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Delineation and Characterization of Geomorphological Features Studies of Muguru Addahalla Watershed, Mysore and Chamarajanagar Taluks of Southern Part of Karnataka, India

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Abstract In the present study an attempt has been made to delineate and characterize the different geomorphic units of Muguru Addahalla watershed located in the southern part of Karnataka State, India. The drainage network and topographic elevation contours have been delineated using toposheets. The geological units have been overlaid on the Indian Remote Sensing (IRS)-1D LISS-111 satellite imagery. The study area is basically a drainage-controlled region wherein the fluvio-geomorphological processes dominate on the surface. Based on the interpretation of satellite data, the hydrogeomorphic units like linear ridges, shallow moderate and deeply buried slopes, shallow valley fills and deep valley fills have been demarcated. These zones have been generated as vector layers using GIS and the geological and geomorphological maps of the study area have been compared. This integrated approach demonstrated that the IRS data used in conjunction with geology, drainage and topographic parameters helped in the evaluation of different geomorphological units and their characteristics. These features were also verified based on the field observations. The geomorphological units can be utilized for the management of natural resources.
Keywords *Fluvio-Morphology; GIS, Drainage; Contour Geomorphological Units; Natural Units*

1. Introduction

Geomorphology deals with the study of the landforms. A systematic study of landforms can reveal the signatures of the past and ongoing geological processes. The geomorphic features of a region have a great bearing on the water resources of that region. Certain geological agents like rivers, glaciers, winds, etc relentlessly operate on the earth's crust to bring about the changes of degradation and aggradation. These features are important from the point of understanding the surface and subsurface water movements. Landforms like plateaus, residual hills, pediments, pediplain, piedmont zones, valleys and other landscape features are suitable for the occurrence of the water resources of any basin or region. Similarly, rainfall pattern is yet another influencing factor in the landform evolution. Rainfall pattern will also be playing a key role in terrain development and for water storage and replenishment. Analysis of rainfall pattern is vital for predicting droughts, cycles of surplus rainfall and runoff pattern, which are ultimately necessary for a comprehensive planning of water resources in a watershed. This study aims to evaluate all these aspects on an integrated approach.

2. Study Area

The Muguru Addahalla watershed spreads in two districts viz. Chamarajanagar and Mysore in southern part of Karnataka (Figure 1). The spatial extent of the study area is 248.827 sq km. The area is covered in Survey of India toposheet numbers 57d/16, 58A/13 and 57H/4. It is bound by north Latitude of 11˚ 58' 20.78'' N to 12˚ 12'33.67" N and East longitude of 76˚ 52' 50.34" E to 76˚ 59' 25.68" E. The topomap of the area is shown in (Figure 2). The area is well connected with all-weather roads (Figure 1 and 2). Physiographically, Muguru Addahalla watershed forms the 'Southern Maidan' region of Karnataka. It is bound by the Doddasampige Reserve Forest area in the east and Suttur village in the west. The River Cauvery drains in the North and city Chamarajanagar is located at the south. The Muguru Addahalla stream originates at Ummathur Gudda ("Gudda" means mound, in the regional language) in the south and it joins the Cauvery River near the village Ayyanurhundi. The maximum elevation of the area is 900 m (MSL) at Ummathuru Gudda and minimum is 540m (above Mean Sea Level) seen at Muguru Addahalla, where it joins the Cauvery River. The rest of the area constitutes very gently dipping plains, dissected by shallow rivulets. Much of the area is under cultivation.

