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MORPHOMETRIC ANALYSIS ON PRECAMBRIAN ROCKS IN PART OF CAUVERY BASIN, CHAMARAJANAGAR DISTRICT, KARNATAKA, INDIA, USING GEOMATICS TECHNIQUE

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ABSTRACT

Morphometric analyses are the suitable tool for hydrological investigations in developing and management of land and surface water resources of a larger region. Survey of India (SoI) toposheet, Remote Sensing (RS) Satellite data, Geographic Information Systems (GIS) and Global Positioning System (GPS) are integrated in mapping of stream order, drainage, slope and other related features of a river basin. The present aim is an attempt to map the morphometric parameters and hydrologic behavior in Precambrian rocks of Dharwar Craton and Northern Granulite Terrains in South India. The drainage network is delivered on geo-coded FCC of IRS-1D, PAN+LISS-III satellite image and merged on SoI toposheets of 1:50,000 scale. The values of linear, aerial and relief variables are calculated and accounted by GIS analysis. The variation in stream length ratio changes due to change in slope, lithology, landforms and topography, while the variation in the values of bifurcation ratio describes the control of lithology/structure and morphology on the network development. These help to delineate the geometry of the basin, drainage network and texture. The final results highlight the applications of geomatics technique in mapping, management and development of surface water resources on hard rock terrain in Southern tip of Karnataka.

Keywords: Morphometry; Precambrian rocks; Upper part of Cauvery basin; Geomatics.

1. INTRODUCTION

Morphometry is the measurement and mathematical analysis of configuration of the earth's surface, shape, size, linear features, gradient of channel network with respect to slope and dimensions of its landforms [14]. Development of a drainage system and the flowing pattern of a river over space and time are influenced by several variables such as geology, geomorphology, structural components, soil, slope and vegetation of the area through which it flows [27]. It provides basin geometry, rock hardness, structural control, recent diatrophism, geological and geomorphic history. The study area lies entirely in the south western transitional zone of an extension of Deccan plateau towards southern tip of Karnataka state. The area reflects 8 watershed stream orders which are moderate to highly dissected and rugged. The total number of streams in the entire basin is 21,495, length is 14,448.5 Km and slope represents nearly level to gently sloping and very steep sloping areas. The entire drainage system belongs to Cauvery river tributaries like Suvarnavathi, Palar, Moyar, Dodda halla, Thatte halla, Gundal, Chikka hole and Uduthorai halla river system. The drainage patterns such as rectangular, trellis, dendritic, parallel, sub-parallel, radial patterns are noticed at hilly terrain, while anastomatic, dichotomic and deranged patterns at the lowland areas. Majority of the basins are characterized by very high drainage texture. Bifurcation ratio of streams suggests level of branching of a natural fluvial system. Morphology, lithology, structure of the basin and high precipitation over the area controls the initiation, development of the drainage network. Circularity ratio and elongation ratio values suggest that the study area has youthful watersheds. This study demonstrates the potentiality of geomatics technique in preparation of more consistent and accurate baseline information on water resources and management.

2. STUDY AREA

The study area is located in between 11^{0}30'45" to 12^{0}22'00" N latitude and 76^{0}30'45" to 77^{0}42'30" E longitude with total aerial extent of 5,685 Km^2 (Fig.1). It includes 4 taluks namely, Chamarajanagar, Gundlupet, Kollegal and Yalendur. Kollegal is the largest of all taluks with an area of 2785 Km^2 (49%), while Yelandur is the smallest with an area of about 256 Km^2 (4.66%). Biligiri-Rangan hill and Male Mahadeshwara hill are situated immediately south of the Cauvery river and south of Amphibolite-Granulite Transition Zone (AGTZ) [4,6,16,35,36]. The Male Mahadeshwara hill is defined by the NNE-SSW oriented Hogenakal and Mettur Fault Planes (MFP). The shear deformation slightly post-dated the regional diapiric event in the Craton [10,12,24,29]. The district is drained by Suvarnavathi and Chikkahole which are the tributaries of Cauvery River [13]. The existence of forests provides raw materials for industries like paper, rayon, saw mills, safety matches and sandalwood.

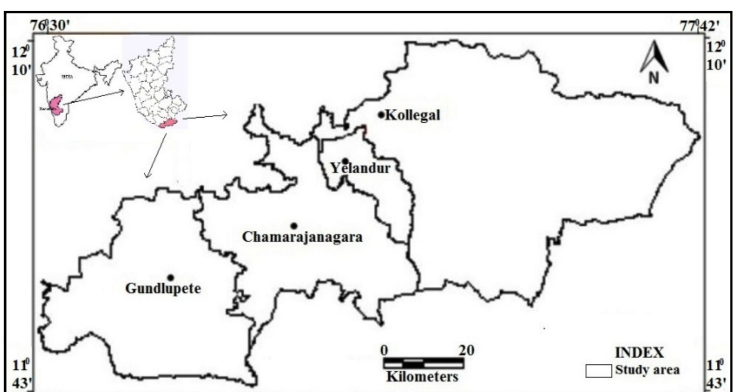


Fig.1. Location map of the study area

3. CLIMATE & RAINFALL

The climate is quite moderate throughout the year with fairly hot summer and cold winter [13,15]. The climate of the district is identified as essentially tropical monsoon type by the inter-play of two conflicting air masses of the southwest and northeast monsoons. The temperature ranges from

13.3^0 to 16.1^0C (Nov-Feb) and may rise upto 39°C (March-May). Throughout the year, the relative humidity is maximum in southwest monsoon season (80%) during morning time. The average annual rainfall is 704.5mm (2010) while the heaviest rainfall recorded in 24 hours at many stations in the district was 205.5mm on 17th October 1916. On an average the district receives rainfall in 45 rainy days, in a year with a rainfall of 2.5mm or more in a day [7,9,10,15,26].

