

# Morphometric Parameters of Shetrunji river basin, Gujarat, India : Analysis and Implications.

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## ABSTRACT:

Shetrunji is one of the major river of Saurashtra. Furthermore, morphometric analysis of Bhadar river basin deals with quantitative assessment of topographic pattern of Earth's surface, the shape and dimension of landforms. The morphometric analysis is done by ETM+ data in Arc GIS 10.1 software. The morphometric parameters like bifurcation ratio, stream number, area, perimeter, drainage density, length of overland flow, constant of channel maintenance, form factor, elongation ratio, basin length, basin relief, relief ratio. At last, morphometric parameter like asymmetry factor is included which shows lateral tilting of the basin.

**KEYWORDS:** Morphometry, ETM+, Arc GIS, Shetrunji.

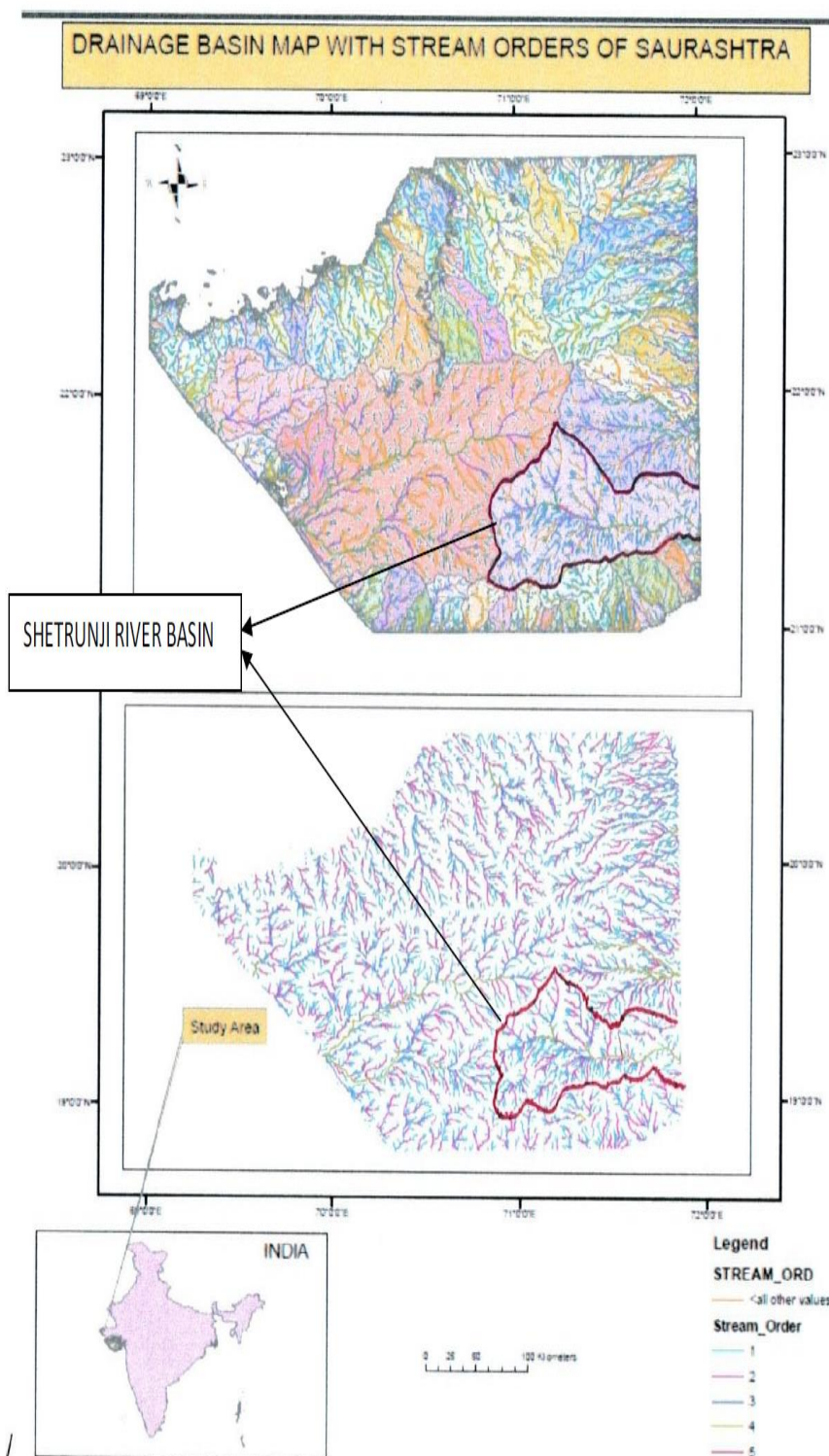
## INTRODUCTION:

