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Research paper

Evaluation of Geomorphological Landforms, Lineaments and Landuse/Landcover Using Geospatial Technologies in Parts of Nalgonda District, Telangana State, India.

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Abstract

The present study is aimed to evaluate hydrogeomorphology, lineaments and landuse/landcover aspects of the study area using the IRS-IC & ID images. The false colour composition of IRS-IC & ID images are used for this study. It is advantageous to use satellite multispectral data as the image data in different bands can be exposed to digital improvement techniques. So the differences in objects can be highlighted to enhance the understanding of the image. Landforms are interpreted on the basis of interpretation element keys such as- tone, texture, size, shape, color etc. and extract the specific information from the false color composited LISS-III sensor images. Field observations showed that ground water occurs under unconfined conditions with water table at shallow to great depth. The lineament density map to be prepared to understand the impacts on groundwater percolation. The hydrogeomorphology, Lineament and Landuse/landcover maps are overlaid to trace groundwater potential zones. An integrated remote sensing and geographic Information System (GIS) based approach has been used for demarcating groundwater potential zones. Remote sensing techniques have been used to describe the hydrogeomorphology, land use / land cover and the lineaments of the study area using SPOT and IRS – I D visual products. Based on this the detailed descriptions of geomorphic features of the area are traced. Great emphasis is also given to the study of lineament pattern of the study area, the land use and land cover.

Key words: *Hydrogeomorphology, Geomorphology mapping, IRS-1D, LISS-III, Lineament, Remote sensing, G.I.S.,*

1. Introduction

Groundwater forms a very little quantity when compared to the total water available on the earth. All life directly and indirectly depends on water. So the evolution of life became possible on earth because of the presence of liquid water. The total amount of water available in the hydrosphere is 1386 M.C.M. Out of this, fresh water constitutes 2.5%. The groundwater constitutes 29.9% of the fresh water, of which 0.9% exists in the form of soil moisture, swamp water, perma frost [1].

The day to day increase in demand, availability, and cost factors are playing a major role on the utilisation of the groundwater for water supply needs of townships and rural areas. The availability of good quality groundwater is more important than the quantity.

The study area falls under semi-arid tract and receives scanty rainfall and has limited groundwater resources. It has a limited number of minor irrigation tanks, which rarely get filled. Water quality, especially excess of fluoride concentration in groundwater, is a major concern in the study area. Fluoride levels in groundwater are considerably higher than the permissible limit especially in Nalgonda district which is known for endemic fluorosis. In as many as 1122 habitations in Ranga Reddy and Nalgonda districts, fluorosis is prevalent and they have fluoride content in excess of 1.5 mg/l drinking water.

"Remote sensing is the technique for acquiring the data about an object on the surface of the earth without physically touching it". It has been an important and effective tool to evaluate the hydrogeomorphic and hydrogeological zones, which will be highly depending upon the physical, geological, hydrogeological and geomorphological characteristics. Therefore, studies have been carried out using remote sensing technique for hydrogeomorphological investigations.

It permits planned and systematic evaluation of regional geological structure for their hydrogeomorphological potential. It yields much information regarding the availability of groundwater in almost all terrains considerably reducing much field work.

Remote sensing has been effectively used as an important tool in the study area to delineate hydrogeomorphological features using standard remote sensing techniques. Besides this, the landuse/landcover pattern and lineament studies are also brought out.

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1.1. Location

The area of study lies in between the longitude 79^0 0'-79° 30' E and latitude 16° 45'-17° 15' N. It is located in and around Nalgonda town in Nalgonda district, Telangana state. An area

about 2,880 Sq.Km. in Narkatpalli, Chityal, Katangur, Nakrekal etc. mandals have been selected, to investigate in detail, the occurrence, movement, estimation of the quality and quantity of the groundwater. Moreover earlier it was reported that this area has been highly fluorinated. Fig. 1 shows the map of the study area.

