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HYDRO GEOMORPHOLOGICAL STUDIES FOR GROUNDWATER PROSPECT ZONES USING GIS AND REMOTE SENSING TECHNIQUES IN CHITYALA MANDAL, NALGONDA DISTRICT

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Abstract-Optimal management of natural resources has become a critical requirement in these days of increased industrial development and growing population natural resource management therefore has to be the key pin for an effective strategy for rural development.Where,Water is the prime natural resource for human beings and hence precious natural asset. The easy and cheaply available ground water is the most important resource for domestic, industrial and agricultural uses.

However, rapid growth of Population, vagaries in monsoon, expansion in irrigation, increased industrialization etc. have resulted into enhanced demand for ground water in various parts of the country. As a result, the ground water prospecting, exploration and management have become a big task in India in general, and certain drought prone areas in particular. Hence, in the current scenario, it has become crucial not only to find ground water potential zones, but also to monitor and conserve this important natural resource.

Hydro-geomorphological mapping is carried out at Chityala Mandal in Nalgonda District, Telangana State using integrated remote sensing and GIS based techniques. The study is to assess the natural resource potential and their spatial variability of geology, hydro-geomorphology, soils, surface water resources, ground water resources, land use /land cover, at cadastral level using high resolution satellite data (IRS-P6-LISS-IV) generation of natural resource information on 1:10,000 scale. Data is analyzed using GIS and preparation of action plans were suggested based on the geo-hydrological characteristics and agricultural needs.

1. INTRODUCTION

1.1 Background

The information on availability of surface and ground water helps in the process of planning and development. The surface water resources are inadequate to fulfill the water demand for agriculture and other purpose. Productivity of ground water can be increased through proper development and exploitation in the study area. Keeping this in view, there is a requirement to select suitable sites for ground water exploration in hard rock areas using an integrated approach of remote sensing, GIS and hydro geological characteristics and to evaluate the ground water potential of Chityala Mandal located in Western part of the Nalgonda District, Telangana State, India..

Remote sensing provides multi-spectral, multi-temporal and multi-sensor data of the earth's surface. One of the greatest advantage of using remote sensing data for hydrological investigations and monitoring is its ability to generate information in spatial and temporal domain, which is very crucial for successful analysis, prediction and validation. Satellite data provides, quick and useful baseline information on the parameters controlling the occurrence and movement of ground water like geology, structure, geomorphology, soil, land use / land cover. (Krishnamurthy, J and Srinivas G (1995)).

1.2 Objective

The main objective is to increase crop production through efficient use of available surface and groundwater resources, restoration of eco-balance through land use system and enhancing the income levels of the rural households through adoption of subsidiary activities in farm and non-form activities at cadastral level.

In this context thematic data like land use / land cover, soil resources, hydro geomorphology, action plans at cadastral level, groundwater potential zones, Rain Water Harvesting Structures, fracture zones identification would be carried out using Remote sensing and GIS techniques.

2. STUDY AREA

2.1 Location and Extent:

Chityala Mandal is located in Western part of the Nalgonda district. The Chityala mandal is about 25 km in North-West direction from Nalgonda district head quarter. The extent of the Chityala stretches from between 17°11'26" and 17°13'83" North Latitudes, and 78°57'38" and 79°11'3" East Longitudes. The Geographical

area is 26,000 hectares, (260 sq km) and the elevation is between 420 to 300 m above MSL and it falls in 1:25,000, Survey of India, Toposheet (56O/4. of NE, NW).

2.2 Methodology

The satellite data has been used for updating of drainage and surface water bodies. The LISS-IV image is a multi-spectral data with a spatial resolution of 5.8m. Location map and Satellite image of the Chityala Mandal is shown in Fig:2.1 and Fig:2.2. Preparation of pre-field lithological, structural and Geo-morphological map units were carried out and Field checks, ground truth collections were identified such that each of the interpreted unit is represented by ground observations. Subsequently the lithological, structural and Geomorphlogical maps have been combined to prepare Hydrogeomorphological Map, on 1:10,000 Scale.

