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Watershed Prioritization Based On Morphometry Analysis for Groundwater Potential in Panjhara River Basin, Sakri Taluka, Maharashtra (India)

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Abstract
Drainage basin analysis is giving a quantitative description water resource of the area. The aim of present study is to identify the morphometric parameters of watershed condition in Panjhara River basin of Sakri Taluka in the state Maharashtra, India. Study areas divided in to 6 sub-watersheds which are nomenclature by groundwater survey and development agency for upper Panjhara River. The study area is having homogeneity in texture and lack of structural control. The steam order is 1^{st} to 6^{th}in all sub-watersheds with dendritic drainage pattern. The work included as the significance of digital elevation model (DEM) for gathering details on Drainage Network (stream order, stream number, stream length, stream length ratio and bifurcation ratio), drainage texture (stream frequency, drainage density, constant of channel maintenance, length of overland flow, total basin relief and relief ratio) and basin geometry (form factor, elongation ratio, texture ratio, circularity ratio drainage texture and compactness coefficient) characteristics. Each parameter has been assigned their ranks according to their weightage and low parameter value is ranked as first and so on. The lowest value sub-watershed TE-103 is considered as high priority for adopting conservation measures. The suitable locations for conservation structures like check dam, nala plugging and percolation tank in high prioritized sub-watersheds, were also identified for the appropriate land and water management system. The highly prioritized zone in structural condition will also useful for mark important location for structures. Although understanding of soil erosion and deposition of earth material.

Keywords: *Morphometric analysis; GIS; Remote sensing; Panjhara River; Prioritization.*

INTRODUCTION

In the development of any area water and land are the most important natural resource. The resources are limited and their use is increasing in day-to-day life. Therefore, sustainable use of resource is required for better development. Although in water resource planning and management, conservation play an important role in the development, the watershed management is helps to protect soil and water. Adoption of better watershed management practices overcomes the issues of drought, flood, excessive runoff, poor infiltration, soil erosion, human health, and low productive yield (Choudhary et al., 2018). The need of quantitative geomorphological analysis in management of water resource is explained by earlier researchers (Horton, 1932; 1945). Afterwards many geomorphologists have further developed the methods of watershed morphometry (Schumm, 1956; Strahler, 1957, 1964). In India, many authors (Sreedevi, et al.2005; Yadav, et al. 2016; Yadav et al. 2014; Golekar et al. 2013) used remote sensing and GIS tools in morphometric analysis and other (Balázs, et al. 2018; Narsimlu, et al.2015; Paudel, et al. 2014; Rai et al. 2014; Singh, et al. 2017; Singh, et al., 2015; Pareta, 2011).

The natural resource management, rehabilitation, hydrological modeling and watershed prioritization of drainage basin is required for quantitative study of the area. Morphometric analysis is a significant tool for prioritization of sub-watersheds even without considering the soil map (Biswas, 1999). Morphometry is the measurement of the configuration of earth's surface shape and dimension of its landform (Clarke, 1996; Choudhary et al. 2018). Morphometric analysis will help to quantify and understand the hydrological characters and their results will usefully input for a comprehensive water resource management and plans (Golekar et al., 2013). With advent of high-resolution digital elevation model, the extraction of drainage parameters gets more popularity in last decades; it works precise, updated and cost-effective way of performing watershed analysis.

The morphometric analysis and their parameters calculation is more convenient method with help of Shuttle Radar Topographic Mission (SRTM) with C-band interferometric radar configuration, with all this satellite data provide the batter method to calculate data with good resolution. The computer system is help to process data file and relevant data. In this study, analysis of morphometric parameter has been carried for prioritization of sub watershed of Panjhara River basin. These drainage morphometric parameters are helpful for idea about the geomorphic set up of the area and also helpful to provide solution for water and soil conservation measures and artificial recharge planning in the area.

Study area

The present study is conducted on Panjhara River Basin of Sakri taluka covering an area of 1347.5 km^2. The origin of river is in Western ghat and flows toward east. The study area lies between latitude 20°47'58''to 21°07'06''and 73°55'24''to 74°30'31''longitude (Fig. 1). The river Panjhara is one of the tributary of Tapi River and covers the Deccan trap Basalt (Upper Cretaceous to Eocene age). The river shows dendritic drainage pattern and sixth rank stream. Sakri taluka has a hot semi-arid climate bordering with tropical wet and dry with average temperature ranging between 5 and 43°C. The annual precipitation of Sakri taluka is 770 mm which occurs mainly in monsoon season (June to September) and July is the wettest month of the year. The major cultivated crops in this area is Cotton, Onion, Jawar, wheat, bajra, sugarcane, rice, soybean, groundnut, vegetables, turmeric, grape, pomegranate, etc.

