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MORPHOMETRIC ANALYSIS OF SINA RIVER BASIN AT MIDSANGAVI USING RS & GIS

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Abstract

Quantitative morphometric analysis can be used to evaluate the drainage basin's properties and identify the hydrodynamic composition of the exposed rocks in the drainage basin. This study presents to maximize the benefits of water use based on watershed management by morphometric parameters & determination of land use of Sina River basin. Morphometric analysis using ESRI Software ArcGIS and land use and land cover using ROLTA GEOMATIC from CWPRS. The Research reveals at 0.475, the drainage density of the study region is regarded as low. This suggests that it has a subsoil with a high porosity, a coarse drainage texture, and a good vegetation cover. The elongation ratio value of 0.67 demonstrates the significant relief in the area. The drainage texture is substantially rougher than the watershed texture, which has a texture ratio of 1.63. Since the form factor is 0.35, the basin sees low peak flows over a longer period of time. The infiltration with the lower runoff is substantial due to the low infiltration number. For the study area, the infiltration number is 0. 088.According to the results of the morphometric study, check dams and bunds should be offered. Land use and Land Cover suggests the vegetation has reduced with the time.

Keywords: Morphometric parameters, Sina, watershed, infiltration

1. INTRODUCTION

1.1 Background

Water As the global population is rising and cities throughout the world are becoming more and more populated, Water is in greater supply than ever. insufficient supply of water, on the other hand, is causing a rise in the demand for water for various purposes and a reduction in the availability of high- quality water because the majority of the close, reliable sources have already been overused (Sabale & Jose, 2022). Due to the increasing need for water for agriculture, drinking, and business demands, urban development and population increases in nations like India put more strain on water supplies. There is currently a severe water crisis as a result of increased water demand, which has impacted both surface and groundwater supplies. Surface-water supply constraints are exacerbated by low-intensity and unpredictable monsoons. Thus, the need for groundwater resources has grown significantly year over year, leading to a sharp fall in groundwater levels. Aquifer zones in numerous regions of the country have dried up as a result of excessive groundwater exploitation. For the water management scheme, it is imperative to increase the basin's recharge (Sabale, Londhe, et al., 2023). By assessing the drainage basin's characteristics using quantitative morphometric analysis, it is possible to ascertain the aqueous makeup of the rocks that are exposed within it (Salvi & Suthar, 2022). Calculating the flexibility of the rocks and determining the basin's yield can both be done using the drainage map of a basin (Sabale et al., 2023). The growing usage of water has led to a severe water crisis that has affected surface water as well as groundwater supplies. Additionally, erratic and weak monsoons add to the growing shortage of surface-water supply. Because of this, the amount of groundwater used has been steadily increasing, drastically lowering the amount of groundwater available. Aquifer zones have become depleted up across the nation as a result of unsustainable groundwater extraction. Therefore, increasing the basin's recharge is crucial for the water management programme (Tapase et al., 2022).

Quantitative morphometric analysis can be used to evaluate the drainage basin's properties and identify the hydrodynamic composition of the exposed rocks in the drainage basin. The drainage map of a basin can be used to calculate the yield of the basin as well as the susceptibility of the rocks. Relationships between different rock types, structures, and drainage networks have been documented by morphometric analysis of drainage patterns. In terms of quantitatively describing The network and structure of drainage basins, morphometric techniques represent a significant advance. These techniques help characterise drainage networks, compare their features, and assess the effects of various factors such as lithology, rock structure, rainfall, and others. The drainage network frequently serves as an example of the interaction between fundamental drainage features, the dominant the weather, earth sciences, some relief and seismic architecture of a watershed. At the basin size, the functioning of the running water ecosystem is significantly influenced by geology, relief, and climate(Sabale & Jose, 2021b). Numerous researchers have recently attempted to produce data that is more precise by employing the use of Geographic Information Systems (GI technologies in a variety of sectors; this has been demonstrated to be an effective, time-saving, and optimal application of GIS technology. GIS is a helpful tool, according to recent studies. More data from drainage networks with various lithologies, climates, and tectonic frameworks are needed in order to interpret the morphometric properties in a useful way (Sabale & Jose, 2021a). The use of GIS for assessing drainage features from diverse data sources has lately come to the attention of numerous studies (Bobade & Rajni, 2021). The main advantages of employing a GIS for drainage study over more conventional methods of analysis come from the GIS's capacity to effectively organise and understand massive amounts of geographic data (Garg et al., 2021). They are frequently viewed as being essential components of management that support decision- makers in making judgements that are more insightful and efficient (Burroughs and McDonnell 1998). While the present study completely accounts for the examination of drainage parameters and field-based hydrological conditions, most earlier studies typically lacked the correlation of actual groundwater conditions through the study of hydrogeological circumstances and related hydrological conclusions (Suthar & Salvi, 2022). The current employs a combined application of GIS and remote sensing methods. As a final option, a system that combines remote sensing and GIS enables quick evaluation of drainage and selection criteria as well as post-implementation evaluation of results for in-depth hydrological study.

2. LITERATURE REVIEW

2.1 Research Carried Out by Various Researchers

Morphometric Analysis And Prioritization Of Vashishthi Watershed (Sahil Sanjeev Salvi , Suvasish Mukhopadhyay , Anuja Rajgopalan , S. D. Ranade. IJARIIE-ISSN-2395-4396 Vol-3 Issue-3 2017)

The morphometric analysis of the Vashishthi Watershed in the Ratnagiri district of Maharashtra, India, focused on its four sub-catchments. Remote sensing and geographic information system (GIS) techniques, employing satellite imagery and topographic maps at a scale of 1:50000, were utilized for this study. The Vashishthi watershed exhibits a dendritic drainage pattern. The investigation concentrated on the linear, aerial, and relief aspects concerning morphometric parameters. The drainage density in the study area ranged from 0.730 to 0.742 Km/km2, indicating excellent permeability of the subsurface. No structural disturbances or significant geological variations were observed, as evidenced by the bifurcation ratio ranging from 1.9 to 2.6. Through morphometric analysis, sub-catchment 1 displayed lower form factor, texture ratio, and elongation ratio values. Conversely, sub-catchment 3 exhibited lower drainage density and stream frequency values. The compound parameter values derived from the study were arranged in ascending order, starting from the lowest value. These findings contribute to understanding the distribution of streams in relation to sub-watersheds, as well as the impact of catchment characteristics (e.g., size, shape, slope) on these distributions.

Morphometric Analysis Of River Catchments, Using Remote Sensing, And GIS (Narender kumar International Journal of Scientific and Research Publications, Volume 3, Issue 6, June 2013)

Utilising was used to investigate the Luni River basin, the upper Sukri River catchment, and its two sub-catchments using RS and GIS. Linear, areal, and relief measurement and analysis for the two sub-catchments were done using GIS. Both of the sub-catchments have control over the geologic structure, strong surface run-off, and limited permeability. The sub-catchment level morphometic analyses and measurements showed a strong correlation between the topographical features and the morphometric parameters. The traits of Sub-catchment 2 are more evenly distributed than those of Sub-catchment 1 in the two sub-catchments. It would significantly improve river basin evolution and information for natural resource appraisal, planning, and management at any scale if basin morphometric features and associated parameters were analysed and measured in GIS. Planning, management, and assessment will affect

Sub-catchment 2 more than they will the other sub-catchments.