4. GEOMATICS

Satellite Remote Sensing (RS) image is a powerful tool and provides synoptic view of a larger area at once. It reveals accurate information using spectral, temporal and spatial resolution. It also provide clues in the distribution of paleo-channels, lineaments, water bearing zones, old river course, fractures and valley fills with limited Ground Truth Check (GTC). Enhancement of linear features is carried out using Image processing techniques. Area and Perimeter are measured in CAD Overlay-2000, lineament extraction are done by Erdas Imagine v8.5 and the values of linear, aerial and relief variables are done using ArcView v3.2 [8].

5. METHODS & MATERIALS

5.1 Methods: Visual Image Interpretation Techniques (VIIT) of IRS-1D PAN+LISS-III merged satellite data on 1:50,000 scale has been carried based on various image and terrain elements. Rocks are the assemblages of minerals having spectral signatures of their constituent minerals, in turn are comprised of various elements in different proportions held together by different bands [2, 4, 28].

5.2 Materials used

i. Topomap: 57H/3, 57H/4, 57H/7, 57H/8, 57H/12, 57H/16, 57D/12, 57D/16, 57A/5, 57A/6, 57A/9, 57A/10, 57A/13, 57A/14, 57E/1, 57E/2, 57E/5, 57E/9 are considered as base maps.
Source: Survey of India (SoI) of 1:50,000 scale, GSI, Bangalore.
ii. Thematic maps: Drainage, Stream Order and Slope maps.
iii. Satellite RS data: Indian Remote Sensing (IRS) 1D LISS-III (year: 2010-11, Resolution: 23.5m), PAN+LISS III (year: 2005-06, Resolution: 5.8m) (Fig.2).
iv. Software analysis: Arc view v3.2, Cad Overlay v2000, ArcGIS v9.2 and Erdas Imagine v8.5.
v. GPS: Garmin 12 is used for limited Ground Truth Check (GTC).

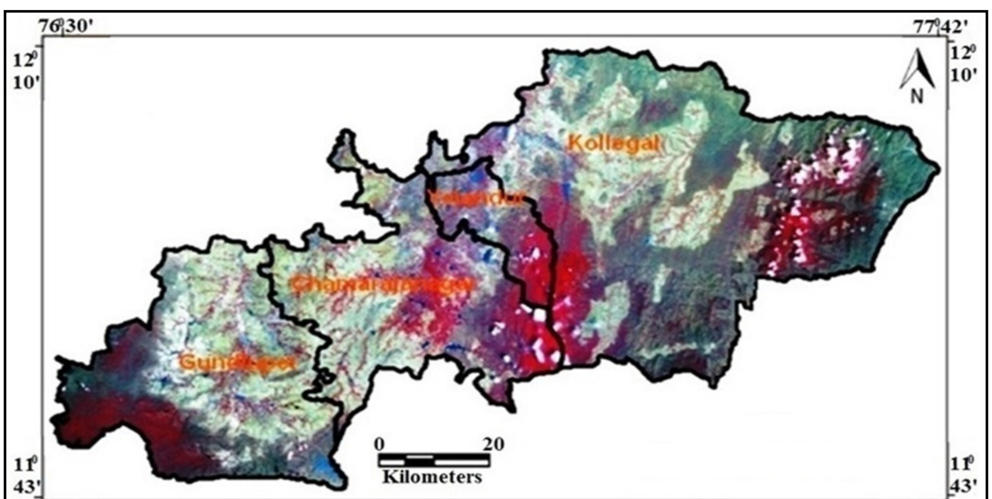


Fig.2. IRS-1D, PAN+LISS-III satellite image of the study area

Results and Discussions

Morphometric analysis: The designation of stream order is the first step in morphometric analysis of a drainage network, based on the hierarchic making of streams proposed by [37]. The drainage network is divided into 8 watershed stream orders with codes N1, N2, N3, N4, N5, N6, N7 and N8, are assigned in CAD-overlay v2000 and length of the stream order is measured in Arc view v3.2 [21,25]. The linear aspects, aerial aspects and relief aspects are calculated using Arc Info v9.2 and Arc view v3.2.

6. LINEAR ASPECTS

The linear aspects of morphometric analysis of drainage network include stream length, stream number, stream order, stream length ratio, stream frequency and bifurcation ratio [25].

