5	Form Factor	Rf	$Rf = A/Lb^2$ Where, A = Area of the basin and Lb = (Maximum) basin length	[20]
6	Constant Channel maintenance	(C)	C = 1/D D= Stream density	[21]
7	Elongation ratio	(Re)	$Re= \sqrt{(4*A/p)}/Lb$	[21]
8	Circulatory ratio	(Rc)	$Rc = 4 * Pi * A/P^2$	[25]
9	Compactness constant	(Cc)	$Cc= 0.2821\ P/A^{0.5}$	[20]

4.2 Linear aspects

Table 4: Linear aspect

Sub watershed identity codes	Area (Km^2)	Perimeter (Km)	Basin length (Km)
SWD-1	3347.18	325.91	89
SWD-2	1992.14	433	85
SWD-3	360.42	100.84	21
SWD-4	1144.64	167.11	39
SWD-5	560.36	128.8	37
SWD-6	904.37	181.31	44
SWD-7	747.47	256.42	34
SWD-8	1005.56	278.9	40
SWD-9	1376.06	353.28	48
SWD-10	1392.92	326.53	55

A linear aspect of a basin resembles the channel patterns of the drainage network. It includes stream order (U), stream length (Lμ), mean stream length (Lsm), bifurcation ratio (Rb), stream length ratio (RL), length of overland flow (Lg) (Table 1).

4.3 Stream Order (U)

Table 5: Order wise total stream length (Km)

Sub watershed identity codes	1	2	3	4	5	6	7	8	Total stream (Km)
SWD-1	1370.7	623.17	376.22	89.14	171.64	1.23	0	0	2632.1
SWD-2	828.18	407.49	145.34	113.15	69.75	89.12	31.65	0	1684.68
SWD-3	296.12	181.07	77.9	21.83	26.52	5.7	12.06	0	621.2
SWD-4	480.25	227.85	112.05	52.43	69.43	67.96	0	0	1009.97
SWD-5	396.54	221.4	124.42	20.34	10.98	34.37	14.08	0	822.13
SWD-6	344.51	172.44	105.14	48.08	32.7	0	0	0	702.87
SWD-7	512.65	296.76	166.66	55.78	17.4	11.2	49.35	0	1109.8
SWD-8	409.9	200.5	91.91	63.68	26.69	0	0	0	792.68
SWD-9	555.56	256.03	124.15	40.27	35.63	1.63	0	40.31	1053.58
SWD-10	1032.2	575.77	262.17	147.41	30.88	0	0	58.68	2107.11

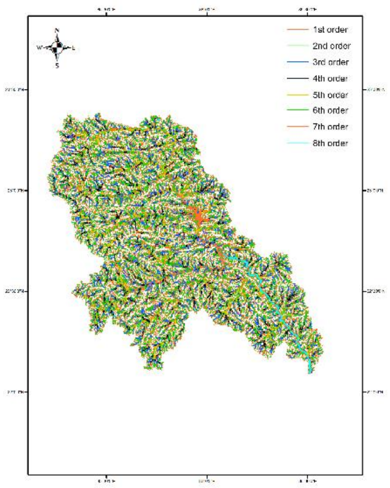

Figure 3: river network and stream order of upper watershed of River Subarnarekha