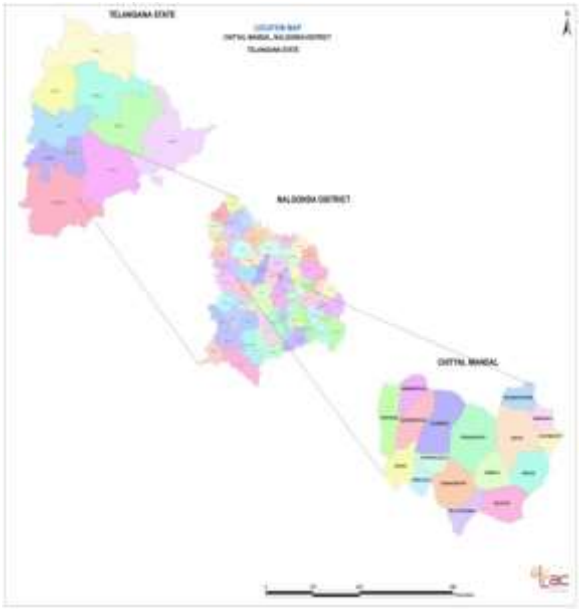

Fig. 2.1 Index (Location) Map of the Chityala Fig. 2.2 Satellite Map(LISS IV) of the Chityala Mandal

2.3 Accessibility

The study area is a part of Nalgonda district, it can be approached by National highway – 9, which is passing through the study area and is also connecting three states Maharashtra, Telangana and Andhra Pradesh. Study area is located 20 km NW of the Nalgonda and about 50 km East of Hyderabad .The Study area is well connected by road from Hyderabad and Rajiv Gandhi International airport, This area is well connected by Railway line from Hyderabad -Vijayawada-Guntur,Vizag. The Major roads and unmetalled roads are digitized and updated from satellite image Shown in Fig. 2.3.

2.4 Physiography & Drainage

The study area exhibits Plains, Pediments, the middle part of the study area exhibits dykes and small hills. The area has general slope towards South and Southeast. The main stream is Peddavagu passing through Gundrampalli and Epuru villages towards Southeast. Apart from this, many minor streams are present in the area and have their general trend towards South and Southeast . The drainage is mostly controlled by the geology and structural pattern that exists in the area. In this area drainage pattern is mainly Dendritic drainage. Dolerite dyke is present in between Peddakaparthy and Chityala villages, which has got the highest elevation(420m) in this area.

2.5 Slope

Slope map of the area provides information regarding the distribution of various slope elements. The slope elements in turn are controlled by the climatomorphogenic processes in the area underline by rocks of varying resistance. The analysis of slope and its representation on map has been one of the important subject matters of research by Geomorphologist, Hydrologist, Planner and Engineer because several problems like precipitation, run-off and infiltration, etc., are directly associated with slopes. For land use planning, the degree of slope is a major controlling factor.

2.5.1 Classification

The slope map has been prepared on 1:50,000 scale. Steeper slopes of more than 35% can be further sub-divided as per local need especially in hilly areas. The aspect indicating flowing directions is depicted on slope map for the last two categories of slope (having more than 15% of slope). Slope map shown in Fig. 2.4.