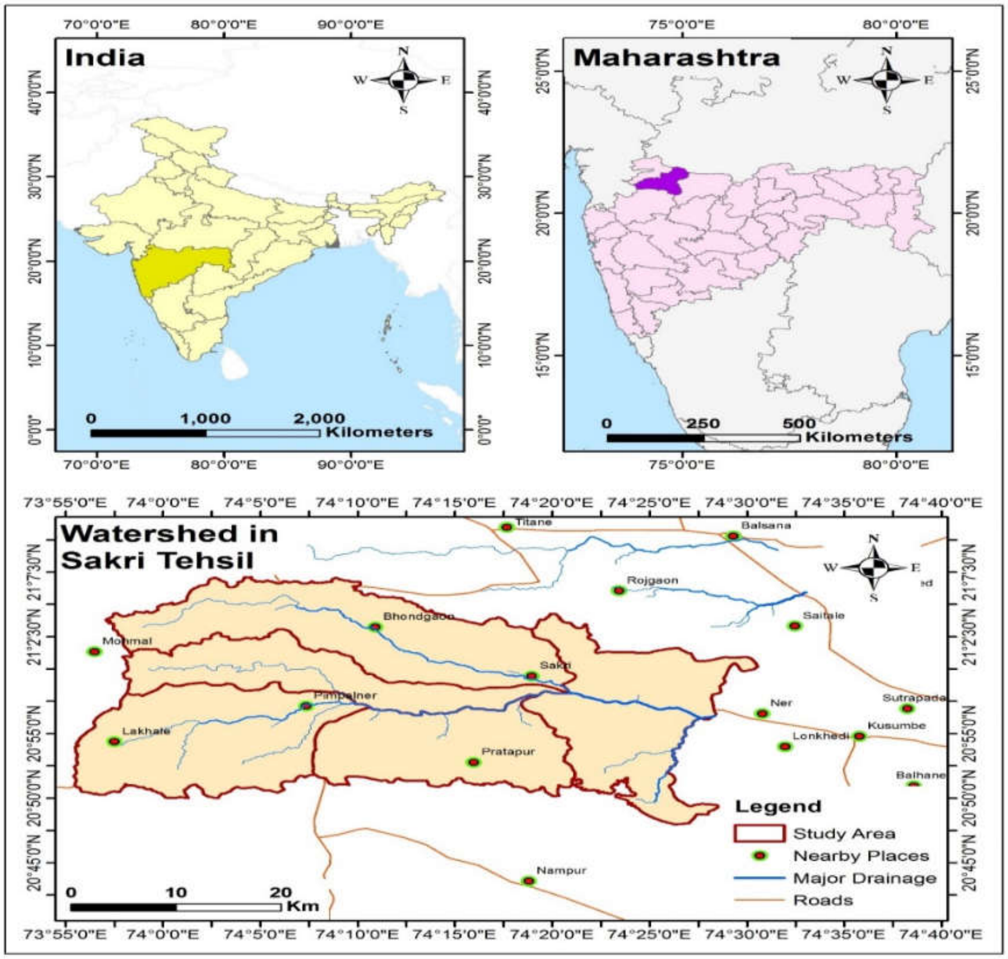

Figure 1: Location map of the study area

METHODOLOGY AND DATA

The toposheets were purchased from Survey of India. The topographical maps were geo-referenced in ArcGIS software. The SRTM (Shuttle Radar Topography Mission) 30m data were used; boundary layer is used as GSDA boundary layer of Panjhara river. The DEM data of study area were freely available and it was downloaded from (usgs.gov). Thereafter, the pre-processed DEM were used for extraction of morphometric parameters. It is economical and time saving method which used in present study.

For the purpose of drainage basin analysis following parameters has been calculated.

1. Drainage Network (Stream Order, Stream number, Stream Length, Stream length ratio and Bifurcation Ratio).
2. Basin Geometry (Form Factor, Elongation Ratio, Texture Ratio, Circularity Ratio, Drainage Texture and Compactness Coefficient).
3. Textural Analysis (Stream Frequency, Drainage Density, Constant of Channel Maintenance, Length of Overland Flow, Total Basin Relief and Relief Ratio).

The quantitative results of the drainage morphometric parameters has presented in Table 1. Prioritization rating of all sub-watershed of Panjhara River is carried out through ranking the calculated morphological parameters. The sub-watershed with low rank is given the high priority for soil erosion and less conservation measures. Groundwater condition which is assessed on the basis of groundwater map acquired from government of Maharashtra's, India (Chaudhary et al., 2018).

