS.

1.INTRODUCTION

Water and land are two of the most important natural resources of the world since they are both essential of life and numerous development projects. These resources are finite and just as the global population grows, so too does need for these resources. As a result, water resource management, conservation and proper planning are expected for long term development.

The water reaches at Earth's surface through precipitation. Some amount of water falling on land seeps into the soil or flows over the surface before entering the streams and lakes. The area of land that supplies water to particular river or lake is known as water shed. The whole world is divided into many watershed/ sub watersheds to make it easy to study the conservation, management and utilization of natural resources.

Morphometric analysis using Geospatial technologies such as Remote Sensing, Geographical Information System (GIS), Global Positioning System (GPS) techniques have been considered as powerful tools. These techniques have ability of obtaining Synoptic view of large area at one time and it is very useful to analysing the data.

The objective of this research is to utilize an integrated approach to prioritize the sub-watersheds for conservation and management of water resources based on the data on geological conditions, rainfall, morphometric parameters, hydrogeomorphic units, land-use, and land-cover mapping by applying weighted factor analysis.

2. LITERATURE REVIEW

The extensive literature review was carried out by referring standard journals, reference books and conference proceedings. The major work carried out by the different researchers is summarized below.

S. Srinivasa vittal et.al [1] In this study, Remote sensing and GIS have proved to be efficient tool in drainage delineation and updating in the present study and these updated drainages have been used for the morphometric analysis. The morphometric analysis of the drainage networks of all 9 sub-watersheds exhibits the dendritic to sub dendritic drainage pattern and the variation in stream length ratio might be due to changes in slope and topography. It is also concluded from the study that that the mature stage of streams in Nagalamadike, Maddalenahalli and Byadanur sub-watersheds and late youth stage of geomorphic development in remaining sub-watersheds. The variation in values of bifurcation ratio among the sub-watersheds is ascribed to the difference in topography and geometric development. The stream frequencies for all sub-watersheds of the study exhibits positive correlation with the drainage density values indicating the increase in stream population with respect to increase in drainage density.

S.Srinivasa vittala et.al [2] In this study, The land use / land cover maps were prepared using satellite images on 1:50,000 scale and topographic maps were used as reference on the same scale. The different land use / land cover classes like settlements, crop land, fallow and agricultural plantations, scrub degraded forest, forest plantation, land with scrub, land without scrub, prosofisjuliform (Bellary jali), salt affected land, barren rocky / stony waste / sheet rock area, rivers, streams and tanks were delineated based on the image characteristics. The cropland may be of either kharif or rabi or double crop (Kharif + Rabi). The major kharif crop identified was groundnut. The double cropped areas are found in command areas like major tanks, either side of stream where deep clay loamy to clayed soil patches found and the double crops identified in the study area are mainly of paddy, ragi and groundnut and noticed in almost all sub-watersheds. The agricultural plantations are mainly of coconut and forest plantations consist of Eucalyptus. The salt affected lands are confined to the eastern and north-eastern parts of the study area and observed in only 4 subwatersheds namely Naliganahalli, Nagalamadike, Maddalenahalli and Dalavayihalli sub-watersheds. Stony waste is noticed in almost all parts of the study area.

S.Srinivasa vittala et.al [3] In this study, The analysis reveals that remote sensing and GIS have proved as vital tools in delineating different groundwater prospective zones based on the integration of various thematic maps viz., slope, lithology, lineament, geomorphology, and borewell details in the present study. The lineament analysis of the sub-watersheds indicates that, majority of lineaments are oriented in ENE, almost E-W, N-S and N 60º-70º W. The borewell locations near lineaments are the best followed by the areas between two lineaments in each sub-watersheds and can be concluded that the lineaments are acting as a pathway for groundwater movement as a result; the maximum number of existing wells are located near the lineaments.

Hema H.C and Govindaiah S [4] In this study,The morphometric analysis has been carried out through measurements of linear, aerial and relief aspects of 9 subwatersheds. The drainage networks of the sub-watersheds of the study area shows dendritic to sub-dendritic patters. The drainage density ranges from 1.71 to 3.04 km/km2 suggesting very coarse to coarse drainage. Drainage texture is one of the important concepts of geomorphology which means that the relative spacing of drainage lines. Drainage lines are numerous over impermeable areas than permeable areas.The different aerial aspects of the basin give a better understanding of nature of the basin. The aerial aspect includes the parameters like basin area, basin perimeter, drainage density, stream frequency, constant channel maintenance, length of overland flow, etc.