1.2. Drainage

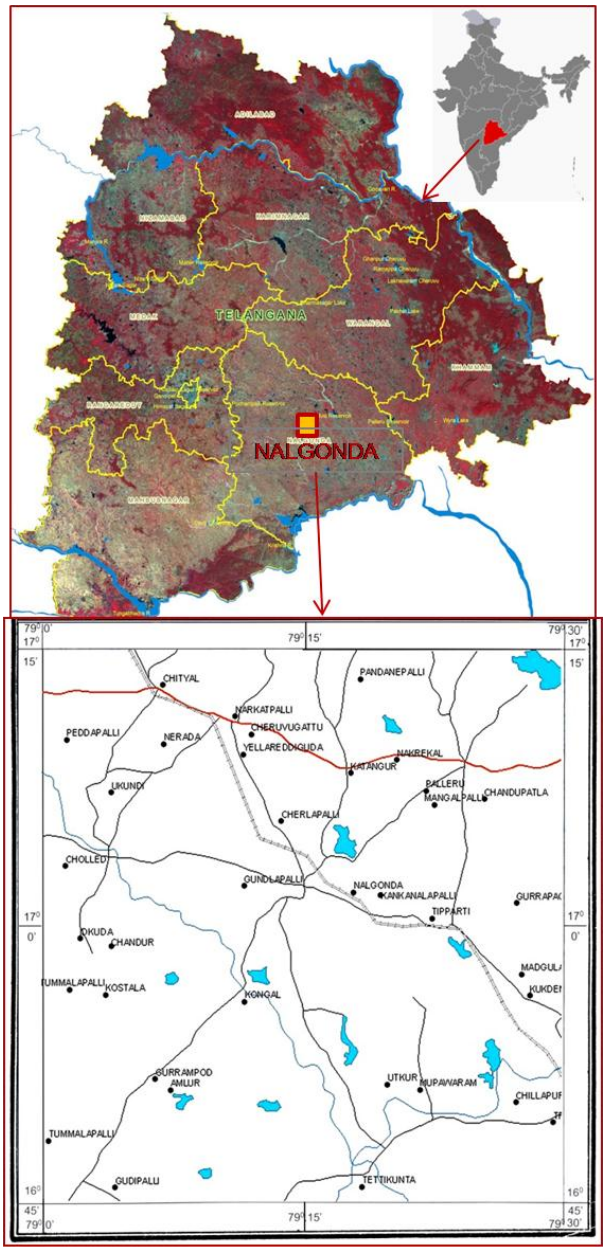

Fig.1: Location map of the study area

There are no perennial streams in the study area. The Palleru river, which is ephemeral in nature, drains from northwest to southeast traversing through the area. Many 1st to 3rd order streams are joining to the main river course. The drainage is medium to coarse textured and dendritic to sub dendritic type, which is characteristic of hardrock terrain and develops in regions of homogeneity. The drainage is mostly structurally controlled and draining through the joints and fractures. The drainage is mainly from northwest to southeast. The shallow valley fill material, mainly sandy in nature underlies the river bed and hence forms very good media for infiltration of rain water to recharge the aquifer. The drainage map shown in the Fig. 3.

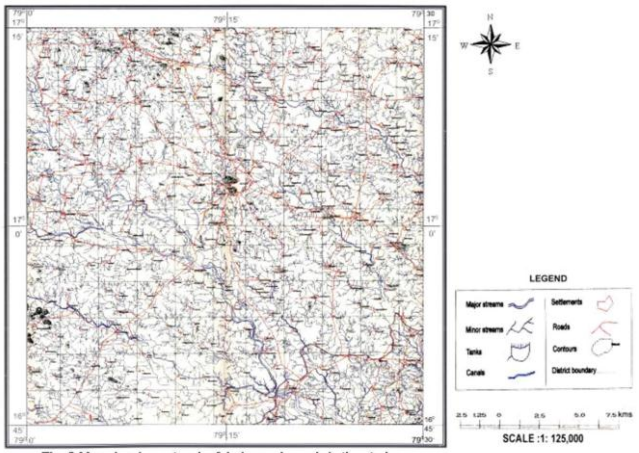

Fig. 3 Map showing network of drains and canals in the study area.

2. Materials and Methods

Preparation of a geological map is the basic requirement to any kind of investigation on land. The geological map can be used to investigate the detailed aspects of land by analysing the results of mineral exploration, groundwater survey and geo-engineering studies.

Toposheet study and visual interpretation techniques, limited field checks are adopted to prepare the geomorphological features. The entire study area has been interpreted using the false colour composite of (FCC) IRS – 1C & ID images and prepared the hydrogeomorphological map, incorporating the geological, structural and groundwater data.

Based on the Hydrogeomorphological studies the area is devided into Plains, Hilly terrain and Valleyfill sediment.