The Strahler's system (1952) of classification is a slight modification of Horton's system (1945) of classification. In this system of classification, the smallest, un-branched fingertip streams are designated as 1st order, the confluence of two 1st order streams give stream of 2nd order; two 2nd order streams join to form a stream of 3rd order and so on. This way all successive streams join and forms stream of next order. The trunk stream is the stream segment of the highest order. Stream of order 1 to 3 are termed as headwater streams and constitute waterways in the upper reaches of the catchment. Nearly 80 % of world's waterways are of order 1 to 3. The largest stream order known is 12, for example, river Amazon has stream order of 12 [26]. Similarly, streams 4 to 6 are medium-size stream. As per the Strahler's (1964) ordering scheme, the upper watershed of river in Jharkhand is eighth-order stream (figure 3). The previous morphometric study conducted on river Subarnarekha also reveals that this basin is of eighth order [27]. The numerous Ist order stream are said to be formed by the continuous erosion of the river banks [28]. The main river stream joined by the major tributaries from its both banks resulting in increase of stream order. The increase in stream order directly affects the size of the river basin. The selected study area catchment has a size of 12831.12 Km2. The area of the catchment represents the area of closed curve forming the horizontal projection of the catchment boundary. In this study, all sub-watersheds are subsequently subjected to hydrology tool of ARC GIS for extraction of detail stream network and other attributes (Table 5). The SWD-1 and SWD-4 is 6th order basins covering an area of 3347.18 Km2, 1114.64 Km2 respectively. Similarly, SWD-3, SWD-2, SWD-5, SWD-7 are 7th order basin having area 360.42 Km2, 1992.14 Km2, 560.36 Km2, 747.47 Km2 respectively. The 8th order basin is present in two subwatershed, i.e, SWD-9 ad SWD-10 which covers an area of 1376.06 Km2 and 1392.92 Km2 respectively.

4.4 Stream Length (Lu)

Table 6: Order wise total stream length (Km)

Sub watershed identity codes	1	2	3	4	5	6	7	8	Total stream (Km)
SWD-1	1370.7	623.17	376.22	89.14	171.64	1.23	0	0	2632.1
SWD-2	828.18	407.49	145.34	113.15	69.75	89.12	31.65	0	1684.68
SWD-3	296.12	181.07	77.9	21.83	26.52	5.7	12.06	0	621.2
SWD-4	480.25	227.85	112.05	52.43	69.43	67.96	0	0	1009.97
SWD-5	396.54	221.4	124.42	20.34	10.98	34.37	14.08	0	822.13
SWD-6	344.51	172.44	105.14	48.08	32.7	0	0	0	702.87
SWD-7	512.65	296.76	166.66	55.78	17.4	11.2	49.35	0	1109.8
SWD-8	409.9	200.5	91.91	63.68	26.69	0	0	0	792.68
SWD-9	555.56	256.03	124.15	40.27	35.63	1.63	0	40.31	1053.58
SWD-10	1032.2	575.77	262.17	147.41	30.88	0	0	58.68	2107.11

The attribute table of the vector layer of the study area as obtained is used to compute and calculate the stream length. Horton's second law suggests that the total length of stream segments is maximum in first-order streams and decreases with the increase in stream order. The stream of relatively smaller length is characteristics of areas with larger slopes and finer texture, whereas the streams which are relatively longer, indicate a flatter gradient. There is an inverse relationship between the number of streams with stream order. As the stream order increases, the SWD-1, SWD- 2, SWD- 4, SWD- 7 show the slight variation in stream order length (table 6). This variation is caused due to the different elevation pattern, undulating landform, and flatter gradient.

4.5 Stream Number (Nµ)

Table 7: Stream number in different order of upper watershed of river Subarnarekha

Sub watershed identity codes	1	2	3	4	5	6	7	8	Total stream
SWD-1	1012	464	192	83	19	1	0	0	1771
SWD-2	967	425	201	55	15	11	1	0	1675
SWD-3	206	86	49	11	1	1	2	0	356

SWD-4	478	206	81	32	5	2	0	0	804
SWD-5	396	167	51	14	2	1	1	0	632
SWD-6	461	216	93	31	10	0	0	0	811
SWD-7	141	49	12	2	1	2	2	0	209
SWD-8	512	275	105	26	7	0	0	0	925
SWD-9	712	375	121	37	0	1	0	1	1247
SWD-10	701	364	111	39	10	0	0	1	1226

The total number of stream segments in a particular order is known as stream number (Horton 1945) Stream number is directly proportional to the size of the total drainage basin area. The total count of the stream segment (Table 7) is found to decrease as the stream order increase in the basin. A higher stream number indicates a high rate of infiltration and less permeability to the soil. The 8th order stream is present in SWD-9 and SWD-10 only.