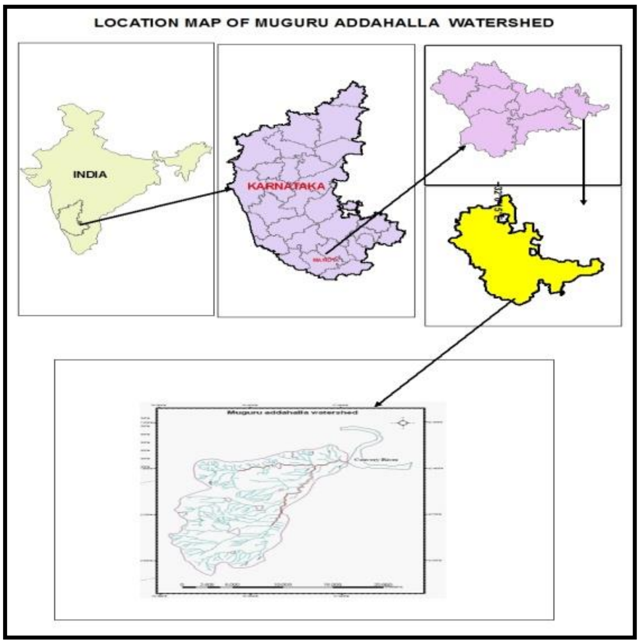

Figure 1: *Location map of the Muguru Addahalla watershed*

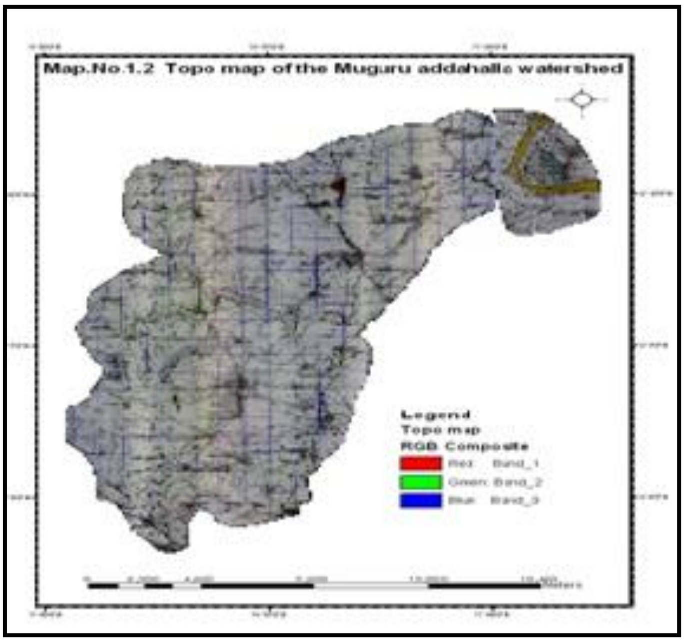

Figure 2: *Topo map of the Muguru Addahalla watershed, (Merged toposheets of 57D/16, 58A/13 and 57H/4)*

3. Methodology

The different thematic maps of the study area were prepared by making use of a base map. This base map was prepared using Survey of India toposheets bearing nos. 57D/16, 58A/13, 57H/4 in 1:50,000 Scale. Pan+LISS merged data was used for preparing various thematic maps. Visual interpretation and validation with field checks were carried out. In all these interpretations, software's like AutoCAD-2000, ERDAS IMAGINE 8.7, and Arc GIS 9.0 were used. For image and topomap mosaicking and subsetting of different scenes, these software were used.

4. Results and Discussion

4.1. Land use/ land cover

Using Remote Sensing and GIS techniques, the study area is classified into different categories from the point of utility and natural cover, as double crop, kharif, plantations, land with scrub, settlement, stream, tank, gullied land and forest plantations. These are shown in Figure 3, and their aerial extension is shown in (Figure 4). The relevant data is given in the Tables 1 and 2.

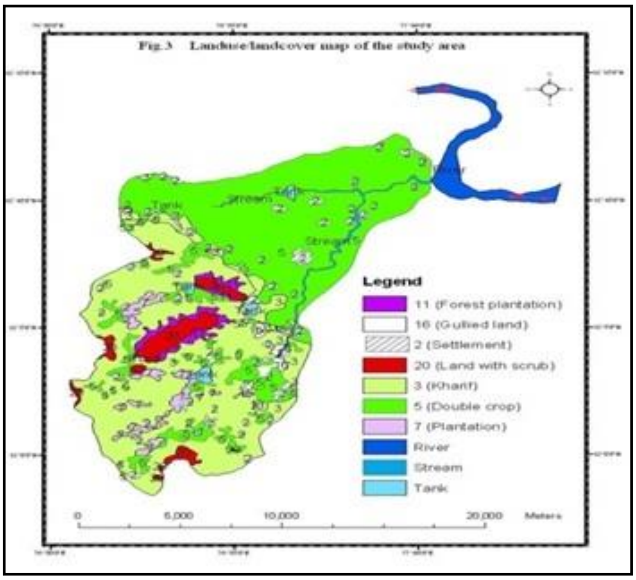

Figure 3: *Landuse / landcover map of the study area*

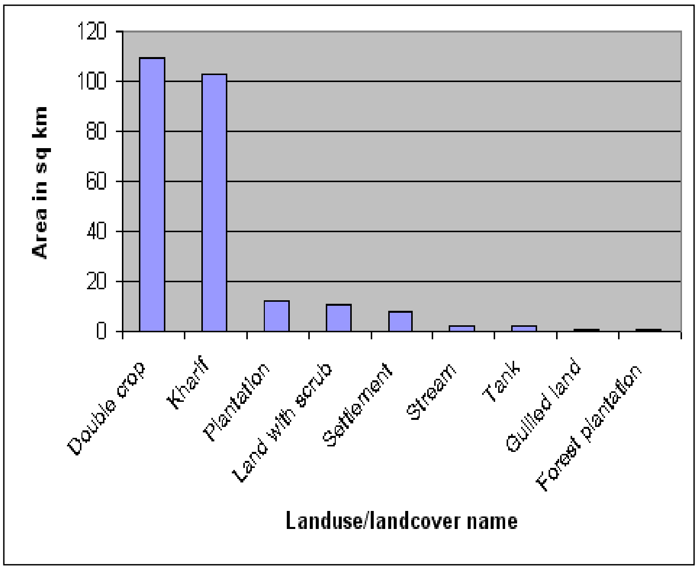

Figure 4: *Graphical representation of Landuse / landcover*

Table 1: *Landuse/landcover Classification*

Serial. no	Lu / Lc	Code	Area in sq.km	Area in Percentage
1	Double crop	5	109.6015	44.16
2	Kharif	3	103.0153	41.51
3	Settlement	2	7.5624	3.05
4	plantation	7	12.031771	4.85
5	Forest plantation	11	0.6333	0.26
6	Gullied land	16	0.7034	0.28
7	Land with scrub	20	10.5286	4.24
8	Stream	Stream	2.2349	0.9
9	Tank	Tank	1.8544	0.75

Table 2: *Hydrosoil unit of the study area (In sq.km)*

Run off potential	Area in sq. km
Habitation mask	6.72
Highest	1.19
Low	111.21
Moderately high	90.45
Moderately low	34.52
Water body mask	4.74