In lithology various geomorphic units have been interpreted from satellite imagery and the hydrogeomorphological map was also prepared by incorporating the geological, structural and groundwater data.

The major geomorphological units identified in the study area helped in the preparation of a complete hydrogeomorphological map. This is shown in Fig. 4.

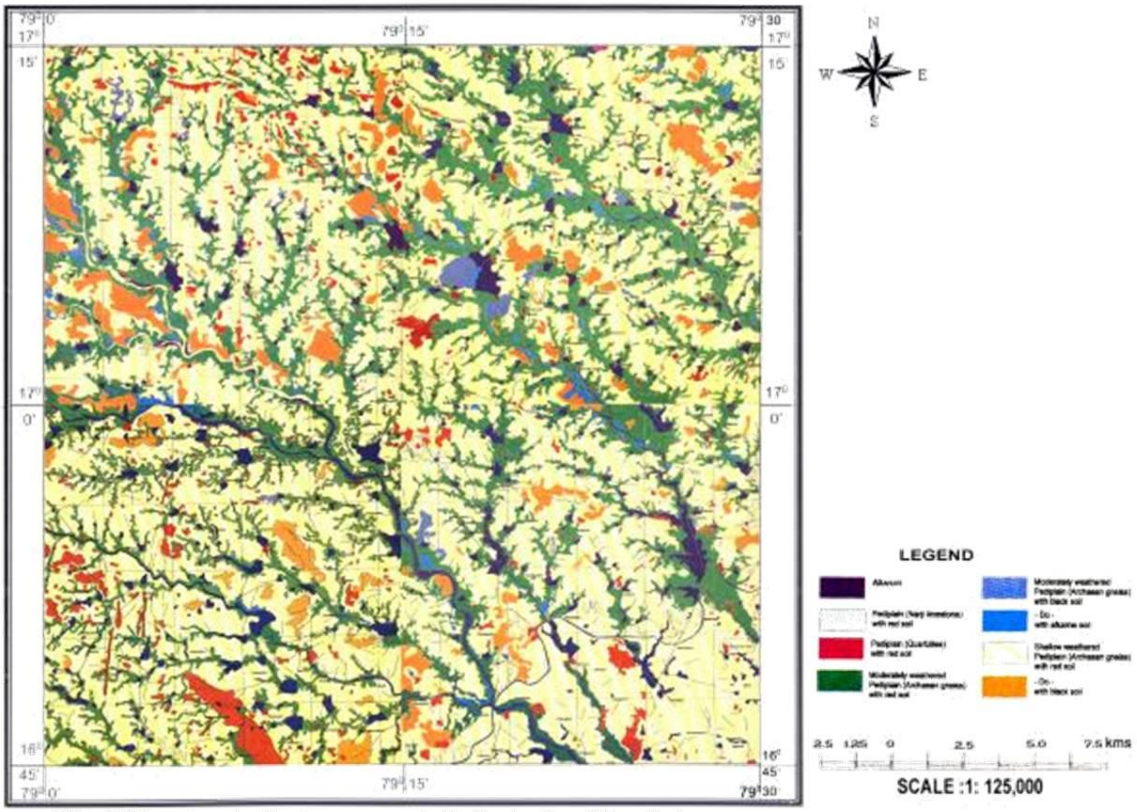

Fig. 4 Map showing hydrogeomorphological units of the study area.