Table 1: Formulae used for calculation of morphometric parameter

Sr. No.	Morphometric Parameter	Formula	Reference
A	**Drainage Network or Linear Parameters**		
1	Stream Order (S_u)	Hierarchical Rank	(Strahler, 1952)
2	Stream Number (N_u)	Nu=∑ (N1+N2+⋯+Nn	(Horton, 1945)
3	Stream Length (*Lu*) Kms	Lu=∑ (L1+L2+⋯+Ln	(Strahler, 1952)
4	Stream Length Ratio (*Lur*)	Lur= Lu/(Lu-1)	(Strahler, 1952)
5	Bifurcation Ratio (*Rb*)	Rb= Nu/((Nu+1))	(Strahler, 1952)
B	**Basin Geometry**		
1	Form Factor Ratio (*Ff*)	Rf= A/(Lb+1)^2	(Horton, 1932)
2	Elongation Ratio (Re)	Re= 2/(Lb (A/π)^0.5)	(Schumm, 1956)
3	Texture Ratio (Rt)	Rt=N1/P	(Schumm andLichty,1965)
4	Circularity Ratio (Rc)	Rc=4π(A/P^2)	(Miller, 1953; Potter, 1957)
5	Drainage Texture (Dt)	Dt=Nu/P	(Horton, 1945)
6	Compactness Coefficient (Cc)	Cc=0.2841×{P/[(A)^0.5]}	-
C	**Drainage Texture Analysis**		
1	Stream Frequency (Fs)	FS=Nu/A	(Horton, 1932)
2	Drainage Density (Dd) in km / km²	Dd=Lu/A	(Horton, 1932)
3	Constant of Channel Maintenance (C) in km² / km	C=1/Dd	(Schumm, 1956)
4	Length of Overland Flow (Lg) Kms	Lg= A / (2 × Lu)	(Horton, 1945)
5	Total Basin Relief (H) m	H = (Maximum Elevation – Minimum Elevation)	(Strahler, 1952)
6	Relief Ratio (Rhl)	Rhl=(H/Lb)	(Schumm, 1956)

RESULT AND DISCUSSIONS

The results and discussion of drainage network, drainage textural analysis and Basin geometric parameters are as follows.

Estimation of Drainage Parameters

Stream order

Strahler (1964) proposed method of stream ranking and numbering, it's a first step of the drainage network analysis. The stream ordering for Order, total number, segments (Table 2), length and total length (Table 2). Change in stream order and stream number suggests that streams are flowing from high altitude and with less lithological variations (Choudhary et al., 2018; Pareta, 2011; Swarnakar and Channabasappa, 2022). The order stream is increases while stream number decreases (Table 2). The highest stream number was found in 6th (Fig. 2). The sub-watershed fence in dendritic drainage pattern that means homogenous subsurface of strata and lack of structural tectonic control (Fig. 3).

Table 2: Sub-watershed wise details for stream order and total number

	Sub-watershed	Area	I	II	III	IV	V	VI	Total
Stream Numbers	TE-89	125.84	125	31	7	2	1	1	167
Stream Length			98	60	22	1	1	14	196.74
Stream Numbers	TE-103	342.8	363	106	25	3	1		498
Stream Length			305	137	50	23	32		547.07
Stream Numbers	TE-104	190.57	199	59	15	2	1		276
Stream Length			145	90	21	28	22		305.37
Stream Numbers	TE-105A	160.42	160	40	12	3	2	1	218
Stream Length			122	73	27	20	9	13	264.45
Stream Numbers	TE-115	224.67	208	45	12	3	1		269
Stream Length			195	117	70	13	17		412.35
Stream Numbers	TE-124	303.22	323	78	19	5	1		426
Stream Length			234	114	56	36	18		459
Stream Numbers	TOTAL	2695.05	1378	359	90	18	7	2	1854
	%		74.3	19.4	4.9	1	0.4	0.1	100
Stream Length	TOTAL		1098.83	590.77	245.89	121.34	100.69	27.08	2184.6
	%		50.3	27	11.3	5.6	4.6	1.2	100

Stream length

Horton (1945) was developed stream length calculation systematically as important factor in basin network. The observations are steam order decreases and length of stream increases, therefore; the length of first order stream is maximum and lowest order minimum. Here the Panjhara river length is 70.5 kms and having a stream order is 6th. The stream flowing though lithological variations, high and steep slopes of the watershed, these are all depending on the formation, permeability and porosity of rock in watershed. For this, all watershed wise detail like stream order and length and total number of segments shown (Table 3).

Table 3: Sub-watershed wise details stream length ration

Sr. No.	Sub-watershed	Stream length ratio					Average
		II/I	III/II	IV/III	V/IV	VI/V	
1	TE-89	0.613	0.373	0.060	1.053	10.186	2.457
2	TE-103	0.448	0.364	0.459	1.412	-	0.671
3	TE-104	0.620	0.229	1.381	0.785	-	0.754
4	TE-105A	0.600	0.370	0.720	0.465	1.410	0.713
5	TE-115	0.599	0.603	0.183	1.351	-	0.684
6	TE-124	0.490	0.487	0.653	0.503	-	0.533
	Average	0.561	0.404	0.576	0.928	5.798	-

Stream length ratio

Horton (1945), defined as the ratio of the mean stream length of a given order to the mean stream length of next lower order, this has an important relationship with surface flow and discharge. The stream length ration in study area watershed is deferent from each other. This change might be attributed to the variation in slope and topography, indicating the late youth stage of geomorphic development in the streams (Vittala, et al., 2004; Nilawar, 2014). The length ratio provides general view about the relative permeability of the basin rock formations. Stream length ratio value is presented in (Table 3).

