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# Drainage characterization of Surana Tons watershed Doon valley

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**Abstract:** The Surana Tons watershed is one of the foremost water courses flowing in Doon valley in central part of dehradun. The watershed is divided in to 10 sub watershed Surana Tons/ Rami Rao ,Surana Tona/Biras Rao, Surana Tona/Nimi Nadi, Surana Tona/Nanota Nadi, Surana Tona/Jajhara, Surana Tona/Surana Nadi, Surana Tona/Bains Wala Rao, Surana Tona/Nun Nadi, Surana Tona/Karwa Pani, Surana Tona/Ramgarh.The morphometric paramentrs of surana tons watershed were measured using remote sensing and GIS technique and the quantitative analysis of watershed development of the watershed and its 10 sub watershed was carried out using LISS III, Landsat ASTER ( DEM) data and survey of India Toposheets. The Drainage orientation data suggest a poly modal circulation. The shape of a watershed is somewhat proportioned having high, moderate slope to low slope , dendrite pattern ,high values of drainage density ,stream frequency and bifurcation ratio. The bifurcation ratio and high drainage density indicate limited association amongst hydrographic networks. The study shows that the area has favorable form for ground water recharging and soil conservation for sustainable development of watershed. The dissimilar morphometric limits have been interrelated by every new to know their primary association and control over the basin hydro geomorphology. The result thus generated provides satisfactory information base required for finale making through premeditated development and demarcation of prioritized vulnerability management areas in hilly topographies.

**Key Words**: 1.Drainage, 2.Morphometry,3. DEM, 4. GIS, 5.Stream

## Introduction

The dimension and numerical investigation of the pattern of the terrain's shell, form, and aspect of its terrain is called morphometry. To recognize the progression and performance of drainage outline, numerous quantifiable techniques have been developed .In hydrology, watershed drainage behaviors are basic in accepting various hydrological procedures. Since watershed is the basic unit in hydrology; therefore, morphometric study at micro watershed scale is beneficial and better rather carry it out on discrete passage or conflicting segment areas. Watershed is a natural hydrological entity which

Permit Surface run-off to a distinct channel, drain, drains, river at a specific point and extent varies from fractions to thousands of $km^2$. Being primary element of fluvial terrain, significant study principal fact has been done on watershed symmetrical classification such as stream network topology and quantitative relating of shape, pattern, and drainage surface. Hydrologic and geomorphic method occur inside the watershed, and morphometric characterization at the watershed scale reveals evidence concerning formation and development of land surface processes and thus offer a holistic insight into the hydrologic performance of a watershed. Morphometric exploration offers a very worthy substitute to understand the fundamental dynamics scheming the hydrological behavior. Additionally, there are a countless of realistic function of computable morphometric study such as stream basin assessment, watershed prioritizing for soil and water preservation, and management of natural assets. Assessment of the measurable morphometric limitations of sub watersheds of a river helps in understanding the geomorphological property on the spatio chronological deviance of the hydrological functions. Moreover, some of the morphometric parameters such as circularity ratio and bifurcation ratio are contribution parameters in the hydrograph study and appraisal of exterior water prospective of an area. In this context, this work represents a better indulgent of hydrologic performance of the research area and its consequence on a diversity of economic or social feature of the valley of Dehradun. Moreover, a more balanced method of drainage morphometric exploration has been occupied in this study contrast to other repeatedly DEM-based drainage generation methods. It uses natural stream network and lake information to condition the DEM prior to the calculation of flow direction and flow accumulation grids. This significantly diminishes inaccuracy overview in the custom of false drainage.