4.2. Slope

Slope aspect and altitude are very important terrain parameters from land utilization point of view. For evaluating various ground features of a basin and to prepare different thematic maps, the slope analysis is important. In the present study, the slope map has been prepared on 1:50,000 base map using the guidelines of All India Soil and Land use Survey (AIS & LUS, 1995). The categories of slopes were classified (Table 3). The general classification of slope, following the above guidelines, is shown below:

Table 3: *Criteria used for classifying the slope categories*

Sl. No.	Slope category	Slope (%)
1	1- Nearly level	0-1
2	2-Very gently sloping	1-3
3	3-Gently sloping	3-5
4	4-Moderately sloping	5-10
5	5-Strongly sloping	10-15
6	6-Moderately steep to steep sloping	15-35
7	7-Very steep sloping	>35

For general slope analysis, the survey of India toposheet in 1:50,000 scales has been used which gives 20 meter contour interval. The closely spaced contours indicate higher order slopes. The slope categories observed are given in the Table 4.

Table 4: *Slope category obtained from Contour spacing on 1: 50,000 base maps (IMSD tech. guideline 1995)*

Slope category	Lower and Upper limit of slope percentage	Lower and Upper limit of contour Spacing
1.	0-1 %	More than 4 cm
2.	More than 1% upto 3%	More than 1.33 cm and upto 4 cm
3.	More than 3% upto 5%	More than 0.8 cm and upto 1.33 cm
4.	More than 5% upto 10%	More than 0.4 cm and upto 0.8 cm
5.	More than 10% upto 15%	More than 0.26 cm and upto 0.4 cm
6.	More than 15% upto 35%	More than 0.11 cm and upto 0.26 cm
7.	More than 35%	0.11 cm and less

Table 5: *Slope area of the study area in sq.km*

Slope Code	Slope area/in sq km	Slope area/in Percentage
1	212.07	85.21
2	19.06	7.66
3	2.29	0.92
4	3.97	1.59
5	2.33	0.94
6	3.78	1.52
7	5.37	2.16

Using topographic maps, all the contours of the study area have been updated to understand the altitudinal variations of the watershed. These are shown in Figure 4. Based on these contour maps and comparing with Table 5, and employing the remote sensing and GIS techniques, the slope map has been generated. The area of each category of the slope were determined. The highest slope is represented by level 1. The level 1 area is more in the study area (85.21 %) and it covers about 212.07 sq km. The directions of slope are found to be along NW, SE, NE, SSE and NNE. The lowest slope area covers 0.92% percentage and is a gently sloping land and covers an area of about 2.29 sq km. The direction of the slope is NW and NNE. Very gently sloping (slope no. 2 is 1 to 3%) covers an area of 19.06 sq km and trending along NE, NNE and SSE directions. Moderately sloping land (Slope no 4 is 5 to 10%) covers an area of 3.97 sq km. Its direction is N, NE and NNE. Strongly sloping (slope.no. 5 is 10 to 15%) area covers about 2.33 sq km (0.94%). It's slope is trending towards SSE and NNE directions. Moderately steep to steep sloping (slope no. 6 is 15 to 35%) covers an area of 3.78 sq km (1.52%). Its slope direction is towards NW and NNE. Very steep sloping (slope no. 7 is >35%) zone covers an area of 5.37sq km (2.16% with a trend towards NNW, SSE and NNE directions.