6.1 Stream length (Lu): The overall length of the stream is 14,448.53 Km. The total flow lengths of streams are 8644.26, 2778.15, 1555.76, 768.69, 405.90, 209.09, 73.15 and 13.53 for first (N1), second (N2), third (N3), fourth (N4), fifth (N5), sixth (N6), seventh (N7) and eighth (N8) order respectively. The stream length decreases with higher order of streams (Fig.5b). The mean stream length of a channel is a dimensional property and reveals the characteristic size of drainage network components and its contributing stream length surfaces [37].

6.2 Stream number (Nu): The total number of streams in the entire drainage network is 21,495. The variation in the total number and total length of the stream in drainage is mainly due to precipitation, morphology and lithology of the terrain (Fig.5a).

6.3 Stream order (U): The study area represents 8th orders of watersheds. The total order of streams such as 16186, 4028, 1032, 184, 45, 14, 4 and 2 of first, second, third, fourth, fifth, sixth, seventh and eighth order segments respectively (Fig.3). The terrain characterized by flat land, steep slope and hilly area, with medium precipitation [8, 9, 25].

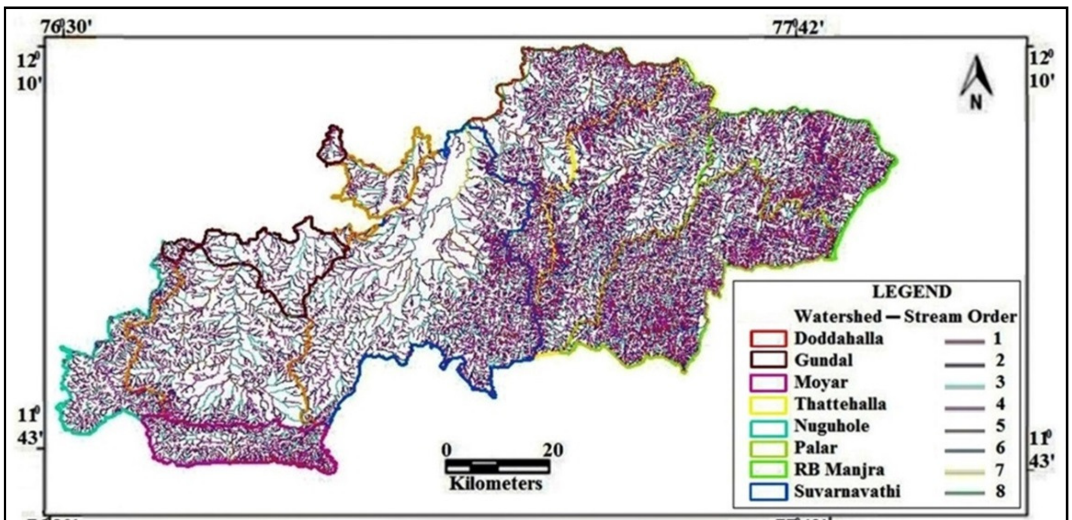


Fig.3. Watershed Stream Orders of the study area

6.4 Stream length ratio (RL): The stream length ratio increases exponentially with increasing order [18]. The variation in the stream length ratio (N1-N) in the drainage networks are due to change in slope and topography.

RL = Lu/Lu-1

where: RL = Stream length ratio

Lu = Mean stream length

Lu-1 = Mean Stream length of segment of the next lower order.

The mean variation length ratio of the study area is 7.27 (Fig.5c). The first and second order exhibits parallel drainage channels tectonically controlled by joints and fractures. The catchment area of the watershed almost lies in the hilly region, characterized by high precipitation during monsoon and steep scarp [5,15,29,40]. The development of fifth, sixth, seventh and eighth order channels is confined to the terrain characterized by low relief on the slope. The stream length ratio between the pair L6/L5 is significantly high (22.59). The pairs L8/L7 (0.68) show abnormal decrease in length ratio (Fig.5f).

6.5 Stream frequency (Fs): Stream frequency is the total number of stream segments of all orders per unit area [17].

Fs = N/A

where: N=Total number of streams

A=Area of watershed

The steam frequency of the watershed varies from 1.45 to 6.85, while the average stream frequency is 3.58. Among 8 watersheds, 6 show very high frequency (>2), while 2 shows high frequency (1-2) (Fig.4).

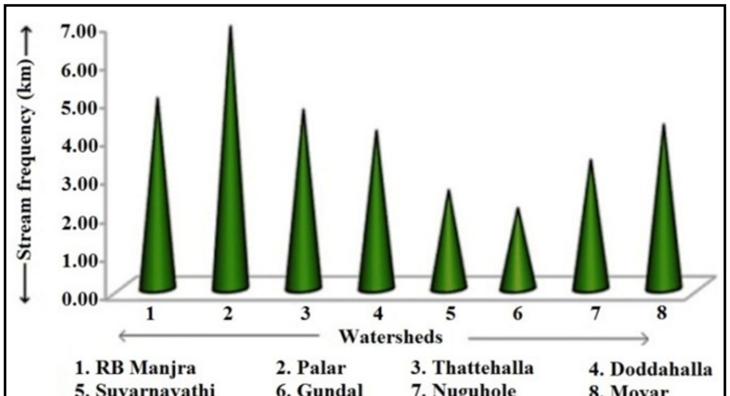


Fig.4. Stream Frequency of Watershed in the study area

6.6 Bifurcation ratio (Rb): The bifurcation ratio of streams implies the level of branching of a fluvial system and provides important genetic segments. Rb as an index of reliefs and degree of dissections in an individual drainage network [18]. Lower Rb values are the characteristics of structurally less disturbed drainage network without any distortion in drainage pattern [22].