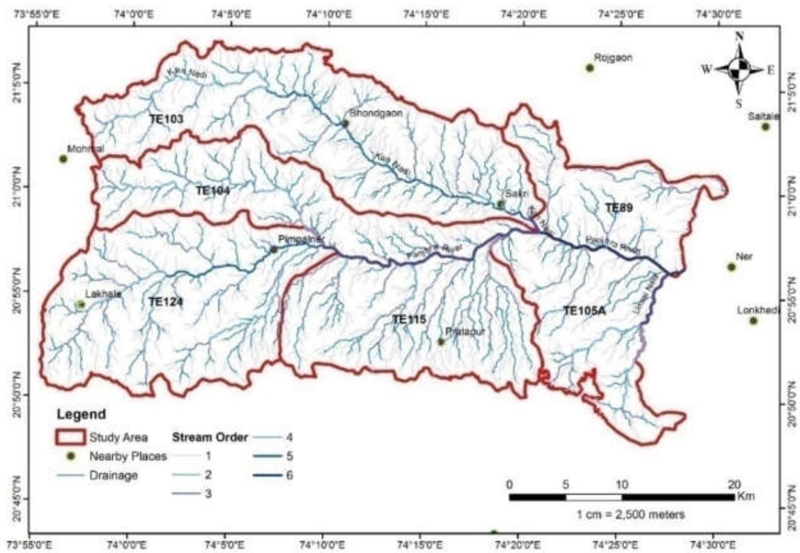

Figure 2: Drainage map of the study area.

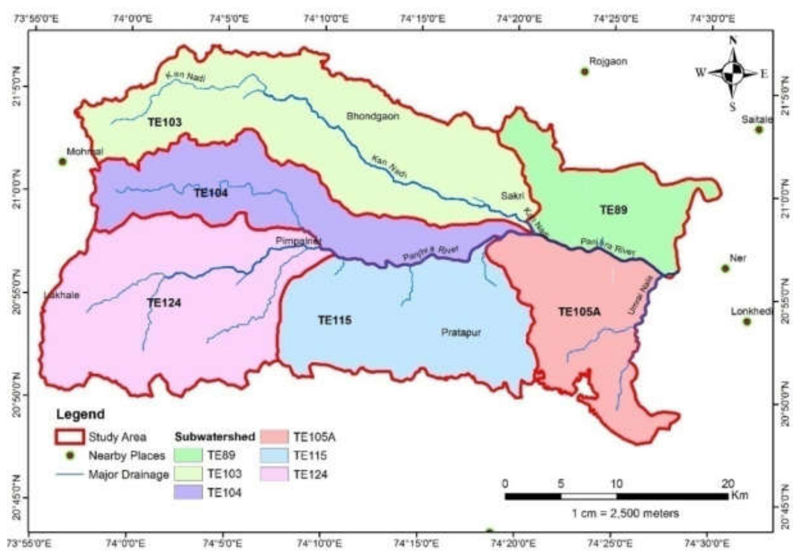

Figure 3: Watershed Map of the study area

Bifurcation ratio (RB)

Schumm (1956), define the Bifurcation ratio is the branching pattern of a drainage network and is defined as ratio between the total numbers of stream segments of a given order to that of the next higher order in a basin. Theoretically bifurcation ratio is 2.0 and natural drain- age system has 3.0-5.0 in which geologic structures do not distort the drainage pattern (Strahler, 1964). If the bifurcation ratio is less, it indicates plain terrain, permeable and soft bed rock where infiltrates more water makes better ground water potential zone. Lower bifurcation ratio is also due to the presence of large number of first and second order streams in the sub-basins (Kumar et al., 2011). In river channel systems it varies within narrow limits, averaging (Table 04) for basin in a wide variety of physiographic and climatic settings. The meaning of ratio can best be visualized by saying that any stream of a given order two to four branches of the next lower order (Leopold, 1971).

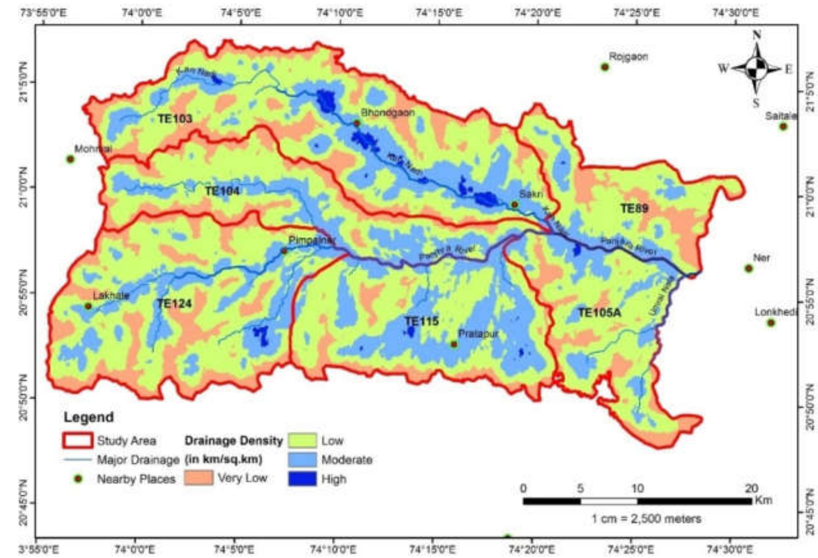

Figure 4: Density Map of the study area

Table 4: Sub-watershed wise details of Bifurcation ration

Sr. No.	Stream Order	Number of Stream	Bifurcation Ratio
1	1	2187	
2	2	569	3.8
3	3	146	3.9
4	4	28	5.2
5	5	11	2.5
6	6	3	3.7
AVERAGE		2944	3.8