Morphometric Analysis of Bhogavati, River Basin, Kolhapur District, Maharashtra, India. (P. A. Pisal, A. S. Yadav, A. B. Chavan IOSR Journal of Mechanical and Civil Engineering IOSR-JMCE ISSN: 2278-1684, PP: 01-08)

Plans for the creation and management of watersheds are essential for maintaining both surface and ground water supplies. Understanding the topography, lithology, erosional state, and drainage pattern of the area is crucial before creating a watershed development plan. The Bhogavati river basin's morphometric properties are described in the current study. It has been shown that the multiple morphometrical metrics of the fifth-order Bhogavati River Basin are helpful for studies on basin-wide water resource management and appropriate land use planning. The dendritic drainage pattern in the region shows that the rock there is homogenous and unmodified structurally. The Basin's Fluvial Geomorphic Cycle is moving from an early mature to an old stage. The Bhogavati river basin is quite long and narrow, as shown by the elongation and circulation ratio.

Morphometric Analysis of Baltira Watershed Using, QGIS Platform. (Vipin Chandra, Milind R. Gidd International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-2, July 2019)

As India's population grows, resources like land and water are becoming increasingly scarce. Therefore, it is essential that these natural resources be preserved and utilized effectively. The main organisational units for protecting resources are watersheds. The assessment of data from dimensionless analysis, which aids in determining the linear and aerial properties, is particularly helpful in the morphometric investigation of basins for understanding landforms and qualities in depth.. For creating topographic and geomorphologic circumstances, it is essential to comprehend the unique characteristics of distinct basins. In this work, QGIS completes a morphometric evaluation for the 273 km2 Baltira watershed (Bobade et al., 2021). One of the tributaries of the Man River is called Baltira. The Baltira watershed appears to have high relief, a steep ground slope, and usually homogenous geology, according to the results of the morphometric investigation. For this experiment, watersheds were identified and drainage parameters were calculated using the hydrological module of QGIS software (Dhawale et al., 2020).

Morphometric Analysis of a Shakkar River Catchment Using RS and GIS. (Sarita Gajbhiye International Journal of U- and E- Service, Science and Technology Vol.8, No.2 2015)

A morphometric study was conducted utilising remote sensing (RS) and geographic information systems (GIS) using satellite imageries and topographic maps on a scale map of 1:50,000 to identify the drainage features of the Shakkar River watershed (area = 2220 km2). The drainage density in the studied area ranges from 2.84 to 3.67 km2/km2, indicating a dendritic drainage pattern and demonstrating how structurally regulated and highly permeable the soil is. Eight subwatersheds serve as the area's boundaries. According to the morphometric analysis, Sub-Watershed 3 has lower Drainage Density and Stream Frequency values. Sub- watersheds 6 and 7 both have weak Circulatory Ratios and Form Factors, while Sub-Watershed 6 has a low Compactness Constant. In subwatershed 2, the relief aspect is less significant. The slope values, on average, range from 9.27 to 88.50%. This morphometric analysis study provides information on the hydrological behaviour of the river and describes the Shakker river catchment's watershed.

Morphometric Analysis of Watershed of Sub-drainage of Godavari River in Marathwada, Ambad Region by using

Remote Sensing (Ashok S. Sangle. Pravin L.Yannawar International Journal of Computer Applications Volume 125 – no.5, September 2015)

The preparation of management and planning of the geography's natural resources frequently makes use of GIS and remote sensing. The development of these technologies has several benefits, from the ability to quickly plan and resolve end-user problems to getting a broad overview of natural resources and qualities at a glance. The management of natural resources utilised to protect water, such as topographical morphometrics, drainage design, and evaluation and characterization of watersheds, is the focus of this study. By improving water levels and managing agricultural practises and drought-affected areas, it aids in meeting the need for water for food production. The Toposheets data set and the DEM 90m resolution values indicated that the watershed had a size of 204 square kilometres. The stated basin topography was represented by 51 streams, with a total length of 99.84 km, a drainage density of 0.48, a form factor of 0.19, a circulation ratio of 0.2, a length ratio of 0.05, and a bifurcation ratio of 2.73.

Morphometric analysis of Morar River Basin, Madhya Pradesh, India, using remote sensing and GIS techniques. (Prafull Singh, Jay krishna Thakur & U. C. Singh Environ Earth Sci (2013) 68:1967–1977)

The investigation of drainage patterns and hydrogeological mapping can help groundwater development. Statistics have been used to measure the drainage of the Morar River Basin and related elements, which has aided research and helped the local population manage and grow their water resources sustainably. The morphometric properties of the basin were calculated and delineated using a geographic information system. The basin's dendritic drainage system lacks structural control and has a uniform texture. The first through sixth orders make up the stream. The region has a low drainage density, which suggests that the soils are quite porous and that the relief is low. The basin belongs to the category of elongated-shaped basins, according to the bifurcation ratio, which ranges from 2.00 to 5.50. The analysis's findings will be helpful in determining the influence of watershed characteristics such as size, shape, slope, and stream network distribution.

Morphometric Analysis Of Thirumanimuttar River, Tamilnadu Using Geographic Information System. (Prafull Singh, Jay krishna Thakur & U. C. Singh (Dr. Vijayakumar Narde International Journal of Current Research Vol. 10, Issue, 12, pp.76001-76006, December, 2018)

To create a suitable plan for the socially acceptable, environmentally sound, and economically viable development of a river basin, baseline morphometric data at the subbasin level are crucial. The current study was conducted in one of Tamil Nadu, India's lesser-known Thirumanimuttar River subbasins of the Cauvery River. To examine the morphometric properties of the basin, we used GIS and RS technologies. Several lower order streams combine to form the seventh order main river, which has a dendritic flow pattern. The basin's governing elements are dominated by structure, as shown by the mean bifurcation ratio of 3.61. The basin is larger, with a median drainage density of 0.996 per km2. The basin's overland flow values are 0.502, which indicates considerable relief. To build a suitable strategy for the socially acceptable, environmentally sound, and ec, baseline morphometric data at the subbasin level are crucial. Our understanding of the hydrological, geological, and geomorphological features of the Thirumanimuttar drainage basin has improved as a result of the study.

Morphometric Analysis of a Drainage Basin: A Study of Ghatganga River, Bajhang District, Nepa.(Sandeep

Adhikari. The Geographic Base Vol. 7: 127-144, 2020)

In this paper, morphometric characteristics of the Ghatganga basin are studied using a geographic information system (GIS). According to this study, stream order (U) and stream number (Nu) have a negative linear relationship that causes stream segments of a particular order to become more and less numerous. The dendritic drainage pattern in the basin indicates high topography, steep ground slopes, less elongated juvenile and adult landforms, and an absence of significant influence from geological features. The following morphometric metrics are used to describe streams: stream length (Lu), bifurcation ratio (Rb), drainage density (D), stream frequency (Fs), texture ratio (T), elongation ratio (Re), circularity ratio (Rc), form factor ratio (Rf), and relief ratio (RH).

Morphometric Characterization of Yamuna River basin around Agra, Firozabad and Etawah Districts, Uttar Pradesh, using Remote Sensing and GIS Techniques. (Liaqat A.K. Rao, Armugha Khan, Himanshu govil. International advanced research journal in science, engineering and technology ISO 3297:2007 certified vol. 4, issue 5, may 2017)

The goal of the current study is to determine the morphometry of the Yamuna River basin using remote sensing and GIS methods. Agra, Firozabad, and Etawah districts in Uttar Pradesh are comprised in part. GIS spatial analysis was used to locate and specialise the morphometric characteristics. The variables of linear, areal, and relief aspects are created by the morphometric parameters. According to the integrated study of the variables, the basin is elongated, has extremely voracious erosion, and has very permeable rocks. The basin is in a mature to ancient stage of geomorphic history, according to hypsometric studies.