Rb = Nu/ Nu+1

where, Nu=Total number of stream segment

Nu+1=Number of segment of next higher order

The bifurcation ratio varies from 0.18 to 5.67 and average bifurcation ratio of the entire basin is 2.99 (Fig.5e). In general, the value within the ranges of 3-5 is an accepted value for natural fluvial system [21].

Table.1: Salient Morphometric attributes in the study area

i. Number of stream segments per order

N1	N2	N3	N4	N5	N6	N7	N8	Σ N
16186	4028	1032	184	45	14	4	2	21495.00

ii. Length of stream segments per order (km)

L1	L2	L3	L4	L5	L6	L7	L8	Σ L
8644.26	2778.15	1555.76	768.69	405.90	209.09	73.15	13.53	14448.53

iii. Mean stream length (km)

L1/N1	L2/N2	L3/N3	L4/N4	L5/N5	L6/N6	L7/N7	L8/N8
0.534058	0.68971	1.507518	4.177649	9.02	14.93532	18.28715	6.765028

iv. Cumulative mean stream length (km)

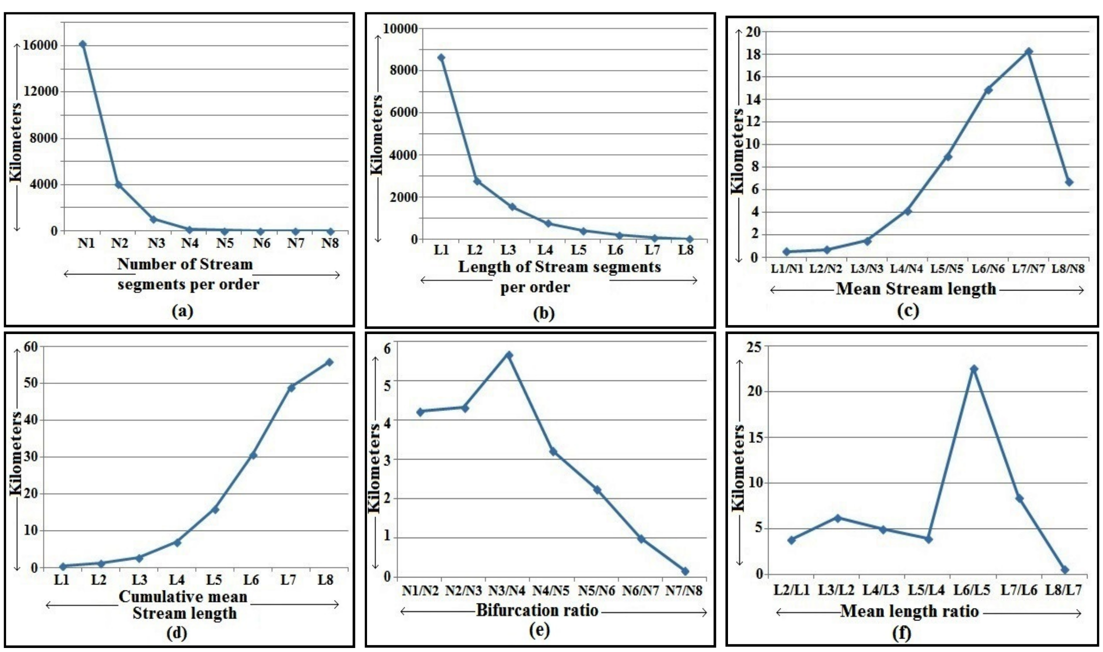
L1	L2	L3	L4	L5	L6	L7	L8
0.534058	1.223768	2.731286	6.908935	15.92894	30.86426	49.15141	55.91643

v. Bifurcation ratio

N1/N2	N2/N3	N3/N4	N4/N5	N5/N6	N6/N7	N7/N8	RB
4.23	4.34	5.67	3.23	2.26	1.00	0.18	2.99

vi. Length ratio and mean length ratio (RI)

L2/L1	L3/L2	L4/L3	L5/L4	L6/L5	L7/L6	L8/L7	RI
3.86	6.25	5.06	3.98	22.59	8.46	0.68	7.27



a - Number of Stream Segments per order (km) **b –** Length of Stream Segments per order (km)
c – Mean Stream length (km) **d –** Cumulative Main Stream length (km)
e – Bifurcation ratio **f –** Length ratio & Mean length ratio

Fig.5. (a - f) Morphometric attributes of drainage network in the study area

7. ARIAL ASPECTS

The aerial aspects include different parameters like area (Au), perimeters (P), Drainage, Drainage density (Du), Drainage texture (Rf), Elongation ratio (Re), Circularity ratio (Rc), Form factor (Rf), Drainage intensity (Di) and Length of over land flow (Lg). These geometrical properties of the basin are dependent on factors like lithology, structures, relief etc.