## 2. Material & Methods

### Study Area

The research area comprises eastern part of Doon valley and its environs having link with the Lesser Himalayas in the north, the Siwalik Hills in the south, river Ganga in the southeast and Dehradun town in the west. It covers an area about 740 km and is bounded between 78 05' E and 78 25' E longitude, and 30 05' and 30 30' N latitude. It falls in SOI Toposheet Nos. 53J/3, 4, 7 and 8. Physiographical Doon valley is an irregular longitudinal synclinal valley, which lies between lesser and sub Himalayan ranges. Doon valley is an inter montane valley positioned within the Siwalik foreland basin in the Garhwal Himalaya (Thakur 1995). Along the northern margins of the Doon valley, the Main Boundary Thrust (MBT) brings the Precambrian rocks of the Lesser Himalaya to override the Siwalik group (Jayangondaperumal et al. 2001) whereas a sudden topographic rise of the Siwalik range demarcates the Himalayan Frontal Thrust (HFT), locally called the Mohand thrust (Nakata 1972), which separates the Siwalik group from the recent alluvium of the plains. The large part of the valley is occupied by a broad synclinal depression, called the Doon syncline (Kishore 2005). To its south, lies a complementary fold structure, Mohand anticline, and the Santogarh anticline lie to its north. The fold structures have folded the Siwalik strata and owe their origin as fault-propagation folds developed as a result of southwestward propagating Mohand Thrust (Yeats & Thakur 1998). A sharp loss of topographic gradient from Mussoorie range to Doon Valley is characterized by a sharp knick point that coincides with the trace of the MBT. The drainage that has developed on the major fans in northern part of the Doon and flowing southwestward is younger than the mountain front drainage (Nakata 1972.)

### Data Sets Used

The input data sets used in this resaerch for achieving the respective aims are as follows.
(i) Quantitative Morphometry: ASTER DEM 30 m.
(ii) Survey of India (SOI) topographical maps at 1: 50,000.

### Method

### Drainage Generation

Dissection and ordered collection of streams is crucial to concentrate on the hydrometric nature of a drainage micro watershed. Drainage channel was generated from Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) 30 m digital elevation model (DEM) in GIS environment. The Hydrology tool method was used for drainage creation which is more logical and consistent when compared to a manual approach. Natural drainage present in SOI Toposheets was digitized and used to manipulate the DEM. For proper determination of flow direction and flow accumulation, DEM sinks were identified and filled. Boundaries of the 10 sub watersheds were derived by defining pour point for each sub watershed. Stream ordering has been done for all sub basin of

Surana tons following the hierarchical level proposed by Strahler. The total stream length of Surana Tons watershed is 2442.91 km (Table 2) of which the 1st and 2nd order streams comprise 86.05%. The stream length ratio ($Lur$) varies from 0.3 to 3.64 and is high for 3rd and 4th order streams in the Watershed (Table 3). With increasing stream order there is a decrease in stream number ($Nu$) and a simultaneous increase in mean stream length ($Lurm$).

## Quantitative Morphometry

In the current research, morphometric investigation of the parameters, namely, stream order, stream length, bifurcation ratio, drainage density, drainage texture, stream frequency, drainage texture, form factor, Basin Length, circulatory and elongation ratio, area, perimeter, and length of all the 10 sub watersheds have been carried out using the standard mathematical formulae given in the Table 4 $ 5. The values of various basin characteristics required for calculating morphometric parameters are shown in Table 1.

## Basin Geometry

Basin shape is controlled by structure, lithology, relief, and precipitation and varies from narrow elongated forms with rough basin perimeter to circular or semicircular forms. Circularity ratio ($Rc$) of Surana tons watershed ranges from 0.23 to 0.72 (Table 4) with high values in Karwa nadi & Jhahra and low values in Surana Nadi (High values of form ratio ($Rf$) and elongation ratio ($Re$) are found in Jhajra and karwa pani , whereas low values are found in Nimi Nadi,Nun Nadi &Surana Nadi. The relative spacing of channels in a drainage basin is expressed by drainage texture. ($Dt$). The $Dt$ values of Surana tons watershed range from 3.64 to 13.44 (Table 1). High values of $D\ t$ are Found in sub watersheds located in the upper reaches of the basin, whereas low $Dt$ values are found in sub watersheds located near the mouth of the basin.$R_c$ bears a strong negative relationship with compactness coefficient ($C_c$), whereas $F_f$ has a positive relationship with $R_e$ **(**Table 4) Low values of are coupled with high relief and vertical gradient and imply the youthful nature of these sub watersheds. Although the circular sub watersheds are more competent in the discharge of run-off they are at greater risk from soil erosion because they have a very short lag time and high peak flows than the elongated basins .The elongated sub watersheds, on the other hand, have low side flow for shorter period and high main surge for longer duration and are less vulnerable to flood hazard.