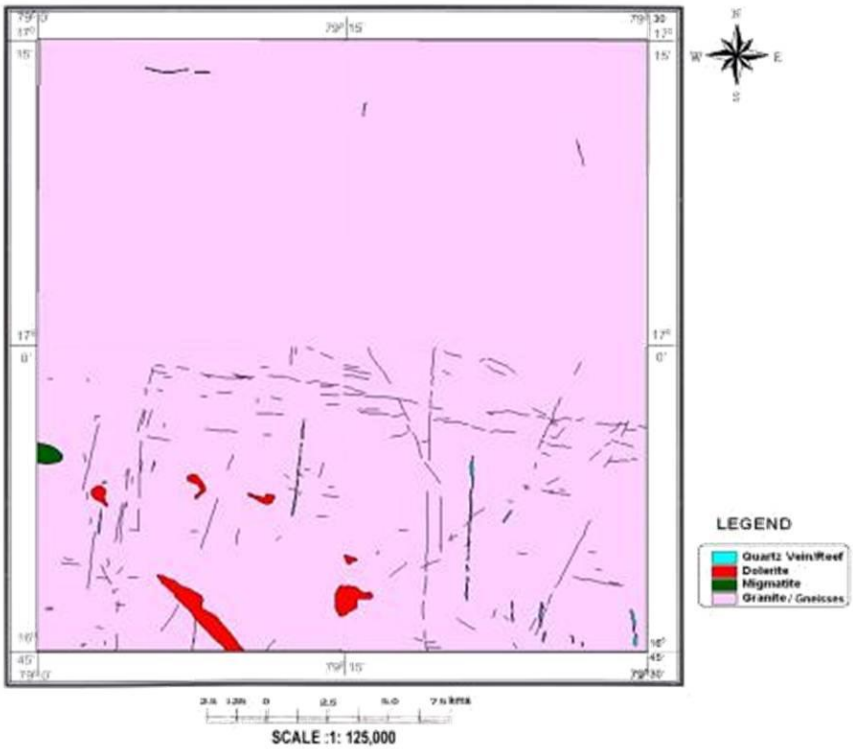

Fig. 2 Geological map of the study area.

Remote sensing has become the most powerful scientific tool for the study of various earth resources and related features. The application potential of remote sensing is so huge that the large areas of land can be studied for various applications within a very short period. The advent of multispectral satellite imageries has revolutionised the remote sensing activity. The characteristic parameters which play an important role in remote sensing for resources are spatial resolution, spectral band widths, repetitive coverage and radiometric sensitivity. In the present study, imageries from IRS – IC & ID have been utilised.

For visual interpretation different types of images are identified from the false colour composite (FCC) IRS 1C & ID for visual interpretation. This type of elements of interpretation of hydrogeomorphological, lineament and landuse / landcover are used.

A mappable, simple or composite linear feature of a surface is called a lineament. Its parts have a rectilinear or slightly curvilinear alignment. They differ distinctly from the patterns of adjacent features showing a subsurface phenomenon.

Lineaments are seen as linear tonal discontinuities in an image, on the satellite false colour composite (FCC). These are identified by standard visual remote sensing techniques and traced out. Linear streams, valleys, fractures, faults, linear growth of fauna etc. give rise to major lineaments.

Land use / land cover information is the basic prerequisite for land, water and vegetation resource utilisation, conservation and management. Land use means activities carried out on land and various uses of land. Land cover means natural vegetation, water bodies, rock/soil artificial cover etc. seen on the earth's surface.

During interpretation of landuse/landcover, various features of the study area have been mapped using remote sensing techniques.

3. Geology of the Study Area

The area of study is geologically a part of Indian peninsular shield. It comprises of Archaean formation known to be geologically the oldest. It is also combined with Proterozoic formation combined with Peninsular gneissic complex rocks. They were also deposited in shallow basins. Later dykes of dolerite, veins of pegmatite and quartz got into these basic rocks

The present study area covers around 2880 sq.kms. and stretches along the northern bank of the Krishna river. The study area is mostly rugged granitic plain which descends towards south-east, where the altitude of the hills ranges from 635 m (in the northwest) to 128 m (in the southeast).

The chosen area is underlain by crystalline rocks and consists of Peninsular gneissic complex i.e. pink and grey varieties of granites and granitic gneisses of Archaean age. The pink and grey granites are intruded by dolerite dykes and followed by injection of quartz, feldspar, pegmatite and epidote veins. Dolerite dykes mark the last period of igneous activity. There have also recent alluvial deposits in the area. They are confined to the valleys between the hill ranges as valley fill deposits and the flood plains of Hallia and Konagal rivers and also to the narrow thin patches along the streams [2]. The geology map shown in the Fig. 2.

4. Results and Discussion

4.1. Hydrogeomorphological Studies

Toposheet study and visual interpretation techniques, limited field checks are adopted to prepare the geomorphological features. Based on the studies the area is devided into Plains, hilly terrain and lineaments. The lithology various geomorphic units have been interpreted from satellite imagery and the hydrogeomorphological map was also prepared by incorporating the geological, structural and groundwater data [3].