7.1 Area (Au) and Perimeter (P): The area and perimeters of the watershed have been measured using ArcGIS v9.2 by performing clean and build option i.e., closed polygon, and the values are expressed in Km^2. Area and perimeter are depending on the number of segments, length of the segments and attitude. If the parameter is high, then the values of area are also high. The perimeter of the watersheds varies from 95.61 to 231.9 Km. Low perimeter is noticed in the gneissic and few parts at charnockite terrain is almost flat to undulating topography, while high perimeter are in the hilly terrain of charnockites.

7.2 Drainage: The drainage system belongs to the Cauvery river basin with its tributaries like Suvarnavathi and Chikkahole. Suvarnavathi rises near Gajjalahalli southeastern part of Chamarajanagar, [23] and flows in the depression along the centre of Chamarajanagar taluk with a N-S disposition in a northerly direction through Chamarajanagar and Yelandur taluks and joining the river Cauvery at Ramapura in Kollegal taluk. Chikkahole is the tributary of Suvarnavathi rises at Hasanurghat range to the South of Chamarajanagar, flows in northerly direction (Fig.6). Drainage pattern are the disposition and preferred occurrence of streams on the surface of land. A drainage pattern can be defined as the design formed by the aggregate of drainage ways in an area regardless of whether they are occupied by permanent streams [19]. Initial slope, lithology and meteorological parameters (precipitation in the form of rainfall) is distinctly assertive in the generation of a drainage pattern. The study area has varied drainage patterns viz., dendritic, parallel, sub-parallel, rectangle, trellis, radial, deranged, anastomatic and dicomatic types (Fig.7).

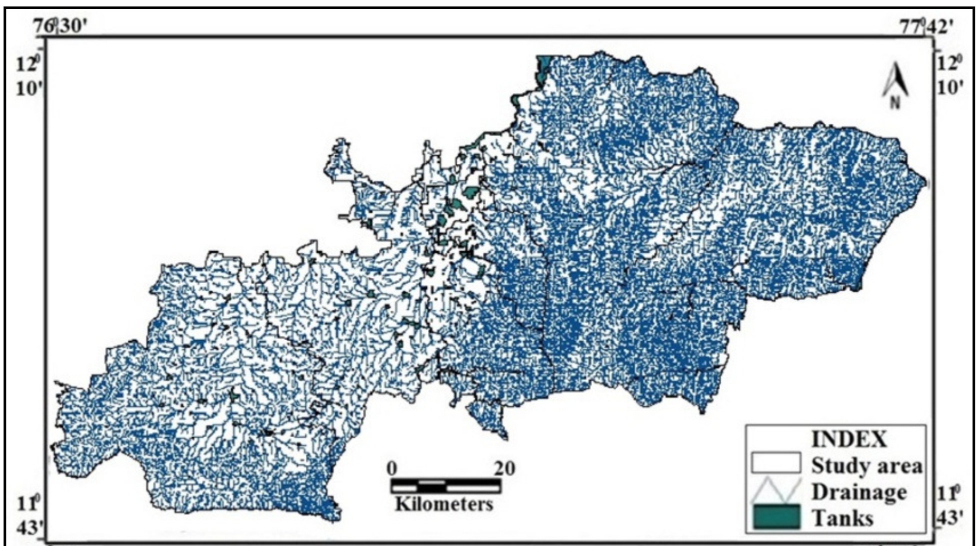


Fig.6. Drainage and tanks of the study area

7.3 Drainage density (Dd): The drainage density is the length of streams per unit area ($Du = Lu * Au$) as defined by [18]. The drainage density indicates the closeness of spacing of channels [17]. The drainage density varies from 1.49-3.85 (Fig.8). Low drainage density generally results in the area of highly resistant or permeable sub-soil material, dense vegetation and low relief. High drainage density is the result of week or impermeable sub-surface material, sparse vegetation and mountainous relief [22,34]. It is observed that 2 watersheds shows (Suvarnavathi and Gundal) low density, 3 watersheds (Doddahall, Nuguhole, Moyar) shows high drainage density and 3 watersheds (RB Manjra, palar, Thattehalla) show very high density.

The frequency and density are high due to precipitation and high slope of the scarp, slope initiated streams are numerous and surface runoff exceeds infiltration. All these factors favor the initiation of streams and accounts for high drainage frequency and density. Presence of varying thickness of soil cover, inhibit the initiation and development of drainage network implies low to moderate drainage frequency and density [8,9,21].

7.4 Drainage texture (Rt): It is the total number of stream segments of all orders per perimeter of the area [18].

Rt = Dd x Fs

where: Rt = Drainage texture

Dd = Drainage density

Fs = Stream frequency

Smith (1950) classified drainage density into five classes' i.e.

(i) Very coarse (<2)
(ii) Coarse (2-4)
(iii) Moderate (4-6)
(iv) Fine (6-8)
(v) Very fine (>8)

Low density represents course drainage texture; while high drainage density represents fine drainage texture [10].