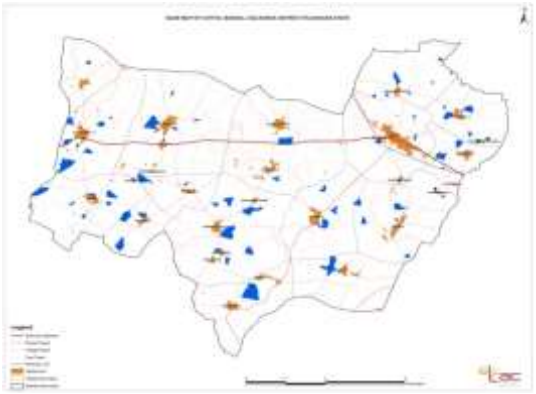

Fig. 2.3 Base Map of the Chityala Mandal

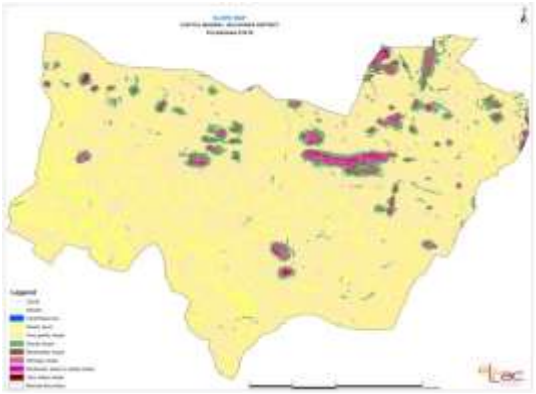

Fig. 2.4 Slope Map of the Chityala Mandal

2.6 Geology & Structure

Chityala mandal is underlain by the formation of South Indian Peninsular shield consisting of older Metamorphic, Peninsular Gneissic Complex, which belongs to the Achaean age. The Peninsular Gneissic Complex are intruded by younger Granite, basic intrusive (dolerite dykes), Quartz & Pegmatite veins. And they are younger than the Achaeans. Quartz veins and Dolerite/ Gabbro intrusive are Lower proterozoic age. Geologically Study area is stable and consisting of hard rock terrain of granite gneiss. These geological factors have a bearing on the capacity of the rocks to hold and transmit groundwater.

The area is marked by numerous fractures and the drainage is mainly controlled by these fractures/lineaments. A number of lineaments running in SE directions are identified. The SE-NW lineaments are more prominent. That study area dolerite dykes are structurally 2 directions one is NE-SW, and second one is NW-SE.

LITHOLOGY	AGE
DOLERITE/GABBRO (Basic intrusive)	LOWER PROTEROZOIC
PENINSULAR GNEISSIC COMPLEX (Granite, Granodiorite and Granite Gneiss)	ARCHAEAN

2.7 Land Use / Land Cover

Land use refers to "man's activities and the various uses which are carried out on the land". Land cover refers to "natural vegetation, water bodies, rock/soil and other natural covers". The information on land use/land cover in the form of maps and statistical data is very important for spatial planning and management of land resources. Further, an understanding of the dynamics of land utilization aspects, such as pattern, fallow lands, forest and grazing land, wasteland, surface water bodies etc., help to plan for optimum land use for sustainable development (NRSA -2011 SIS-DP) Today, there is plenty of information available on land use/land cover in the form of maps ,records and statistical figures.

2.8 Description of Land use / Land cover Classes

2.8.1 Built Up Land

It is defined as an area of human habitation developed due to non-agriculture activities that include buildings, transport, communications, utilities in association with water and vegetation. Total numbers of villages covering in the Chityala mandal in the Built-up area covers 6.32Sq km.

2.8.2 Agricultural Cropland

These are the areas with standing crop as on the date of satellite overpass. They are widely distributed in different terrains; prominently appear in the irrigated areas irrespective of the source of irrigation. This also includes fallow lands. Agricultural land occupied 190 Sq km in the study area.

2.8.3 Agricultural Plantation

This category includes the horticulture areas that refer to cultivation of Mango, citrus fruits, orchards and other horticultural nurseries, shrubs, fruits, , vegetable gardens etc. mostly under irrigated conditions. Agricultural plantation occupied 7.39Sq km in the study area.

2.8.4 Forest

Forest areas bearing an association predominantly of trees and other vegetation types (within the notified forest boundaries) capable of producing timber and other forest produce. Forest area covered 1.55Sq km. These areas are separable from cropland, especially with the data acquired during kharif season. Plantations appear in dark-red to red tone with regular and sharp edges indicating the presence of a fence around it.

2.8.5 Waste Lands

This category has a similar description as mentioned in the earlier class excepting that they possess sparse vegetation or devoid of scrub and have a thin soil cover. 42.55Sq km area covered in this study area.

2.8.6 Barren/Rocky/Stony Waste

The rocky lands can be easily discriminated from other categories of wastelands because of their characteristic spectral response. They are located in steep isolated hillocks/hill slopes, crests, plateau and eroded plains associated with barren and exposed rocky/stony wastes, lateritic outcrops, mining and quarrying sites. 2.079Sq km area covered in this study area.

2.8.7 Water Bodies

6.96Sq km area covered Water bodies in the study area. Rivers/streams are natural course of water flowing on the land surface along a definite channel/slope regularly or intermittently towards a sea. They are useful source for ground water recharge. LU/LC Map of the study area at cadastral level and statistics of resources is shown in Fig.2.5.and 2.6.