B.N. KrishnaMurthy et.al [5] In this study, GIS techniques characterized by very high accuracy of mapping and measurement prove to be a competent tool in morphometric analysis.The morphometric analysis were carried out through measurement of linear, areal and relief aspects of the watershed 14 morphometric parameters are analyzed of sixth order of Cauvery sub basin.The morphometric analysis of the drainage network of the watershed show trellis and dendric patterns. The watershed indicates normal watershed category. The value of stream frequency indicate that the watershed show It is a technique which is also used in planning and development to identify land quality for optimum utilization.

Sindhu D et.al [6] In this study, the catchment has suffered less structural disturbance and is more elongated. The catchment has enough slope for the runoff to occur. There is moderate soil erosion in the entire catchment hence conservation methods can be proposed on the priority basis for conservation of natural resources available in the catchment area.The quantitative morphometric analysis of the drainage basin is considered to be the most satisfactory method because it enables us to understand the relationship between different aspects of the drainage pattern of the same drainage basin the drainage details derived from Survey of India (SOI) topo maps on 1:50000 scale was updated with remotely sensed data. Morphometric analysis was carried out to estimate dimensional parameters using Arc- GIS software. Morphometric analysis was divided into linear, areal and relief aspects.

K. Ibrahim-Bathis, S.A. Ahmed [7] In this study, The depth of groundwater level changes through the seasons and in the monsoon and post monsoon period the groundwater depth is nearly 5– 10 m below ground level in most places according to the Central Ground Water Board (CGWB) report. The presentgroundwater resource will be further enhanced by adopting the water harvesting structures and deepening on the existing lakes and tanks.The measure has to initiate to reduce the surface runoff and increase the infiltration and surface water bodies. Delineated groundwater zone map is useful for locating the drilled well and dug well for the irrigation and domestic water consumption purpose.The majority of the crops in the region depends on rainfall, and the development of the irrigation facility will enhance the agricultural productivity in the region.

Shivanna S et.al [8] In this study, the area is a part of hard rock terrain. Drainage pattern in the study watershed is mainly controlled by lithology and structures. Topography, lithology and lineaments of the Hesaraghatta watershed has important water bearing on hydrological characteristics of the area. Morphometric analysis of Hesaraghatta watershed reveals that it is a sixth order, elongated, medium to coarse textured basin. Land use is an important concept and it includes the natural resources like soil, vegetation, water flora and fauna.The impact of climate, soil, vegetation etc., on the land use of an area mainly depends on the topographic conditions.
Siddnagowda [9] In this study, the present study is an effort to studying the Weighted overlay analysis of the Kanakapura watershed. The Kanakapura watershed was delineated into nine sub-watersheds based on various morphometric parameters. In order to bring all the thematic layers, having diverse, dissimilar inputs, into an integrated analysis, a common scale of value is applied to each layer. The sub-watersheds were categorized into four levels of ranking, ranging from 1 to 4, on the basis of their infiltration potential, namely: very low, low, medium, and high, respectively. Each layer is assigned a weightage based on its importance in contribution towards the groundwater recharge process.

J Harsha et.al [10] In this study, the study of hypsometric curve reveals that Arkavathi river basin is close to young but not old type of basin. Hence, the basin possesses considerable scope for erosion in future. The presence of fatter terrain in midlands in between uplands and lowlands is confirmed by hypsometric curve. That puts existing reservoirs and water bodies across midlands at risk of sedimentation and loss of crucial live storage which will lead to accentuation of water stress in the basin. Morphological characteristics of the basin indicate variation in different stream orders that confirms the anomalous basin development and local variation in topography in the basin.