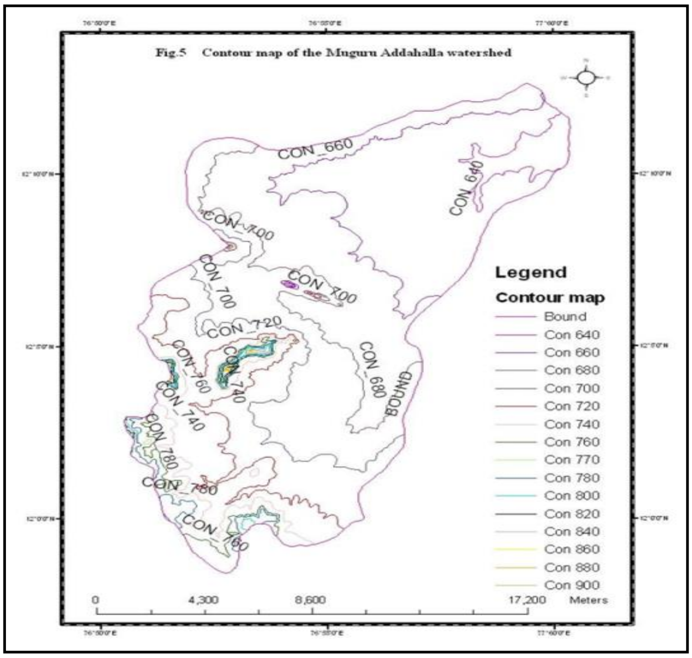

Figure 5: Contour map of the Muguru Addahalla watershed

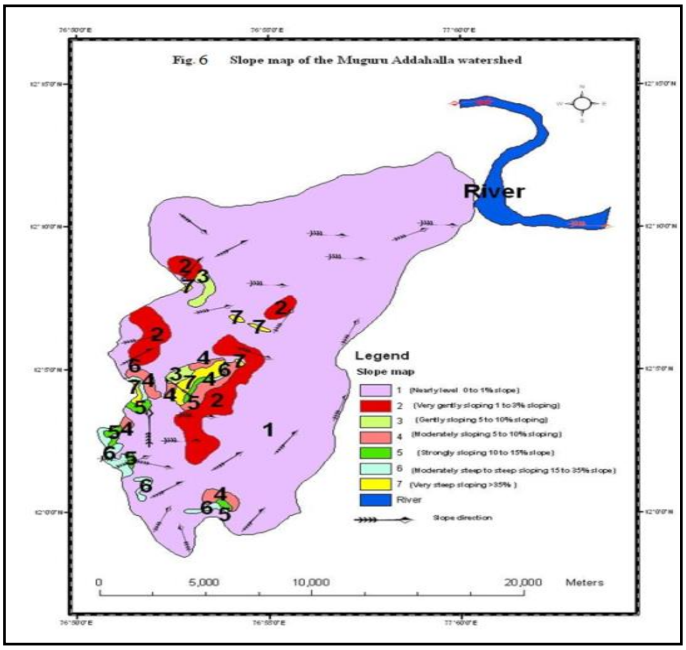

Figure 6: Slope map of the Muguru Addahalla watershed

4.3. Morphometric Characteristics

Stream drainage development is a natural dissection of the land surface created by flowing water along the slopes. It's vertical, horizontal and length of depression depends on bedrocks, topography, geological structure and the nature of the soil etc. Many other factors like slope, rainfall and vegetation etc, also contribute for the development of a drain. The study area is represented by dendtritic to subdendritic type of drainage pattern. The dendritic drainage pattern is the most common drainage pattern characterized by branching or tree like drainage pattern. Drainage network in the present study was prepared by toposheets and Pan+LISS merged data, in which the spatial resolution of the data is 5.8 m. For this interpretation keys like tone, texture, pattern and association were used. After visual interpretation of the drainage map of the study area, it was scanned and digitized using AutoCAD 2000 and ERDAS IMAGINE and finalized after field validation for the doubtful drainages. Some of the drainage paths were updated near Thottavadi village, northeast of Hallikerehundi, southwest of Vatalupura, near Kannahallimole, southeast of Ayyanurhundi, east of Honnegowdanahundi, south of Halakathurhundi and west and southwest of Karya.

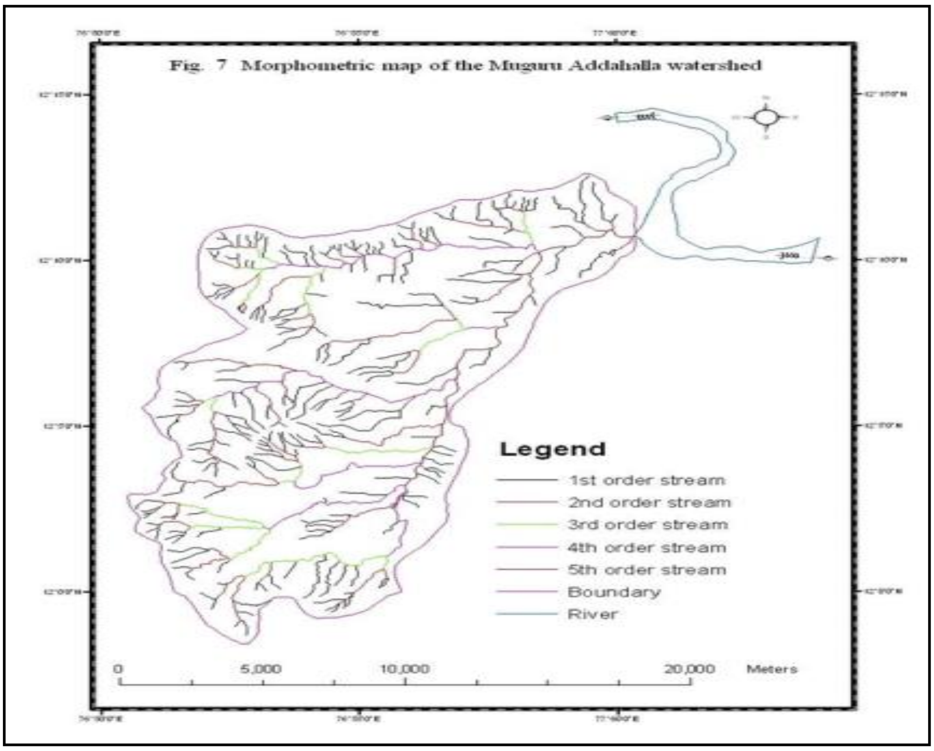

Figure 7: *Morphometric map of the Muguru Addahalla watershed*

4.4. Lithological Characteristics

The lithological units have been mapped for their spatial extent, and contact relationships have been marked out based on both field observation and satellite imagery studies. The *categorization of lithological units was attempted based on Quadrangle map of Geological Survey of India (GSI), Using remote sensing and GIS.* The characteristics of various structural patterns were also enumerated. The middle infrared region of the electromagnetic spectrum with the wave length range between 2.08 to 2.35 micrometer is more suitable to differentiate the contact zones between various lithological boundaries.