## Table. 1. Methodology adopted for computation of morphometric parameters

| *Morphometric Parameters* | *Formula/Definition* | *References* |
|---|---|---|
| Area | Plan area of the watershed (km2) GIS software analysis | Horton (1945) |
| Basin perimeter (P) | Perimeter of the watershed (km) GIS software analysis | Horton (1945) |
| Stream order | Hierarchical rank | Strahler, A. (1952b) |
| Basin length (Lb) | Length of the stream (km) GIS software analysis | Horton (1945) |
| Mean stream length (Lsm) | Lsm = Lu/Nu (km) where,<br>Lsm = mean stream length<br>Lu = total stream length of all orders<br>Nu = total no. of stream segments of order "u"<br>GIS software analysis | Strahler, A. (1964) |
| Stream length ratio (RL) | RL = Lu/Lu − 1, where Lu − 1 = the total stream length of its next lower order | Horton (1945) |
| Bifurcation ratio ($R_b$) | Rb = $N_u/N_{u+1}$<br>Where $N_u$ = Total no. of stream segment of order 'u'<br>$N_{u+1}$ = Number of segment of the next higher order | Schumm (1956) |
| Mean bifurcation ratio (Rbm) | Rbm = average of bifurcation ratio of all orders | Strahler, A. (1964) |
| Drainage density ($D_d$) | $D_d = L_u/A$<br>Where $D_d$ = drainage density<br>$L_u$ = total stream length of all orders<br>A = area of the basin,($km^2$) | Horton (1945) |
| Stream frequency ($F_s$) | $F_s$ $N_u/A$<br>Where $F_s$ = Stream frequency<br>$N_u$ = total number of streams of all orders<br>A = area of the basin,($km^2$) | Horton (1945) |
| Circulatory ratio ($R_c$) | $R_c = 4* TT*A/P^2$<br>Where$R_c$ = circularity Ratio<br>TT= TT value i.e., 3.141<br>A = area of the basin, km2<br>$P^2$ = square of the perimeter, km | Miller(1953) |
| Elongation ratio ($R_e$) | $R_c$ $(4*A/TT)^{0.5}/L_b$<br>Where $R_c$ = elongation ratio<br>A = area of the basin, $km^2$<br>TT = TTvalue i.e., 3.141<br>$L_b$ = basin length, km | Miller (1953) |
| Form factor ($F_f$) | $F_f = A/L_b^2$<br>Where $F_f$ form factor<br>A = area of the basin, $km^2$<br>$L_b$ = basin length | Schumm (1956) |
| Drainage texture (T) | $T = N_u/P$<br>Where $N_u$ = total no. of streams of all orders<br>P = basin perimeter, km | Horton (1945) |
| Compactness constant ($C_c$) | $C_c = 0.2821\ P/A^{0.5}$<br>Where $C_c$ = Compactness Ratio<br>A = Area of the basin, $km^2$<br>P = basin perimeter , km | Horton (1945) |

## 3. Results and Discussion

### 3.1 Stream Order *(U)*

The uppermost rivulet order is between the 10 sub watersheds is 5 and is revealed by three sub watersheds: WS6, WS8 and WS9. The lowermost stream order is four and is shown by *WS1, WS2 WS3 WS4 WS5 WS7 WS10*. An assessment of Table 3 and **Figure 1** specifies that the 10 sub watersheds subsidizing superficial runoff and deposit tons desperately due to variation in their substantial uniqueness. East side of the river noticeably subsidizes additional to absolution and since high slope & higher velocity enhances the erosion rates, therefore, this side also contributes higher sediment loads into the east side. Further, the total number of stream segments decrease with stream order. This is referred to as Horton's law of stream numbers. Any deviation indicates that the terrain is typified with high relief and/or moderately steep slopes, underlain by varying lithology and probable uplift across the basin. In practice, when logarithms of the number of streams of a given order, are plotted against the order, the points lie on a straight line .Similar geometric relationship was also found to operate between stream order and stream numbers in all sub watersheds of this study area. It indicates that the whole area has uniform underlying lithology, and geologically, there has been no feasible fortify in the Watershed.