4.6 Stream length ratio (RL)

Table 8: Stream length ratio of upper watershed of river Subarnarekha

Sub watershed identity codes	2/1	3/2	4/3	5/4	6/5	7/6	8/7
SWD-1	0.45	0.60	0.24	1.93	0.01	0.00	0.00
SWD-2	0.49	0.36	0.78	0.62	1.28	0.36	0.00
SWD-3	0.61	0.43	0.28	1.21	0.21	2.12	0.00
SWD-4	0.47	0.49	0.47	1.32	0.98	0.00	0.00
SWD-5	0.56	0.56	0.16	0.54	3.13	0.41	0.00
SWD-6	0.50	0.61	0.46	0.68	0.00	0.00	0.00
SWD-7	0.58	0.56	0.33	0.31	0.64	4.41	0.00
SWD-8	0.49	0.46	0.69	0.42	0.00	0.00	0.00
SWD-9	0.46	0.48	0.32	0.88	0.05	0.00	0.00
SWD-10	0.56	0.46	0.56	0.21	0.00	0.00	0.00

Stream length ratio is calculated as the ratio of mean stream length of any given order (u) to the predecessor order of mean stream length (u-1). Stream length ratio signifies the relationship between the surface flow discharge and erosion stage of the basin. The erosion pattern over a long period of time also indicates the geomorphic development stages of the stream. The value obtained for different watershed shows a slight increase in stream length ratio from lower to higher stream order (Table 8). There is a slight variation for stream length ratio for SWD-5 and SWD-7. The variation of stream length ratio between successive stream orders is due to the differences in slope and topographic conditions. The overall values of stream length of subwatershed suggest the developed geomorphic stage of a stream.

4.7 Mean Bifurcation Ratio (Rb)

Table 9: Bifurcation ratio of upper watershed of river Subarnarekha

Sub watershed identity codes	1/2	2/3	3/4	4/5	5/6	6/7	7/8	total	Mean
SWD-1	2.18	2.42	2.31	4.37	19.00	0.00	0.00	30.28	4.33
SWD-2	2.28	2.11	3.65	3.67	1.36	11.00	0.00	24.07	3.44
SWD-3	2.40	1.76	4.45	11.00	1.00	0.50	0.00	21.10	3.01
SWD-4	2.32	2.54	2.53	6.40	2.50	0.00	0.00	16.29	2.33
SWD-5	2.37	3.27	3.64	7.00	2.00	1.00	0.00	19.29	2.76
SWD-6	2.13	2.32	3.00	3.10	0.00	0.00	0.00	10.56	1.51
SWD-7	2.88	4.08	6.00	2.00	0.50	1.00	0.00	16.46	2.35
SWD-8	1.86	2.62	4.04	3.71	0.00	0.00	0.00	12.23	1.75

SWD-9	1.90	3.10	3.27	0.00	0.00	0.00	0.00	8.27	1.18
SWD-10	1.93	3.28	2.85	3.90	0.00	0.00	0.00	11.95	1.71

The bifurcation ratio is calculated by dividing the number of streams in the lower order by the number of streams in the higher of the two orders. In this study, the mean bifurcation ratio lies in between 1.18-4.33 (Table 9). The SWD-9 has lowest bifurcation ratio where as SWD-1 has the highest bifurcation ratio of 4.33. The higher the bifurcation ratio is an indicator of structural disorientation. In general, the Rb values lies between 3 to 5 for which geological structures of the watersheds do not disturb the drainage pattern. So, as per the obtained result for the SWD-1, the value is within the range, which suggests there is no possible structural disorientation. The bifurcation ratio, having a value about 2 to 3 is of the flat region. Thus, considering the obtained value, SWD-4, SWD-5, SWD-7 have flatter gradient.