Bipin anand et.al [11] In this study, we conclude on the basis of morphometric and change detection analysis carried over the Vrishabhavathi river basin that the Vrishabhavathi morphology is severely affected by the rapid urbanization in recent decades.Runoff pattern has not changed majorly; only some changes in peak times in several months have occurred.Drainage network is entirely affected, streams of various orders are disappearing, vegetation and green cover is reduced as we observed in the analysis.From this study it can be concluded that remote sensing techniques and GIS tools proved to be a competent tool in morphometric analysis and change detection analysis for the spatio-temporal analysis of urban influence, climate, vegetation, geomorphological and hydrological evolution of the Vrishabhavathi river basin area.

DevananthamAbijitha et.al [12] In this study, The hard-rock terrain in the northern part of the study area was led to the generally low groundwater potential due to hydrogeological conditions of the subsurface.Verification of the groundwater potential map using field data indicates that this approach of prediction is effective and reliableIn the validation, 56 observed wells are taken whose post-monsoon water level is analyzed with resultant groundwater potential maps obtained from AHP and MIF. The water level fluctuation ranges from 10 to 20 m3 /h. The region below the ROC curve is between 0 and 1. A larger area under the ROC curve refers to the higher efficiency of spatial modelling models such as groundwater mapping potential.

Hema hc et.al [13] In this study, Prioritization of sub-watershed is the foremost task towards integrated and efficient watershed development and management, which will further aid decision-makers and planners achieve the appropriate allocation of resources. This will help in the creation of a detailed database under each natural resource theme, which is essential for effective and efficient conservation and management of deteriorating watersheds. This paper summarizes the integrated approach for developing a multicriteria prioritization of sub-watersheds in the Kanakapura watershed area, Ramanagaram District, Karnataka. The entire area has been divided into nine sub-watersheds and prioritization has been carried out considering various parameters, including rainfall, drainage density, slope, drainage density, lineament density, hydrogeomorphic units, and LULC.

A Bharath et.al [14] In this study, Morphometric analysis is a fundamental approach for describing the physiological and quantitative features of a watershed. Already been used to preserve natural resources by prioritizing sub-watersheds. GIS and remote sensing techniques can be effectively used to evaluate morphometric characteristics rather than traditional approaches.Geospatial technology was used to conduct a quantitative morphometric study for the sub-basins of the Kalinadi basin. This study highlights sub-watershed prioritization based on watershed morphometric parameters considering their impact on soil erosion susceptibility.Nineteen morphometric parameters are evaluated for all the sub-watersheds of the Kalinadi basin.

Samarth Suresh et.al [15] In this study, The Aquatic life is soon to be disturbed if the contaminations continue to be discharged into this river from industrial outputs. Overall, the utilization of Ground and surface water from this Arkavathi River should be limited for drinking and domestic purposes, and subjected to further tests and sufficiently treated in order to prove its potability before supplying to consumers.Water samples will be collected directly from the Arakavathi river for testing of surface water and from bore wells, hand pumps, wells.Give natural importance to every part of test boundary.

Arjun suresh, et.al [16] In this study was carried out in the Brahmaputra River, which is highly prone to erosion and deposition. These erosion and deposition events are considered major factors are influencing Bankline migration and river shifting. In the case of Brahmaputra, the river is considered to be a braided river due to its flow mechanism.The shift in Bankline migration was assessed with the help of satellite images from 1990 to 2021 and theapplication of geospatial technology.A natural force like the river is hard to control, and natural disasters based on the river are tough to predict. However, in-depth monitoring of the morphological change and river bank dynamics may have the possibility to broaden the idea. This research has captured the river's changing behavior through time-series satellite imagery analysis. Remote sensing analysis has been in geographical research.

PazhuparambilJayarajanSajil Kumar et.al [17] In this study,used GIS, remote sensing, and AHP for the delineation of groundwater potential zones in the Chennai River Basin (CRB). This basin area is important for the water supply to Chennai, both the metropolitan and surrounding rural areas. Earlier studies were smaller in scale and, from the literature, the need for groundwater potential mapping for the entire basin was understood. Factors influencing groundwater recharge are determined based on literature survey, field analysis and expert opinion. Based on this preliminary investigation geomorphology, geology, lineament, annual rainfall, pre-monsoon water level, depth to bed rock, soil, land use, aspect and slope were chosen as main factors.