3. STUDY AREA

Area Details

Table No 1 Area Details

Name of Watershed/RiverBasin	Sina River
Area	2646.645 sq.kms
Geometrical Location	Latitude- 190 09' 16'' N - 190 10' 13'' N Longitude- 750 24' 56" E - 750 25' 51" E
Village	Midsangavi
Taluka	Pathardi
District	Ahmednagar
State	Maharashtra, India

Fig 1: Google Earth Area of Project

AREA MAP

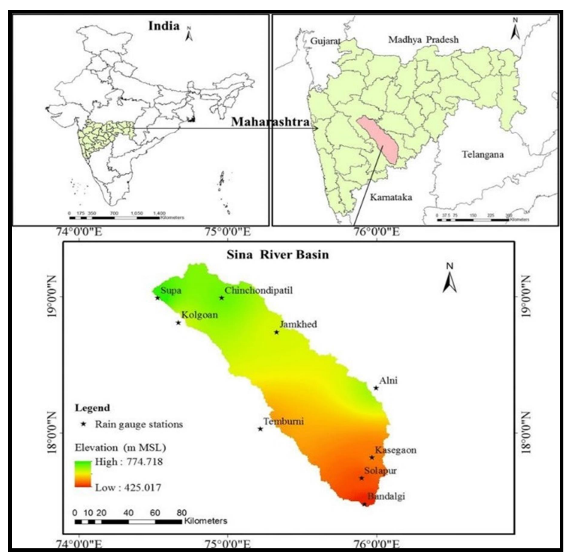


Fig 2: Map of Sina River Basin

4. DATA COLLECTION

Geographical Data

Geographical data of Midsangavi are studied and Thematic Maps are prepared.

Toposheet

A topographical map is a representation in two dimensions of a three-dimensional land surface. Among topographical maps, a toposheet is one. We have compiled the topographies of the study region that were provided to us by the Bhuvan website and the Survey of India (SOI).

Toposheet No: E43D8

Scale: 1:50000

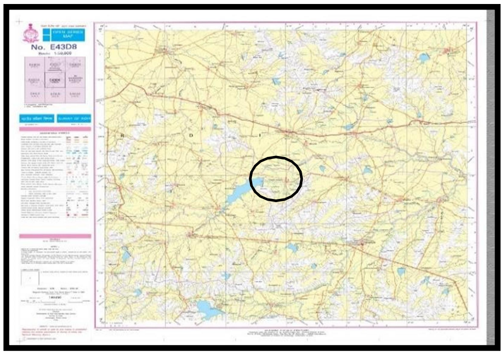


Fig 3: Toposheet

Digital Elevation Model

A digital elevation model is a computer model or three- dimensional depiction of a terrain's surface made using elevation information from the ground. The DEM is used to extract stream networks, specify watersheds, carry out research, and digitally map soil.

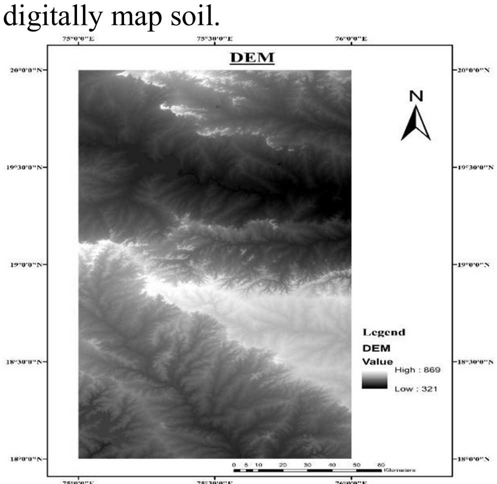


Fig 4: DEM File

GEOLOGICAL DATA

The entire area of the Midsangavi is occupied by the basaltic rock.

When basalt, an aphanitic (fine-grained) extrusive igneous rock, was exposed at or very near the surface of a rocky planet or moon, it quickly cooled from a low-viscosity, magnesium and iron-rich lava known as mafic lava. Basalt accounts for more than 90% of all volcanic rock on Earth. Chemically speaking, coarse-grained, slowly cooling gabbro and fine-grained, quickly cooling basalt are equivalent. Basalt lava is typically produced by 20 volcanoes year, according to specialists. Basalt is a prominent type of rock found on other planetary bodies in the Solar System. The plains on Venus, which make up more than 80% of its surface, are primarily comprised of basaltic rock, whereas the lunar maria are plains of flood-basaltic lava flows.

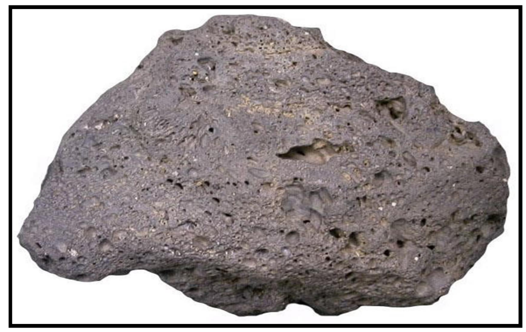


Fig 5: Basaltic Rock

Hydrological Data

Rainfall Data

Table no 2 Rainfall Data

Parameters	Annual Rainfall (mm)	Remark
Min Rainfall	250	Sina River Basin
Max Rainfall	1095	
Avg Rainfall	551	

Land Use Land Cover

Although land use and land cover are frequently used interchangeably, they each have a distinct definition. The term "land cover" describes the ground's top layer of cover, including things like flora, urban infrastructure, water, bare soil, etc. For tasks like thematic mapping and change detection.

On Earth, upper mantle is thought to be the genesis of basaltic magmas. Basalt chemistry thus provides information about processes occurring deep below the Earth. Baseline information is established by analysis, which identifies the land cover. The phrase "land use" refers to how a piece of land is used, for as for enjoyment, agriculture, or as a habitat for animals. The phrases "land use" and "land cover" generally refer to the classification of human activities and natural elements on the landscape throughout a specific time period using accepted scientific and statistical methods of analysis of relevant source materials. Use of land the type of land cover present has a considerable impact on groundwater recharge.

Water can more easily reach the surface of the earth thanks to the biological decomposition of the roots, which also helps to loosen the soil and rock. Vegetation is able to prevent water from evaporating directly from the soil because plant roots can sense and react to changes in water levels.

5. SOFTWARE EXPOSURE

ESRI ARC GIS

A member of the ESRI ARC-GIS product family, client software, server software, and online geographic information system services all fall under this category. Due to a shortage of data, remote sensing and GIS are the most effective methods for morphometric analysis for creating regional hydrological models to address a range of hydrological difficulties in the ungagged watershed, especially for developing nations like India.

The hydrology features of ArcGIS are used to evaluate the water movement within a catchment. We may inspect the digital elevation model (DEM), understand the drainage system, and extract hydrologic data from a DEM utilising the tools in ArcGIS. By visualising geographic statistics using layer-building maps, such as trade data or temperature data, a geographic information system (GIS) named ArcGIS makes it possible to manage and analyse geographic data.