4.8 Relief aspects

Table 10: Relief aspect of upper watershed of river Subarnarekha

Sub watershed identity codes	Minimum relief (M)	Maximum relief (M)	Total Relief (M)	Ruggedness number	Relative relief	Dissection Index
SWD-1	209	1043	834	1.82	0.08	0.80
SWD-2	171	906	735	1.67	0.08	0.81
SWD-3	169	655	486	1.16	0.24	0.74
SWD-4	150	913	763	1.77	0.16	0.84
SWD-5	132	463	331	0.78	0.08	0.71
SWD-6	207	880	673	1.44	0.15	0.76
SWD-7	115	885	770	2.22	0.55	0.87
SWD-8	179	643	464	0.86	0.09	0.72
SWD-9	86	919	833	1.58	0.12	0.91
SWD-10	48	738	690	1.33	0.10	0.93

The relief aspects include total relief (H), relief ratio (Rh), relative relief and ruggedness number (Rn) (Table 10). Based on geophysical and topographic conditions of the terrain, relief aspects are used to evaluate the direction of stream flow and represent the denudation progression occurring within the catchment.

4.9 Basin relief (H)

Basin relief determines the geomorphic processes and landform characteristics. It is the elevation difference between the lowest and the highest point on the watershed. The lowest basin relief of 48 m is observed in the plains and highest of 1,043 m in the plateau region dominated by mountainous structures. The maximum basin relief is associated with SWD-1, whereas the lowest basin relief of 48 m is found in SWD-10. The maximum relief is a possible indication of available potential energy in the form of water channel moving down the slope, which can be harassed judicially for energy production.

4.10 Basin relief ratio (Rh)

Relief ratio (Rh) measures the overall steepness of a drainage basin and is an indicator of the intensity of the erosional process operating on the slope of the basin. There is a direct relationship between the relief and the gradient of the channel. High relief ratio of the basin is an indicator of the hilly region. The Rh depicts an inverse relationship with shape parameters and increases with decreasing drainage area and size of sub-watersheds of a given drainage basin. The overall steepness of the drainage basin can be ascertained using this parameter, which is useful as an indicator of the intensity of the erosion process in the watershed. A high value of relief ratio is the characteristics of the hilly region. The value of relief ratio of all subwatershed is between 8.65 to 23.14. The maximum value of relief ratio is obtained for the SWD-3 and minimum of for SWD-2. Since the obtained value is high, so, it can be inferred that the drainage basin has a steep slope. This may be the fact that region is predominantly dominated by a plateau with undulating landforms which make the surface steep.

4.11 Ruggedness number (Rn)

It is the product of maximum basin relief (H) and drainage density (D), where both parameters are in the same unit. Extreme values of ruggedness number occur when both variables are large, when a slope is not only steep but long, as well (Strahler, 1958). In the present study, the value of ruggedness number is 0.78 indicate a steep slope. The watershed areas having low relief, but high drainage density is rugged in comparison to the areas of higher relief having less dissection. In this study, the value of ruggedness number is found to be in the range of 0.78 to 2.22. (Table 10). The highest value of Rn is observed in SWD-7, where both total relief and drainage density values are high.

4.12 Areal aspect

Table 11: Areal aspects of upper watershed of river Subarnarekha

Sub watershed identity codes	Stream frequency	Drainage density	Drainage texture	Form factor	Elongation ratio	Circulatory ratio	Compactness constant	Constant of channel maintenance
SWD-1	0.53	0.79	5.43	0.42	0.73	0.40	5.00	1.27
SWD-2	0.84	0.85	3.87	0.28	0.59	0.13	2.68	1.18

SWD-3	0.99	1.72	3.53	0.82	1.01	0.45	1.50	0.58
SWD-4	0.70	0.88	4.81	0.75	0.97	0.51	1.39	1.13
SWD-5	1.13	1.47	4.91	0.41	0.72	0.42	1.53	0.68
SWD-6	0.90	0.78	4.47	0.47	0.77	0.35	1.70	1.29
SWD-7	0.28	1.48	0.82	0.65	0.9	0.14	2.65	0.67
SWD-8	0.92	0.79	3.32	0.63	0.89	0.16	2.48	1.27
SWD-9	0.91	0.77	3.53	0.60	0.87	0.14	2.69	1.31
SWD-10	0.88	1.51	3.75	0.46	0.76	0.16	2.47	0.66

The areal aspects (Table 11) determine various relationships between stream area, its length, basin shape, etc. It includes drainage density (Dd), drainage frequency (Fs), texture ratio (Rt), form factor (Rf), constant channel maintenance (Cm), circulatory ratio (Rc), compactness constant (Cc), Infiltration number (Ig), elongation ratio (Re).