4.1.1. Denudational Hills

Hills are denuded because of differential erosion and weathering. They stand as mountains, mountain hills or relief hills exhibiting themselves as barren and rocky with steep sides. Their structures consist of fractures, joints and lineaments. They have mostly Peninsular gneissic complex group of rocks. These hills are relatively low relief features and less aerial extension occurring on the plains. These landforms occur both on fluvial plain, piedmont and pediplains.

This type of units situated near the villages of Chityal, Raegudem and Peda, western part of Nalgonda, Sarpalapalli, Muhammadapuram.

4.1.2. Residual Hills

These hills are relatively low relief features wtih less aerial extension occurring on the plains. These land forms occur both on fluvial plain, piedmont and pediplains. These residual hills formed as material left behind when part of the rock is removed by erosional process. These geomorphic units were in Narkatpalli, Gopalpally (Venugopalaswamy gutta), Wanipakala, Gummabhaigudem, Lingotam, Cheruvugattu, Yellareddiguda, Urmadla, Boyagudem, Pallipahad and Yerrapalli.

4.1.3. Inselbergs

A steep sided, round topped mound, which occur in isolation or as one of a group, rising above the general level of a pediplain have been identified as inselbergs. They have been mainly formed with granitic gneiss found in the villages of Dupalli, northwestern side of Annawaram, Makkapalli, Jalagambavitande, Muhammadapuram, Tummalapalli, Embavi, Gopalapalli, Narkatpalli, Nerada and Nimmani

4.1.4. Pediplain

Pediplains with over burden of weathered or deposited materials have been identified as buried pediplains. Rock formations subsequently undergo weathering. The degree and thickness of weathering depends on the nature of slope, resistance of the underlying rock to weathering, presence of joints and fractures, precipitation and climatic conditions of the area. On the basis of the thickness of the weathered / deposited mantle, the buried pediplains have been divided as follows.

1. Shallow weathered pediplain.
2. Moderately weathered pediplain.

4.1.5. Shallow Weathered Pediplain (Nargi Limestone) with Red Soil

This pediplain consists of Limestone and Dolomite, and has flat and smooth surfaces. It also shows fractures and lineaments. The lower part of the formation is a massive limestones, often with pleasing colours, uniform grain and compact. The upper part is usually argillaceous, flaggy limestones yielding slabs of various sizes, of light to dark grey colour slabs from 1.27 cm, 25.4 to 38.1 cm thick and upto 1.75 meters of 2 meters long and 40 cm to 90 cm. wide can be obtained. Pediplain forms 0 m–5 m thick sediment file. It is formed due to weathering of limestone and dolomites. It has unconsolidated alluvial material made up of rock debris and soil thickness of 0 m–5 m with constant recharge from streams offering poor to moderate yields along fracture / lineament zones for groundwater exploration. This types of pediplain is found on the northern side of Bodamparti village, northern side of Koratical village along the meander of Konagal river.

4.1.6. Shallow Weathered Pediplain (Quartzite) with Redsoil

It consists of unconsolidated material made up of rock debris and soil thickness of 0 m to 5 m with constant recharge from streams offering moderate yields along fracture/lineament zones for groundwater exploration. This type of pediplain from quartzites which is found around Walal village.

4.1.7. Shallow Weathered Pediplain (Archaean Gneiss) with Red Soil

This pediplain consists of Archaean granite rock having flat and smooth surface. It also shows fractures and lineaments. Pediplain forms 0 m–5 m thick sediment. It is formed due to intensive weathering of Archaean gneisses. It consists of unconsolidated alluvial material made up of rock debris and soil thickness of 0 m–5 m with a constant recharge from streams offering poor to mod-

erate yields along fracture/lineament zones suitable for groundwater exploration. This shallow weathered pediplain of Archaean gneiss with red soil exposed in 60% of the study area.

4.1.8. Shallow Weathered Pediplain (Archaean Gneiss) with Black Soil

This area is exposed in some places mostly adjacent to the moderately weathered pediplain, which is located all along either side of the streams in the study area.