Estimation of Textural parameters

Drainage density (DD)

Horton (1932), has been introduced drainage density. It is an expression to indicate the closeness of spacing of channels. It shows landscape analysis, runoff potential, infiltration rate, climate condition, and vegetation cover. High drainage density shows to fine drainage texture, low drainage density shows to coarse drainage texture. The low or impermeable sub-surface rocks, hilly relief and scatter vegetation lead to high drainage density. If drainage density value is nearly zero it indicates a permeable basin with high infiltration rates and high amount ground water potential. The low drainage density is likely to result in the area of highly resistant permeable subsoil material under dense vegetation and low relief (Abrahams, 1972; Abrahams and Ponczynski, 1984; Nautiyal, 1994). The drainage density is presented in (Table 5). Drainage density map of the study area has depicted in figure 4.

Texture ratio

Horton (1945) Texture ratio shows the relative distance of drainage lines. It is considered as the number of stream segments of all order present in all area of sub watershed (Smith, 1950; Horton, 1945). Climate, rainfall, types of rock, relief, and development stage are effect on development drainage texture. The texture ratio is presented in (Table 5).

Length of overland flow

Horton (1945) length of overland flow is the length of water more over the land before it meeting concentrated into certain stream channels. The length of overland flow is defined as half of the reciprocal of drainage density (Chaudhary et al., 2018). It is one of the most important independent variables, affecting both the hydrological and physiographical developments of the drainage basin (Horton, 1945). The Length of overland flow is presented in (Table 5).

Stream frequency

Horton (1932) define the number of streams in per unit area is known as stream frequency of the basin. When the stream frequency is high it signals greater surface runoff and steep ground surface (Das and Pardeshi, 2018). In this study area drainage frequencies are varying for different sub watersheds. The stream frequency is presented in (Table 5).

Constant of channel maintenance

Schumm (1956), the constant of channel maintenance is the inverse of drainage density. Generally, lower the Constant of channel maintenance values of watershed indicate lower the permeability of rocks and high the Constant of channel maintenance values shows high permeability of basin rock. The Constant of channel maintenance is presented in (Table 5).

Total basin relief

Horton (1945), total basin relief is the maximum vertical distance between the lowest and the highest points in a basin (Strahler, 1964). Basin relief is an important factor in understanding the denudational characteristics of the basin. The basin relief is providing a significant quantitative assessment of geomorphological and hydrological characteristics prevailing in the slopes of the drainage basin, especially erosional properties. Thus, sub watershed with high values is suggesting hazardous hydrological dynamics with high erosion density, whereas lower values reflect sub-basins with high infiltration capacity and low discharge peak (Hazem, 2020). Hence, the steep slope factor contributes to the risk of runoff and early hydrological peak (Bhat et al., 2019). The Total Basin Relief is presented in (Table 5). The slope map of the study area has depicted in figure 5.

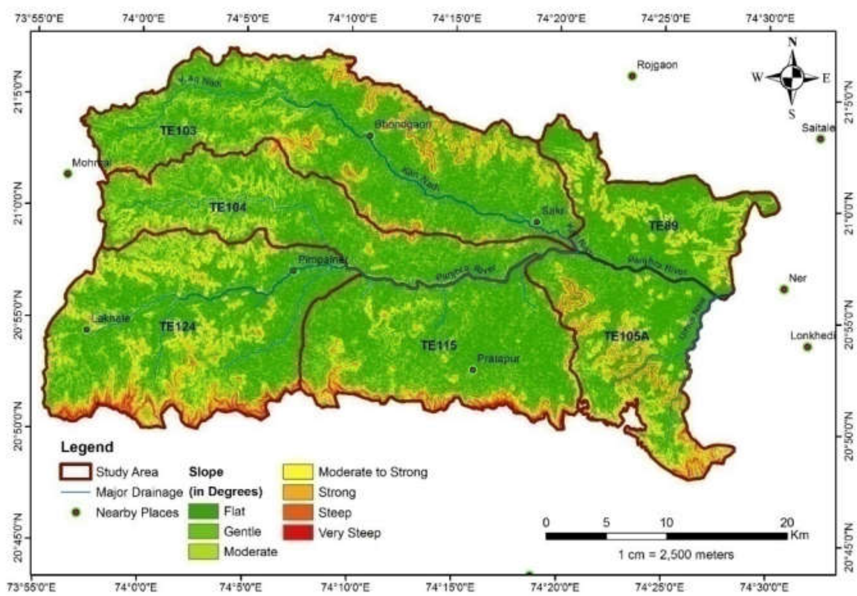

Figure 5: *Slope Map of the study area*

Relief ratio

Schumm (1956), defined as the ratio of maximum relief to horizontal distance along the longest dimension of the basin parallel to the principal drainage line is known as relief ratio and determine by type of rocks and slope of the basin. If the values of relief ratio are high it indicates hilly region and low ratio indicates pediplain and valley region (Kumar et al.2011). Relief ratio helps to identify where to establish settlement and afforestation also for agricultural purpose. The Relief ratio is presented in (Table 5).

