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BASIN RELIEF MORPHOMETRY ANALYSIS OF GUNJAVANI RIVER BASIN, VELHE, PUNE DISTRICT

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ABSTRACT

Two basic generalizations about rivers were realized long before geomorphology emerged as an organized science: 1) stream form the valleys in which they flow and 2) every river consists of a major trunk segment fed by number of mutually adjusted branches that diminish in size away from the main stream. The many tributaries define a network of channels that drain water from a discernible, finite area which is the drainage basin, or watershed, of the trunk river

KEYWORDS: *Relative Relief, Isotan Map, Hypsometric Curve, Cross Profile*

INTRODUCTION

Morphometry is the precise and objective measurements of landforms. Morphometry involve quantitative analysis of geometric properties of the future Strahler A. N. (1957) describe the term morphometry as measurement of the shape or geometry of any natural form, while Clarke J.I. (1970) defined the morphometry as the measurement and mathematical analysis of the configuration the earth's surface and of shape, and dimensions of the land forces.

Morphometry can be Divided into Two Branches

- Relief Morphometry
- Fluvial Morphometry

Relief Morphometry

Includes an analysis of the relief of the terrain with the help of absolute relief and relative relief, slope aspect etc. while fluvial morphometry includes the consideration of linear areal and relief aspects of fluvial originated drainage basin. In linear aspects this related to stream are studied such as stream order hierarchy stream numbers, stream length etc. and in ariel analysis includes the study of the basin parameter shape of the basin.

Basin Area and Related Morphometry

Relief Analysis

In terrain analysis such as relative relief analysis, absolute relief analysis, slope analyses are included. Relief means the differences in elevation or physical outline of land surface or ocean floor relief includes absolute relief which is the highest relief in the area from mean sea level similarly relative relief is the differences between highest and lowest altitudes in the area, while available relief is the difference between an original upland surface and bottom of neighbouring graded valley.

Slope Analysis

Slope analysis includes average slope, slope angle, dissection index etc. Average slope includes generalisation of the slope angles for the particular area slope angles can be obtained from the contour map by using various methods. The dissection index is the ratio of the maximum relative relief to maximum absolute relief.

- **Fluvial Morphometry**

The fluvial morphometry includes the linear aspects of the streams like stream orders which is a classification of stream in which a stream is numbered according to its position in drainage plane R. E. Horton (1945) originally has proposed the scheme of stream ordering such as 1^{st} order, 2nd order and so on. Linear aspect also includes stream numbers, and stream length. Stream number is the number of stream in each order for a given drainage basin while the length is the distance of the starting point of a stream up to its confluence or up to the mouth of the stream. Areal aspects such as basin perimeter basin area and basin shape are also studied besides stream frequency drainage density and drainage texture.

LITERATURE OF REVIEW

The main objective of the study to computed basin morphometric characteristics for various parameters. The quantitative analysis of morphometric parameters is found to be of enormous effectiveness in river basin assessment, watershed prioritization for soil and water conservation and natural resources management at watershed level (Biswas et al 1999; Panda and Sukumar, 2010 and Nag and Lahiri, 2011).

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms (Agarwal, 1998; Obi Reddy et al., 2002). A major emphasis in geomorphology over the past several decades has been on the development of quantitative physiographic methods to describe the evolution and behaviour of surface drainage networks (Horton, 1945; Leopold & Maddock, 1953; Abrahams, 1984). The source of the watershed drainage lines have been discussed since they were made predominantly by surface fluvial runoff has very important climatic, geologic and biologic effects e.g. Sharp and Malin, 1975; Pieri, 1976, 1980; Carr and Clow, 1981; Carr, 1999; Baker, 1982, 1990; Higgins, 1982; Mars Channel Working Group, 1983; Laity and Malin, 1985; Gulick and Baker, 1989; Haberle, 1998; Malin and Carr, 1999; Grant, 2000; Malin and Edgett, 2000; Goldspiel and Squyres, 2000; Williams and Phillips, 2001; Cabrol and Grin, 2001; Gulick, 2001; Craddock and Howard, 2002; Carr and Head, 2003; Hynek and Phillips, 2003; Craddock et al., 2003; Stepinski and Collier, 2004; Pareta, 2004; Howard et al., 2005. The morphometric characteristics at the watershed scale may contain important information regarding its formation and development because all hydrologic and geomorphic processes occur within the watershed (Singh, 1992). Morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect of the characterization of watersheds (Strahler, 1964). GIS techniques are now a day used for Quantitative Morphometric Analysis of a Watershed of Yamuna Basin, India using ASTER (DEM) Data and GIS Kuldeep Pareta, Upasana Pareta International Journal of Geomatics and Geosciences Volume 2 Issue 1, 2011 249assessing various terrain and morphometric parameters of the drainage basins and watersheds, as they provide a flexible environment and a powerful tool for the manipulation and analysis of spatial information.