4.1.9. Moderately Weathered Pediplain (Archaean Gneiss) with Red Soil

Moderately weathered pediplain is a gently undulating plain with less than 15 m thickness weathered file. This unit consists of unconsolidated alluvial material made up of rock debris and soil deposited in pediplain areas. These fills are fairly thick with constant recharge from the streams offering moderate to good potential with sustained yields due to high recharge. It is suitable for dug wells and shallow bore / tube wells. This area is occupied either side of all the existing streams in the study area

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4.1.10. Moderately Weathered Pediplain (Archaean Gneiss) with Black Soil

This unit occupied in the study area around the villages of Pitampalli, Banganicheruvu, Urmadla, Aurawani, Gandhinagar, Turupugudem, Chikatimamidi, Pericakondawaram, Ramachandrapalli, Tatikal, Bandapalem, Aralbhavi, Pangal, Chandanapalli, Erragaddagudem, Aragudem, Turkanibavi, Mallawaram, Phulmandi and Pusalpahad

4.1.11. Moderately Weathered Pediplain (Archaean Gneiss) with Alkaline Soil

This unit occupied in the study area around the villages of Pedapalli, Raegudem, Mogilidori, Yellareddiguda, Tipparti, Ukundi, Singaram, Ratipalli, Anaparti, Turupugudem, Chikatimamidi, Marrigudem, Cholled, Mungod, Pullentla, Bodamparti, Kodandaput, Taskanigudem, Sirdepalli, Pagdumarri, Palem, Pericakondawaram, Pamangundla, Ammatvagu, Resulgudem, Ramachandrapalli, Tatikal, Mangalpalli, Nakrekal, Godavarigudem, Baddagudem, Dandempalli, Arajabhavi, Nalgonda, Gurrapagudem, Gaddikondawaram, Seshammagudem, Kottagudem, Kankanalapalli, Sarvayyagudem, Chandur, Regattu, Ampur, Venkatadripalem, Mukkamala, Gudipalli, Dupalapalli, Rajpet, Ganganapalem, Keshavapuram, Dacharam, Gundravanigudem, Mallawaram, Phulmandi, Utkur, Kupaspalli, Palem and Anmola.

4.1.12. Alluvium

These deposits are found along the flood plains of Hallia and Konagal rivers to the north and northeast of Chandur and Mungode villages.

4.2. Lineaments

The lineaments in the study area are present in different directions with different lengths. Fig.5 shows that the majority of lineaments having the trend N 20^0 W to E-W, with 52.94% of lineaments are found in this direction [4]. In the north eastern direction the major set of lineament trend N20^0E to E-W with 43.05% of lineaments are found in this direction. Apart from this some of the lineaments trends N-S direction i.e., 3% and E-W direction with 2% [5]. A map of the entire area of study has been drawn , indications areas of high, moderate and low density lineaments based on the studies on lineament density (Fig. 6).

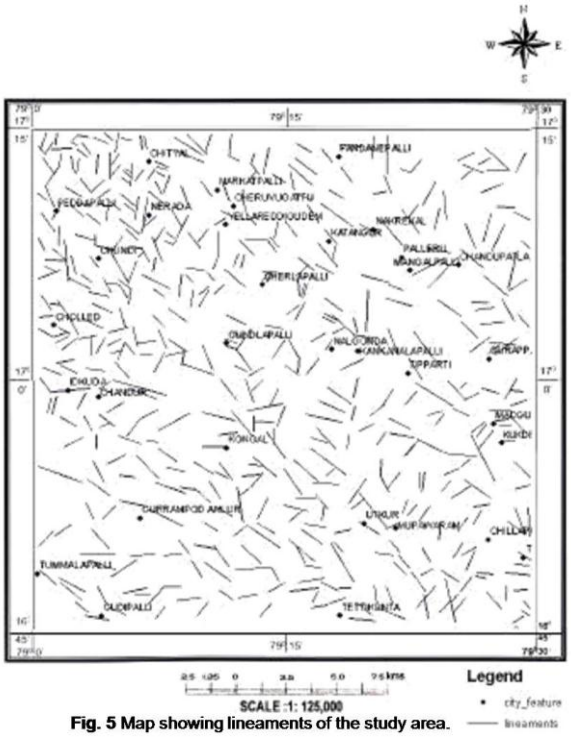

Fig. 5 Map showing lineaments of the study area.

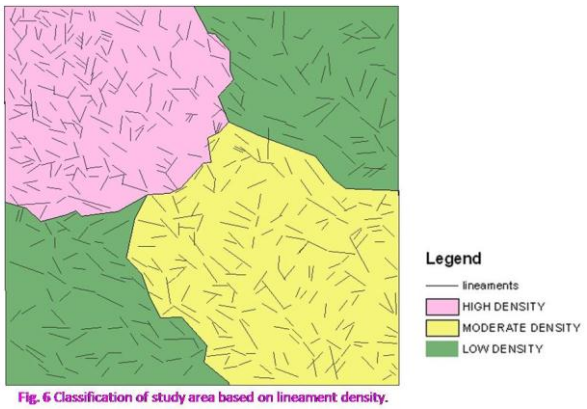

Fig. 6 Classification of study area based on lineament density.