Table 5: Sub-watershed wise details of Texture and Basin Geometry

Drainage Texture Analysis							Basin Geometry						
Parameter	Bifurcation ratio	Stream Frequency	Drainage Density	Constant of Channel Maintenance	Length of Overland Flow	Total Basin Relief	Relief Ratio	Form Factor	Elongation Ratio	Texture Ratio	Circularity Ratio	Drainage Texture	Compactness Coefficient
Symbol	(Rb)	(Fs)	(Dd)	(C)	(Lg)	(H)	(Rhl)	(Rf)	(Re)	(Rt)	(Rc)	(Dt)	(Cc)
TE-89	2.99	1.33	1.56	0.64	0.32	358	0.14	0.19	0.013	1.88	0.36	1.88	1.68
TE-103	4.75	1.45	1.6	0.63	0.31	482	0.11	0.17	0.004	1.93	0.3	3.05	1.83
TE-104	4.2	1.45	1.6	0.62	0.31	463	0.12	0.11	0.006	1.98	0.23	1.93	2.12
TE-105A	3.21	1.36	1.65	0.61	0.3	514	0.33	0.57	0.018	1.64	0.31	1.98	1.81
TE-115	3.84	1.2	1.84	0.54	0.27	636	0.41	0.81	0.015	2.66	0.46	2.66	1.48
TE-124	4.26	1.4	1.51	0.66	0.33	785	0.25	0.3	0.007	3.83	0.54	3.83	1.37

Estimation of Basin Geometry parameters

Form factor

Horton (1932), form factor is the ratio of the width to the length of the drainage-basin. The length to be used is not necessarily the maximum length but is to be measured from a point on the watershed-line opposite the head of the main stream. For a drainage-basin with a side outlet the length may be less than the width. The form factor value varies from 0 in highly elongated basin to 1 for perfectly circular basin. The Form factor is presented in (Table 5).

Elongation ratio

Schumm, (1956), define the elongation ratio is the ratio of the diameter of a circle of the same area as the drainage basin to the maximum length of the basin. The higher the elongation ratio of a basin indicates active denudational process with high infiltration capacity and low runoff in the basin and lower indicates higher elevation and high headward erosion along tectonic lineaments (Chaudhary, 2018). The elongation ratio is presented in (Table 5).

Texture ratio (RT)

Schumm (1956), define the texture ratio is an important factor in the drainage morphometric analysis. The texture ratio is expressed as the ratio between the first order streams and perimeter of the basin, it depends on the underlying lithology, infiltration capacity and relief aspects of the terrain (Pareta and Pareta 2012).The Texture ratio is presented in (Table 5).

Circulatory ratio

Miller (1953) Circulatory ratio is the ratio of the basin area to the area of a circle with the same perimeter as the basin. In the given area circulatory ratio varies from 0 to 1. The circularity ratio is influenced by geological structures, climate, relief, land cover and stream length and slope of the basin (Chaudhary et al. 2018). The circularity ratio is presented in (Table 5).

Drainage texture

Smith (1950), the meaning of drainage texture is relative spacing of drainage lines. The term drainage texture must be used to indicate relative spacing of streams in a unit area along linear direction (Chaudhary et al., 2018). Drainage texture of any drainage basin depends on climate, rainfall, vegetation, soil and type of rock, infiltration rate, relief and the stage of development (Horton, 1945; Smith, 1950). The drainage texture helps to understand permeability, ground water recharge potentiality while higher the drainage texture which means higher permeability and better groundwater recharge potentiality. The drainage texture is presented in (Table 5).

Compactness coefficient

Gravelius (1914), the compactness coefficient of a sub-basin is the ratio of perimeter of sub-basin to circumference of circular area, which equals the area of the sub-basin. The Compactness Coefficient is independent of size of sub-basin and dependent only on the slope. If the basin was a perfect circle, then Compactness Coefficient would be equal to 1. The Compactness Coefficient is presented in (Table 5).