Drainage Map and Location Map

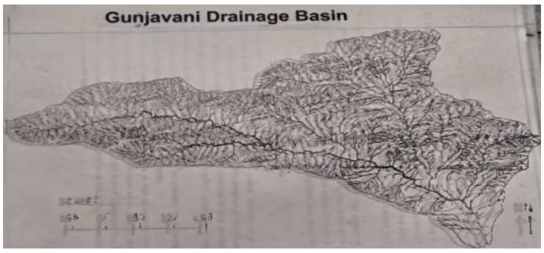

Figure 1

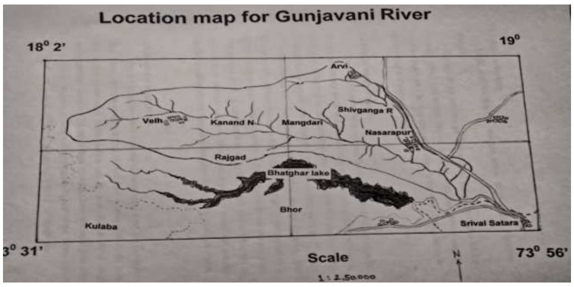

Figure 2

About the Study Area

For the morphometric analysis selected study area is a Gunjavni river basin which is major tributary of Nira river system. The study area lies in the south west Pune district and is most of the Velhe tahsil administrative division. The basin area stretches from Western Ghats crest up to the confluence of Nira and longitudinal extent of the study area is 73˚31' E to 73˚56'E longitude and 18˚2'N to 19˚N latitudes.

Gunjavani river basin comprises of Kanand and Shivganga basin from the northern part of basin area besides these. There is no major tributary of Gunjavani River from southern part of the basin.

Gunjavani river basin is experiencing sub humid to semi arid climate condition varying from west to east. The rainy season is characterised by concentrated rain fall up to 2200 mm is the western source regions of the basin. The average annual rainfall decreases towards the confluence area in the west up to 2000 mm. The annual average temperature of the basin is 31˚c to 33˚c.

Physical Environment of the Study Area

The ground surface which supplies rain and or melt water to a particular steam and its tributaries which drain that area is called drainage basin. This is demarcated by well defined perimeter on the basis of water divide. Total network of master stream and its tributary streams of a particular drainage basin is collectively called drainage as a network which includes all type of stream viz., permanent seasonal, ephemeral etc. Not only this hills and water paths are also include in drainage network drainage basin, hydrological cycle includes input of water through evapotraspiration surface runoff, through flow interflow base flow and channel runoff.

The basin is bounded by Raireshwar plateau to south attaining a height of 1408.2 m above sea level, the rivers Kanand, Shivganga rise at an attitude of 436 m and 1005 m respectively and Gunjawani at 673 m above sea level. The basin is bounded by Raigarh and Torna to the south attaining a height of 1402 m and 1411.2 m above sea level respectively. The terraces and pediments are covered by thin cover of colluviums and debris displaced from the hill top. The drainage network and hydrogeomorphology of both streams is a result of specific hydrogeomorphic conditions. The flow characteristics and channel development are consequently affected by vegetation.

The Kanand and Shivganga have maintained a steep slope as compare to Gunjavani River. The valley floor slope and the channel slope ratio which is considered as a variable of stability (Kale V. S. & Rajguru S. N., 1988). The total drainage basin length is 46 km. Both the basins are less circular in shape, the elongation being pronounced especially in Kanand river basin. The gorge and potholes are however characteristic of Kanand river only.