Table.2: Drainage density and Texture

Sl No	Texture	Density in km/km^2	Drainage networks
1.	Very coarse	<1.24	0
2.	Coarse	>1.24 & <2.49	4
3.	Moderate	>2.49 & <3.73	5
4.	Fine	>3.73 & <4.93	1
5.	Very fine	>4.93	0

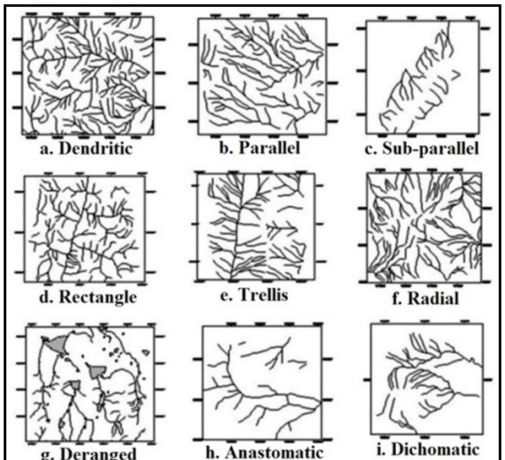


Fig.7. Drainage patterns of the study area

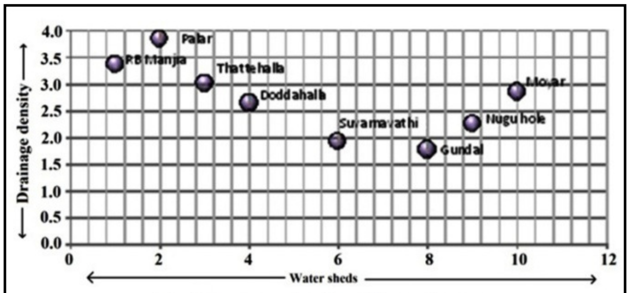


Fig.8. Drainage density of the study area

7.5 Elongation ratio (R): A circular type of drainage is efficient in run-off discharge than elongated network [32]. The elongation ratio is an indicative of shape of the river network and expressed by the following formula,

Re = 2A/L

where, Re = Elongation Ratio
2 = Constant
A = Area of the drainage network
L = Maximum in the length ratio

The value of elongation ratio generally varies from 0.6 to 1.0 over a wide variety of the climatic and geomorphologic type (Fig.9). Values closed to 1.0 are typical of region of over low relief, whereas values in the range of 0.6 to 0.8 are generally associated with high relief and steep slopes [38]. These values can be grouped into four categories namely,

(i) Circular (>0.9)
(ii) Oval (0.8 -0.9)
(iii) Less elongated (0.7-0.8)
(vi) Elongated (<0.7)

Elongation ratio varies from 0.46 to 1.19. The average elongation ratio is 0.69. Out of 8 watersheds, Gundal shows circular, whereas R.B. Manjra, Palar, and Suvarnavathi shows less elongated, while remaining 4 shows elongated. A circular drainage system is more efficient in the (Thattehalla, Doddahalla, Suvarnavathi, Nuguhole, Moyar) discharge of run-off than elongated drainage system [32].

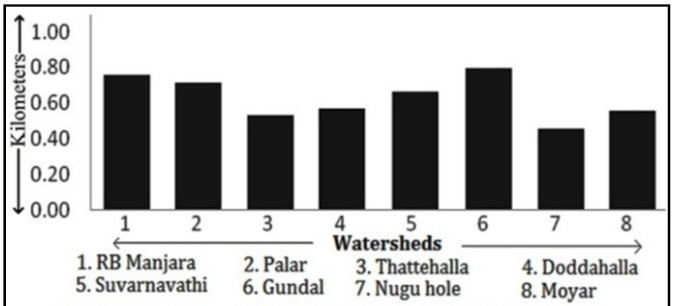


Fig.9. Elongation ratio of watersheds in the study area

7.6 Circularity ratio (Rc): The ratio of the circle having the same circumference as the perimeter of the circulatory ratio [20]. It is also influenced by the length and frequency of stream, geological structures, land use/cover, climate, relief and slope of the drainage network and is expressed as:

$$Rc = 4\pi A/P^2$$

where, Rc = Drainage circulatory

A= Area of the drainage network

P=Perimeter of the drainage network

The circularity ratio ranges from 0.15 to 0.59. The Gundal watershed has value of Rc >0.5. It indicates moderate to high relief and the drainage system are structurally controlled [7].

7.7 Form factor (Rf): It is defined as the ratio of drainage network area to square of the drainage length [17] and expressed as:

$$Ff = A/Lp^2$$

where: Ff = Form factor

A = Area of the drainage network

Lp^2 = Square of drainage network length

The Rf values vary from 0.16 to 0.57. The value of form factor would always be less than 0.7854 (for a perfectly circular drainage network) (Fig.10). Smaller the value of form factor, more elongated will be the drainage network.

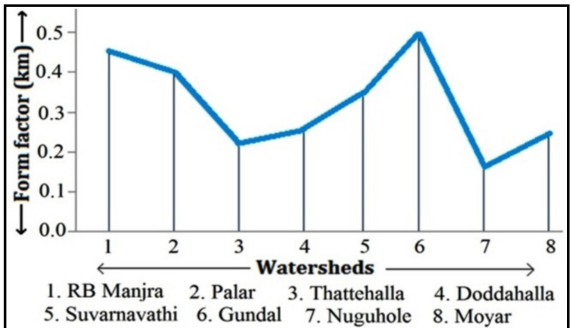


Fig.10. Form factor of watersheds in the study area

7.8 Length of overland flow (Lg): The length of flow of water over the ground before it becomes concentrated in definite stream channels [18]. The length of over land flow values of the study area shows variation from 0.13 to 0.68. It is approximately equal to half of reciprocal of drainage density (Fig.11). Overland flows are sustained by a relatively thin layer of surface detention. It disappears quickly often within few minutes through absorption of infiltration by soil at the end of the rainfall. The values of Lg are higher for Gundal and Suvarnavathi watersheds, indicates low relief; whereas the value of Lg are low for RB Manjra, Palar, Thattehalla, Doddahalla, Nuguhole, and Moyar watersheds indicates high relief.