H. Chandrashekara et.al [18] In this study, the length of overland flow in both the reservoir catchment in the present study is more than 0.3. Hence, the reservoir catchments selected for study have longer flow paths associated with more infiltration and reduced runoff. The results of morphometric analysis provide information about catchment development on priority basis and areas vulnerable for land degradation. The catchments taken for study fall under very coarse texture category. The higher value of stream frequency is observed in Manchanabele catchment and Nelligudde catchment indicates low conducting subsurface material, sparse vegetation and high relief. The length of overland flow in Nelligudde reservoir catchment is 0.785 km/km2 and Manchanabele reservoir catchment is0.725 km/km2. The length of overland flow in all the reservoir catchments and lake Catchments in the present study is more than 0.3. Hence, the reservoir catchments selected for study have longer flow paths associated with more infiltration and reduced runoff. The higher value of form factor in Manchanabele catchment indicates wider basin and lower value of form factor in Nelligudde catchment indicates narrow basin.

3.METHODOLOGY

3.1 Digital elevation model:

A digital elevation model or digital surface model is a 3D computer graphics representation of elevation data to represent terrain or overlaying objects, commonly of a planet, moon, or asteroid. A "global DEM" refers to a discrete global grid.

3.2 Geometric correction:

Geometric correction is undertaken to avoid geometric distortions from a distorted image, and is achieved by establishing the relationship between the image coordinate system and the geographic coordinate system using calibration data of the sensor, measured data of position and attitude, ground control points, atmospheric condition etc.

3.3 Extraction of Drainage network:

Extraction of Drainage network plays an important role in geomorphologic analyses, hydrologic modelling, and non-point source pollutant simulation, among others.

The extraction of drainage networks from digital elevation data is important for quantitative studies in geomorphology and hydrology. A method is presented for extracting drainage networks from gridded elevation data. The method handles artificial pits introduced by data collection systems and extracts only the major drainage paths. Its performance appears to be consistent with the visual interpretation of drainage patterns from elevation contours.

3.4 Delineation of study area: Watershed delineation means is that drawing lines on a map to identify a watershed's boundaries. These are typically drawn on topographic maps using information from contour lines. Contour lines are lines of equal elevation, so any point along a given contour line is the same elevation.

3.5 Sub-watershed:

Sub-watershed means a division of the district as nearly equal in size to other divisions of the district as feasible and including as nearly as practicable one or more tributaries to the main stream which drains from the district.

This occurs when the precipitation (rain or snowmelt) at the soil surface exceeds the sum of infiltration and surface subtraction. The surface water component accepts solids with associated contaminants liberated from top soil by erosion and leaching.

3.6 Morphometric Analysis

Morphometry is the measurementand mathematical analysis of the configuration of the Earth's surface, shape and dimensions of its landforms (Clarke, 1966). This analysis can be achieved through measurement of linear, aerial and relief aspects of basin and slope contributions (Nag and Chakraborty, 2003). In the present study, the morphometric analysis for the parameters namely stream order, stream length, bifurcation ratio, stream length ratio, basin length, drainage density, stream frequency, elongation ratio, circularity ratio, form factor, relief ratio, etc.,

3.7Basic parameters:

Watershed area (A) is the total area enclosed in the watershed boundary. It directly influences the runoff volume from a watershed. In this study, the area of the sub-watersheds ranges from 50km2-100km2,

The perimeter (P) of a basin is the entire stretch of its boundaries. It resembles the shape and size of the drainage basin. The elongation ratio and circulatory ratio are two parameters that are influenced by the basin perimeter.

Basin length (Lb) is described by various individuals in several different ways. According to Schumm, the basin length is the longest distance running parallel to the prime drainage channel.

It indicates the main channel where the highest runoff quantity occurs.Basin width (Wb) is the distance of line that is drawn perpendicular to basin length. In this research.

Stream order (U), which is based on a traditional organizational hierarchy of channels, is indeed a criterion for every watershed assessment. In this study, stream ordering is done according to Strahler's method here the very first stream is one that has no tributaries, and then as two first-order streams merge to form second order streams and so on the highest stream order is considered as stream order of the watershed.