The Gunjavani source is about 1400 m above the sea level. These are in Western Ghats.

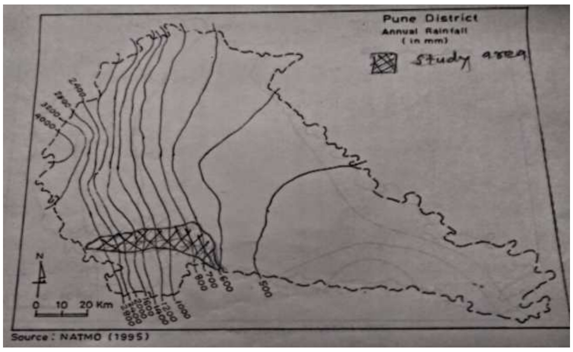

Figure 3

OBJECTIVES OF THE STUDY

The basin relief morphometry analysis of Gunjavani river basin is carried out with the following objectives

- To analysis relief aspects of the basin.
- To study Hypsometric curve and cross profiles of the basin.

METHODOLOGY

Various base maps such as contour map, drainage map, are prepared with the help of scale. Topographic map at the scale 1:50,000.

Based on contour map and drainage map different basin parameters and drainage network analysis is carried out.

With the help of basin parameters and drainage network analysis relationship between them is studied. Field visit for field observations.

Relief Aspects of the Basin

The relief aspects of the drainage basins are related to the study of three dimensional features of the basin involving area, volume and altitude of the basin. Volume and altitude of vertical dimension of landforms where in different morphometric methods are used to analyse terrain characteristics, which are the result of basin processes thus, this aspect includes (Hypsometric analysis) altitude and slope angle average ground slope, relative relief, relief ratio, dissection index of terrain etc.

Hypsometric Analysis

Hypsometric analysis involves the measurement and analysis of relationship between attitude and basin area to understand the degree of dissection and stage of cycle erosion or stage of landform evolution.

Area height curves indicate actual areas between two successive contours and hence horizontal axis represent area in terms of percentage of total area and vertical axis shows height.

According to F. J. Monkhouse and H. R. Wilkinson (1967) the values of area are plotted as ratio of the total area of the basin against the corresponding height.

The hypsometric integral has been accepted as an important morphometric indicator of the stage of basin development A. N. Strahler (1952) related the hypsometric integral of above 60% is youthful, 60 % o 35 % mature and below 35 % as old stage.

Clinographic Analysis: Clinographic curve represent average slopes between successive contours and thus present panoramic view of terrain clinographic curves reveal the breaks in slope and sudden changes in the relief of the area and they also show the general trend of the surface.

Altimetry Analysis: Altimetry includes the numerical frequency of highlands including summits of flat at various attitudes e.g. spot height summits, shoulder, benches etc.

Average Slope: Slopes defined as angular inclinations of terrain between hilltops and valley bottoms resulting from the combination of many causative factors like geological structure absolute and relative reliefs, climate, vegetation cover, drainage texture and frequency, dissection index etc.

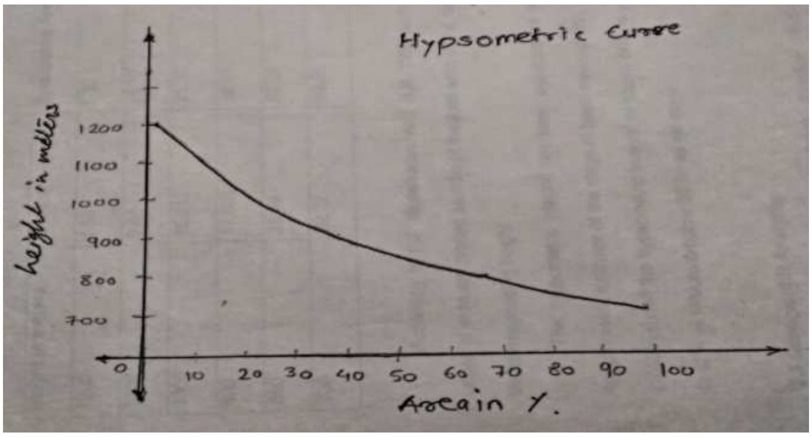

Figure 4

Table 1

Height in Meters	% Area	Cumulative Area in %
1200	1.33	1.33
1100	9.44	10.77
1000	10.61	21.38
900	17.39	38.77
800	28.49	67.26
700	32.72	100

Isotan Map:

Gradient is always expressed as a ratio between the difference of the maximum and minimum and horizontal equivalent. After finding out the slope of every square of the map showing the lines joining equal value of tangent is drawn which is equal as station map this method was proposed by Miller and therefore it is called as Millers isotan map.