Fig 6: ESRI ARC GIS

GOOGLE EARTH PRO

Google Earth is a computer program that utilizes satellite imagery as its primary source to generate a 3D representation of our planet. By overlaying satellite images, aerial photography, and GIS data onto a 3D globe, the application allows users to explore cities and landscapes from different perspectives. Through Google Earth Pro, we had access to satellite images, maps, and terrains, which enabled us to determine the size of the catchment area. Initially introduced as a business-oriented upgrade to Google Earth, Google Earth Pro was offered at a price of $399/year until late January 2015. However, Google later made it freely available to all users, incorporating additional features such as a video maker and data importer. Since version 7.3, Google Earth Pro serves as the default desktop application for the Google Earth service. It is compatible with Windows, Mac OS X 10.8 or later, Linux, and offers add-on software for video production, advanced printing, and precise measurements.

ROLTA GEOMATICA SUITE

The Rolta Geomatica Suite is a single, integrated piece of software that provides reliable answers for every desktop geomatics problem and transforms imagery into information. It is an integrated piece of software for both image processing and remote sensing. Urban and utility mapping, studies on change detection, and radiometric or atmospheric correction of photos obtained from data agencies can all be done using it. It can be used to analyze optical and SAR data, assisting in locating the movement of objects like troops or tanks along vulnerable border areas.

Features:

- Modern technologies for picture categorization and geometric correction.
- Creation of cartographic maps.
- Hyperspectral and radar analysis.
- Data visualisation and editing tools for the Rolta Ortho Engine, Rolta Chip Manager, Rolta EASI, Rolta FLY, and Rolta Modeller.
- Analysis of spatial rasters.
- Availability of both Indian and foreign remote sensing sensors.

Fig 8: Rolta Geomatica Logo

6. METHODOLOGY

Selection of Catchment Area

The rainfall data is collected from the Tehsil office in Pathardi. Also, information about the scarcity of water in different villages in Pathardi is obtained.

Digital Elevation Model

A "Digital Elevation Model" (DEM) is a type of digital cartography dataset that shows a continuous topographic elevation surface through a grid of cells. Each cell's position represents the elevation of a feature. Digital elevation models are a "bare earth" representation because they only include details on the height of geological features like valleys, mountains, and landslides, to name a few. They lack any knowledge of the elevation of any above-ground components, such as vegetation or buildings.

Contour Map

Contoured mapping is by far the most popular method for topographic mapping. The base contour is the contour from which contouring starts, while the contour interval is the vertical space between contour lines. Points of equal elevation are connected by contour lines.

Drainage Map

The drainage map was digitally transformed into a line coverage that showed the entire stream network. The toposheets were utilised to gather information, which was subsequently used to digitise the different tributaries and updated using satellite images.

Lithology of Area

Lithology is the study of the chemical, mineralogy, and physical characteristics of rocks. Lithology research can provide vital information about the formation and productivity of soils, the appropriateness of a certain area for agriculture, the flow of water, and other crucial environmental factors that are influenced by the underlying rock type.

Lithology states that the type of rock exposed at the surface has a significant influence on the amount of groundwater recharged. One of the ways lithology affects groundwater recharge is through regulating the percolation of water flow. To reduce the degree of ambiguity in the process of establishing lineaments and drainage, lithology is researched.

Morphometric Analyzing

The analysis of size and shape, known as morphometry or morphometrics, involves quantitative assessment. This approach is commonly applied to organisms, providing valuable insights into various aspects. Morphometric analyses contribute to the examination of an organism's fossil record, studying the impact of mutations on shape, investigating developmental changes in form, exploring the covariances between ecological factors and shape, and assessing the influence of mutations on shape. By identifying shape changes, morphometric analysis enables the quantification of evolutionary features and facilitates the inference of information related to an organism's ontogeny, function, or evolutionary relationships. A key objective of morphometric analysis is to statistically test hypotheses regarding the variables that influence shape.

When it comes to understanding the relationships among different elements within an area, watershed morphometric analysis proves to be the most effective approach. This methodology involves comparing multiple watersheds, each characterized by distinct topographical and geomorphological attributes. The analysis focuses on three primary components: linear, aerial, and relief features. By studying these aspects, valuable insights can be gained into the interconnected nature of watersheds and their characteristics.

ARC GIS Tools

Hydrology

A surface's structural components can be described using the hydrologic modelling capabilities in the ArcGIS Spatial Analyst extension package. The hydrologic tools can be used to create stream networks, define watersheds, locate sinks, determine flow direction, compute flow accumulation, and more. Hydrology tool allows us to operate the following aspects from the raw DEM file:

1. Fill
2. Basin
3. Flow Direction
4. Flow Accumulation

Clip

The watershed area can be selected or delineated from the entire file using the clipping tool. Only the input feature characteristics will be in the output when you run the clip tool.

1. On the Editor toolbar, select the Geoprocessing tool.
2. Pick the movie clip.
3. Enter the raw file and the clipping region.
4. Select the type of clip operation, such as whether to keep or throw away the intersections' area.

Surface

These tools allow you to produce a new dataset that pinpoints a certain pattern inside an original dataset, starting with a raster elevation surface as input. You can determine patterns like contours, angle of slope, steepest downslope direction, shaded relief, and visibility that were not immediately obvious in the original surface. Each surface tool offers information on a surface that can be utilized independently or as a starting point for further investigation.

1.Contour

2.Slope

Above parameters are determined using surface tool

METHODOLOGY ADOPTED FOR MORPHOMETRIC ANALYSIS.

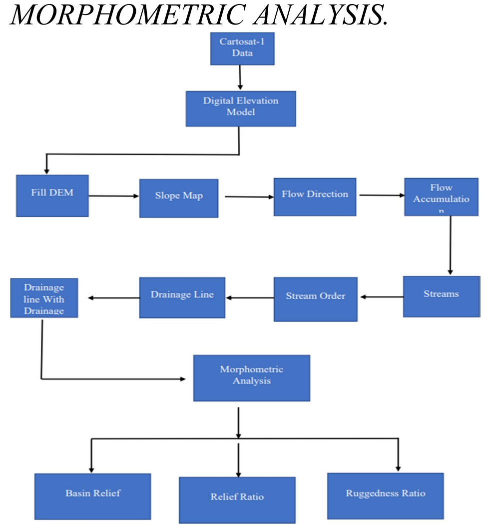


Fig 9: Analysis Flow Chart

Fill Dem

Pick the movie clip

In order to understand how water travels downhill without becoming trapped in a nearby depression, a field model must be created.

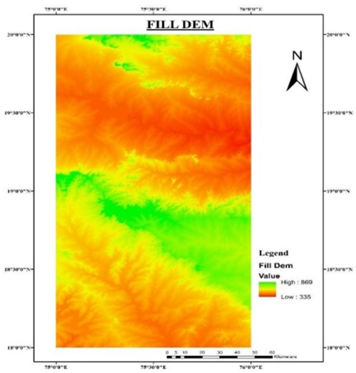


Fig 10: Fill Dem Map

Basin

A watershed is a region of land that "sheds" water into a particular body of water. It serves as a separate drainage system for surface runoff. A natural border known as the water divide or the ridge line divides one watershed from another.

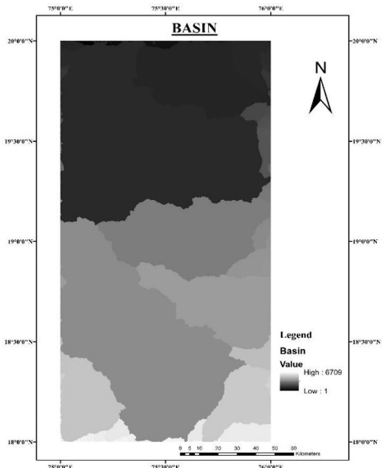


Fig 11: Basin Map

Contour

An area that is similarly elevated (or tall) above a predetermined level, such as mean sea level, is connected by a contour line, which is frequently just referred to as a "contour". An example of a map using contour lines is a topographic one, which shows valleys, hills, and the steepness or leniency of slopes.