Morphometric analysis concerns with the quantitative assessment of the topographic pattern of Earth's surface, the shape and dimension of its landforms (Clarke,1966). The study of drainage basin has emphasis on understanding of geometric characteristics of the fluvial landscape( Pophare & Balpande, 2014). Then, drainage pattern on earth's surface has tremendous bearing on the subsurface geology and operative processes (Ritter, 1980, Pati et. al, 2006, Pati et. al, 2008).E, Excluding, morphometric analysis was applied to resolve issues related to watershed analysis (Vijith and Satheesh,2006, Thomas et. al , 2010, Mishra et. al, 2011, Singh, 2014, Prabhu and Baskaran, 2013, Withanange et. al, 2014, Prakash et. al, 2016). After that, it is also used for analysis & prioritization of microwatershed (Pankaj and Kumar, 2009, Vandana, 2013). There are voluminous literature concerning morphometry. But, the above mentioned are noteworthy.

## DRAINAGE BASIN SET UP:

The Shetrunji is one of the major rivers of Saurashtra. The Shetrunji basin is the Eastern most basin of Saurashtra and is situated in between 21° 00' to 21° 47' North latitude and 70° 50' to 72°10' East longitude (location map- fig-1) The river Shetrunji originates at Chachai hills in Gir forest of Junagadh district at R.L. 380 m above m.s.l. and flows towards East direction till its confluence with Gulf of Khambhat near Santhrapur port. The River Shetrunji, fertile the area of Amerli and Bhavnagar districts and some part of Junagadh district of Saurashtra. The Shetrunji drains an area of 5514 sq km out of which more than 50% in Amerli district.

The location map of Saurashtra can be shown by fig-1.



The total length of this East flowing river from its origin to the outfall into the Gulf of Khambhat is 182 km. This river receives tidal influence for a length of 5 km from mouth. The Shetrunji receives several tributaries on both banks. There are 9 tributaries having lengths more than 15 km. Out of which Safara, Shel, Khari and Talaji are the 4 tributaries on the right bank of Shetrunji and the remaining 5 tributaries namely Stali, Thebu, Gagadia, Rajwal and Kharo are on left bank. The drainage system on left bank of Shetrunji is more extensive as compared to the right bank area. The Stali, Thebi and Gagadia are important tributaries feeding from left bank of Shetrunji and drain nearly 34% of total catchment area of the river Shetrunji. The Gagadia and Theli (Thebu) are the principal tributaries of Shetrunji rising from the high ground near Visavadar Talukas of Junagadh district. Then, The average rainfall in the Shetrunji basin is 604.52 mm. The South -West monsoon sets in by middle of June and withdraws by the first week of October. About 90% of total rainfall is received during July and August. Owing to the topographical characteristics climate is variable. Summer temperature varies from 35°C to 47°C.

The geology of Saurashtra can be shown by fig-2.

