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Sustainable Development Study Of The Venna River Watershed Using Drainage Morphometry

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Abstract:

Morphometry is a statistical and mathematical study of the Earth's surface that examines the dimension, form, and composition of landscapes. For this investigation, the Venna River basin has been chosen. This river has 60 km length with 125 sq. Km. Catchment area. It’s provide the water for near about 30 villages. For the present study, 30-meter resolution SRTM remote sensing data were obtained from the USGS website and processed using ERDAS Imagine and ArcGIS software. The generated DEM, map of slope, and drainage map were applied for the morphometric study of the river Venna Watershed.

Keywords- *Catchment, Morphometric SRTM, USGS.*

Introduction :

Morphometry is a statistical and mathematical study of the Earth's surface that examines the dimension, form, and composition of landscapes (Clarke, 1966). The quantitative evaluation of drainage systems is essential when assessing a watershed and its hydrodynamic properties. (Strahler, 1964). The drainage network and flow pattern of a river are determined by the geographical structure, structural controls, geomorphological features, vegetation cover, and soil characteristics of the region, exhibiting spatial and temporal variability due to dynamic environmental and geological processes. (Rekha et al., 2011). Morphometric analysis is successfully conducted by quantifying areal, linear and relief parameters, When determining the water process and land surface characteristics within a watershed, the slope of the river system and the associated watershed are essential variables.(Nantiyal, 1940; Magesh et al., 2012; Qadir et al., 2021; Nag and Chakraborty, 2003) Landform characteristics can be linked to morphometric parameters to evaluate surface water and flow intensity in drainage systems. (Bird and Ozdemir 2009). It is a fundamental aspect of geomorphology and is widely applied in hydrology, watershed management, and terrain analysis. Morphometric analysis involves the systematic assessment of various parameters, The three main categories of morphometric analysis are relief, regional, and linear. The relief features aid in assessing the shifts in location and the development of the landscape, while the linear aspects of the river net and the regional components analyze the growth of the flooded area.

Study area:

The Venna Watershed resides in the Western Ghats, within the Satara district of Maharashtra, at latitude 17°42'00" N and longitude 74°03'00" E. It serves as a tributary of the Krishna River, with their confluence occurring at Sangam Mahuli, in the eastern part of Satara city. The Venna River Valley is located on average at a height of 1411 meters. The total circumference of the valley is 125.7489 kilometers, while the total length of the river flow is 60.133 kilometers.

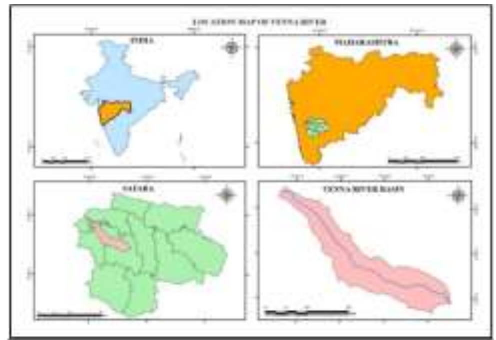

Fig- 1 Location Map of Study Area

Aims and Objective:

- To analyse Morphometry of the Venna River Watershed
- To conduct study of the hydrological characteristics of the Venna River.

Methodology:

The SRTM (Shuttle Radar Topography Mission) Remote Sensing Data with 30 meters of spatian resolution, which was obtained from the USGS (United States Geological Survey) website, is one example of secondary geo-local data used in this study. Advanced software for geological analysis of Arcgis and Erdas IMAGIN to utilize SRTM data was utilized to help in the processes and analysis.With the use of this platform, significant thematic layers such as drainage maps, slope maps, and digital elevation models have been generated. The Venna River watershed geographical area was morphometrically assessed based on the drainage map generated by hydrological modeling tools. This study provided comprehensive information on drainage characteristics, including drainage density and bifurcation ratio, which enhanced comprehension of the valley's geometric and hydrological structure.