### 3.2 Stream Length *(Lu)/*Mean Stream Length *(Lsm)*

Study of the result has shown in Tables 3 and 4 shows that the total length of stream segments is the highest in case of first order streams. It reduces as order increases in all the sub watersheds (Tables 2 and 3). The results reiterate the fact that the area is underlain with identical lithology with no possible basin upliftment. The study reveal that the area depends only on the drainage characteristics for movement of water. Further, since there are equal number of watersheds in the both side of the river but the total stream length of all the orders from east side is greater than the west side, therefore, the longer travel times make this side hydrologically extremely active. From this observation, it is concluded that during a same intensity run off whole of the East or West side of the river, the West side will show short basin lag times compared to East side under similar soil moisture and vegetation cover. Moreover, Table 4 indicates that Lsm in these sub watersheds range from a least of 0.21 km for stream order 2 of WS 5 to a maximum of 3.64 km for the order 3 of WS9. According to the Horton's law of stream lengths, Lsm of any given order is greater than that of lower order. A comparative analysis of Lsm and stream length ratio of all the sub watersheds is shown in Table 4.East side of the river clearly contributes more to discharge and since higher velocity enhances the erosion rates, therefore, this side also contributes higher sediment loads into the Tons River. Further, the total number of stream segments decrease with stream order. This is referred to as Horton's law of stream numbers. Any deviation indicates that the terrain is typified with high relief and/or moderately steep slopes, underlain by varying lithology and probable uplift across the basin. In practice, when logarithms of the number of streams of a given order, are plotted against the order, the points lie on a straight line. Analogous geometric association was also found to function connecting stream order and stream statistics in all sub watersheds of this study area. It signify that the entire area has homogeneous under lithology, and geologically, there has been no probable uplift in the basin.

### 3.3 Stream Frequency/Channel Frequency *(Fs)*

(Fs) is the sum of number of streams of all orders per unit area. The study of the results shown in Table 5 shows that Fs is maximum in sub watershed WS12 Nun Nadi Watershed (5.57 /km2), followed by Karwa Pani (5.39 /km2), Ramgarh (5.23/km2).The lowest stream frequency is of watershed Nimi Nadi and Jhajra (4.38 /km2) and (4.57 /km2) respectively.Fs has been correlated to permeability, penetration potential, and relief of watersheds .The values observed in Tons specify that Nun Watershed is having rocky terrain and very low infiltration capacity out of all the 10 sub watersheds. Additional, it is noted that Fs shrink as the stream number amplify. Fs of Nimi Nadi Watershed and Jhajra Watershed reveal that this sub watershed is comparably covered with good amount of vegetation and has very good infiltration capacity.

### 3.4. Bifurcation Ratio (Rb)/Mean Bifurcation Ratio (Rbm)

Result of the results shown in Table 5 shows that mean bifurcation ratio (Rbm) of the 10 sub watersheds is 1.9,1.77,1.93,1.71,2.48,1.77,1.92,1.19,2.07,2.06 for WS1 to WS10, respectively. Rbm does not specifically continue stable from one order to the next, because of prospect of deviation in bsin conformation and lithology, but it be inclined to be a persistent during the series. High Rbm signify early hydrograph uttermost with a potential for high runoff. Moreover, wherever in a basin, powerful geological dominate; Rbm shows only a small variation for different regions on different environment. Higher Rbm values are the attribute of structurally more disturbed watersheds with a protruding misrepresentation in drainage pattern and vice versa. Maximum Rbm is seen for WS9 Karwa pani (Rbm = 2.07), and thus it will show early hydrograph peak (smaller basin lag time)which also indicates strong structural control on the drainage development for this watershed. The minimum Rbm is observed for WS4 Nanota Nadi ($Rbm$ = 1.71), representing delayed hydrograph peak.

### 3.5. Drainage Density (D)

Reasons which disturb $D$ drainage Density are typically same as particular influencing length of the Drain, specifically, conflict to enduring, perviousness of rock configuration, climatic condition and vegetation. The pass through time by stream within the basin is exact by D. High drainage density is observed in the area of fragile and impermeable subsurface material, sparse flora and hilly terrain.

**Table No: 2 Stream order-wise frequency distribution of number of streams along with order**

| S.no | Watershed Name | Stream Order1 | Stream Order 2 | Stream Order 3 | Stream Order4 | Stream Order 5 |
|---|---|---|---|---|---|---|
| 1 | Surana Tons/ Rami Rao | 40 | 18 | 9 | 6 | |
| 2 | Surana Tona/Biras Rao | 66 | 26 | 16 | 13 | |
| 3 | Surana Tona/Nimi Nadi | 62 | 22 | 17 | 10 | |
| 4 | Surana Tona/Nanota Nadi | 143 | 57 | 41 | 33 | |
| 5 | Surana Tona/Jajhara | 184 | 85 | 57 | 15 | |
| 6 | Surana Tona/Surana Nadi | 300 | 130 | 70 | 45 | 1.91 |
| 7 | Surana Tona/Bains Wala Rao | 41 | 21 | 11 | | |
| 8 | Surana Tona/Nun Nadi | 120 | 45 | 27 | 13 | 25 |
| 9 | Surana Tona/Karwa Pani | 299 | 162 | 63 | 38 | 17 |
| 10 | Surana Tona/Ramgarh | 52 | 19 | 16 | 7 | |

