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GEOMORPHOLOGICAL INVESTIGATIONS OF GHATKHED MINI WATERSHED, AMRAVATI DISTRICT, MAHARASHTRA WITH REFERENCE TO WATER RESOURCE MANAGEMENT USING REMOTE SENSING AND GIS TECHNIQUES

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Abstract

In the present study, an approach is made to develop a methodology to assess the impact on the environment in a watershed by human intervention and of natural hazard. The present study deals with the analyses of geological, geomorphologic, morphometric and hydro geochemical parameters to evaluate the landscape pattern of Ghatkhed mini watershed of Amravati region along with its environmental pollution. The Present mini water shed area covered in an area of Latitude $20^0$51'00" to $21^0$00'00" and Longitude $77^0$46'30" to $77^0$55'30" comes under the Survey of India Toposheet No. 55 H/13. The present study area is lies on Amravati University to Mardi road. Watershed is a region delineated with a well defined topographic boundary and water outlet. It is a geographic region within which hydrological conditions are such that water becomes concentrated within a particular location, for example, a river or a reservoir, by which the watershed is drained. Within the topographic boundary or a water divide, watershed comprises a complex of soils, land forms, vegetation, and land uses. The results demonstrate the presence of various geomorphic landforms. The analysis reveals that the influence of drainage morphometry is very significant in understanding the landform processes, soil physical properties and erosional characteristics.

INTRODUCTION

Extracting natural resources to their maximum level has resulted in reduction of the supply level per capita where the concurrent increase in population has resulted in increased demand in study area. As the demand increases, people are interested in extracting more resources, which affects the sustainability of resource generation. Water is one of Earth's most critical resources essential to every ecosystem. Water sustains all life, and helps maintain the environmental balance of our planet too. Water is essential in human development from the personal water needs of every individual to the demands of agriculture and industry. Watersheds have been classified into different categories based on area viz Micro Watershed (0 to 10 ha), Small Watershed (10 to 40 ha), Mini Watershed (40 to 200 ha), Sub Watershed (200 to 400 ha), Watershed (400 to 1000 ha) and Sub basin (above 1000 ha).

According to A. N. Strahler (1968), geomorphology is an analysis of the origin and evolution of the earth feature, Geomorphology does not study merely the physical, chemical, and biological processes affecting the evolution of landform but also the structure of the earth's crust, the geological process as well as the climatic influence, because it is combine influence of all these factor that determine landforms. The Detail Geomorphological studies of the area have been done in Ghatkhed mini water shed. Systematic geomorphologic mapping is carried out in the Survey of India Toposheet no. 55H/13. The present study area is lies on Amravati University to Mardi road (Fig. 1). The Toposheet comprises parts of Amravati. Water is one of the main resources essential for the overall socio-economic development of any region and it requires careful planning and appropriate exploration. Geomorphology deals with the study of surface feature of the earth. This will give the detail information about the development and deposition of material plains, valley, and basin and various other landforms. A systematic study of these factors unable one to draw influence about the delineation of perspective ground water zone is a region. Geomorphological study of the area including identification of various

units, land forms, lineaments, soil maps and morphometric analysis of the drainage in Ghatkhed mini water shade.