Table 6: *Categories of various lithological units and their spatial extents*

Sl. No.	Lithology Code	Area/sq km	Percentage Area Cover
1	GTGN	247.0975	99.28
2	DYKE	0.9647	0.39
3	UM	0.2144	0.09
4	AMP	0.6084	0.24

GTGN : Gneisses Granodiorite, Tonalite and Migmatite gneiss
AMP : Amphibolite and Hornblende schist
UM : Metaultramafics, Metapyroxenite, Serpentinised dunite and Peridotite
Dyke : Dolerite\Gabbro dyke
GSI : Geological Survey of India
GIS : Geographical information system

Among the different lithologies, granitoids cover the largest area of 99.28% followed by dyke (0.39%) and amphibolites (0.24%). The ultramafics occupy the least area (0.09%)

Gneisses, Granodiorite, Tonalite and Migmatite Gneiss (GTGN)

The major rock types of this study area include Tonalite, Trondhjemite and Granodiorite (TTGs). These rocks occur as slightly weathered zones and found at ground level exposures. However, much of the TTG area has been under soil cover. Some isolated outcrops are seen intermittently. Generally, these are well foliated rocks. The strike of the foliation trends along N-S with steeply dipping configurations. Some mafic enclaves and hornblende schists are commonly noticed within these gneissic rocks. The mafic enclaves are hornblende rich, schistose to amphibolite in character. They also show sharp to diffused contacts with the gneisses. The gneisses commonly show migmatitic character at several places. The migmatitic gneisses are pinkish to grayish on the surface and display wavy and banding structures. The migmatitic gneisses also contain wide variety of mafic enclaves. The observations also suggest that many phases of TTGs have been formed episodically.

Amphibolite and Hornblende schist (AMP)

In the southern part of the study area, amphibolite and hornblende schists occur within the gneissic country rocks. They are dark grey to green in colour. Amphibolites range in fabrics with granular to schistose. It is traversed by infrequent thin quartz veins. Hornblende schist is medium to course grained and slightly schistose and display strong green colour. They commonly show trends along NE-SW. They normally occur as lenticular patches and linear bodies. Their boundaries with gneisses are normally found to be tectonised. They are more weathered than the surrounding gneisses. They mostly represent the older mafic remnants, but intense deformation and metamorphism defines the clear cut relationships between the larger gneisses and minor mafic units.

Metaultramafics, Metapyroxenite, Serpentinised dunite and Peridotite (UM)

Minor occurrences of metaultramafic rocks like metapyroxenite, serpentinised dunite and peridotites occur in southern part of the study area. These constitute about 0.09% of the spatial extent of the terrain. They generally trend as elongated enclaves within the gneissic terrain. They display strong fabric pattern along N-S similar to that of the fabric pattern in TTG gneisses. They are seen as dark greenish coloured sub-weathered outcrops. They are also more strongly weathered than the surrounding gneisses.

Dolerite / Gabbro Dykes

These are frequently noticed in the study area. They are medium to coarse grained very narrow to slightly wider bodies. They cover an area of 0.9647 sq/km. They mainly trend in the direction of NW-SE, but some also trend in different directions. They have varying width with mainly doleritic in composition and are coarse to medium grained. They normally play an important role in ground water movement and storage. Ground water prospective zone maps have been prepared keeping this as an important factor because, the upstream of the dyke normally stores good amount of water and conversely the downstream side of the dyke will be poorer in ground water.

4.5. Structural Features

Structurally, the area displays shears, joints, faults and lineaments. They are small to moderate in extent with variable dipping configurations. They too play some significant role in ground water percolation. As joints, fractures, and shears are smaller and localized, they could not be quantified through remote sensing data. However, the linear features like lineaments have been quantified. Most of the drainage network in the study area is controlled by these lineaments. Many structural features like folds axis, faults and shears, besides dyke bodies normally appear on remote sensing data products as lineaments. Often the lineaments develop in a systematic way and hence a spatio-statistical analysis of lineament pattern provides information regarding their tectonogenesis and relevance to ground water movement. The term lineament was originally used by Hobbs (1904), to describe linear features that are "significant lines of land scape" although linear features have been discussed since 1800's (Hodgson, 1974). Lineaments are both local and regional features. Bhave et al., (1989) opined that the term lineament is preferentially used to define the unidirectional earth features of larger magnitude. The other synonyms related to lineament that is linear, lineation, geofracture, suture, mega fracture and shear. Several tectonic process and related parameters are involved in the formation of lineaments (Rakshit and Prabhakara Rao, 1989) and they act as neotectonic windows (Ramaswamy, 1997). Lineaments have major tectonic, magmatic, economic and neotectonic significance, and their role in surface and sub surface hydrology is assuming more and more importance. From the point of their origin Sonder (1947) has developed global shear pattern. It envisages lineaments as regular fracture patterns that pervade the globe, generated by the forces of the rotation of the body on its axis. Flattening of the earth in north-south along its axis would produce a set of north-trending tensional and east-trending compressional weakness zones and northwest and northeast trending shears. These would be propagated throughout the life of the planet. Katterfield and Charushic (1970) later recognized such a pattern on satellite imagery of the moon and other planets, and visualized similar dynamics. Lineaments of the study area investigated and interpreted in the background of their regional studies carried by early workers. Based on their characteristics they are grouped into 4 categories by Ganesh Raj (1987) viz. (a) Continuous, (b) Discontinuous, (c) Simple and (4) Composite. Lineament which show uninterrupted linear scarp is termed as continuous lineament. In discontinuous lineaments the discrete features are aligned along a contact path and are relatively closely spaced, such as a linear stream valley or a series of aligned topographic escarpments. A composite lineament consists of more than one type of feature, such as a combination of aligned tonal features and stream segments. Kowalik and Gold (1976) suggested a classification of lineaments based on their lengths as shown in Table 7.