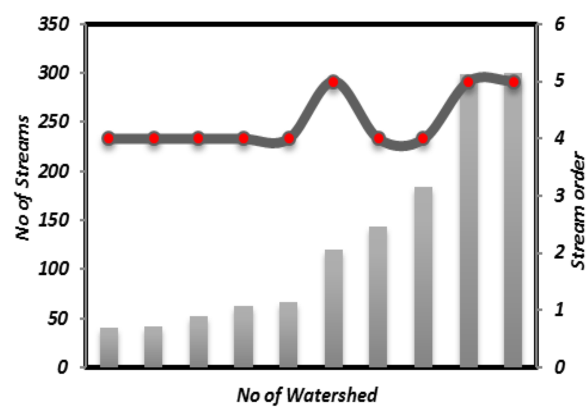


**Figure 1 : Showing relationship between Stream no and Stream order**

*t a glance the D values from Table 4 indicates that WS8, have lowest D values (below 2.0 km/km2), while WS1, WS2, WS3, WS4, WS5, WS7, have moderate D values (2.0–2.5 km/km2). Sub watersheds WS6, and WS 9 have high D values (between 2.4 and 3.0 km/km2). The small and modest D watersheds tell that they are form of permeable material, worthy flora and low relief which consequences in additional permeation capacity and comparably are good sites for ground water recharge as compare to high D watersheds. On the basis of D, WS8 will have the maximum basin lag time; whereas WS6 will reveal the shortest lag time.*

## Table No: 3 Details of Hierarchical order of Stream Mean length Ratio

| S.no | Watershed Name | Stream Length Ratio(2/1) | Stream Length Ratio(3/2) | Stream Length Ratio(4/3) | Stream Length Ratio(5/4) |
|---|---|---|---|---|---|
| 1 | Surana Tons/ Rami Rao | 0.41 | 0.51 | 0.92 | |
| 2 | Surana Tona/Biras Rao | 0.36 | 0.62 | 0.69 | |
| 3 | Surana Tona/Nimi Nadi | 0.3 | 1.22 | 0.25 | |
| 4 | Surana Tona/Nanota Nadi | 0.41 | 0.89 | 0.9 | |
| 5 | Surana Tona/Jajhara | 0.53 | 0.74 | 0.2 | |
| 6 | Surana Tona/Surana Nadi | 0.33 | 0.51 | 0.36 | 1.36 |
| 7 | Surana Tona/Bains Wala Rao | 0.63 | 0.46 | | |
| 8 | Surana Tona/Nun Nadi | 0.43 | 0.47 | 0.49 | 2.47 |
| 9 | Surana Tona/Karwa Pani | 0.55 | 0.42 | 3.64 | 0.51 |
| 10 | Surana Tona/Ramgarh | 0.33 | 1.23 | 0.33 | |

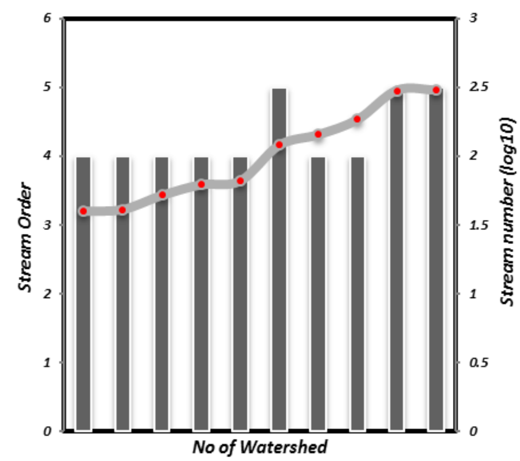


*Figure 1: showing relationship between stream order and Stream no (log 10)*

### 3.6 Drainage Texture (Rt)

Drainage texture (Rt) is inclined by infusion capability. There are five diverse texture classes: very coarse (<2), coarse (2–4), moderate (4–6), fine (6–8), and very fine (>8). According to this categorization, in this WS 1 & WS7 watershed is coming under coarse category WS3, WS2, WS10 have moderate Rt, and WS4, WS5, WS6, WS8, and WS9 have very fine Rt (Table 6). Hierologically very coarse texture watersheds have large basin lag time periods [56] followed by coarse, fine, and very fine texture classes. This indicates thatWS1 (Rt = 3.63) shows longer duration to peak flow, while WS9 (Rt = 13.44) demonstrations the smallest.