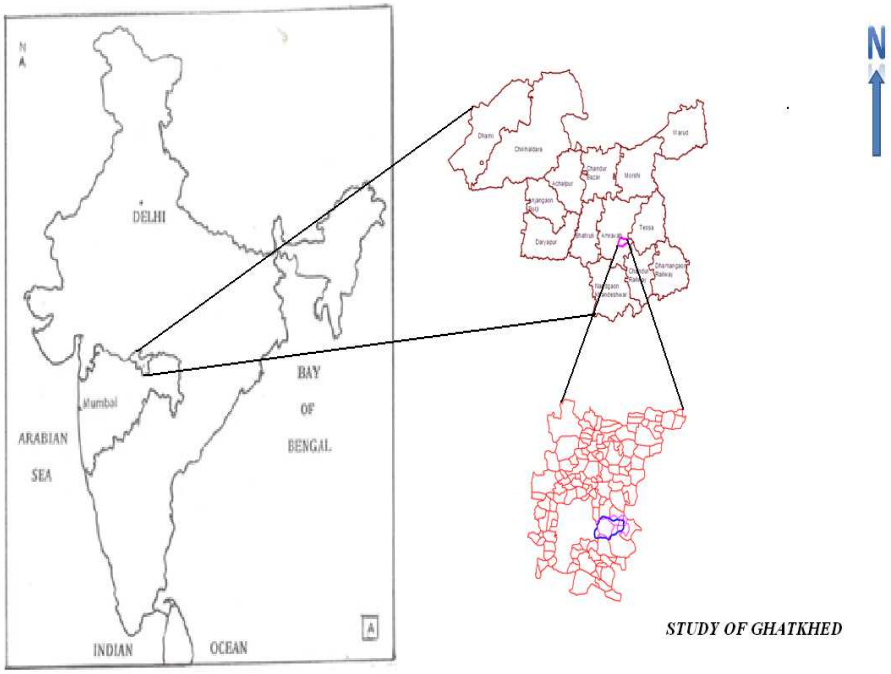

Fig. 1 - Location Map of Study Area

Regional Geology

Regional geology includes Wardha, Purna alluvium lying over Deccan trap basalts underlying with Gondwana sandstone & Achaean gneisses. The visually interpreted geological frame work of the area comprises of Achaean gneisses, Gondwana sequence and basaltic flows and alluvium (Table 1).

Table1. Stratigraphic Succession of the Study Area

Sr. No.	Age	Formation	Lithology
1.	Recent	Wardha Alluvium	Clay, Silt, Sand
2.	Pleistocene	Purna Alluvium	Clay, Silt, Sand, Pebbles, Boulder and Kankar
3.	Eocene to Upper Cretaceous	Deccan Basaltic Trap	Vesicular, Zeolitic basalt and massive basalt
4.	Permian	Gondwana	Clay, Sandstone
5.	Archaean	Metamorphic	Gneisses

Geomorphology of Study Area:

Highly Dissected Plateau:

The landforms of highly dissected plateaus occur in the East-Southern and West-Southern part of the study area. Thin soil cover and rock outcrops mark these landforms. The forest is the dominant land use of these landforms.

Moderately Dissected Plateau:

The moderately dissected plateau landforms are seen surrounding the highly dissected basaltic plateau unites in the North-Southern part of the area. The moderately high hills and medium dissection are the characteristics of this landform. This landform characterized by sparse vegetation and thickness of weathering is moderate.