Morphometric Analysis of River Venna

Linear Parameters :

Stream order:

The Strahler (1952), system states that the main characteristics utilized for the morphometric evaluation are the Total Stream Length,Mean Stream Length, the stream length ratio, and the Bifurcation ratio. The analysis of the river's biological drainage patterns, the growth and structure of its branches, and the partition of its water channel all depend heavily on these factors. the hierarchical ranking system defines river order and serves as a method for assessing a stream's position within the overall tributary network. (Leopold et al. 1964). The sixth stream order is found in the Venna River catchment region.This flow sequence shows that the catchment area's watercourses are well organized, pointing to a sophisticated and intricate drainage system.

Stream Length:

The length of the stream is a very important geographical and hydrophic feature of the watershed area, as it provides useful information about the flow of the surface of the surface. The number of drains in different flow of the loop type of water is recorded and the length of the drains is measured from the mouth of the river to the drainage. The flow length is based on the theory of Horon (1945). The total stream length for the area involved in this study is recorded at 646.85 km, which clearly indicates the extension and complications of the drainage area of the water area.

Stream Length Ratio:

The Stream Length Ratio is the ratio of the average stream length in the two consecutive streams, which is considered to be the indicator of the geometric and hydrological development of the river system. According to the theory of Horton (1945), the average length of the continuous stream sequence adheres to geometric progress, in which the flow length also increases as the flow sequence increases. The ratio of the flow length is related to the mobility of the surface stream, the nature of the distribution of ups and the state of the river valley (Kulkarni, 2013). This ratio depends mainly on the geometric composition and slopes of the terrain (Srivastava et al., 2017). The study shows the amount of flow length for the Venna River, which shows the late Youthful Stage of this river valley, and indicates that the river system is still in the process of stabilization.

Mean Stream Length:

The average length ratio of the flow for a given flow sequence is determined by the average length of the back lower order. This ratio is considered to be a sign of the structural complexity of the river system as well as the state of the earthquake of the terrain. According to Sridevi and others (2005), the flow length is an important factor in assessing the phase of the water sector, along with the nature of the surface distribution of the surface. In this study, the average flow for the Venna River has been found 49.78 km, which represents the regional expansion of the river and the locustic features.

Bifurcation Ratio:

The concept of Bifurction ratio is first introduced by Horton (1932), which is determined by the number of drains in the specific flow and the number of drains in the lower stream order. After that, Straaller (1964) explained the definition of this concept and explained that the bipolar ratio is the ratio of the number of rivers in any stream order. The bipolar ratio is found to be 3.79 for the Venna River Watershed area. This value comes from 3 to 5, which indicates the effects of geological and structural elements of the study (sreedvi et al., 2005). This type of value usually represents the drainage system under the semi-structural effect, which controls the direction of the river drains, branching methods, and flow structure.

Aerial Aspects

The study analyzes various morphometric components of the Venna River Watershed area, such as texture ratio, drainage density, form factor, flow frequency, length-virtue ratio, circular ratio and land flow. Through these dimensions, a thorough assessment of water scientific behavior, acclaiming structure and performance processes has been achieved.

Basin Perimeter:

The length of the border of a catchment, as measured along the drainage division, is known as the catchment perimeter. It provides information about the catchment's spatial distribution, drainage connectivity, water flow pathways, and surface runoff potential in addition to aiding in defining its size and shape. The perimeter also affects important water processes, like sediment transport and surface runoff reaction.

Area of watershed

According to Schumm (1964), there is a positive correlation between the area of a watershed and the total length of its stream channels as the basin area increases, the stream length also increases. This relationship emphasizes the fundamental connection between drainage network development and basin morphology. Understanding this linkage is important for interpreting the complexity and geomorphic evolution of the watershed.

Drainage Density:

Drainage density indicates how closely stream channels are spaced within a watershed. (Hortton,1932). In the river basin, it represents a crucial factor in the linear hierarchy of terrain within stream eroded landforms and does not exhibit a consistent variation across different stream orders within the basin. Langbein (1947). In general, drainage density increases as the ability of the underlying minerals to infiltrate declines as the soil's transmissivity declines. Drainage Density of Venna river watershed is 1.97 km. Calculated drainage density for the River Venna is comparatively low indicating moderate infiltration capacity of the River surface.