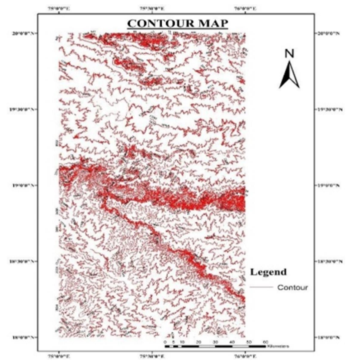


Fig 12: Contour Map

Slope

A two-dimensional representation of a surface's gradient is a slope map. The slope's current gradient, whether severe or gradual, is shown. Slope maps are useful for several purposes, including locating possible hazards and planning construction work.

A slope is an area of terrain that rises or descends. The slopes on the property must be recognized by the farmer or irrigation system operator.

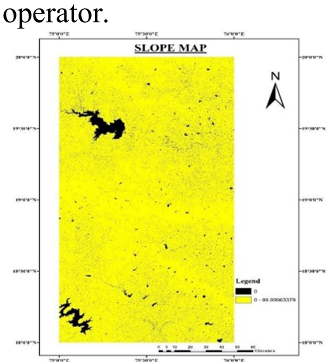


Fig 13: Slope Map

Flow Direction

The stream's direction within each cell is referred to as flow direction. The flow direction determines which adjoining cell water will travel.

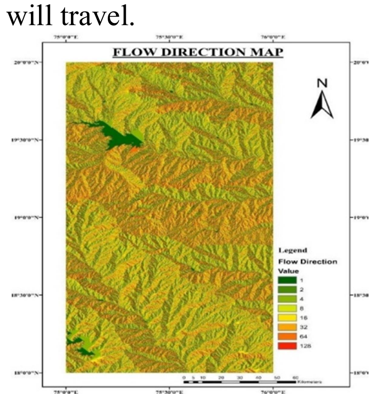


Fig 14: Flow Direction Map

Flow Accumulation

When runoffs are simulated, the flow accumulation is produced by determining the flow direction.The amount of cells that will drain into a particular cell is counted as flow accumulation.

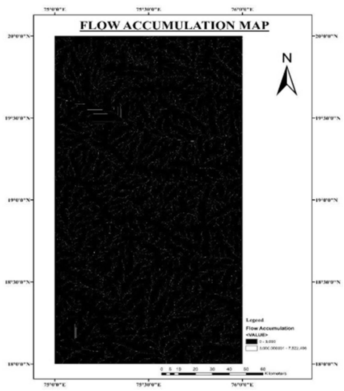


Fig 15: Flow Accumulation Map

Stream Network

In geomorphology and hydrology, the degree of branching in a river system is expressed as a positive whole number known as the stream order or waterbody order.

Depending on a river's distance from its source, its confluence with other rivers, and its place in the river system's hierarchy, a river's or a river's section can be arranged topologically in a number of different ways.

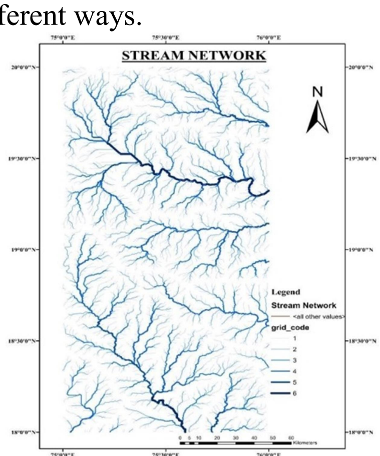


Fig 16: Stream Network Map

Drainage Line

It gives details about the basin's geography, soil composition, runoff characteristics, potential for surface water, and more. The longest flow channel refers to the flow path that extends farther from a headwater (often the watershed split) to the outlet than all other flow paths in the watershed.

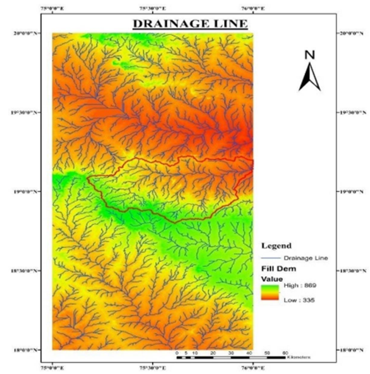
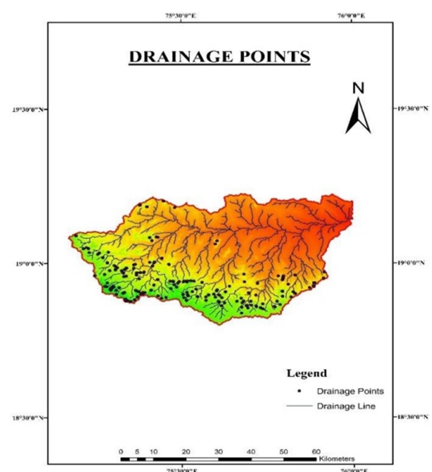


Fig 17: Drainage Line Map

Drainage Point

Drainage divides are the lines separating two watersheds. The point on a surface where water
flows out of a space is known as the exit or pour point. It is located at the watershed's lowest point.



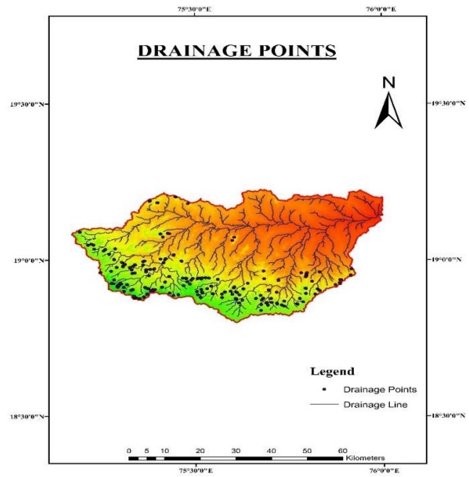


Fig 18: Drainage Point Map

Longest Flow Path

The watershed's longest flow channel is the flow path from a headwater (often the watershed split) to the outlet that is longer than all other flow channels.

the period of time needed for runoff to travel from the watershed's farthest point to the outlet, or concentration time.

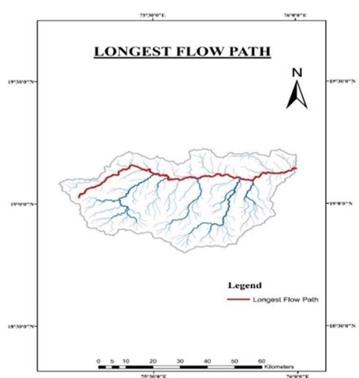


Fig 19: Longest Flow Path Map

Land Use and Land Cover

In contrast to land cover, which depicts the actual shape of the ground, such as a forest or open water, land use documents how people use the land. By comparing historical land cover data and maps, coastal managers can spot trends and changes in land use.

For Land Use and Land Cover, we have chosen to use Rolta Geomatica.

Importing data into. PCIDSK format:

1. To import to. PCIDSK, choose Import from the File menu. Opens the. PCIDSK Import window.
2. Select the Source File by clicking Browse in the. PCIDSK Import window. Navigate to and choose the file you want to import using the File Selector box, then click OK.
3. Choose the Destination File from the. PCIDSK Import box. To launch the File Selector window, click Browse, or simply type the path and file name in the Destination File field.
4. From the Format Options drop-down menu, choose a format.