Table 6: Calculated value and result of texture parameter

Parameter	**Stream Frequency**	**Drainage Density**	**Constant of Channel Maintenance**	**Length of Overland Flow**	**Total Basin Relief**	**Relief Ratio**
Symbol	(Fs)	(Dd)	(C)	(Lg)	(H)	(Rhl)
TE-89	**1.33**	**1.56**	**0.64**	**0.32**	**358.00**	**14.29**
RESULTS	Low	Moderate	least erodible	More channel erosion	Elevated	Moderate
TE-103	**1.45**	**1.60**	**0.63**	**0.31**	**482.00**	**10.97**
RESULTS	Low	Moderate	least erodible	More channel erosion	Elevated	Moderate
TE-104	**1.45**	**1.60**	**0.62**	**0.31**	**463.00**	**11.54**
RESULTS	Low	Moderate	least erodible	More channel erosion	Elevated	Moderate
TE-105A	**1.36**	**1.65**	**0.61**	**0.30**	**514.00**	**32.61**
RESULTS	Low	Moderate	least erodible	More channel erosion	Elevated	Very high
TE-115	**1.20**	**1.84**	**0.54**	**0.27**	**636.00**	**40.59**
RESULTS	Low	Moderate	least erodible	More channel erosion	Highly elevated	Very high
TE-124	**1.40**	**1.51**	**0.66**	**0.33**	**785.00**	**25.30**
RESULTS	Low	Moderate	least erodible	More channel erosion	Highly elevated	High

Table 7: Calculated value and result of geometric parameters

Sr. No.	**1**	**2**	**3**	**4**	**5**	**6**
Parameter	Form Factor Ratio	Elongation Ratio	Texture Ratio	Circularity Ratio	Drainage Texture	Compactness Coefficient
Symbol	(Rf)	(Re)	(Rt)	(Rc)	(Dt)	(Cc)
TE-89	**0.19**	**0.013**	**1.88**	**0.36**	**1.88**	**1.68**
RESULTS	Slightly elongated	More elongated	Very coarse	Less elongated	Very coarse	High elongated
TE-103	**0.17**	**0.004**	**1.93**	**0.29**	**3.05**	**1.83**
RESULTS	Slightly elongated	More elongated	Very coarse	elongated	Coarse	Elongated
TE-104	**0.11**	**0.006**	**1.98**	**0.23**	**1.93**	**2.12**
RESULTS	Slightly elongated	More elongated	Very coarse	elongated	Very coarse	Elongated
TE-105A	**0.57**	**0.018**	**1.64**	**0.31**	**1.98**	**1.81**
RESULTS	Slightly elongated	More elongated	Very coarse	Less elongated	Very coarse	Elongated
TE-115	**0.81**	**0.015**	**2.66**	**0.46**	**2.66**	**1.48**
RESULTS	Circular	More elongated	Coarse	Less elongated	Coarse	High elongated
TE-124	**0.30**	**0.007**	**3.83**	**0.54**	**3.83**	**1.37**
RESULTS	Slightly elongated	More elongated	Coarse	Less circular	Coarse	High elongated

Table 8: Sub-watershed wise ranking and prioritization

MORPHOMETRIC PARAMETERS																
Drainage Texture							**Basin Geometry**								**Ranking**	
Parameter	Bifurcation ratio	Stream Frequency	Drainage Density	Constant of Channel Maintenance	Length of Overland Flow	Total Basin Relief	Relief Ratio	Form Factor	Elongation Ratio	Texture Ratio	Circularity Ratio	Drainage Texture	Compactness Coefficient	Compound factor	prioritization rank	Interpretation of Rank
Symbol	(Rb)	(Fs)	(Dd)	(C)	(Lg)	(H)	(Rhl)	(Rf)	(Re)	(Rt)	(Rc)	(Dt)	(Cc)	-	-	-
TE-89	6	5	5	2	2	6	4	3	4	2	4	1	3	3.6	4	Medium
TE-103	1	1	3	3	3	4	5	2	1	3	2	5	5	2.9	1	High
TE-104	3	2	4	4	4	5	6	1	2	4	1	2	6	3.4	3	Medium
TE-105A	5	4	2	5	5	3	2	5	6	1	3	3	4	3.7	5	Low
TE-115	4	6	1	6	6	2	1	6	5	5	5	4	2	4.1	6	Low
TE-124	2	3	6	1	1	1	3	4	3	6	6	6	1	3.3	2	Medium

Anticipation of Groundwater Prioritization for sub-watersheds

The groundwater is the ideal component on the earth. Therefore, the analysis and management of water is challenging in stipulated time frame for day-to-day use in study area, while requirement of drinking and industrial water is increasing. In such conditions the morphometric analysis of a watershed could be the ideal to derive the useful information about the watershed and also marking prioritization of such sub-watersheds (Sujata et al., 1999). Morphometric analysis is based on (stream length, number of streams, bifurcation ratio, density of streams per unit drainage area, elevation difference, slope, and perimeter and area of drainage basins) that are considered to characterize stream networks and drainage basin systems since the surface stream patterns are usually influenced by the underlying sediment type or lithology, geological structures, the topography and various hydrological factors (Cheng et al., 2001). The analyses of morphometric parameters are significant in identifying and determining the zones of groundwater potentialities and areas of high erosional risk (Yadav et al., 2016). Prioritization of Six sub-watershed has been done to identified zone of high soil erosion activity, so with the time proper conservation measures can be taken for checking the soil erosion in that particular area (Chaudhary et al., 2018). The calculated parameter of all six sub-watersheds and priority ranking has been depicted in Table 6 and 7. The prioritization of sub-watersheds has shown in map (Fig. 6 and Table 8).