Only the difference between highest and lowest point its minimum point does not given as correct idea about the nature of the terrain so Strahler find out the nature of angle obtained isotan values. In order to find out isotan map. First the Tan θ value are calculated and then these Tan θ value are converted into degree and these degree are further converted into sin θ values. Isotan map prepared the advantage of this map is that it gives the direction of the area. The slope may be different. This can be understood only the comparative of isosin and isotan maps.

$\text{Tan } \theta = VI/HE$

Where,

θ= Angle of slope

VI= vertical interval

HE=Horizontal equivalent

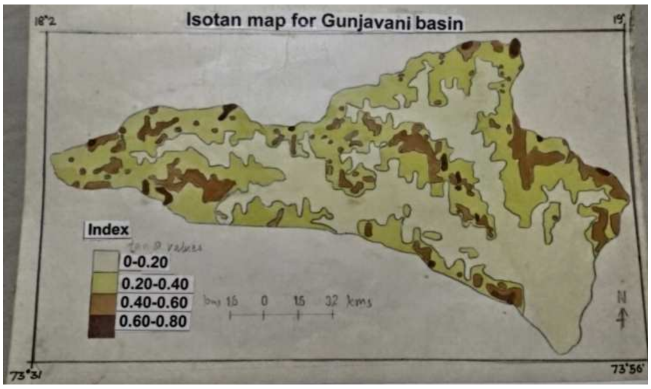

Figure 5

Relative Reliefs:

Relative relief also termed as amplitude of available or local relief is defined as the difference in height between the highest and lowest point in a unit area, it may be grid square, rectangle or a minute grid square relative relief is a very important morphometric variable which is used for the overall assessment of morphological characteristic W. S. Glock used the term amplitude of relief and define it as the vertical distance a horizontal fairly flat up and down to the initial grades of the streams J. C. Maxwell defined relative relief as the quotient of maximum relief and basin perimeter but these two schemes give only a single value of relative relief for the entire basin and hence isopleths map cannot be prepared with the result spatial variation of relative relief within the basin cannot be visualized.

In the study area south west side the Torna is very high relative relief. At middle of the basin the Raigarh is high relative relief on the north east of Singhgad and east Purandhar forts are of high relief area.

Index of Relative Relief Map

Table 2

Contour Interval	Relief
0-80	Low relative relief
80-160	Moderately low relief
160-240	Moderately high relief
240-320	High relative map

Dissection Index:

Dissection index expressing a ratio of the maximum relative relief to the maximum absolute relief.

- DI= Rr/Ar
- Rr= relative relief
- Ar= Absolute relief

Law of Channel Slope

The mean channel slope (gradient) is defined as the ratio of vertical drop to horizontal distance measured from the upper end to the lower end of a single stream of a given order.

Study of Cross Profile:

The cross profile of the upper part indicates narrow valley with steep valley sides dissected by gullies. Due to heavy rainfall the valley sides are highly eroded giving rocky appearances. Description of each cross profile the cross section no one which is drawn across the river valley about the screen east from the water divide shows the narrow river valley.

The cross section drawn at Velhe indicates river valley broader than the upper part. The slope angles of valley sides are less than the upper part.

Towards east of the velhe cross section no -5 drawn at Sakhar shows the valley becomes wider with shallow bottom. This profile shows confluence of Gunjavni and Kanand river.

The cross section profile no -11 which is drawn the Gunjavani and Ambavane channels with pebbles (valley width more than 20 km)

The cross section no-13 drawn near Nasarapur shows confluence of Gunjavani and Shivganga with deep channel and wide valley.

The divides become lower and lower finally merge into the valley of Nira river.