File re-projection:

You can manually alter the projection of images, bitmaps, or vectors in GDB-supported files with a valid projection using the Reproject window, and then save the data to a new file. Identifying the files utilized for reprojection

1. Click Browse in the Reproject box to choose the Source file. Locate and choose the file to be reprojected using the File Selector, then click Open.
2. Select the Destination file from the Reproject pane. To access the File Selector, click Browse, or simply type the path and file name in the Destination File field.
3. From the Output Format drop-down list, choose a file format. Then, in the choices area, type the format choices.

Image Mosaicking:

1. Enter the name of the file. The name of the file containing the input data to be processed is specified. There must be an overlap between FILI and FILO's georeferenced limits.
2. Using the raster channel(s) as input Names the input channel(s) that will be used to read data from FILI and move it to FILO.
3. Segment of the input vector Names the vector segment in the input file

(FILI) that specifies the line to be used for mosaicking.

4. The input data from FILI is relocated to and replaces the corresponding data in FILO if no vector segment is given. To alter the input image data before it is sent to the output file (FILO), the Input Lookup Table specifies the lookup table segment from the input file (FILI). If this argument is left undefined, the picture data from FILI is transferred to FILO in its original state.
5. Specifies the name of the file that will hold the output data. Running MOSAIC requires that FILO is already present.

There must be an overlap between FILI and FILO's georeferenced limits.

Image Classification:

There are two methods of Image Classification:

1. Supervised
2. Unsupervised

The Supervised Classification approach is what we have chosen.

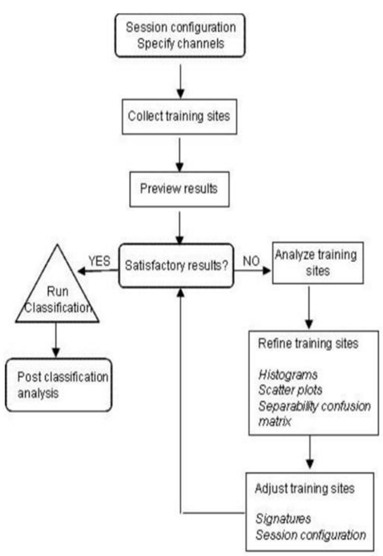


Fig 20: Classification Process Flow Chart

METHODOLOGY ADOPTED FOR LAND USE AND AND LAND COVER

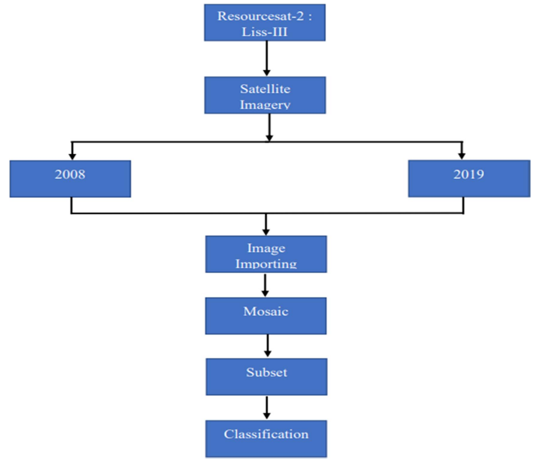


Fig 21: Process Flow Chart (LULC)

SATELLITE IMAGES

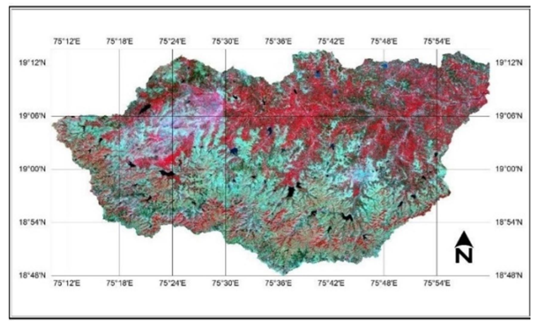


Fig 20: Classification Process Flow Chart

RESULTS AND ANALYSIS

LINEAR ASPECT

Bifurcation Ratio

The linear characteristics of stream order, stream length, and bifurcation ratio were determined, and the findings are shown in the table. Linear characteristics of watersheds are mostly related to drainage network channel patterns, where topological parameters are examined.

Lower bifurcation values are indicative of a watershed that has undergone structural disturbance but whose drainage pattern has not changed as a result of the disturbance. The basin form is also reflected by the bifurcation ratio.

Table No 3 Bifurcation Ratio

Name of Catchment	Order	No. of Streams	Bifurcation Ratio	Mean Bifurcation Ratio
CH1	1	248	1.83	2.48
	2	135	2.59	
	3	52	1.06	
	4	49	4,45	
	5	11	-	

Fig 24: Bifurcation Ratio

Compound Value of Linear Aspect

Table No 4 Compound value of Linear Aspect

Sr. No.	Morphometric Parameters	CH1
1	Bifurcation Ratio (Rb)	2.48
Cp for Linear Aspect		2.48

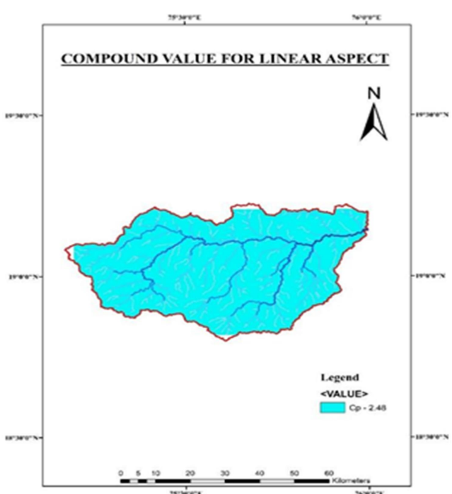


Fig 25: Compound Value for Linear Aspect

The bifurcation ratio varies from 2 on flat, undulating surfaces to 4 or 5 in drainage basins with mountains or multiple cracks. If the bifurcation ratio is at its lowest, there is a higher likelihood that the drainage basin will be level or rolling. Due to its high bifurcation ratio, the watershed under study is highly susceptible to flooding. The watershed's surface is level, and its drainage basins are rolling, according to the value of the bifurcation ratio mentioned above.

AERIAL ASPECT

The morphometric factors that make up aerial aspects include drainage density, stream frequency, texture ratio, form factor elongation ratio, circulatory ratio, and length of overland flow.

Drainage Density

It is the ratio of total length of the order stream to the surface area of the basin.

Dd = Lu /A

Where ,

Dd = Drainage Density

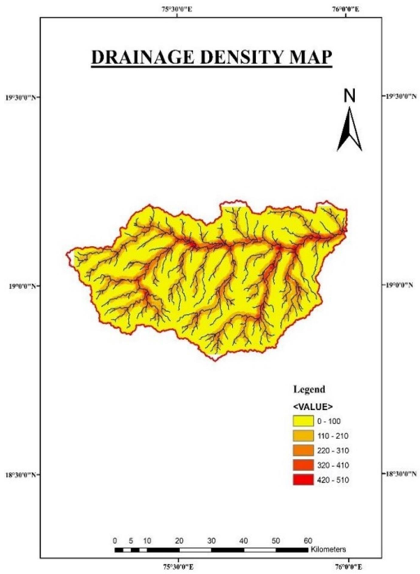
Lu = Total Stream Length of all Orders A = Area of the basin (sq.km)

Table No 5 Drainage Density

Name of Catchment	CH1
Dd	0.4752

There are five classes of drainage density, based on value ranges (km/km2): extremely coarse (2), coarse (2-4), moderate (4-6), fine (6-8), and very fine (>8). The drainage density is rather coarse, as indicated by the watershed value of 0.4752.