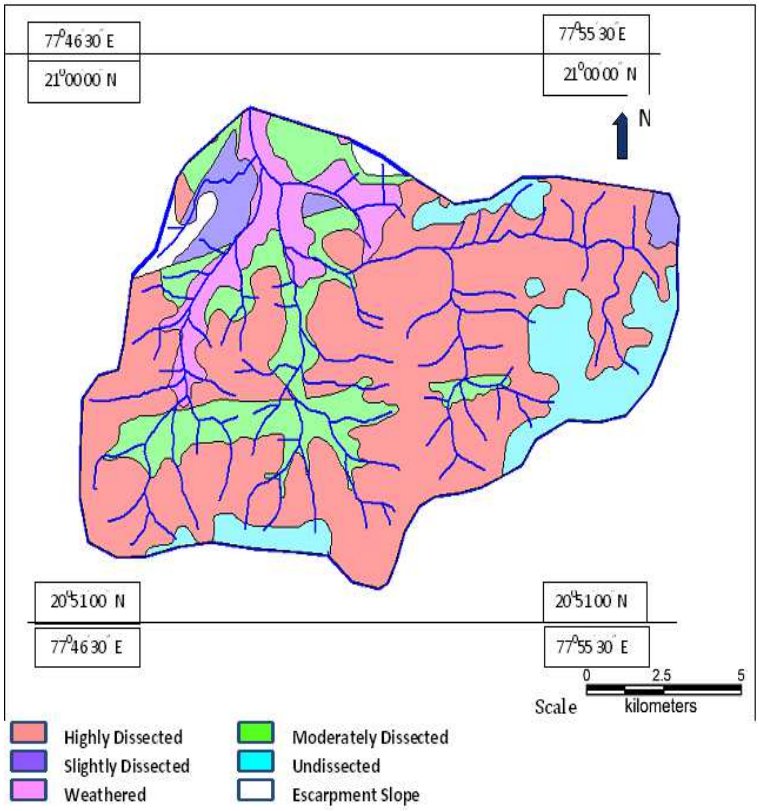

Fig. 2 –Geomorphological map of the study area,

Slightly Dissected Plateau:

The slightly dissected plateau landform is mostly undulating landform. Moderate to thick soil cover appreciable zone of weathering and less dissection are main characters of this landform.

Undissected Plateau:

In this map undissected plateau in the North-Eastern to South Eastern part of the area. The undissected plateau landforms are also seen surrounding the highly dissected basaltic plateau unites in the North-Eastern part of the area. Soil cover is moderate.

Weathered plateau:

The weathered landform occurs in the Northern part of the study area. This landform is characterized by the thick soil cover due to highly weathering of the landform. This landform is observed to have considerable thickness of weathered zone,

fairly good soil cover tend to identify thick cover of vegetation.

Escarpment slope:

The escarpment slope mostly shown in Northern part of area which is surrounded by slightly and moderately dissected plateau.

Morphotectonic Analysis

The drainage pattern of the area ranged from dendritic to sub-dendritic and at places the drainage was structurally controlled by lineaments (Fig.3). Lineament study of the area from remotely sensed date provides important information on sub-surface fractures that may control the movement and storage of ground water (Pradeep Raj *et al.,* 1996). In this region 18 lineaments have been identified and marked in the area. They are having varying dimensions. Lineament map shows that there are two predominant sets of lineaments; one set trending NE-SW and other (Fig 3).

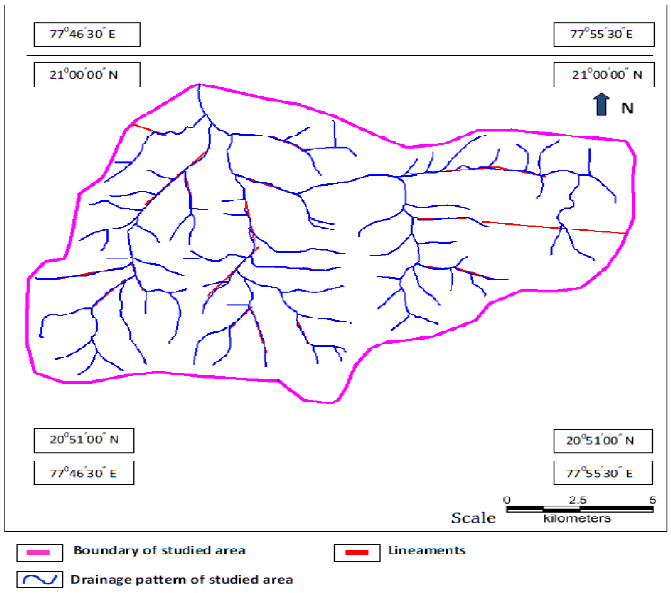

Fig.3. Drainage & Lineament map of Study Area

Table 2

Morphometric analysis (Linear aspect of drainage network) of Ghatkhed mini watershed.

Stream Order (U)	Number of Streams (N_u)	Total length of Streams in km (L_u)	Bifurcation ratio (R_b)	Mean Bifurcation ratio
1	71	0.00071	2.290	
2	31	0.00023	1.069	2.719
3	29	0.00016	4.8	
4	6	0.00008	-	

Table 3.