4.3. Landuse / Landcover Categories

It has been found that most promising groundwater potential zones coincide with the double cropped agricultural land. Landuse/landcover have been identified, and a brief description of each category is presented below [6] and [7]. Fig.7 shows the landuse/landcover map of study area.

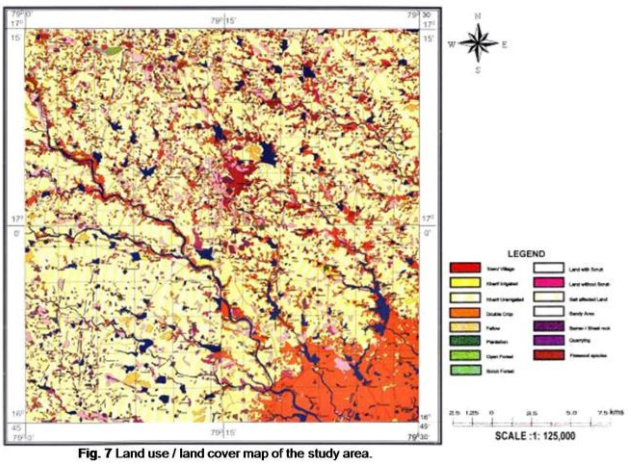

Fig. 7 Land use / land cover map of the study area.

4.3.1.Town / Village (Builtup Land)

An area of human habitation developed due to non agricultural use and has a cover of buildings, transport, communication, utilities in association with water, vegetation and vacant lands is called a built up land. It can be a town or village. All settlement areas of Chityal, Cheruvugattu, Yellareddiguda, Nalgonda, Cherlapalli, Idkuda, Chandur, Kostala, Konagal, Gurrampod, Amlur, Nakrekal, Mangalapalli, Chandupatla, Kankanalapalli, Tipparti, Madugulapalli, Kukadem, Utkur, Chillapur, Tummalapalli, Gudipalli, Peddapalli, Ukundi, Gurrapagudem, Mupawaram, Tripuravaram, Gundlapalli, Katangur, Cholled, Nerada, Pandanepalli and Tettikunta are built up lands in the area of study.

4.3.2. Agricultural Land

The land primarily used for farming and for production of food, fiber, other commercial and horticultural crops it is termed as agricultural land. It includes land under crops fallow, plantations etc.

4.3.3. Crop land

Those lands with standing crop as on the date of the satellite image is cropland. The crops may be of either Kharif or Rabi seasons **.**

4.3.4. Kharif Irrigated

Single crop cultivated areas are very few in the study area which are located in and around Kistapuram, Aneparti, Chikatimamidi, Raegudem, Gudivada, Gollaguda, Rayapuram, Duppalapalli, Erragaddagudem, Bangarigadda, Tummalapalli, Chandur, Gundrapalli, Kostala, Yadavalli, Timannagudem, Venkatapuram, Guntipalli, Timmapur, Ganganapalem and Tettikunta .

4.3.5. Kharif unirrigated

This kharif un-irrigated area is nearly 40% - 50% the area of study.

4.3.6. Double Crop

Many of the places in the area of study come under this category. In these area very large groundwater potential zones are located .

4.3.7. Fallow

Fallows are generally found where water facilities are limited and also due to shifting cultivation. These features can be observed at Raegudem, Peddapalli, Chandampalli, Aurwani, Kompalli, Donka, Anantaram, Pagdimarri, Kodandaput, Bopatkuntla, Gollaguda, Ammatvagu, Mangalapalli, Kottagudem, Annawaram, Samalpalli, Tummalapalli, Mallapur, Dacharam, Torgan, Guntipalli and in marshy areas.

4.3.8. Plantations

An area under agricultural tree crops, planted adopting certain agricultural management techniques is called plantation land. Tea, coffee, rubber, coconut, areca nut, citrus, orchards and other horticultural nurseries are cultivated. These areas are located in the villages of Naibhavi and Lingotam.