4.13 Stream frequency

The number of stream segments per unit area is termed stream frequency (Fs). There is a direct relationship between surface runoff with stream frequency and drainage density. The stream frequency of all sub-watersheds is given in table 10. The value ranges from 0.28 to 1.13. It depends on the lithological characteristics of the basin and reflects the texture of the drainage network. The phenomenon that affects the variation of stream frequency is duration and type of precipitation. The precipitation in the form of thundershowers will immediately result in a large volume of surface runoff. This creates more surface drainages lines. The other parameters, which affect the stream frequency are vegetation cover, basin relief, subsurface material permeability. The stream frequency of all SWD shows that the basin has moderate vegetation, high infiltration capacity, forest cover, and barren land and later peak discharges owing to low surface runoff rate.

4.14 Stream density

The stream density determines the time travel by water. The measurement of Dd is a useful numerical measure of landscape dissection and runoff potential15. It reflects the land use and affects infiltration and the basin response time between precipitation and discharge. Drainage basin with high Dd indicates that a large proportion of the run-off activity due to precipitation. On the other hand, a low drainage density indicates the most rainfall infiltrates the soil surface and few streams are required to carry the run-off. Dd is the result of interacting factors controlling the surface runoff and in turn influences the output of water and sediment from the drainage basin. The Dd of the SWD-3, SWD-5, SWD-7, SWD-10 is high indicating low permeability of the subsurface material.

4.15 Stream texture

Horton (1945) defined the drainage texture as the total number of stream segments of all order in a basin per perimeter of the basin. Smith (1950) has classified drainage texture into five different textures, i.e., very coarse (<2), coarse (2 to 4), moderate (4 to 6), fine (6 to 8) and very fine (>8). Some natural factor like climate, type of vegetation cover and its density, rock surface, soil type, infiltration capacity, relief and stage of development influences drainage texture coarse drainage texture is a result of low drainage density while fine drainage texture gives high drainage density. More value of texture ratio more will be a dissection, contributing more soil erosion. According to Smith classification, SWD-7 is of very coarse stream texture, while SWD-2, SWD-3, SWD-8, SWD-9, SWD-10 are of coarse stream texture and SWD-4, SWD-5, SWD-6 are of moderate stream texture.

4.16 Form factor

The form factor is the numerical index commonly used to identify different basin shapes. It is the ratio of basin area (A) to the square of basin length (Lb). Smaller the value of form factor, more elongated will be the basin while the larger value is the representative of the circular basin. The form factor value of all sub watershed lies between 0.28 to 0.82, which is quite low, indicating an elongated shape basin.

4.17 Length of overland flow

It represents the total length of flow of water over the ground surface before it becomes concentrated in specific stream channels. The surface water moves over the land and leads to the stream tracing a particular stream channel whose characteristics depend on the steepness of the slope and land cover conditions. A scholar defined the length of overland flow as the length, projected to the horizontal, of non-channel flow from a point on the drainage divide to a point on the stream channel. The geo-hydrological development of the drainage basin is greatly affected by the length of overland flow. The length of overland flow value of sub-watershed ranges from 0.29 (SWD-3) to 0.64 (SWD-1, SWD-6). Shorter the length of overland flows quicker the surface run-off. The obtained value length of overland flow suggests that the SWD-3, SWD-5, SWD-7 have high surface runoff.