### 3.7. Elongation Ratio (Re)

The values of elongation ratio (Re) usually fluctuate from 0.37 to 0.92 coupled with an extensive diversity of macroclimate and physiography. Standards nearby to 1.0 are usual of areas of precise little relief however, that from 0.6 to 0.8 are related with extraordinary relief and steep ground slope. These values can be grouped into three categories, namely, circular (>0.9), oval (0.7–0.6), and less elongated (<0.6). Re for the sub watersheds WS2, WS5, WS10 is having (0.7–0.6), which designates that sub watersheds are elongated with high relief and moderately sloped. Only watershed WS9 is having value (>0.9). Re for the watershed WS1, WS3, WS4, WS6, WS7, WS8 is having (<0.6) which indicates that sub watersheds are elongated with high relief and steep slope. The Lag period for WS2, WS5& WS9 indicates mild slants and lengthier stream routes.

## 3.8. Form Factor (Rf)

The watershed with excessive form factors have high peak flows of smaller extent, although elongated sub watersheds with short form factors have lower peak flow of longer duration. In this study, WS3, WS6, WS8, show lower form factor (Table 4) indicating elongated shape and suggesting flat hydrograph peak for longer duration. Water flows of such elongated basins are easier to manage than those of the circular basin. WS1, WS4, WS10, WS7, have slightly circular shape as suggested by moderately higher Rf. Sub watersheds WS2, WS5, have high Rf indicating that they have developed into quite circular to rectangular and WS9 is having uppermost Rf shape. Basin morphology has reflective influences on the basin hydrology.

### Table No: 4 Details of Morphological Parameters in Research

| *Watershed Name* | *A (Sq. Km)* | *P* | *Bl* | *Rf* | *Re* | *Rc* |
|---|---|---|---|---|---|---|
| *Surana Tons/ Rami Rao* | *15.34* | *20.07* | *7.78* | *0.25* | *0.566* | *0.47* |
| *Surana Tona/Biras Rao* | *22.02* | *21.42* | *7.8* | *0.36* | *0.67* | *0.60* |
| *Surana Tona/Nimi Nadi* | *25.34* | *28.91* | *12.77* | *0.15* | *0.44* | *0.38* |
| *Surana Tona/Nanota Nadi* | *55.62* | *44.98* | *15.01* | *0.24* | *0.56* | *0.34* |
| *Surana Tona/Jajhara* | *74.56* | *37.23* | *14.01* | *0.37* | *0.69* | *0.67* |
| *Surana Tona/Surana Nadi* | *41.54* | *47.26* | *19.14* | *0.11* | *0.37* | *0.23* |
| *Surana Tona/Bains Wala Rao* | *14.28* | *18.94* | *7.50* | *0.25* | *0.56* | *0.50* |
| *Surana Tona/Nun Nadi* | *41.26* | *34.47* | *14.5* | *0.19* | *0.49* | *0.43* |
| *Surana Tona/Karwa Pani* | *107.26* | *43.07* | *12.62* | *0.67* | *0.92* | *0.72* |
| *Surana Tona/Ramgarh* | *17.95* | *22.1988* | *7.87* | *0.289* | *0.61* | *0.45* |

| ***Watershed Name*** | ***D*** | ***Rt*** | ***Cc*** | ***Rb*** | ***Fs*** |
|---|---|---|---|---|---|
| ***Surana Tons/ Rami Rao*** | ***2.28*** | ***3.63*** | ***1.44*** | ***1.9*** | ***4.75*** |
| ***Surana Tona/Biras Rao*** | ***2.57*** | ***5.64*** | ***1.28*** | ***1.77*** | ***5.49*** |
| ***Surana Tona/Nimi Nadi*** | ***2.02*** | ***4.38*** | ***1.61*** | ***1.93*** | ***4.38*** |
| ***Surana Tona/Nanota Nadi*** | ***2*** | ***6.09*** | ***1.70*** | ***1.71*** | ***4.92*** |
| ***Surana Tona/Jajhara*** | ***2.31*** | ***9.15*** | ***1.22*** | ***2.48*** | ***4.57*** |
| ***Surana Tona/Surana Nadi*** | ***5.14*** | ***11.11*** | ***2.06*** | ***1.77*** | ***4.95*** |
| ***Surana Tona/Bains Wala Rao*** | ***2.28*** | ***3.85*** | ***1.41*** | ***1.92*** | ***5.11*** |
| ***Surana Tona/Nun Nadi*** | ***1.86*** | ***6.67*** | ***1.5*** | ***1.19*** | ***5.57*** |
| ***Surana Tona/Karwa Pani*** | ***2.42*** | ***13.44*** | ***1.17*** | ***2.07*** | ***5.39*** |
| ***Surana Tona/Ramgarh*** | ***2.35*** | ***4.23*** | ***1.47*** | ***2.06*** | ***5.23*** |