4.3.9. Forest

An area (within the notified boundaries) bearing an association predominantly of trees and other vegetation types capable of producing timber and other forest produce.

4.3.10. Open Forest

All hills and foot hill areas in the study area come under this land cover zone. It is situated on Chityal village and other hills.

4.3.11. Scrub Forest

It is described as a forest where the vegetative (crown) density is less than 20% of the canopy cover. It is the result of both biotic and a-biotic influences. Scrub is a stunted tree or bush /shrub. It is located near Raegudem village.

4.3.12. Land with or Without Scrub

They occupy (relatively) higher topography like uplands or high grounds with or without scrub. These lands are generally prone to degradation or erosion. These exclude hilly and mountainous terrain**.**

4.3.13. Land with or without Scrub

It is an area (within the notified forest boundary) bearing an association predominantly of trees and other vegetation, capable of producing timber and other forest products. All hills and foot hill areas in the study area comes under this land cover zone. This unit occupied nearly 10% - 15% of the study area.

4.3.14. Wastelands

It is described as degraded land which can be brought under vegetative cover with reasonable effort, and which is currently underutilised and land which is deteriorating due to lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed constraints such as by location, environment, chemical and physical properties of the soil or financial or management constraints.

4.3.15. Salt Effected Land

Salt affected land is generally characterised as the land that has adverse effects on the growth of most plants due to the action or presence of excess dissolved sodium salts. This salt effected areas were associated with stream flowing areas and tank surrounding areas, which are along the banks of Cholled, Sirdepalli, Narsimbatla, Anantaram, Tipparti, Binbavi, Ramachandrapalli, Baddagudem, Seshammagudem, Gurrapagudem, Mallepalligudem, Chandur, Venkatapuram, Kukdem, Marepalli and Utkur were identified.

4.3.16. Sandy Area

The areas with stabilised accumulations of sand unchanged or transported in riverine or inland (desert) areas. These are found in the form of sand dunes, beaches, channel (river/stream) islands etc. This type of area has been identified at Yapalgudem, Sarvaram villages**.**

4.3.17. Barren / Sheet Rock

The rock exposures of varying lithology often infertile and devoid of soil cover and vegetation are termed as barren land. They occur amidst hill forests as openings or scattered as isolated exposures or loose fragments of boulders or as sheet rocks on plateau and plains. This type of area has been identified at hills of Gudibund, Venugopalaswamy gutta, Cheruvugattu, Tirumalagiri etc .

4.3.18. Quarrying

A quarrying unit is identified at Tirumalagiri .

4.3.19. Fire Wood Species

20% of the area of study is on top of hills and mounts where fire wood species grow.

5. Conclusions:

Geologically the area is marked by granite gneisses with local variants such as grey granites, pink granites, migmatites, aplites and younger basic intrusives like dolerites. Remote Sensing studies revealed that geomorphologically the area is marked by features such as denuded hills, residual hills, inselbergs, pediplains of different types and alluvial cover. Erosion and weathering process creates denudation hill and is poor to infiltration of surface water. Residual hills has very low groundwater potential as they are unfractured rock and have low infiltration. The landuse/landcover studies revealed that land under use include built up land, agricultural land, forest land, waste land, salt effected land, sandy areas etc. The landuse/landcover of an area gives excellent idea about the occurrence of groundwater of that area. For example, the area which favours the intensive agricultural activities, indicate the areas where groundwater resources are promising and have been developed. A sudden change in landuse/landcover may be indicative of change in hydrogeological conditions. Anomalous growth of vegetation or the presence of perennial and healthy vegetation in low lying areas may be indicative of the presence of high moisture zones and shallow aquifers. Land use planning is continuous process. It is necessary to understand the existing geomorphic units and extents for future land use planning. Based on mapped geomorphic units, local and government authority can make decision to land use planning. As far as the lineament pattern is concerned the highest lineament density occur in the northwestern part followed by moderate lineament density in southeastern and northeastern parts. The southwestern part show relatively less number of lineaments. So, low lineament density indicates low infiltration rate, whereas the high lineament density areas indicate high infiltration for a potential zone for groundwater development. The Hydrogeomorpholgy analysis of a study area is a very simple tool, which covers the modern techniques of remote sensing and GIS. The technique coupled with geological data can certainly be used in evaluating the parameter pertaining to groundwater and accurate zoning of groundwater potential of a region.

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