Areal Aspect of drainage network

Morphometric parameters	Formula	Result
Area (sq.km)	A	23.79
Perimeter (km)	P	20.8
Drainage density (km/sq.km)	D = Lu/A	4.96
Stream frequency	$F_s = N_u/A$	5.76
Texture ratio	$T = N_1/P$	3.41
Basin length (km)	L_b	0.000164
Elongation ratio	$R_e = 2\sqrt{A/\pi}/L_u$	4084
Circulatory ratio	$R_c = 4\pi A/P^2$	0.69
Form factor ratio	$R_f = A/L_b^2$	8845

Ghatkhed Watershed:

The watershed considered for this study is the drainage of a small joining Wardha basin at Ghatkhed village in Amravati district. Watershed comprises two villages i.e. Ghatkhed and Indla occupying a total geographical area 23.79 sq.km. (Fig. 4)

Land Use/ Land Cover

In the present land use/ land cover study of area, the classification system developed by National Remote Sensing Agency (NRSA) (1989) is adopted to generate land use/ land cover. In the study area, land forms are formed are as follow; (Fig.5)

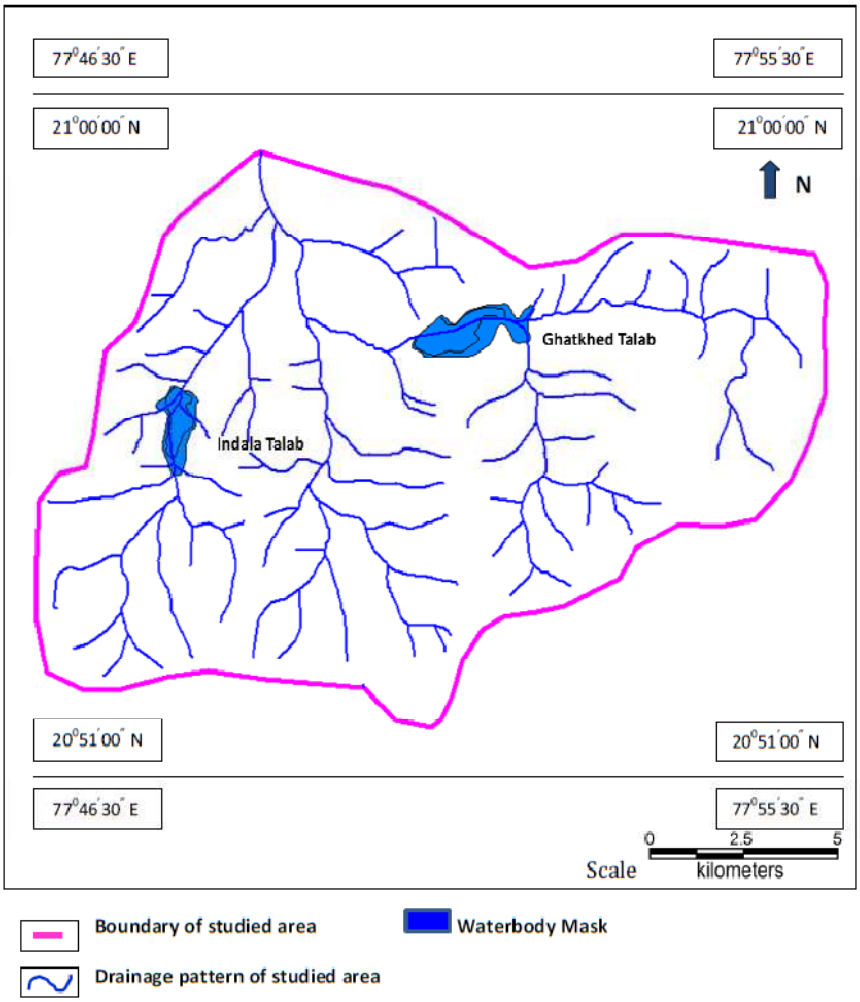

Fig. 4- Watershed Map Showing Water Bodies

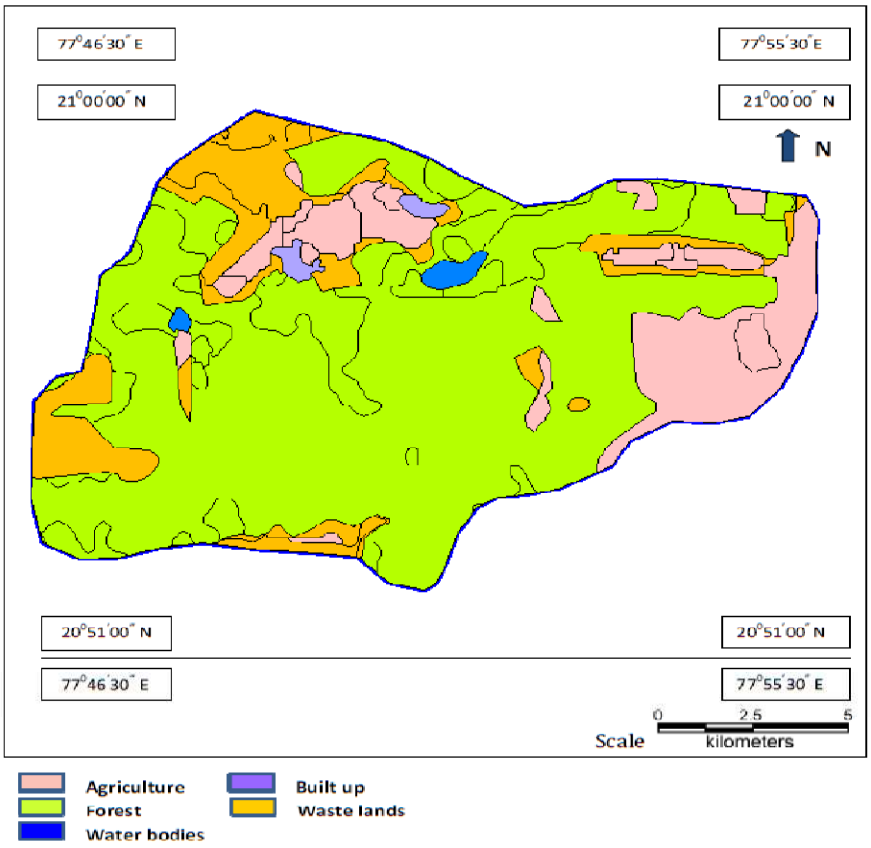

Fig.5- Land Use map of the Study Area

1) Agriculture land

Agricultural land is the land primarily used for Vegetation/Plantation. Crop land is the land under cultivation. In figure 5, the crop land was easily identify by South–East region. Fallow land is the agriculture land in which the crops are taken out and un-cropped for one or more season but not less than one year.

2) Built up land

Built up land is defined as an area of human population develops that had cover of buildings, transport, communication utility in association with water, vegetation and waste land. In the study area, built up land shows widely spread in South and South-West region with the help of land use/land cover map, Toposheet and field check.

3) Forest land

In the study area, forest land covered to all over the area. They show Indala Protected Forest land was identified with the help of Toposheet and field check.

4) Waste lands

Waste land has been described by the National Waste land Development Board, Ministry of Environment and Forest Government of India, Such land include accelerating soil erosion and excessive land degradation including scrub land with vegetation and scrub land without vegetation. In the study area, the waste land shows in North-East, North-West and South-West region.

5) Water bodies

It is an area of impounded water and often with regular flow of water. It includes man made resources, lake, rivers and streams. In the study area, the Indala Talab located in the West zone of the Amravati district and the Ghatkhed Talab located towards the South-West zone of the map. Water bodies were identified by very dark blue tone depending on depth, volume and turbidity (Figure 4). Texture is smooth and shape is irregular.