Watershed is a highly permeable basin with good infiltration capacity, has a healthy vegetative cover, and is structurally sounder.



Stream Frequency

Stream frequency (Horton, 1945) is defined as the ratio of the total area of the basin/watershed to the total number of stream segments in all orders. Amount of streams per square foot of land is discussed.

Stream frequency is influenced by infiltration potential, permeability, and basin relief. A drainage basin reacts to processes that result in runoff. Stream frequency is influenced by a variety of factors, including rainfall, relief, starting rock resistivity, and drainage density of the basin.

Fs = Nu / A Where ,
Fs = Stream Frequency
Nu = Total number of streams of all orders A = Area of the basin (sq. km)

Table No 6 Stream Frequency

Name of Catchment	CH1
Ff	0.24

The frequency value shows that the geology of this basin has low porosity, low relief, and nearly uneven terrain.

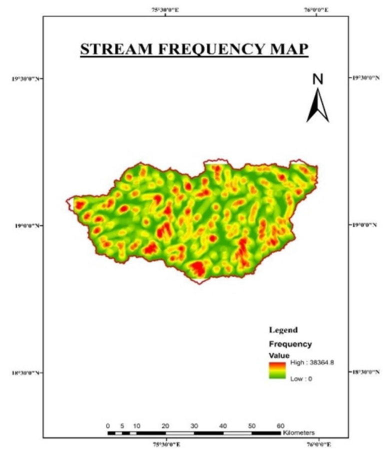


Fig 27: Stream Frequency Map

Texture Ratio

The underlying lithology, infiltration potential, and relief aspect of the terrain are all important considerations in the drainage morphometric study, which also takes texture ratio into account. The texture ratio is computed as the number of streams divided by the circumference of the basin.

T = Nu / P Where,
Nu = Total no. of streams of all orders P = Basin Perimeter (km)

Table No 7 Texture Ratio

Name of Catchment	CH1
T	1.633

According to texture ratio, there is little to no risk of soil erosion in the watershed area.

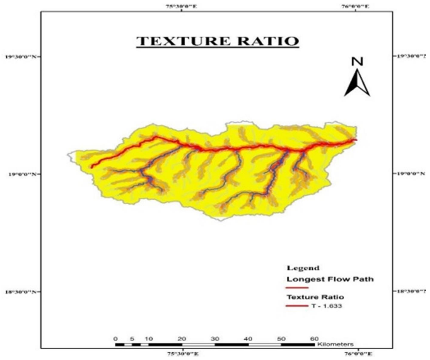


Fig 28: Texture Ratio Map

Form Factor

The form factor is the ratio of the square measure to the area of the watershed. The flood hydrograph continuously influences the basin morphology. The form factor value ranges vary considerably. Values for the form factor range from 0.78 (long) to >0.78 (circular).

Ff = A/ Lb2 Where,

Ff = Form Factor

A = Area of the basin (sq.km) Lb = Basin Length (km)

Table No 8 Form Factor

Name of Catchment	CH1
Fs	0.1870

As the value is less than 0.78 the basin is elongated.

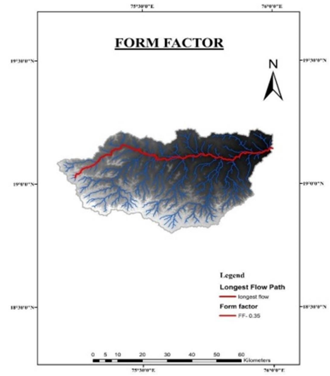


Fig 29: Form Factor Map

Elongation Ratio

The elongation ratio is the ratio of the diameter of a circle to the longest possible basin length.

The ratio varies from 0.6 to 1.0 over a range of climatic and geologic regimes. For regions with significant relief and a steep ground slope, typical values fall between 0.6 and 0.8, whereas for areas with limited relief, they approach 1.0.

Re = 1.128 A0.5/ Lb

Where,

Re =Elongation Ratio

A = Area of the basin (sq.km) Lb = Basin Length (km)

Table No 9 Elongation Ratio

Name of Catchment	CH1
Re	0.67

The area has high relief and a steep ground slope, according to the watershed's elongation ratio

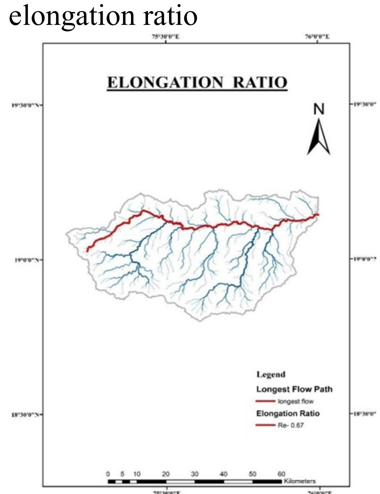


Fig 30: Elongation Ratio Map

Circulatory Ratio

The ratio of a watershed's area to the surface area of a circle whose diameter is the same as its perimeter is known as the circularity ratio. Rc also has a dimensionless feature. The value of the circularity ratio (Rc) and the existence of structural issues are related. It serves as a reminder of the significance of the bifurcation ratio (Rb), which asserted that a small value suggested there were no structural disruptions and a large value suggested the watershed was strongly controlled structurally.

Rc = 4πa/p2 Where

A = Area of the basin (sq. km) P = Basin Perimeter (km)

Table No 10 Circulatory Ratio

Name of Catchment	CH1
Re	0.362

Infiltration No.

Drainage density and stream frequency lead to the infiltration number, which measures a watershed's potential for infiltration. Lower infiltration numbers indicate higher infiltration and lower run-off

.In = Dd*Fs Where

Table No 11. Infiltration No.

Name of Catchment	CH1
In	0.088

7.1.2 Compound Value of Aerial Aspect

Dd = Drainage Density Fs = Stream Frequency

The proposed water basin has less run-off and more infiltration.

Length of Overland Flow

The distance water travels over land before being concentrated into a specific stream channel is known as the overland flow length.

LoF = 1/ 2Dd Where

Dd = Drainage Density

Table No 12 Length of Overland Flow

Name of Catchment	CH1
LoF	0.2376 km

Constant Channel Maintenance

The constant of channel maintenance is the space needed to keep a drainage channel every foot in good condition. The drainage area required to maintain one unit of channel length is represented by the constant of channel maintenance, which gauges the erodibility of a watershed.

C = 1/ Dd Where

Dd = Drainage Density

Table No 13 Constant Channel Maintenance

Name of Catchment	CH1
C	2.104 km2

Table No 14 Compound Value of Aerial Aspect

Sr. No.	Morphometric Parameters	CH1
1	Drainage Density (Dd)	0.47
2	Stream Frequency (Fs)	0.187
3	Texture Ratio (T)	1.633
4	Form Factor (Ff)	0.35
5	Elongation Ratio (Re)	0.67
6	Circulatory Ratio (Rc)	0.36
7	Infiltration No. (In)	0.088
8	Length of Overland Flow (LoF)	0.237

9	Constant Channel Maintenance (C)	2.104
Cp for Aerial Aspect		6.1

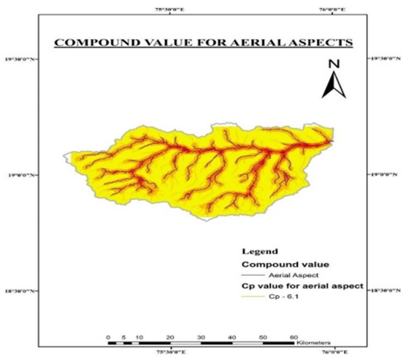


Fig 31: Compound Value for Aerial Aspects Map

RELIEF ASPECT

Relief Aspects deals with three-dimensional metrics including Ruggedness Number, Ruggedness Ratio, Relief Ratio, and Basin Relief. The relief aspect is related to the variation in elevation between the watershed's reference sites.