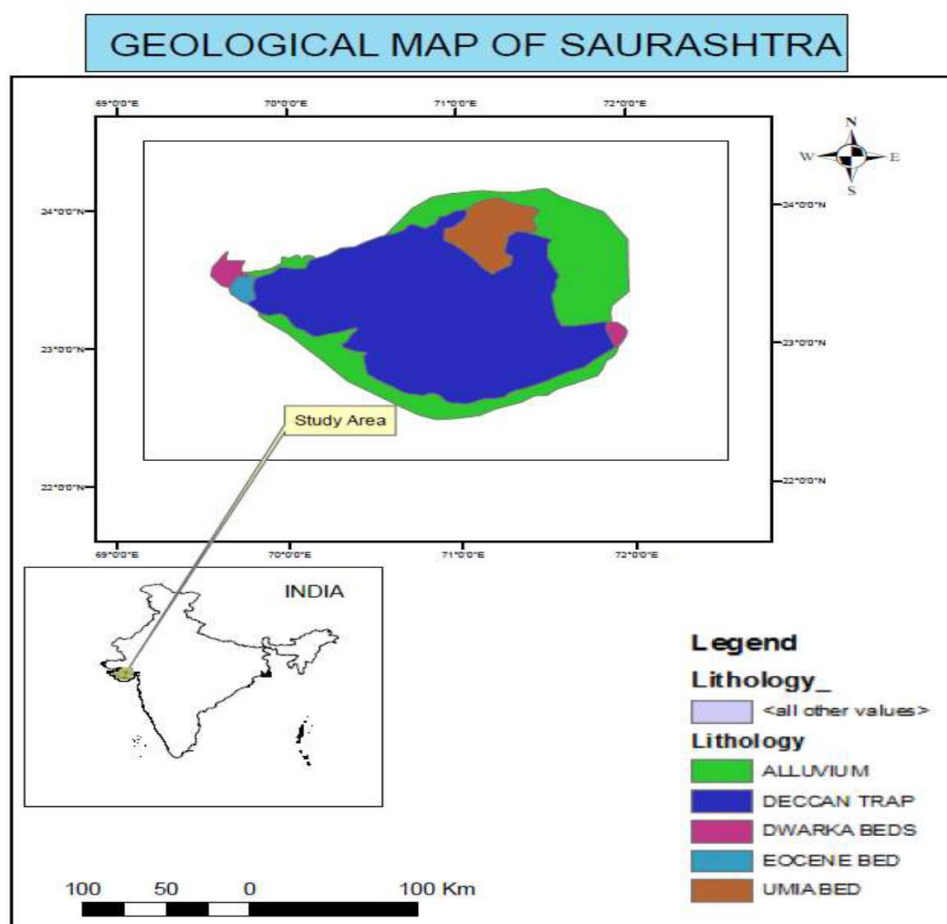


Fig-2

## METHODOLOGY:

Drainage are digitized, by ETM+ data in Arc GIS 10.1 software. Then, drainage are splitted in to different orders up to fifth orders. After that, morphometric parameters are calculated. The multi temporal landsat image(path-149, row-44-45 Mapper) have been downloaded free of cost from GLCF (Global land Cover Facility). Its date of acquisition is 16 oct. 2000.

**RESULT AND DISCUSSION:**

The following parameter are calculated in result and discussion (Table-1 &2):-

**(1) Bifurcation ratio:-**

It is the ratio of number of stream of a given order to no. of next higher order. It indicates relief and dissection(Horton 1945). The 1st/2nd order has ratio of 4.17, 2nd /3<sup>rd</sup> stream has 4.11, 3rd /4th order has 4.5 and 4th/5th order stream has 2 respectively. The mean bifurcation ratio is 14.78.

**(2) Stream order:-**

It is defined as measure of position of a stream in hierarchy of tributaries (Leopold et. al, 1969). Furthermore, the classification of stream based on the number and type of junction has been proved to be useful indicator of stream size, discharge and drainage area (Strahler, 1957). It is the fifth order drainage basin. The stream ordering follows Strahler method.

**(3) Stream number:-**

The first order streams are 463, 2nd order streams are 111, 3rd order streams are 27, 4th order streams are 6, while 5th order stream are 3 .in number.

**(4) Area:-** It is measured in km<sup>2</sup>. . The area of Shetrunji river basin is 5183.268 sq.km.

**(5) Perimeter:-** It is the outer boundary of watershed. The perimeter of Shetrunji river basin is 236.18 km.

**(6) Drainage Density:-**

It refers to the closeness of spacing of channels and quantitatively obtained by the ratio of total channel segments within a basin (Horton, 1945, Strahler, 1964). The drainage density of Shetrunji river basin is 0.40. Then, low Dd of the Shetrunji watershed is favour of resistant lithology or highly permeable subsoil materials.