Soil (Erosion):

Soil erosion is a major watershed problem. In a watershed there may be many different sources of erosion. The main objectives are to pinpoint main erosion sites, define their extent, study their causes and, most importantly, suggest possible corrective or rehabilitation measures.

Soil erosion is one form of soil degradation along with soil compaction, low organic matter, and loss of soil structure, poor internal drainage, Stalinisation, and soil acidity problems. These other forms of soil degradation are serious in them and usually contribute to accelerated soil erosion. Soil erosion is a naturally occurring process on all types of lands. The agents of soil erosion are water and wind. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks. In the study area, Soil erodibility of different parts of watershed area have been found using GIS as follows; (Fig. 6)

Moderate to severe

Moderate to severe soil erosion is all over part of study area but specially the SW part . Moderate to severe soil erosion is due to presence of highly dissected plateau that having exposed rock surface and deep slope.

Severe to very severe

Sever to very severe erosion is shown in NE part of study area. Only gully erosion will be noted and the areas be marked on the map. Extremely active bank slides and cutting, heavy deposits of fresh bed loads, torrent nature of flows.

Slight

Slightly soil erosion is found at the surrounding part of North and East region of study area. It is mostly characterized by the presence of moderately dissected plateau and denudationl slope that having thick soil cover and high rate of weathering.

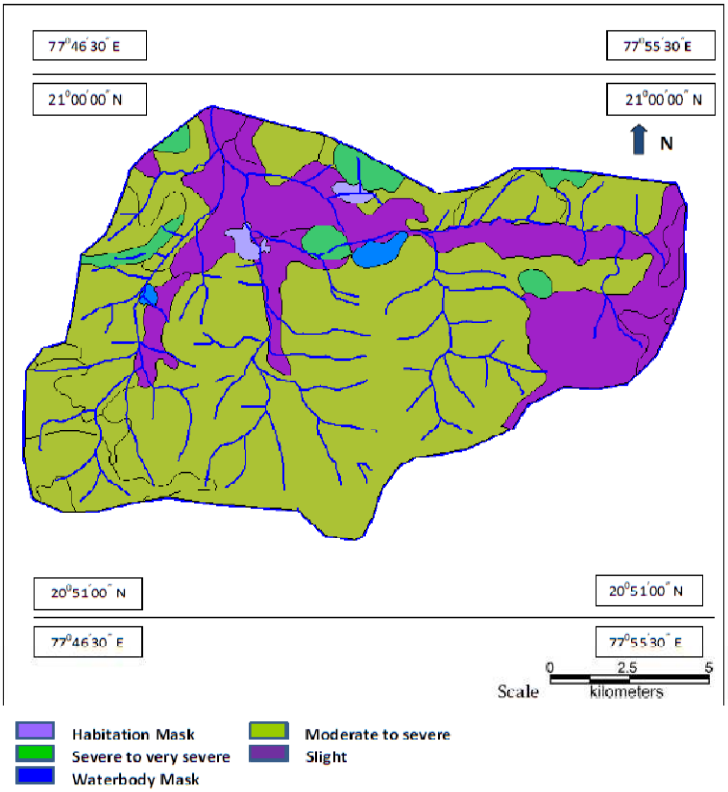

Fig. 6- Soil erosion map of the Study Area

Water resource management

The hazardous growth and concentration of population and industries in urban areas in recent years has caused many serious problems. One of the major problems is the scarcity in groundwater occurrence. Groundwater is the natural gift to the living beings which is most precious and widely distributed resource on the earth, Groundwater is the renewable resource but its renewability is not infinite. So the groundwater management and development has to be planned in scientific way. So that the adverse effect of over development could be avoided. Reliable estimation of groundwater resources applying suitable methodology is a prime necessity. Ground water resource assessment was done for Ghatkhed area occupying a total geographical area of 23.79sq.km.