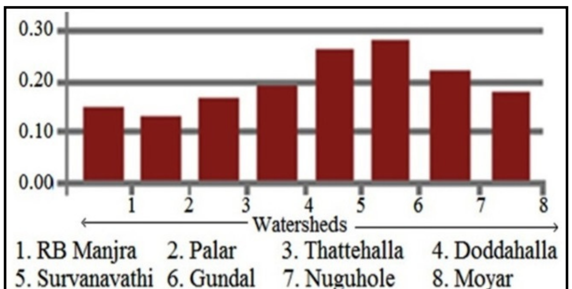


Fig.11. Length of Overland flow of watersheds in the study area

8. RELIEF ASPECTS

Relative relief, Relief ratio and Ruggedness number are the relief properties.

8.1 Relative relief (Rhp): The elevation difference between the highest and lowest point on the watershed is known as relative relief.

$$Rhp = H \times (100)/P$$

where, H = Maximum drainage relief
P = Perimeter of the drainage (Km)

The relative relief Suvarnavathi and Gundal shows moderate relative relief (100-300m) and other watersheds show high relative relief (>300m).

8.2 Relief ratio (Rh): Schumn (1956) defined relief ratio as the ratio of maximum relief to horizontal distance along the longest dimension of the drainage network parallel to principal drainage line.

$$Rh = H/Lb$$

where: Rh = Relief ratio
H = Total relief (Relative relief of drainage network in kilometers)
Lb = Length of the drainage network

Relief ratio varies from 7.12 to 37.86. Among 8 watersheds, Gundal basin shows low relief ratio (0-10), Suvarnavathi, Nuguhole watersheds show moderate relief (10-20), RB Manjra, Palar, Thattehalla, Doddahalla and Moyar watersheds show high relief ratio (20-50). Low relief basins are noticed in resistant basement rocks like gneisses and high relief basin in charnockites rocks having high degree of slope [10,15,29].

8.3 Ruggedness number (HD): The ruggedness number (dimensionless) is a product of drainage density and relative relief per km and expressed as:

$$Rn = Bh \times Dd$$

where, Bh = Relief of the drainage network
Dd = Drainage density

The ruggedness number ranges from 0.36 to 4.53. Among 8 watersheds, Suvarnavathi drainage network shows low (0-0.50) Gundal drainage network show high ruggedness number.

9. SLOPE ANALYSIS

Slope is the loss or gain in altitude per unit horizontal distance in a direction. It may be dependent on lithology, climate, meteorological parameter, runoff, vegetation, geological structure and the process of denudation that can estimate run-off and erosion. The maximum development of slopes is found in the hilly terrains. Several methods have been suggested to calculate the slope value [33, 39, 41]. Slope map of an area provides information regarding the distribution of various slope classes and helps in understanding the runoff characteristics of a watershed [3] (Fig.12). It is helpful in prioritizing areas for developmental measures and identification of suitable areas for agriculture [31].