Table 7: *Classification of Lineaments (Based on Kowalik and Gold, 1976)*

Sl. No.	Lineament Class	Length(km)
1	Short /Minor	1.6 to 10
2	Intermediate	10 to 100
3	Long / major	100 to 500
4	Mega	>500

5. Nature of the Lineaments in the Study Area and Their Classification

In the study area, lineaments are both continuous and discontinuous. As briefed earlier, uninterrupted linear scarp is an example of continuous lineaments. In discontinuous lineaments, the surface feature aligns in a consistent direction and is relatively closely spaced. Both simple and composite lineaments are also observed in this area. Simple lineament is characterized by single type of feature, such as a linear stream or valley. Composite lineaments consist of more than one type of feature. Generally the lineaments of any area are classified as confirmed lineaments and inferred lineaments. Confirmed ones are those which have been identified in satellite imageries and also by field validation, whereas the inferred ones are neither visible on the imageries nor could be recognized in the field. In the study area, most of the lineaments have been confirmed through the imagery and field studies. However, there is a possibility of concealed lineaments and they too could have played important role in ground water accumulation.

Fallowing Kowalik and Gold (1976) the lineaments of the study area have been classified and the pie diagram shows the total number of lineaments in which less than 1 km ones are found to be 188 in number and the 1 to 2 km lineaments are 51 and 2 to 3 km lineaments are 12 and the total length of the lineaments is contributed by lineaments of 2-3 km length followed by 1 to 2 km and <1 km lineaments. It depicts that lineaments of < 1 km account for 113.80 km cumulative length and 1 to 2 km lineaments occupy 67.43 km. Lineaments of 2 to 3 km length account for 137.47 km cumulative strike length.

Table: *Spatial Distribution of Lineaments in the study area*

Lineament range in km	Total length of lineament in each class(km)	Total no of lineaments
Less than 1Km	113.80	188
1 to 2km	67.43	51
2 to3 km	137.47	12

6. Total length wise distribution of lineaments in the Pie diagram

The lineaments are running in N-S, E-W, NW-SE, NE-SW, NNE-SSW, NNW-SSE directions. It can be seen that 2 to 3 km lineaments are align along the stream course, shears and less frequently along the contacts of different litho units. 1-2 km and less than 1 km lineaments are found along and sides of the drainage segments. Joints, fracture and fissure zones and contact zones of litho boundary. All these characteristics are identified on the satellite imageries, based on parameters like colour, tone, texture, pattern and association. Lineaments, especially the geotechnical ones are known to be excellent sites for groundwater movement and storage. The ground water potential of the study area has been appraised from this angle, because good net-work of lineaments, as is found here, contribute significantly for ground water potential. As such, the bedrocks of the study area are not so favorable for ground water movement, due to their inherent properties, but are rendered considerably favorable due to the existence of lineaments.

7. Geomorphology

7.1. Residual hills

It is formed due to differential weathering and erosion and a more resistant formation (controlled by rock type) stand as hills. The structures which control their formation are joints and fractures. The lithology in residual hill area is dominant with granodiorite, tonalite and migmatitic gneiss. They are the prominent and elevated features in the study area. Such hills are noticed in northwest and adjacent areas of Hanumanapura. They are also noticed around Karya and also west and northwest of Ummatturu village. Residual hills cover an area of 3.0958 sq km (1.24% of the watershed). The tributary Muguru Addahalla originates at Ummathur Gudda at an altitude of 300m from MSL as a first order stream.

7.2. Pediments

Gently sloping smooth surfaces of eroded bedrocks between hills and plains with veneer of detritus lithologies like granodiorite, tonalites and migmatitic gneisses, constitute the pediment zones. Fractures play an important role in their formation. These pediments are situated west and northwest of Ummathuru village, west of Paduvalamarahalli, southwest of Hanumanapura and west and northwest of Bagali village. The total area covered by pediments is 5.715 sq km (2.3% of the watershed).

7.3. Pediment Inselbergs

The isolated low relief hills surrounded by gently sloping, smooth, erosional bed rocks constitute the pediment inselbergs. Bedrocks like granodiorites and migmatitic gneisses are the lithologic units controlling the pediment inselbergs. Again here also joints fracture, and lineaments have controlled their formation. Prominent pediment inselbergs are situated in northeast of Hallikerehundi. The area occupied by them is 0.1461 sqkm (0.06% of the total area).

7.4. Pediment Inselberg Complex

These are isolated low relief hills surrounded by gently sloping smooth bed rocks. As the dominant lithologic unit of the area is granitoids, this pediment inselberg complex is also encompassed by granodiorite, tonalitic and migmatitic gneisses. These are controlled by structures like joints, fractures and lineaments. The only difference between the pediment inselberg complex and pediment inselberg is, in the case of pediment inselberg, it is a single isolated low relief hill but in the case of pediment inselberg complex it is more than one isolated low relief hill but occurring very closely. These land forms are observed in the northeast of Badanaguppe village. The area covered by them is around 1.607 sq km (0.65% of the total area).

7.5. Pediplain (Shallow)

They are formed by coalescence of buried pediments, where a thick overburden of weathered materials accumulate. The intensely weathered areas of granitoids constitute these landforms. Varying thickness of shallow overburden are observed in such areas. Weathering of the bedrocks has been initiated by fractures, joints and minor lineaments. The area covered by such land forms is very vast, and account for about 107.81 sq km (43.31%of the total area). These land forms are spread over the villages namely, Hosahalli, Badanaguppe, Hanumanapura, Honnegowdanahundi, Karya, Kuderu, Demahalli, Hallikerehundi, Dasanuru, Ummatturu, Jennuru, Jennuru Hosuru and Bagali, Hosuru Hundi.