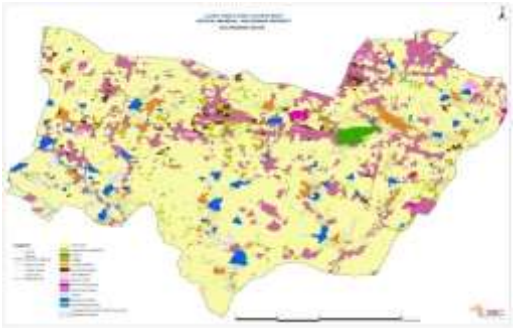

Fig. 2.5 LU/LC Map at Cadastral Level of Chityala Mandal

Fig. 2.6 LU/LC Statistics of Chityala Mandal

2.9 Hydro Geomorphology

The procedure adopted to prepare the hydro geomorphology map of the project area is given in the flow. It consists of basically four distinct parts. They are

- Acquisition of satellite and collateral data
- Preparation of pre-field interpretation maps
- Limited field checks in the doubtful areas and
- Preparation of hydro geomorphological map

The hydro geomorphology units obtained are moderately weathered pediplain, Shallow weathered Pediplain, Denudational hill, Isenberg, Dyke and Pediment.

2.9.1 Moderately Weathered Pediplain (PPM)

It is a gently sloping smooth surface of granite gneiss with more than 5m depth of weathered material, generally covered with red soil. In general, the ground water prospects are moderate to good. Good yields can be expected along fractures / lineaments with yields. These landforms are observed only in the Granite and they occupied major part of the area, and mainly, confined to the major rivers, streams and narrow valley zones. Ground water development is extensive in these areas due to the availability of good ground water potential. These landforms are developed throughout Study area.

2.9.2 Shallow Weathered Pediplain (PPS)

It is a gently sloping smooth surface of Granite gneiss with less than 5m depth of weathered material, generally covered with red soil. The ground water prospects are poor to moderate.

2.9.3 Residual Hill (RH)

It is an isolated low relief relict hill occupying considerably small area. The ground water prospects are poor. These landforms are seen in the granite rocky terrain of the area. These landforms are located in the North part and NE part of Study area.

2.9.4 Pediment (P)

It is a gently sloping rock-cut surface of granite with thin veneer of detritus. In general, the ground water prospects in a pediment area is poor. These rock-cut outcrops are exposed extensively near northeastern part of the Study area.

2.9.5 Dyke/Dyke Ridge/Quartz Reef (D/DR/QR)

It is a vertical to steeply dipping highly jointed basic/acid intrusion exposed in the form of a linear heap of boulders. In general the ground water prospects are poor. Moderate yields are expected on the upstream direction of a dyke/dyke ridge/quartz reef. These landforms are developed in the Middle and Eastern part of the Study area.

3. GROUND WATER PROSPECTS

Study of geological, hydrological, and meteorological data provides information on the parameters such as rock types, geological structures, landforms, and recharge conditions which control the occurrence and distribution of ground water. The study area is divided into various Hydro geomorphic units based on landforms, genesis, geology, soils etc.

The major landforms of the area include shallow weathered pediplains, moderately weathered pediplains, denudational, residual hills, inselbergs, pediment and Dykes. The ground water prospects in shallow weathered pediplains are moderate to poor and while in moderately weathered pediplains the prospects are good to moderate. In pediments, the ground water prospects are negligible to poor while in hilly areas it is negligible to poor. Excellent groundwater prospects may be expected in the fracture valley depending upon the thickness of the weathered material.

In the Study area, the groundwater occurs in the weathered and fractured rocks under water table and semi-confined conditions. The study area is predominantly underlined by hard rock's which have very low permeability or transmissivity values. But, due to the development of secondary porosity with the introduction of fracturing and weathering, they have improved chances of tapping potential aquifers. The presence of dykes as barriers to ground water movement also has improved yield prospects of the aquifers existing upstream of the dykes . The degree of weathering in the hard rock's varies from a meter to as much as more than 15 m.

The degree of fracturing and depth of fracturing vary from place to place. In general, as evidenced by CGWB exploratory drilling in the district, the intensity and occurrence of fracturing reduce after 80 Ft depth and mostly poor after110 Ft depth.

North-eastern part of the study area consists of pediments and Residual hills with poor to negligible ground water prospects, in western part of the watershed is shallow weathered Pediplain with moderate to poor groundwater conditions.