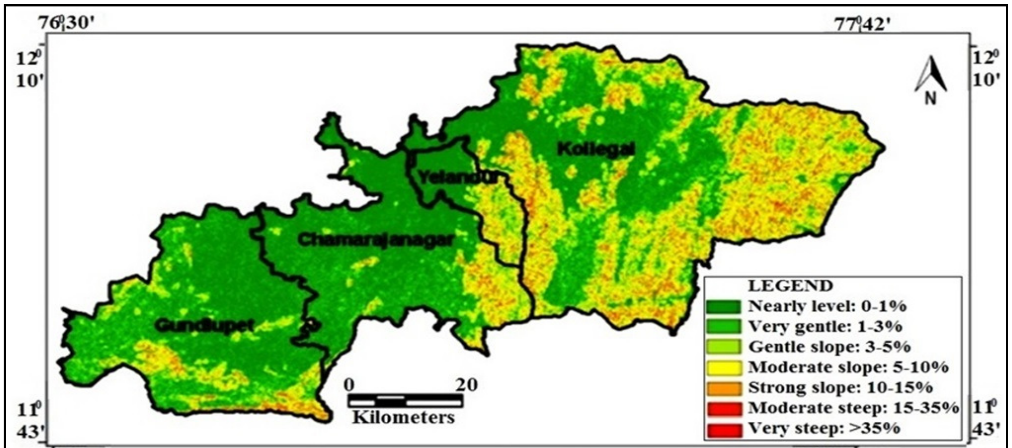


Fig.12 Slope map of the study area

9.1 ***Slope aspects:*** Slope map is prepared by SoI topographical map on 1:50,000 scale and SRTM (Shuttle Radar Topography Mission) data of 90m contour intervals by adopting template method [1] and digitized using ArcGIS v9.2 and Cad Overlay v2000. The catchment characteristics (run-off and erosion) of an area are determined by the slope. Steeper the slope, higher is the run-off & erosion and lesser run-off towards gentle slope [15]. Major part of the study area is dominated by nearly level slope (41.91%) varying from 0^0 to 1^0 in the central, northern, southern and north-western part of the low-lying area of gneissic terrain. The second most significant slope category is very gently slope (22.61%) varying from 1^0 to 3^0 covering central, northern, western and patches of eastern part of gneissic terrain and amphibolite rocks terrain [8,9,15,29]. The nearly level slope and very gentle slope region provides scope for infiltration of rainfall. The third slope category is gently sloping (8.09%) varies 3^0 to 5^0 occupying southwest, northwest, north east and southern parts. The pockets of varying slope within the low lying gneissic terrain is represented by residual hills, ridges, mounds, spurs and peaks fall under this category. Moderate sloping, strongly sloping, moderately steep to steep sloping contribute as 9.14%, 5.16% and 2.49% respectively and it varies from 5^0 to 35^0 concentrated towards southeast, northeast, southwest parts [5,29]. Another most significant slope category is the very steep slope (10.59%) varying >35^0 contributing towards southeast, southwest, and northeast part of hard metamorphic rock in charnockite terrain. These are hilly terrain having geomorphic features of escarpment, parallel ridges, valleys, cliff are initiated in the slope. A stupendous rise in elevation is seen within a short distance that contribute to the rapid increase in slope as indicated by the closely spaced contour lines in the area, is dominated by charnockite terrain [4,6].

Table.3: Slope categories in the study area

Sl No	Slope Category	Slope percentage	Lower & upper limit contour spacing (cm)	Area (Km^2)	Percentage (%)
1.	Nearly level	0-1	>4	2383.13	41.91
2.	Very gently sloping	1-3	1.33-4	1285.79	22.61
3.	Gently sloping	3-5	0.80 - 1.33	459.83	8.09
4.	Moderately sloping	5-10	0.40-0.80	519.59	9.14
5.	Strongly sloping	10-15	0.26-0.40	293.58	5.16
6.	Moderately steep to steep sloping	15-35	0.10-0.26	141.72	2.49
7.	Very steep sloping	>35	0.11 and above	602.27	10.59

Table.4: Basin parameters of the study area

Sl.No	Basin Parameter	Values
1	Maximum length of the Watershed	61.4
2	Perimeter of the watershed(km)	231.9
3	Cumulative stream length(km)	14448.53
4	Cumulative stream segment	21495
5	Bifurcation ratio (Mean)	2.99
6	Length ratio (Mean)	7.27
7	Stream frequency (Mean)	3.58
8	Drainage density (Mean)	2.62
9	Form factor(Mean)	0.36
10	Circularity ratio(Mean)	0.32
11	Elongation ratio(Mean)	0.70

9. CONCLUSIONS

Geologically, charnockites and peninsular migmatitic gneisses forms the drainage basin in the study area. The terrains are geomorphologically characterized by youthful rugged high hills and structurally controlled mountain ranges with steep slopes, scarp faces, narrow gorges and long parallel ridges. These hill slopes are having steep valleys and triangular facets. Pediplains are recorded near the river courses; stream courses are structurally controlled and join the main streams approximately at right angles. The stream courses are narrow and controlled by lineaments. However, the topography changes with bedrock lithology in peninsular gneiss. The first and second order exhibits parallel drainage channels tectonically controlled by joints and fractures. Circularity ratio and elongation ratio values suggest that the study area has youthful drainage networks. The drainage networks are moderate to highly dissected and highly rugged. Majority of the drainage networks are characterized by high drainage texture indicating the rocks are undergone highly shearing and metamorphic deformational effect. Presence of varying thickness of soil cover, inhibit the initiation and development of drainage net, implies the low to moderate drainage frequency and density. Slope is nearly level to gently sloping and very steep sloping areas. The drainage system of the study area belongs to tributaries of Cauvery river viz., Suvarnavathi, Palar, Moyar, Doddahalla, Thatte halla, Gundal, Chikka hole and Uduthorai halla river system. The drainage patters are rectangular, trellis, dendritic, parallel, sub parallel, radial patterns that demarcates at hills, mountainous areas while anastomatic, dichotomic and deranged patterns are noticed at the lowland areas. The drainage density is low, medium and high; course to moderate drainage texture are identified. Morphology, lithology, structure of the area and high precipitation over the area controls the initiation and development of drainage network. The variation in the bifurcation ratio, stream length ratio and length of overland flow suggest morphologic, lithologic, structural control and high precipitation over the development of drainage network. The length of overland flow is lower, indicating the semi arid region. Thorough scientific estimation & development of groundwater in hard rock terrain is very much necessary for future sustainability. Geomatics application are the advent high-tech tool on account of reliability in cost effectiveness and time being method proving more accurate baseline information in delineation of stream order and its analysis. Mapping of various thematic maps such as watershed stream order, drainage and slope categories are prepared from geomatics tools along with limited field survey data.

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