Stream number (Nu) refers to the cumulative amount of stream segments of each order. The quantity of stream units of every other order from that of a reciprocal geometric sequence with the order unit, according to R. E. Horton. Stream number categorizes the surface runoff features i.e., a higher number of first-order streams indicate higher permeability and erodible topography.

3.8 Linear parameters:

Stream length (Lu) is the total combined length of all the stream segments of a specific order in a basin. One of the most important drainage properties is stream length, which shows the basin's runoff and sediment properties. With the benefit of GIS software watershed geometry, the cumulative stream lengths of different orders are calculated. It is extracted from the origin to the end of the rivers and indicates the chronological expansion of the rivers.

The stream length ratio (Rl) is the ratio of the total stream length of any order to the total stream length of its subsequent previous order. The discrepancies in stream seg-

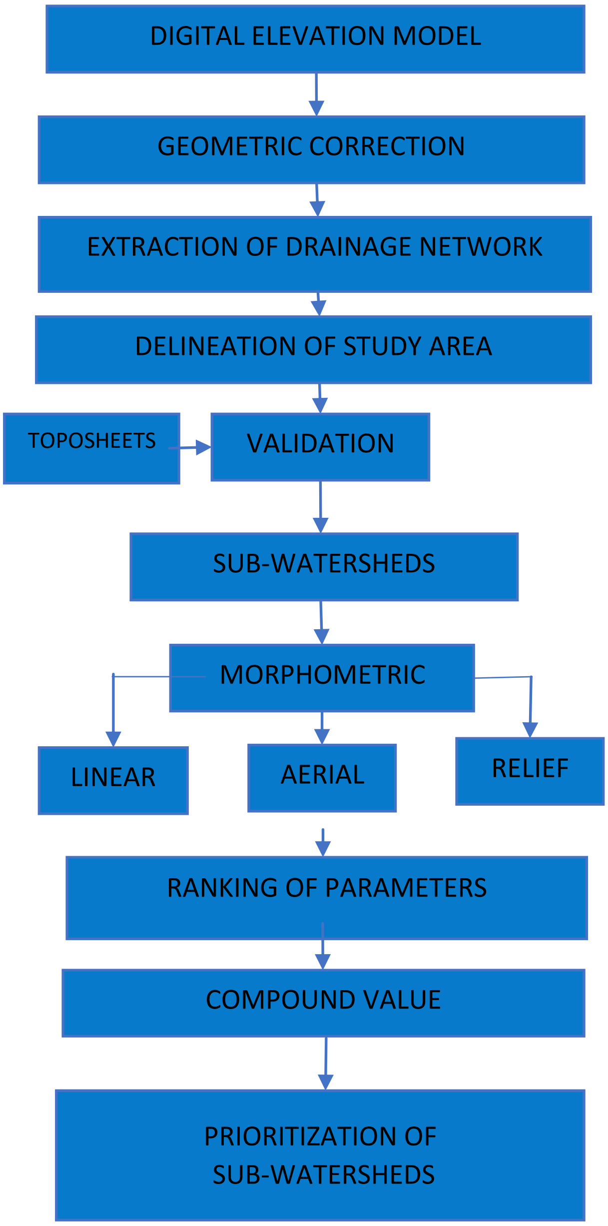
ment ratios of the sub-watersheds could have been influenced by changes in elevation and topological constraints.
The Bifurcation Ratio (Rb) is the proportion of the total number of streams of a specified order to the total number of streams of the subsequent higher-order. It is indeed a dimensionless property that indicates the level of convergence among rivers of different stream orders in a watershed. The low Rb values imply a flat area with a flowing drainage system.
Rho coefficient (ρ) is the proportion of stream length ratio to bifurcation ratio. It is a significant parameter that governs the storage capacity of the stream network and level of drainage development.
Stream frequency (Fs) is the quantity that represents the total quantity of streams per unit area. It is classified according to the nature and quantity of precipitation, the composition of rocks, and the penetrability of the soil in the area to determine the indices of different stages of landscape growth.
Drainage density (Dd) is the ratio total length of streams to the basin area. It indicates the stream development and its spacing. It is influenced by rock, soil, climate, relief, channel head, valley density, source area and the landscape evolution.
Drainage texture (Dt) is the ratio of the number of streams to the basin perimeter. It signifies the relative spacing of streams.
Length of overland flow (Lof) is about a portion of the entire length among river systems, making it about equivalent to half of the inverse of drainage density. It is perhaps the main individual parameters affecting the geographical and hydrological evolution of a watershed.
Drainage intensity (Di) is the proportion of stream frequency to the drainage density. Lower values of drainage density, drainage texture and drainage intensity signify that the watershed is more prone to soil erosion.
Infiltration number (If) is an important parameter that indicates infiltration rate and surface runoff. It is obtained by multiplying stream frequency and drainage density.
Circularity ratio (Rc) is the proportion of watershed area to the area of a circle which has the same circumference as that of basin perimeter. Values of circularity ratio help to identify the stage of watershed development i.e., the lower value represents the younger stage, medium values represent the mature stage and higher values represent the older stage of a watershed.
Elongation ratio (Re) is the proportion of diameter of a circle whose area is the same as that of the watershed to the basin length. If the values are higher, it indicates the watershed is less elongated and vice-versa.
Form factor ratio (Ff) is the proportion of the watershed area to the square of the basin length. Generally, the form factor ranges from zero (extremely long shape) to unity (round shape).
Lemniscate's ratio (K) is utilized to govern the gradient of the basin.
Compactness coefficient (Cc) is the proportion of basin perimeter and circumference of a circle which has the same area as that of the basin (Potter, 1957). It is reliant on basin slope and independent of basin size.
Shape factor (Sf) is the proportion of square of basin length to the watershed area. It is a significant feature that influences the runoff and sediment quantity. Lower values indicate less erosion susceptibility and vice versa.
Constant of channel maintenance (C) is the reciprocal of drainage density. It characterizes the drainage area essential to maintain a unit length of the channel and it is affected by relief, geological and climatic parameters. Larger values of channel maintenance designate higher permeability and mature to the old stage of the watershed and vice-versa.