**(7) Stream Frequency:-**

It can be defined as number of stream segments per unit area (Horton, 1945). The value of stream frequency is 0.23.

**(8) Drainage Texture:-**

It is an expression of the relative channel spacing in a fluvial dissected terrain. It depends upon number of natural factors such as climate, rainfall, vegetation, rock and soil types, infiltration capacity, relief and soil types, infiltration capacity, relief and stage of development of a basin(Smith, 1950). It should be noted that drainage density of less than 2 indicates very coarse, between 2&4 indicates coarse, between 2 and 6 indicates moderate, between 4 and 8 indicates fine and greater than 8 indicates a very fine drainage texture. The drainage texture of Shetrunji river basin is 0.092 which indicates very coarse texture.

**(9) Length of overland flow:-**

It can be defined as the length of water over the ground before it gets concentrated in to definite stream channel which affects both hydrological and physiographic development of the drainage basin.(Horton,1945). The Lg value of value of Shetrunji river basin is 0.2 which shows shorter path for the concentration of flow and short distance required for flow concentration.

**(10) Constant of channel maintenance:-**

The parameter which is inverse of drainage density is termed as Constant of Channel Maintenance. The value of C of Shetrunji river basin is 2.5 which shows the higher infiltration rate of the river basin.

**(11) Form Factor:-**

It is used to predict the flow intensity of a watershed of a defined and this has direct linkage to peak discharge (Horton 1945, Gregory and Walling, 1973). The value of Ff is 0.0119 which is low and indicates more elongate plan view of river basin suggesting consequent flatter peak of short duration.

**(12) Elongation Ratio:-**

It can be defined as the ratio of diameter of a circle of the same area as the basin to maximum basin length (Schumm, 1956). Values close to 1.0 are typical of regions of very low relief whereas that of 0.6 to 0.8 are associated with high relief and steep ground slope (Strahler, 1964). These values are further grouped into three categories, namely circular ( $>0.9$ ), oval (0.9-0.8) and elongated ( $< 0.7$ ). The value of elongation ratio is 0.030 of Shetrunji river basin which shows elongated shape and has strong relief and steep ground slant.

**(13) Basin Length:-**

It can be defined as the length of basin parallel to main drainage line. The basin length of Shetrunji river basin is 115.24km.

**(14) Basin Relief:-**

It determines the stream gradient and influences flood pattern and volume of sediment that can be transported (Hadley and Schumm, 1961). Besides, it is important factor in understanding denudational characteristics of the basin (Sreedevi et. al. 2004). The basin relief of Shetrunji river basin is 611km.

**(15) Relief Ratio:-**

It is a dimensionless height to length ratio and is widely accepted as an effective measure of gradient aspects of watershed (Schumm, 1956). The value of relief ratio is 5.30, indicating presence of areas of steeper slope and higher relief underlain by resistant rocks (Vittala et al. 2004).

**(16) Asymmetry Factor:-**

Asymmetry Factor can be defined as  $Af = 100 (Ar/At)$ , where Ar-Area of the right part of the basin of main drainage line, and At-total area of the drainage basin. According to Molin et. al. (2004), when AF is greater than 50, the channel has shifted towards left side of the drainage basin. On the other hand, a value less than 50 is indicative of channel shift towards right side of the drainage basin. The value of AF is 23.70, which shows lateral tilting towards right right side.