7.6. Pediplain (Moderate)

Flat and smooth buried pediplain and pediment with moderately thick overburden are called pediplain moderate. Thickness of weathered material is high when compared to pediplain shallow. The weathered materials are chiefly constituted by gneisses and migmatites. They are extended towards southwest of Demahalli upto Dasanua, Ankushayyanahalli, Badanaguppe, Karya and Hanumanapura villages covering a total area of 34.1008 sq km (13.7% of the total area).

7.7. Pediplain Shallow Command Area

These are the Pediplain shallow land forms but occurring in the irrigated command area. Like in other areas, they are formed by coalescence of buried pediments where a thick overburden of weathered materials occurs to form pediplain shallow. Here, the overburden is a weathered mantle of granodiorite, tonalitic and migmatitic gneisses, with varying thickness. The weathering is controlled by fracture, faults and lineaments. This zone is extended towards north, northeast and northwest of Bagali, Hyakanur and Vatalu villages and the areal extent is 66.0929 sq km (26.56% of the total area).

7.8. Pediplain Moderate Command Area

Flat and smooth buried pediplain and pediment with moderate thickness of overburden occurring in irrigated command area are termed as pediplain moderate command area. The lithology here includes granodiorite, tonalitic and migmatitic gneisses. They are controlled by fracture and lineaments. Thickness of the weathered mantle is high when compared to pediplain shallow command area**.** It is extended towards west and southwest of Ayyanurhundi, and extends up to Hanumanapura. They are also observed close to Marahallipura, Badanaguppe, Karapura and Ankushayyanapura, Dasanuru, Ummatturu and Kuderu. The aerial extent of the landform is 25.553 sq km (10.28% of the total area). Besides mapping and delineating the above land forms, the water bodies have also been delineated using toposheets updated with imageries. These surface water bodies influence the surrounding bore wells and ground water recharge conditions. Out of the total surface water bodies, the streams occupy 2.23 sq.km (0.9% of the total area) and the lakes (tanks) occupy about 2.51 sq.km (1.01% of the total area).

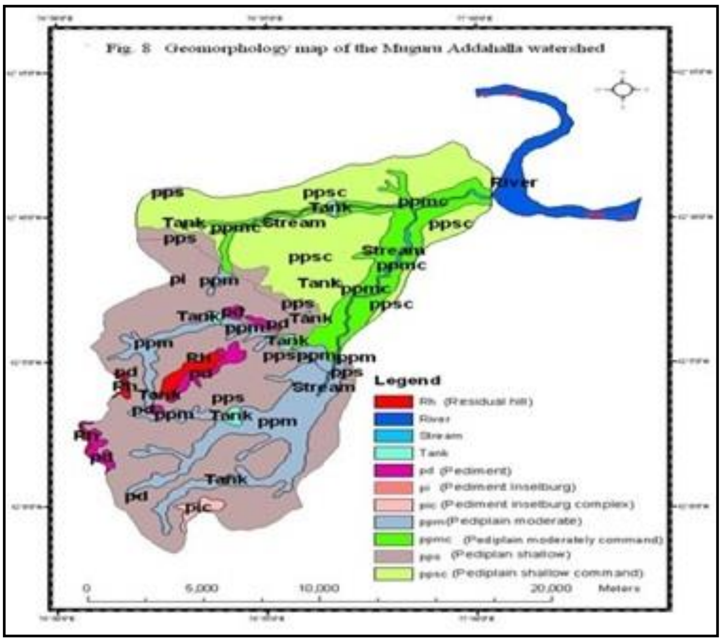

Figure 8: *Geomorphological map of the Muguru Addahalla Watershed*

Table 8: *Geomorphic units of the study area (In sq .Km)*

Serial No.	Geomorphic unit	Area in sq.km	Percentage
1	PI	0.1461	0.06
2	PD	5.712	2.3
3	PIC	1.607	0.65
4	PPM	34.1008	13.7
5	PPMC	25.553	10.28
6	PPS	107.8075	43.31
7	PPSC	66.0929	26.56
8	RH	3.0958	1.24
9	STREAM	2.2349	0.9
10	TANK	2.5141	1.01

PI : Pediment Inselberg
PD : Pediment

PIC	:	Pediment Inselberg Complex
PPM	:	Pediplain Moderate
PPMC	:	Pediplain Moderate Command
PPS	:	Pediplain Shallow
PPSC	:	Pediplain Shallow Command
RH	:	Residual Hill

8. Hydrogeomorphological Characterization of the Study Area

The geomorphic unit-wise ground water prospect zones, their subsurface phenomenon, their identification and distribution were done based on the analysis of directly observable terrain features like geological structures, geomorphic features and their hydrological significances. Remote sensing techniques also helped for a better understanding and more systematic analysis of various geomorphic units.