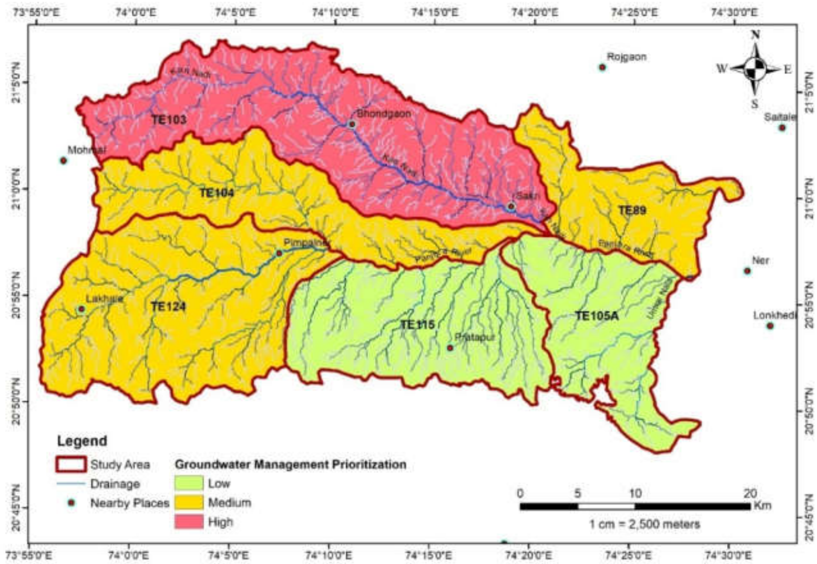

Figure 6: Prioritization watershed map of the study area

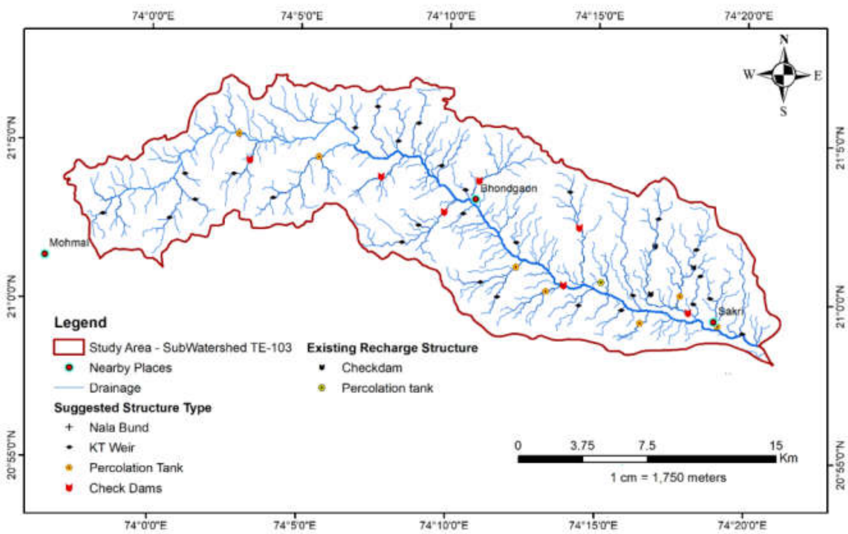

Figure 7: Existing and Suggested measuring structure

Selection of suitable sites for water conservation structures

The Remote sensing and GIS techniques are highly beneficial and helpful while doing prioritization work of river basin. It is also very good to identification of suitable locations for water conservation structures in (TE-103) high prioritized sub-watersheds. The ranking of the most critical sub-watershed through the morphological parameters were analyzed. A total 90water conservation structures sites were marked and suggested in sub-watershed TE-103, out of these 48 sites for nala plugging, 28 Kolhapur Types Weir sites, 7 percolation tank site, and 7 Check dam sites were found to be suitable for the proper management practices (Fig. 7). This type of practice is essential for the understanding and implementation of erosion prevention measure and land or soil management practices.

CONCLUSION

The study is concluded that morphometric analysis is the better way to evaluate and ranking sub-watershed for soil erosion and deficit with surplus zones, the study is done for Panjhara river basin in Sakri taluka of Dhule District. Sub-watershed TE-103 is found the high prioritization and high groundwater deficit zone. Whereas, sub watershed TE-89, TE-104 and TE-124 is found moderate soil erosion while sub watershed TE-115 and TE-105A were found low soil erosion and less groundwater prioritization. Drainage density is moderate permeability of rocks and in higher altitude areas have high drainage density. Low stream frequency shows gentle slopes, moderate infiltration, hilly regions and poor groundwater condition in all sub-watersheds. The sub-watersheds are elongated, more channel erosion and area are elevated to highly elevated while least erodible, it shows the geological and topographical control on the sub-watersheds. On the basis of prioritization and ranking of sub-watersheds most effective conservation measuring structure are mark on map (Fig. 7) there are 90 conservation structure for (TE-103) sub-watershed was proposed. Although the remaining sub-watersheds are also not in very good condition, with respective groundwater and surface water. The geological and topographical conditions are nearly closed to priorities watersheds and need to take conservation measures for future safety.

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