4.18 Constant channel maintenance

A scholar used the inverse of drainage density as a property termed as "constant of channel maintenance". Constant channel maintenance depends on the basin relative relief, lithology, climatic condition, etc. Higher values suggest more area is required to produce surface flow which implies that part of water may get lost by evaporation, percolation etc. lower value indicates fewer chances of percolation/infiltration and hence more surface runoff. The value of constant of channel maintenance for all the sub watershed of the study area lies within 0.58 to 1.27. The constant channel maintenance value of SWD-1, SWD-2, SWD-4, SWD-6, SWD-8, SWD-9 is high indicating that higher basin area is required for the maintenance of stream length of 1 km as compared to others.

4.19 Circulatory ratio

It is estimated as the ratio of the area of the basin (A) to the circular area (Ac) having a circumference equal to the perimeter of the river basin. When the value of circulatory ratio approaches unity, the basin shape tends to be circular. The value of the circulatory ratio of the study area lies within 0.13 to 0.51, which is less than unity. It signifies that the basin is elongated in shape. The various factors that predominantly affect the basin shape are relief and stream pattern that arises due to a continuous erosional activity of the land surface.

4.20 Compactness constant

It is the ratio between basin perimeters to the perimeter of a circle to the same area of the watershed. It derives the relationship between actual hydrologic basins to the exact circular basin having the same area as that of a hydrologic basin. The value of compactness constant is an indicator of erosion risk factors. Lower values signify less vulnerability while higher values indicate great vulnerability for erosion. It is one of the major aspects considered for evaluation and conservative measures to be implemented in a watershed for management and planning. The value of SWD-1 has the value of 5 indicating high erosion risk assessment factor. It reflects that this sub-watershed needs conservation measures as it is more vulnerable to erosion.

5. PRIORITIZATION OF SUB-WATERSHED

Table 12: Rank allocation to areal aspect of sub watershed of upper watershed of river Subarnarekha

Sub watershed identity codes	Stream frequency	Bifurcation ratio	Drainage density	Drainage texture	Form factor	Elongation ratio	Circulatory ratio	Compactness constant
SWD-1	9	1	2	2	2	3	8	9
SWD-2	7	2	5	5	7	10	6	10
SWD-3	2	3	1	1	9	7	1	2
SWD-4	8	5	10	10	8	5	5	5
SWD-5	1	4	6	6	10	4	4	4
SWD-6	5	9	9	9	6	2	9	7
SWD-7	10	6	8	8	1	8	3	8
SWD-8	3	7	7	7	5	1	7	1
SWD-9	4	10	4	4	3	6	10	6
SWD-10	6	8	3	3	4	9	2	3

The calculation of morphometric parameters helps in knowing various aspects of the geohydrological behavior of the upper watershed of river Subarnarekha. In the present study, the prioritization of watershed is done by considering the areal and linear aspects, whereas the role of relief aspects is not undertaken. There exists a correlation among various morphometric parameters, which is used for prioritization of subwatershed for management and planning. The earlier approaches of prioritization through the concept of only compound parameter ranking are not considered because this method gives equal importance to all morphometric parameters. In the case of risk evaluation and conservation practices, no input constraints can be treated equally because it gives rise to biases. Moreover, every sub-watershed has its own unique geo hydrological characters, which cannot be neglected in priority identification. Linear and areal parameters that are considered as erosion risk estimation factor are the length of overland flow, bifurcation ratio, drainage density, circularity ratio, compactness coefficient, drainage texture, stream frequency, form factor, and elongation ratio. The erosion factors are directly proportional to the linear aspect parameters. Thus, considering the relationship and to avoid the possibility of equal weightages assigning techniques, the methodology of WSA (Weightages Sum Analysis) is adopted. This method considers the statistical correlation techniques to decide which parameter should be considered for final analysis and subsequently for ranking purposes. The earlier studies related to the watershed prioritization reveals that the shape parameters show a negative correlation with surface runoff as well as soil erosion, whereas all the other linear parameters show a positive correlation with soil erosion17. So, considering, there is a direct relationship of land and water degradation factors with parameters, like, stream frequency, drainage density, drainage texture ratio and bifurcation ratio, the ranking is assigned to each of the values obtained from the morphometric calculation (Table 12). The assigning of highest priority, i.e., 1 for the SWD having the maximum calculated value of the parameter, and least priority ranking are given to the SWD having a minimum value. Remaining parameters (circulatory ratio, form factor, elongation ratio, compactness constant and basin shape) has an inverse relationship with the land and water degradation factors, so, rating is done by assigning highest priority, i.e., 1 for the SWD having minimum value of the parameter, and a similar procedure is followed until the last priority number is assigned. The ranks were assigned to all the parameters in consideration and a correlation matrix (Table 13) is developed. The analysis of the correlation matrix reveals that circulatory ratio shows a negative correlation with most of the morphometric parameters except stream frequency and compactness constant. Similarly, drainage density shows a positive correlation with all morphometric parameters except circulatory ratio. Consequently, weighted sum methodology is applied to calculate the sum of all correlation. The grand total obtained from the sum of all correlation variables is 11.030. Then, individual weightages are calculated for each parameter by dividing the sum of the correlation coefficient by grand total. Based on the individual parameter, a prioritization model with the following equation is formulated for actual and final ranking.