To arrive at local specific recommendations(water conservation methods) at village level, hydrogeomorphological map to identify / proposed rain water structures like check dams recharge pits etc., Rainwater harvesting structures like check dams percolation tanks, farm ponds are already in progress, observed from field work. The construction of the artificial recharge structures should be taken up on the designed for 50% of non-committed run-off so as not to deprive the downstream watersheds (Waltz, F.A. (1986). The predominant groundwater irrigated areas along lineament, and facture systems brought out by satellite data interpretation are of immense use of for taking up artificial recharge structures. The locations which are recommended for artificial recharge structures (check dams) are upstream of the irrigated areas and some recharge pits are proposed in and around the village settlement locations for recharge the ground water through surface runoff which is useful for sustaining the drinking water bore wells.

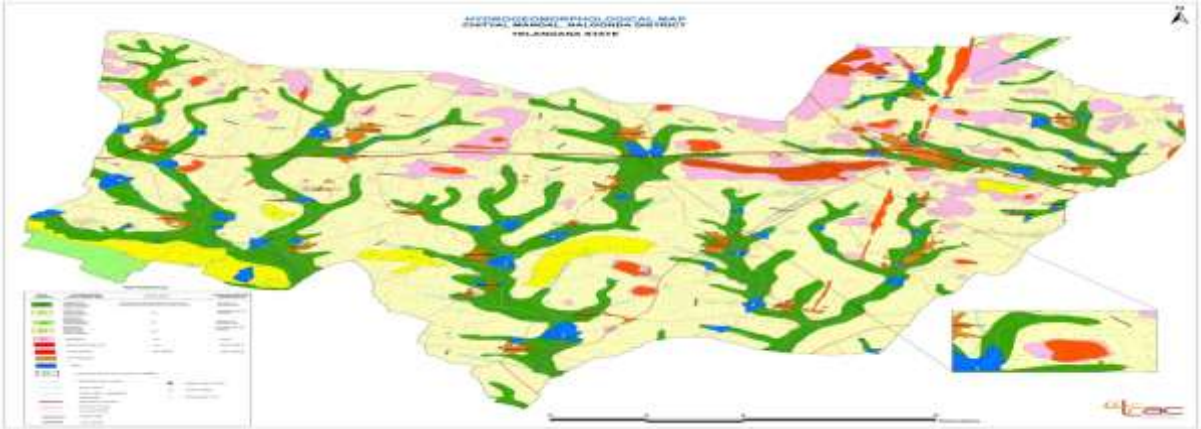

Fig. 2.7 Hydro Geomorphological Map of the Study Area at Cadastral Level

CONCLUSIONS & OBSERVATIONS

The observations are as follows:

- Based on the Hydro geomorphology map Hill with Granite are having negligible ground water prospects. Moderately weathered Pediplain (Granite) are having moderate to good ground water prospects and very good yields are expected along fracture / lineament.Shallow weathered Pediplain

(Granite) are having moderate to poor ground water prospects and very good yields are noticed along fractures/ lineaments zones. Pediment (Granite) is having poor ground water prospects and structural hill (Granite) is having negligible ground water prospects. Vegetative Barriers prevent soil erosion and silting of tanks. They also augment production of food, fuel, fodder and fiber from farm lands by growing suitable species.

- Irrigation and water management and horticulture species planting on field bunds are suggested where the irrigation practice is existing. In paddy fields, field to field irrigation is a common practice. For horticulture plantations check basin irrigation system may be adopted for efficient utilization of water. In order to bring extensive area under irrigation and to cover horticulture plantations and efficient utilization drip irrigation is suggested. Different horticulture species are also suggested on filed bunds, to get more economical benefits.
- Ground water development with conservation measures and horticulture nurseries are suggested in the cultivated areas associated with lineaments. Irrigation is also suggested for major vegetable crops. Drip irrigation for horticulture plantations is suggested.
- Fodder/fuel wood/silvipasture development is suggested in marginal lands with 0-5% slope.
- Shelter belt/strip plantation is suggested all along the roads. They also provide shade and improve the environmental conditions and they provide additional income to the people.
- These areas need to be provided with mini farm ponds for improving soil moisture regime and water for cattle and also useful for ground water recharge. In the higher slopes brushwood, rubble and masonry check dams be constructed.

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