Form factor

Form factor is the ratio of basin area to the square of its length. In the study area, a low form factor value of 0.14 indicates an elongated basin shape, suggesting lower peak flow and delayed runoff response. Result of form factoris flatter peak flows sustained over a long period, whereas watersheds which have greater form factor indicating the more circular basin and are getting higher peak flow in short periods.

Stream frequency:

According to Horton (1932), stream frequency is the total number of stream segments per unit area of a watershed. The Venna River watershed has a stream frequency of 2.11 per square kilometer, following the research of Reddy et al. (2004). This small amount suggests a low-relief landscapes and increased subsurface permeability. However, it might be difficult to accurately estimate stream frequency because of variations among drainage systems (Singh, 1980).

Length of Over Land Flow:

The surface length is related to the opposite amount of the flow of the flow, which is closely connected to the sheet flow distance; it is approximately half of the opposite ratio of the approximate drainage density. The length Overland Flow is the distance that passes between the surface and the average flow before the specific stream is included in the surface (Horton, 1945). Water processes, such as irritation, stream concentration, and energy, are greatly affected by this length. The surface length for the Venna River Watershed area is 1.01 km.

Elongation ratio:

It is the ratio of a circle's diameter to circumference that has the same area of catchment. It is an important hydrological indicator that gives information on the structural and functional features of a river watershed; whereas a more elongated basin typically has a delayed and less effective runoff discharge. Elongation ratio for the Venna River Basin is 0.6.

Circularity ratio:

The circularity ratio compares a basin to a circle with the same perimeter, indicating how the basin's shape influences runoff concentration and hydrological response. (Miller, 1953). The circulation ratio is impacted by several elements, including basin slope, climate, land cover and land use, relief, stream length and frequency, and underlying geological formations. These factors collectively determine the hydrological behavior and drainage efficiency of the basin. (Shekar and Mathew, 2023d, Shekar et al., 2023a). The circularity ratio ranges from zero to one and is impacted by factors like stream frequency and stream length, characteristics of geology of the terrain, catchment slope, relief, and climate. Higher values indicate a more circular basin, which tends to facilitate quicker runoff, while lower values correspond to elongated basins with slower runoff response. (Bali et al., 2012). Circularity ratio for the same river watershed is 0.27. a circular basin allows for faster drainage.

Constant of Channel Maintenance : Constant of Channel Maintenance is the opposite amount of drainage density and indicates the area of terrain required to maintain a specific length flow. For the Venna River Watershed area, this constant is 0.51, which indicates a low -capacity and comparatively stable vessel system in the river channel.

Table- Morphometry Parametres	
Linear Aspect	
Stream order	6
Total Stream Length	646.85
Length of main stream	49.31
Stream Length Ratio	3.3
Bifurcation Ratio	3.79
Length of Over land flow (Lg)	1.01
Aerial Aspect	
Area of Basin	328.54
Perimeter of Basin	122.16
Drainage Density	1.96
Stream Frequency	2.1
Slope	5-58 %
Elongation Ratio	0.6
Circularity Ratio	0.27
Constant of chhanel maitainance	0.5
Relief Aspect	
Basin Relief (Bh)	839
Relief Ratio	0.5
Source- Computed by Researcher	

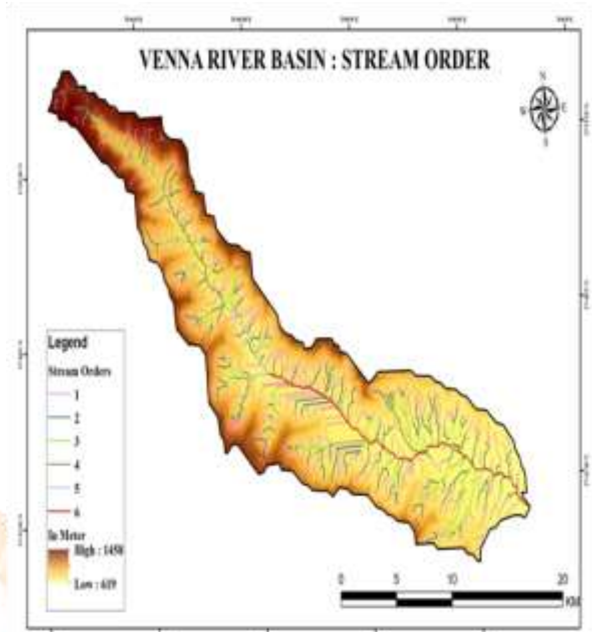

Fig- 2 Drainage Map of Venna River Basin

Relief Factor:

Relief means variation in height in the watershed, representing the variation between its maximum and minimum elevation. It is a key topographical parameter influencing the features of a basin's slope. Larger variations in the valley's elevation, known as high relief values, usually result in steep slopes and raise the risk of soil erosion. Conversely, low relief values reflect a flat slope and low capacity likelihood, indicating a gentle height.

Relief ratio:

The concept of Relief ratio first presented by Schumm (1956), which indicates the ratio between the longest and the total height (relief) of the valley. This measurement is usually based on the parallel line of the main drain. This is a basic parameter, explaining the trend of the overall slope of the valley and the locustic variety. Based on the relief ratio, it helps to understand the severity of the performance based on the valley. Therefore, these parameters are extremely important in analyzing geo-shaped dynamics and structural features. The release ratio for the Venna River Watershed area is 0.51, which indicates the presence of a medium slope and erosion process.

Relative relief :

Melton (1957) used the ideas of watershed relief and perimeter to determine a number of geomorphic characteristics, including relative relief. The real change in elevation inside an area with respect to a point of reference in the area is quantified by relative relief. Because it takes into consideration the dynamism and slopes features of the landscape, this statistic is especially important because it offers a more thorough knowledge of how the landscape has changed over time. When these elements are taken into account, relative relief becomes a crucial instrument for studying morphogenesis, or the processes that create landforms, providing important information on the changes and evolution of a region's topography.

Conclusion:

The Venna River Basin's bifurcation ratio reflects the influence of geological and structural controls within the study area. A relatively low bifurcation ratio suggests reduced erosional activity along the Venna River channel. The basin exhibits a more elongated form rather than a circular shape, indicating limited contribution of surface runoff from its tributaries. Furthermore, the drainage density analysis reveals a moderate infiltration capacity across the river surface, suggesting a balanced interaction between surface and subsurface hydrological processes.

References-

Bali, R., Agarwal, K. K., Nawaz Ali, S., Rastogi, S. K., & Krishna, K. (2012). Drainage morphometry of Himalayan Glacio-fluvial basin, India: hydrologic and neotectonic implications. Environmental Earth Sciences, 66, 1163-1174.

Clarke, J. I. (1966). Morphometry from Maps, Essays on Geomorphology. New York: Elsevier Publ. Co., 235–274.

Horton R. E. 1945 Erosional development of streams and their drainage basins; hydrophysical approach to quantitative morphology. GSA Bulletin 56 (3), 275–370. https://doi.org/10.1130/0016-7606(1945)56[275:EDOSAT]2.0.CO;2.

Horton, R. E. (1932). Drainage basin Characteristics. Am. Geo Phys. Union Trans. 13, 348–352. doi:10.1029/tr013i001p00350

Kulkarni M. D. 2013 The basic concept to study morphometric analysis of river drainage basin: a review. International Journal of Science and Research 4 (7), 2319–7064.

Langbein, W. B. (1947). Topographic Characteristics of Drainage Basins. U.S. Geol. Surv. Water-supply Paper 986 (C), 157–159.

Leopold L. B., Wolman M. G. & Miller J. P. 1964 Fluvial Processes in Geomorphology. Dover Publications, Inc, New York.

Magesh, N. S., Jitheshlal, K. V., Chandrasekar, N., and Jini, K. V. (2012). GIS Based Morphometric Evaluation of Chimmini and Mupily Watersheds, Parts of Western Ghats, Thrissur District, Kerala, India. Earth Sci. Inform. 5 (2), 111–121. doi:10.1007/s12145-012-0101-3

Melton, M. A. (1957). An analysis of the relations among elements of climate, surface properties, and geomorphology. (No Title).