Basin Relief

Relief Ratio

It establishes the slope, which has an impact on runoff and silt movement.

The phrase "relief ratio" refers to the ratio of a basin's total relief, or the difference in elevation between its lowest and highest points, to its longest dimension that is parallel to its major drainage line. It is a ratio without any dimensions.

Rh = Bh /LB Where

Bh = Basin Relief

Lb = Length of Basin

Table No 16 Relief Ratio

Name of Catchment	CH1
Rh	0.047

Basin relief, or Bh, is the elevational difference between a basin's highest and lowest points on the valley floor.

Relief is measured by subtracting the highest point of the basin from the elevation of its mouth. The slope is established, and slope impacts runoff and silt movement.

Bh = H-h Where,

H = Maximum Elevation h = Minimum Elevation

Table No. 15 Basin Relief

Name of Catchment	*CH1*
Bh	*0.41*

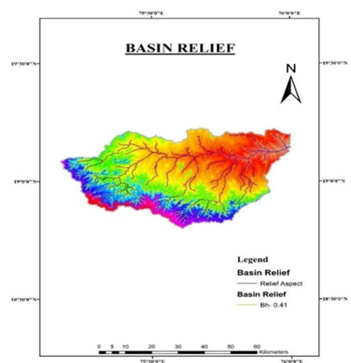


Fig 32: Basin Relief Map

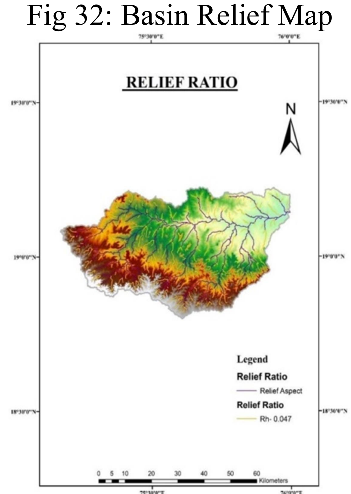


Fig 33: Relief Ratio Map

Ruggedness number

The ruggedness number combines slope steepness and length to indicate the degree of land surface instability.

Rn = Bh*Dd Where
Bh = Basin Relief
Dd = Drainage Density

Table No 17 Ruggedness number

Name of Catchment	CH1
Rn	0.194

The catchment has a ruggedness score of 0.19, meaning that the area is less likely to experience soil erosion.

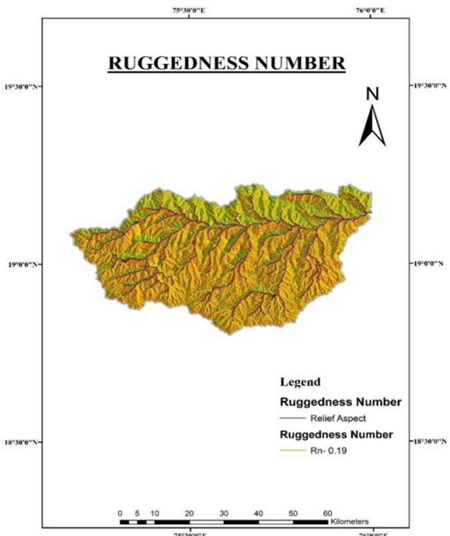


Fig 34: Ruggedness Number Map

Compound Value of Relief Aspect

Table No 18 Compound Value of Relief Aspect

Sr. No.	Morphometric Parameters	CH1
1	Basin Relief (Bh)	0.41
2	Relief Ratio (Rh)	0.047
3	Ruggedness No. (Rn)	0.19
	Cp for Relief Aspects	0.647

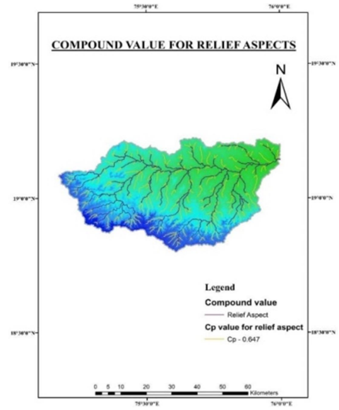


Fig 35: Compound Value for Relief Aspects Map

FINAL COMPOUND VALUES OF MORPHOMETRIC PARAMETERS

Table No 19 Final Compound Values of Morphometric Parameters

Sr. No.	Compound Value of All Morphometric Parameters	CH1
1	Compound Value (Cp) Of Linear Aspect	2.48
2	Compound Value (Cp) Of Aerial Aspect	6.1
3	Compound Value (Cp) Of Relief Aspect	0.647
	Total Cp Value	9.227

CLASSIFIEDIMAGES

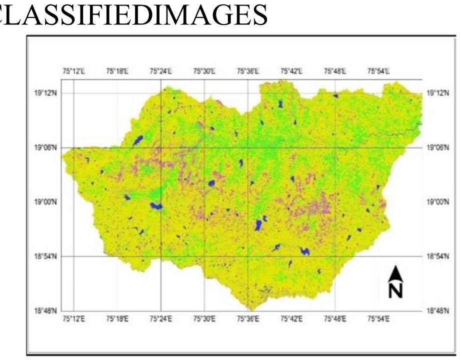


Fig 36: Classified Image (Year:2008)

Water
Barren Land
Vegetation
Barren Land
Built-up Area

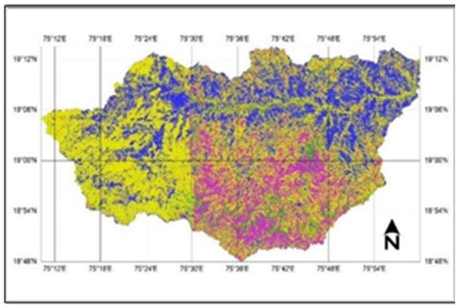


Fig 37: Classified Image (Year:2019)

LAND USE AND LAND COVER

Table No 20 Classified Image [Year: 2008]

Name	% Area	Area
Water	37.25	985.87
Vegetation	9.05	239.52
Barren Land	49.1	1299.5
Built-up Area	4.6	121.74
Total	100%	2646.64

Table No 21 Classified Image [Year: 2019]

Name	% Area	Area
Water	20.65	546.56
Vegetation	6.46	170.97
Barren Land	44.67	1182.25
Built-up Area	28.22	746.88
Total	100%	2646.64

CONCLUSION

1. At 0.475, the drainage density of the study region is regarded as low. This suggests that it has a subsoil with a high porosity, a coarse drainage texture, and a good vegetation cover.
2. The elongation ratio value of 0.67 demonstrates the significant relief in the area.
3. The drainage texture is substantially rougher than the watershed texture, which has a texture ratio of 1.63.
4. Since the form factor is 0.35, the basin sees low peak flows over a longer period of time.
5. The infiltration with the lower runoff is substantial due to the low infiltration number. For the study area, the infiltration number is 0.088.
6. According to the results of the morphometric study, check dams and bunds should be offered.
7. **7.** Land use and Land Cover suggests the vegetation has reduced with the time.

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