5.1 Prioritization model equation

= (0.151 * stream frequency) – (-0.045 * form factor) + (0.242 * drainage density) – (0.125 * circulatory ratio) + (0.242 * drainage texture) + (0.169 * compactness constant) – (0.018 * elongation ratio) + (0.099 * mean bifurcation ratio)

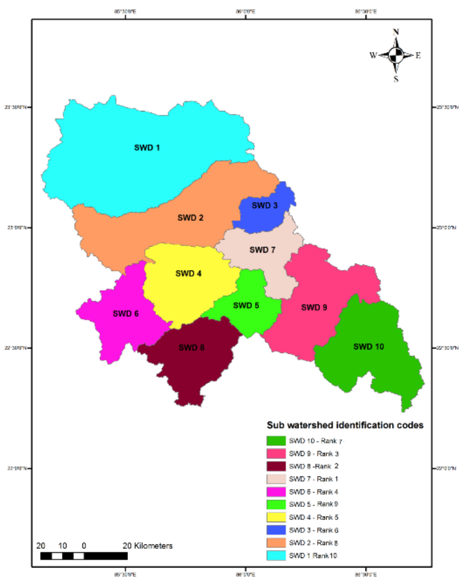

Figure 5: Subwatershed priority rank of upper watershed of River Subarnarekha

This prioritization model equation is applied to subwatershed and the value obtained is called as a compound parameter value, which is used for priority assessment (Table 14). Subwatershed having the lowest value is assigned the highest priority level. Similarly, the lowest priority is given to the subwatershed whose compound parameter value is highest. A Sub watershed priority rank of all individual sub-watersheds is represented in figure 4. In this study, the SWD-7 (1.275) receives the highest priority and is allotted rank 1 followed by SWD-8 (1.718). The least priority is given to SWD-1 having a compound parameter value of 2.815 and this subwatershed is allotted rank 10. Based on compound parameter value of all 10 subwatershed, three class of priority level (Table 15) is constructed i.e, low, medium and high. The priority level "high" is assigned to the values from 1.275-1.718. The subwatershed falling under this range is SWD-7, covering 5.8% only. Consequently, the subwatershed SWD-1, SWD-2, and SWD-5 are given lowest priority that covers 46 % of the total area.

Based on the defined level of priority of all 10 subwatershed, prioritization zonation map is prepared. (figure 5). The high value of priority signifies the extent of vulnerability of soil and water loss from the surface of a watershed. Based on the map, it can be ascertained that 5.8 % of the upper watershed of river Subarnarekha are in susceptible zone of risk. This area needs immediate attention from planners and policymakers for watershed planning and conservation.