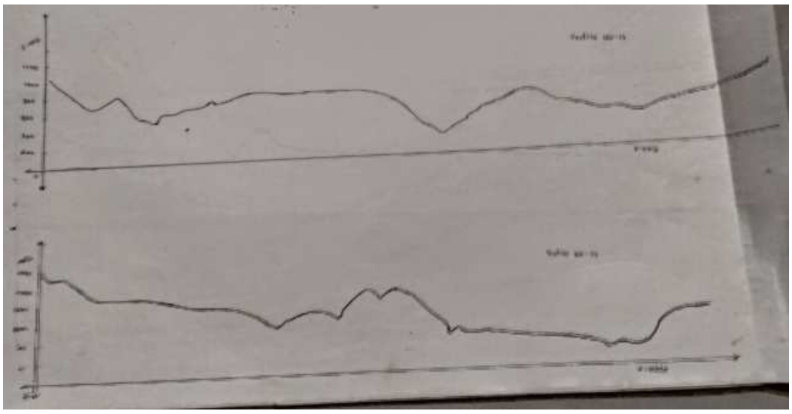

Figure 6

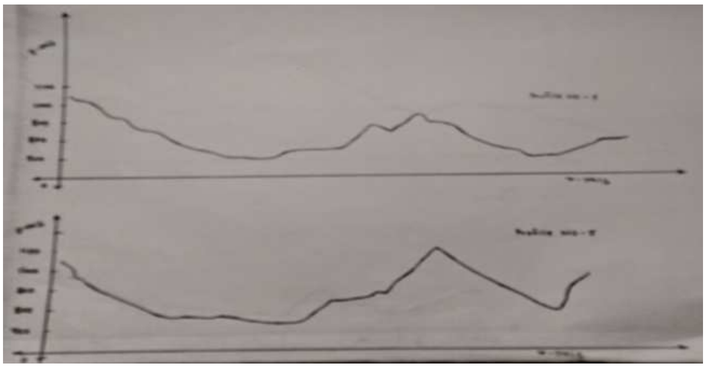

Figure 7

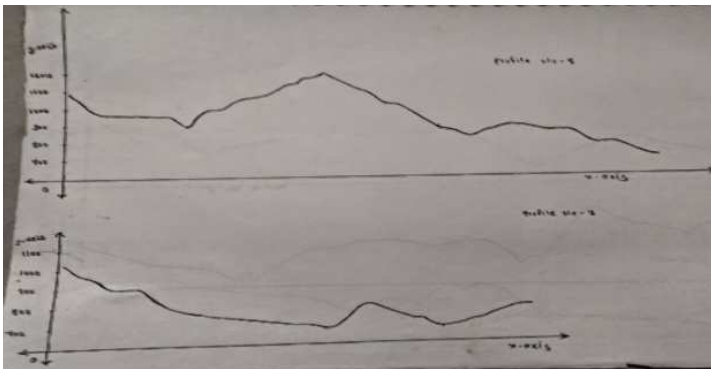

Figure 8

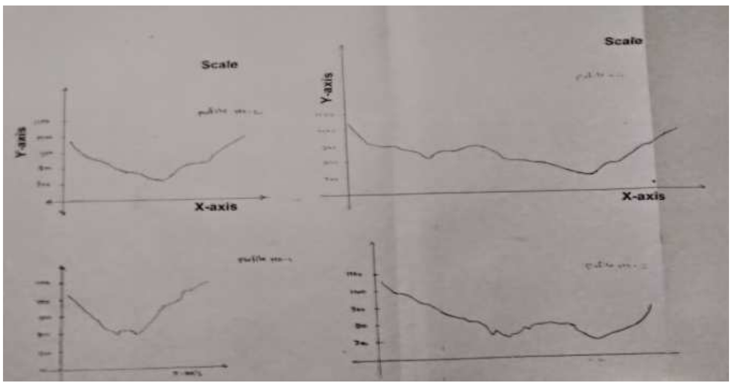

Figure 9

The Longitudinal Profile

Profile generally indicates the flow depending upon the river gradient. It gives the idea about its gradient varying and how the river descends from its source towards the lower stenches.

Upper part of the river is mainly areas of collection of water and erosion of the land surface while the lower part of the river is an area of deposition with a gradation predominant. The middle is one of the transitions of these two

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