The overall stage of ground water development for the area is 78.18%.Watershed wise resources computation indicate that the Ghatkhed, Indala watersheds fall in "Semi-Critical" category. Hydro geologically the study area can be broadly divided into two hydro geological zones namely hard rock terrain and alluvial terrain. The study area is characterized by the presence of shallow unconfined aquifers. The occurrence and distribution of groundwater is mainly controlled by geological, geomorphological structural and climatic condition of the region. The hard rock terrain consists of Deccan Basalts which show poor, moderate and good groundwater potential depending on the intensity of weathering and presence of fractures and joints. Whereas, alluvial zone showing very good groundwater potential.

In general, the groundwater occurs under both water table and semi confined conditions in the basaltic terrain of the study area. In hard and compact basaltic terrain where the availability of groundwater is poor as the storage space is limited and also the joints and fractures are negligible with thin soil cover whereas, highly fractured, jointed basalt with amygdaloidal and vesicular horizons have proved to be potential areas for groundwater development. The phreatic and semi confined aquifers in the area can certainly be utilized as potential water

resource for irrigation and water supply. The results demonstrate the presence of poor water quality in the northern saline tract of the alluvial zone which is not suitable for either drinking and irrigation purposes whereas, the trappean regions show fair to excellent quality for groundwater which is suitable for the drinking and irrigation purposes.

The water quality of the area can be improved by adopting artificial recharging methods and also by pumping the saline water into the Purna River during rainy seasons. In the study area the highly fractured, weathered and jointed horizons of Deccan Traps have yielded large amount of water, which shows good quality whereas, the massive basalts have shown poor yield. In general, the study area has great potential for large-scale groundwater resource development due to the presence of groundwater in unconfined, semi confined and confined conditions in deep fractured regions. In order to achieve planned and sustainable scientific development of ground water resource, it is suggested that priority be given for dug wells due be surplus availability of groundwater in shallow aquifers down to a depth of 20m bgl. The existing shallow dug wells may be depended to a maximum depth of 20m bgl so as to tap the vesicular unit of underlying flow. Dug wells ending in the vesicular zones may be further depending so as to tap its full thickness. Suitable measures are taken to construct water conservation and artificial recharge structures like rooftop drainage recharge, percolation, trenches / tanks and under-ground bandhara.

Summary and Conclusions

Geomorphological study of the area indicate various units, land forms, lineaments, soil maps and morphometric analysis of the drainage in Ghatkhed mini water shade. On the basis of geomorphological investigation **t**hin soil cover and rock outcrops is marked and the forest is the dominant land use of these landforms. The moderately high hills and medium dissection are the characteristics of this area. This landform characterized by sparse vegetation and thickness of weathering is moderate. The slightly dissected plateau landform is mostly undulating. Moderate to thick soil cover

appreciable zone of weathering and less dissection are main characters of this landform. The undissected plateau landforms are also seen. The weathered landform is also occurs in area. This landform is characterized by the thick soil cover due to highly weathering of the landform. This landform is observed to have considerable thickness of weathered zone, fairly good soil cover tend to identify thick cover of vegetation. The escarpment slope mostly shown in Northern part of area which is surrounded by slightly and moderately dissected plateau. The drainage pattern of the area ranged from dendritic to sub-dendritic and drainage was structurally controlled by lineaments.

The whole study area can be interpreted as moderate morphogenetic region showing horizontal nature of lava flows with a fair degree of uniformity in the rock types. They have undergone the changes brought by the secondary processes like weathering and denudation. The lithological differences in the lava flows (compactness and vesicularity) are mainly responsible for the variation in the landscapes. The linear ridges breaking the monotony of the plain represent the topographic forms developed by intrusive phase of igneous activity which offer more resistance to the weathering agencies and consequently stand on bold relief.

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