Table 13: Correlation matrixes of morphometric parameters of upper watershed of river Subarnarekha

	Stream frequency	Bifurcation ratio	Drainage density	Drainage texture	Form factor	Elongation ratio	Circulatory ratio	Compactness constant
Stream frequency	1	-0.188	0.224	0.224	0.067	-0.636	0.285	0.685
Bifurcation ratio	-0.188	1.000	0.345	0.345	0.309	-0.273	-0.152	-0.297
Drainage density	0.224	0.345	1.000	1.000	0.224	0.079	-0.309	0.103
Drainage texture	0.224	0.345	1.000	1.000	0.224	0.079	-0.309	0.103
Form factor	0.067	0.309	0.224	0.224	1.000	-0.309	-0.527	0.394
Elongation ratio	-0.636	-0.273	0.079	0.079	-0.309	1.000	-0.055	-0.382
Circulatory ratio	0.285	-0.152	-0.309	-0.309	-0.527	-0.055	1.000	0.261
Compactness constant	0.685	-0.297	0.103	0.103	0.394	-0.382	0.261	1.000
Sum of correlation	1.661	1.091	2.667	2.667	1.382	-0.497	0.194	1.867
Grand total	11.030	11.030	11.030	11.030	11.030	11.030	11.030	11.030
Final weightages	0.151	0.099	0.242	0.242	0.125	-0.045	0.018	0.169

Table 14: Compound parameter constant and priority ranking of sub- watershed of upper watershed of river Subarnarekha

Sub watershed identity codes	Compound parameter constant	Priority ranking
SWD-1	2.815	tenth
SWD-2	2.048	eight
SWD-3	1.934	sixth
SWD-4	1.901	fifth
SWD-5	2.199	ninth
SWD-6	1.807	fourth
SWD-7	1.275	first
SWD-8	1.718	second
SWD-9	1.743	third
SWD-10	1.980	seventh

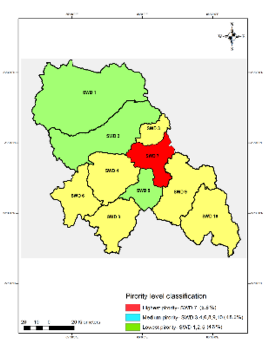

Figure 5: Zonation map of upper watershed of River Subarnarekha

Table 15: Priority level and type allocation of sub- watershed of upper watershed of river Subarnarekha

Priority type	Priority level	Sub watershed identity codes	Percentage of area (%)
High	1.718-1.275	7	5.8
Medium	1.980-1.718	3,4,6,9,8,10	48.2
Low	2.815-1.980	1,2,5	46

6.CONCLUSION

The advancement of GIS and remote sensing techniques has resulted in an efficient and effective study of geo-morphometric aspects of the drainage basins. GIS-based tools facilitate the analysis of various geomorphological parameters of the drainage basin like the lithology, surface run off potential, infiltration capacity, etc. The morphometric parameters like drainage density, frequency is very significant classification of the drainage basin that controls and determines the pattern of various geomorphological parameters like runoff pattern, sediment yield, etc. The Dd of the basin reveals that the nature of subsurface strata is more or less permeable mainly due to the rocky structure presents on the river bed and adjoining river banks. The basin as a whole has low texture ratio, which reveals the high infiltration capacity and low runoff rate. Various morphometric parameters reveal the elongated shape of the basin and a delay in surface runoff. Based on final weightages analysis of the Subarnarekha, it is found that SWD-9 covering an area of 747.47 km2 has received the highest priority. Accordingly, the priority classification map identifies the potential areas that should be considered for soil, water, and land conservation work. The division of priority into three different class help in preparation of susceptible zoning aspects. This zoning map is useful in classifying the area, which is under threat of high soil and water loss due to various hydro-geomorphologic conditions. The classification map reveals that the SWD-3, SWD-4, SWD-6 SWD-8, SWD-9, SWD-10 falls under the medium priority. These areas are quite satiable for implementation of conservation practices at this stage to avoid any anticipated land degradation phenomena. Thus, quantification and correlation among various individual morphometric parameters give a more logical approach to watershed prioritization.

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