Miller, V. C. (1953). A Quantitative Geomorphic Study of Drainage basin Characteristics in the Clinch Mountain Area, Virginia and Tennessee. New York: Columbia University, Department of Geology, ONR. Proj, NR 389-402, Tech rep 3 https://agris.fao.org/agris-search/search.do?recordID=US201400058936.

Nag, S. K., and Chakraborty, S. (2003). Influence of Rock Types and Structures in the Development of Drainage Network in Hard Rock Area. J. Indian Soc. Remote Sens 31 (1), 25–35. doi:10.1007/bf03030749

Nantiyal, M. D. (1940). Morphometric Analysis of a Drainage basin, District Dehradun, Uttar Pradesh. J. Indian Soc. Remote Sensing 22 (4), 251–261.

Ozdemir, H., and Bird, D. (2009). Evaluation of Morphometric Parameters of Drainage Networks Derived from Topographic Maps and DEM in point of Floods. Environ. Geol. 56, 1405–1415. doi:10.1007/s00254-008-1235-y.

Qadir, A., Yasir, M., Abir, I. A., Akhtar, N., and San, L. H. (2021). Quantitative Morphometric Analysis Using Remote Sensing and GIS Techniques for Mandakini River Basin. IOP Conf. Ser. Earth Environ. Sci. 540, 012021. doi:10.1088/1755-1315/540/1/012021

Reddy, G. P. O., Maji, A. K., and Gajbhiye, K. S. (2004). Drainage Morphometry and its Influence on Landform Characteristics in a Basaltic Terrain, Central India - a Remote Sensing and GIS Approach. Int. J. Appl. Earth Observation Geoinformation 6, 1–16. doi:10.1016/j.jag.2004.06.003

Rekha, V. B., George, A. V., and Rita, M. (2011). Morphometric Analysis and Micro-watershed Prioritization of Peruvanthanam Sub-watershed, the Manimala River Basin, Kerala, South India. Environ. Res. Eng. Manag. 57 (3), 6–14. doi:10.5755/j01.erem.57.3.472

Schumm, S. A. (1956). Evolution of Drainage Systems and Slopes in Badlands at Perth Amboy, New Jersey. Geol. Soc. America Bull. 67, 597–646. doi:10.1130/0016-7606(1956)67[597:eodsas]2.0.co;2

Shekar, P. R., & Mathew, A. (2023). Detection of land use/land cover changes in a watershed: A case study of the Murredu watershed in Telangana state, India. Watershed Ecology and the Environment, 5, 46-55.

Shekar, P. R., Mathew, A., Abdo, H. G., Almohamad, H., Abdullah Al Dughairi, A., & Al-Mutiry, M. (2023). Prioritizing sub-watersheds for soil erosion using geospatial techniques based on morphometric and hypsometric analysis: a case study of the Indian Wyra River basin. Applied Water Science, 13(7), 160.

Shrivastava L., Shashikant N. & Rani R. 2017 GIS-based morphometric analysis of Pench River Basin. International Journal of Recent Scientific Research 8 (5), 16953–16959. https://doi.org/10.24327/IJRSR.

Singh, K. N. (1980). Quantitative Analysis of Landforms and Settlement Distribution in Southern Uplands of Eastern Uttar Pradesh (India). Varanasi: Vimal Prakashan.

Sreedevi, P. D., Subrahmanyam, K., and Ahmed, S. (2005). The Significance of Morphometric Analysis for Obtaining Groundwater Potential Zones in a Structurally Controlled Terrain. Env Geol. 47 (3), 412–420. doi:10.1007/s00254-004-1166-1

Strahler, A. N. (1957). Quantitative Analysis of Watershed Geomorphology. Trans. AGU 38, 913–920. doi:10.1029/tr038i006p00913.

Strahler, A. N. (1964). "Quantitative Geomorphology of Drainage Basins and Channel Networks," in Handbook of Applied Hydrology. Editor V. T. Chow (New York: McGraw Hill Book Company). section 4.

Strahler, A. N. (1964). "Quantitative Geomorphology of Drainage Basins and Channel Networks," in Handbook of Applied Hydrology. Editor V. T. Chow (New York: McGraw Hill Book Company). section 4.