3.9 Relief parameters:

Total relief (H) is usually designated as basin relief and it is mathematically characterized as the difference between the highest and lowest elevation of the watershed. It greatly affects the slope of the basin and in turn impacts the soil erosion susceptibility.
Relief ratio (Rh) is the proportion of basin relief to the length of the basin. The relief ratio gives a better picture of relief aspects than compared to total relief.
Relative relief (Rr) is the proportion of basin relief to the basin's perimeter.
Ruggedness number (Rn) is the product of basin relief and drainage density. Higher the value of ruggedness number, more rugged will be the topography and vice-versa.

3.10 Prioritization of sub watersheds:

The sub-watersheds are prioritized based on various Morphometric parameters. Prioritization is the process in which the sub-watersheds are arranged in a hierarchy based on the need for treatment for watershed conservation i.e., the watershed which requires higher maintenance is given top priority ranking and vice versa. Based on the literature survey. Prioritization of sub-watersheds can also be done using the analysis of surface and ground water quality. Soil erosion has a direct relationship with linear, aerial and relief parameters. Therefore, a sub-watershed with the smallest value of these parameters is designated as the first rank, the next smallest value is designated as the second rank and so on, finally, the largest value is assigned as the last rank. For each sub-watershed, the compound value is derived by averaging the ranks allotted to all the parameters. Finally, the sub-watershed with the lowest compound value is rated as the highest priority, the next lowest value is rated as the second highest priority and the sub-watershed with the largest compound value is designated with the last priority.



4. CONCLUSION:

Morphometric analysis is a fundamental approach for describing the physiological and quantitative features of a watershed. It has already been used to preserve natural resources by prioritizing sub-watersheds. GIS and remote sensing techniques can be effectively used to evaluate morphometric characteristics rather than traditional approaches. The geospatial technology was used to conduct a quantitative morphometric study for the sub-basins. Study highlights sub-watershed prioritization based on watershed morphometric parameters considering their impact on soil erosion susceptibility. Based on theparameters, erosion-prone zones are identified by implementing the compound values method which ranks the sub-watersheds. The research concludes that the study of drainage morphometry is a vital method to understand the characteristics of a watershed and it can be effectively utilized to prioritize the sub-watersheds. The results can be used by the decision-making authorities to allocate the resources optimally to ensure sustainability cost effectively.

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