## 4. Hydrological Interferences from Morphometric Analysis

Morphometric study of watershed centered on remote sensing and satellite derived Digital Elevation Model (DEM) are furthermost important figures for appropriate hydrology study of each topography which tangentially support hydrogeological rank of the watershed. The computable examination of morphometric configurations is make to be of substantial worth in watershed delineation, soil and water protection and their preservation. The morphometric search sustained out in the Surana Tons watershed displays that the basin has slight relief and strained shape. These scanned stream factors provide relative indexes of the permeability of rock faces in various parts of a drainage basin. If these figures are integrated with the other hydrological characteristics of the drainage basin, the approach of siting recharge and water-harvesting measures delivers better groundwater development and management plan. The drainage pattern in the present watershed is dendritic in nature. This might be owing to more or fewer similar lithology and physical controls. In the study area high drainage density is observed over the higher slope area with impermeable hard rock substratum, and minor drainage density over the extremely permeable sub-soils and low relief zones. Small drainage density areas are auspicious for understanding of groundwater potential zones. Slope shows an actual important role in influential penetration vs. runoff relation. Penetration is contrariwise connected to slope i.e. milder is the angle, complex is penetration and fewer is runoff and vice versa.

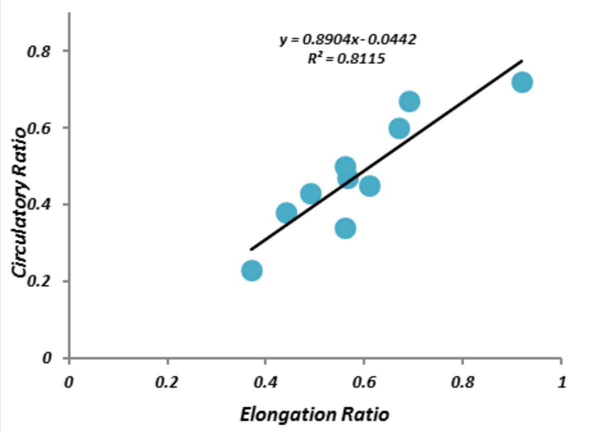


**Figure no 3: shows Relationship between Rc and Re**

## 5. Conclusion & Recommendation

The hydrology related study carried out for the watershed settles that the watershed is devouring low relief. Drainage network of the basin displays as mainly dendritic type which specifies the homogeneity in texture and lack of structural control and helps understand various terrain parameters such as nature of the bedrock, infiltration capacity, runoff, etc. Subordinate drainage density and stream frequency indicate high permeability rate of the subsurface formation. The observed parameters reveal recharge-related measures and areas where surface-water augmentation measures can be commenced for water resource controlling and soil management structures. Outsized measure watershed study using GIS, remote sensing data and Digital elevation Model (DEM) has resourceful implements for accepting any terrain constraints such as nature of bedrock, permeation capacity, surface run off etc., which supports in improved considerate the situation of land form and their processes, drainage management and development of groundwater prospective for watershed planning and management. This work will be useful for natural resource management at the micro level of any topography for sustainable development by organizers and decision producers for sustainable watershed development Programme. The results observed in the present work can be used for site appropriateness of soil and water conservation configurations in the region and successively, these parameters were integrated with other hydrological information viz., land use/cover, land forms, geology, water level and soil in the GIS domain to arrive at a decision regarding a suitable site for soil and water conservation structures (Nala bund, check dam, and percolation tank, recharge shaft, etc.) in the area for groundwater development and management. The research suggested that the watershed desires a hydrogeological and geophysical analysis in future for appropriate water management and assortment of simulated groundwater revitalize configurations within the research extent.

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