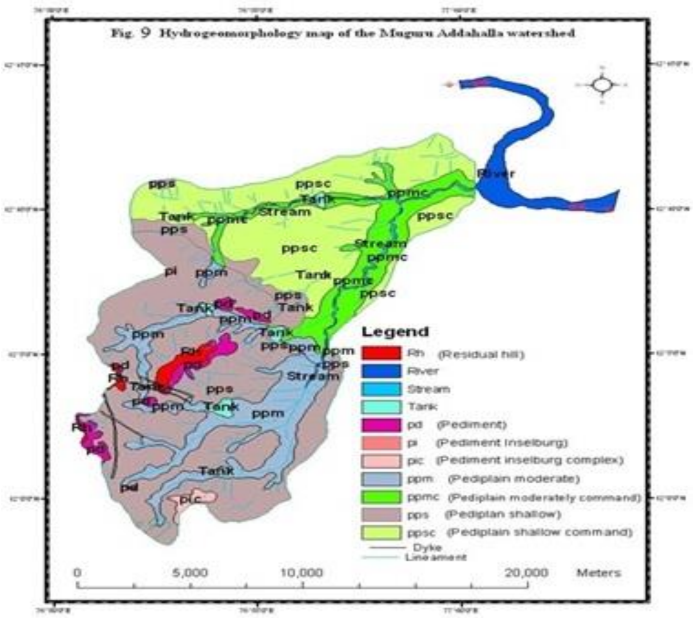

Figure 9: *Hydrogeomorphological map of the Muguru Addahalla Watershed*

Table 9: *Ground water prospect of Hydrogeomorphic unit*

Sl. No	Map Symbol	Geomorphic Unit	Structure	Description	Ground Water Prospect
1	Rh	Residual hill	Joints, fractures, Lineaments	Isolated low relief formed due to differential erosion so that a more resistant formation and as residue like small hills.	Poor to nil
2	Pd	Pediment	Sometimes Fracture controlled	Gently sloping, Smooth surface of erosional bedrock between hill and plain with veneer of detritus.	Moderate to poor, varies with underlying Lithology; presence of fracture lineaments.
3	Pi	Pediment Inselberg	Sometimes Controlled by joints, fracture lineaments etc.	Isolated low relief/hill surrounded by gently Sloping smooth erosional bedrock with veneer of detritus.	Moderate to poor
4	Pic	Pediment Inselberg comple	Same as that of Pediment Inselberg complex	Isolated low relief/hill surrounded by gently Sloping smooth erosional bedrock with veneer of detritus and coalescence of group of Pediment Inslberg.	Moderate to poor
5	Pps	Pediplain shallow	Joints, fracture Lineaments etc	Coalescene of pediments marked by a large area and shallow soil depth.	Moderate to poor varies With underlying Lithology and structure.
6	Ppm	Pediplain moderate	Joints fracture lineaments etc	Coalescene of pediments marked by a large area and moderate soil depth.	Good to moderate varies with underlying Lithology and structure.
7	Ppsc	Pediplain shallow Comman	Joints fracture and lineaments	Coalescene of pediments marked by a large area and shallow soil depth and recharge the ground water by Canal water.	Moderate to poor varies With underlying Lithology and Structure and sometimes moderate to good depending On structure and the amount of ground water Recharge by the canal.
8	Ppmc	Pediplain moderate	Joints fracture and lineaments	Colaescene of pedinents marked by a large area and moderate soil depth and recharge the ground water by the canal water.	Good to moderate varies With underlying Lithology and Structure and sometimes good to very good depending on structure, the amount of ground water recharge by canal.
9	Dyke	Dyke	**Dyke**	It is the discordant type of Igneous body having wall type of structure.	Acts as a ground water barrier water is available on the upstream of the dyke.
10	Lineament		Lineament	It represents joints, fracture, Shear zones	Good to very good

8.2. Recharge Geomorphic Unit of the Study Area

Residual hill (RH), Pediment (PD), Pediment Inselberg (PI) and Pediment Inselberg Complex (PIC) are the regions of medium to high slope gradient (slope category 4-7). In these regions, infiltration is expected to be less and hence the runoff is expected to be more. Water gets collected from these regions, but moves towards pediplain shallow (PPS), pediplain moderate (PPM), pediplain shallow command (PPSC) and pediplain moderate command (PPMC) regions. All these land forms come under the slope category 1 to 3.

8.3. Discharge-prone Geomorphic Unit of the Study Area

The Pediplain shallow (PPS) and Pediplain Shallow Command Area (PPSC) landforms come under 1st to 3rd order stream regions. Here, the ground water potential is expected to be poor to moderate. It will be moderate to good depending on the existence of fractures, fissures and jointed zones. Pediplain Moderate (PPM) and Pediplain Moderate Command (PPMC) land forms come under 1st to 5th order streams. Here, the ground water potentiality is expected to be moderate to good. It will be very good depending upon the existence of fractures, fissures and jointed zones. Such studies have been carried out for different river basins based on remote sensing and GIS techniques by various workers (Krishnamurthy 1991 & 1996; Gupta and Ganeshraj, 1992; Gupta 2002; Travaglia et al., 1987).

9. Conclusion

Remote sensing and GIS proved to be efficient tool in drainage basin analysis. In this study, the integrated method adopted by using topographic and drainage details, lithologic units, hydrogeomorphic units and other parameters was focused to identify the groundwater potential zones. The landforms like plateaus, residual hills, pediments, pediplain, piedmont zones, valleys and other landscape features are suitable for the occurrence of the water resources of any basin or region. The geomorphic unit-wise ground water prospect zones, their subsurface phenomenon, their identification and distribution were done based on the analysis of directly observable terrain features like geological structures, geomorphic features and their hydrological significances. Remote sensing techniques also helped for a better understanding and more systematic analysis of various geomorphic units.

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