**Table 1: Different morphometric parameters used for morphometric analysis**

	Parameters	Definition
<b>Linear aspects</b>	Perimeter (P) (km)	
	Basin length (Lb) (km)	
	Stream order(Nu)	Strahler (1957)
	Stream length(Lu) (km)	Horton (1945)
	Bifurcation ratio(Rb)	$Rb = Nu/N(u+1)$ , Horton (1945)
<b>Areal aspects</b>	Stream lengthratio (RI)	$RI = Lu/L(u-1)$ , Horton (1945)
	Rho coefficient( R)	$R = RI/Rb$ , Horton (1945)
	Area (A) (km <sup>2</sup> )	
	Drainage density(Dd) (km km <sup>-2</sup> )	$Dd = \sum Lt/A$ , Horton (1945)
	Stream frequency(Fs) (km <sup>-2</sup> )	$Fs = Nt/A$ , Horton (1945)
	Drainage texture(T) (km km <sup>-4</sup> )	$T = Dd \times Fs$ , Smith (1950)
	Length of overland flow(Lg) (km)	$Lg = 1/2 Dd$ , Horton (1945)
	Constant of Channel maintenance(C) (km)	$C = 1/Dd$ , Schumm(1956)
	Form factor (Ff)	$Ff = A/Lb^2$ , Horton (1945)
	Circularity ratio (Rc)	$Rc = 4\pi A/P^2$ , Miller (1953)
<b>Relief aspects</b>	Elongation ratio (Re)	$Re = 1.128 \sqrt{A/Lb}$ , Schumm(1956)
	Basin relief (r) (km)	$R = H-h$ , Schumm (1956)
	Relief ratio (Rr)	$Rr = R/Lb$ , Schumm (1956)
	Ruggedness number (Rn)	$Rn = R \times Dd$ , Strahler (1958)
	Gradient ratio (Rg)	$Rg = Es - Em/Lb$ , Sreedevi et al. (2004)
	Melton ruggedness ratio (MRn)	$MRn = H-h/A^{0.5}$ , Melton (1965)

River Basin	Stream Order(u)	Stream Numbers $N_u$	Total length of the stream in km $L_u$		
Shetrunji River Basin	1 <sup>st</sup>	463	11083.317		
	2 <sup>nd</sup>	111	5423.423		
	3 <sup>rd</sup>	27	2085.725		
	4 <sup>th</sup>	6	558.986		
	5 <sup>th</sup>	3	11.089		
		$\sum N_u - 122$ 0	$\sum L_u - 2098.5$		
	Bifurcation Ratio ( $R_b$ )				Mean $R_b$
	1 <sup>st</sup> order/ 2 <sup>nd</sup> order	2 <sup>nd</sup> order/ 3 <sup>rd</sup> order	3 <sup>rd</sup> order/ 5 <sup>th</sup> order	4 <sup>th</sup> order/ 5 <sup>th</sup> order	
4.17	4.11	4.5	2	14.78	

Area of the River basin	A	5183.268 sq km
Perimeter	P	236.18 km
Drainage Density (km/sq km)	$D = L_u / A$	0.40
Stream Frequency	$F_s = \sum N_u / A$	0.23
Basin Length	$L_b$	115.24 km
Basin Relief	$R = H - h$	611 km
Relief Ratio	$R_r = R / L_b$	5.30 m/ km
Elongation Ratio	$R_L = 1.128 \sqrt{A} / L_b$	0.030
Form factor ratio	$R_F = A / L_b^2$	0.119
Assymetry factor	$A_r = 1228.665$ sq km, $A_t = 5183.268$ sq km $T - D_d \times F_s$	$A_r - 100 \times$ $(1228.665 / 5183.268) = 23.70$ 0.092
Drainage Texture	$L_g = \frac{1}{2} D_d$	0.2
Length of overland flow	$C = 1 / D_d$	2.5
Constant of channel maintenance		

## CONCLUSION:-

The morphometric analysis carried out for the Shetrunji river basin shows that the basin has moderate relief and more or less circular shape of the basin. The drainage network of drainage basin is dendritic which indicate the homogeneity in texture and lack of structural control. The lower drainage density and stream frequency indicates high permeability rate of subsurface formation. It has very coarse drainage texture. Form factor give information about shape of the basin while elongation ratio give information about relief and slope of the ground. At last, Assymetry factor give information about the lateral tilting of the basin. In this way, morphometric parameters give information about morphological characteristics of the basin & tectonic activity of the basin.

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