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Advances in Applied Science Research, 2013, 4(4):255-265

Advances in Applied Science Research
Pelagia Research Library

ISSN: 0976-8610
CODEN (USA): AASRFC

Analysis of ground water potential in Chandragiri Mandal, Chittoor District, Andhra Pradesh

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ABSTRACT

Ground water prospects of any area depend on its geological structure, geomorphic features and their hydrological characters. Identification and mapping of these elements is thus imperative for ground water exploration and optimal management of this precious resource. In the present paper ground water potentiality in Chandragiri mandal, Chittoor district, Andhra Pradesh has been evaluated by analyzing the hydro geomorphic parameters using Remote sensing Techniques. Satellite image and Topographical map have been used to prepare the required thematic maps like geology, lineaments, geomorphology, surface water bodies and drainage. These maps have been integrated in GIS environment to demarcate the hydro geomorphic units. Nine hydro geomorphic units viz. Flood plain, Moderately Weathered pedi plain, Shallow Weathered Pedi plain, Residual hill, Denudation hill, Structural hill, Inselberg, Pediment and Bajada have been derived from the integrated map. Ground water potentiality has been qualitatively assessed by analyzing the derived hydro geomorphic units after considering the field information.

Key words: Ground water potential, Geomorphology, Lineaments, Pediplains, Pediments, Inselburg

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INTRODUCTION

Rapid growth of population has projected the demand for food production and opened new ways to improve the utilization of surface and sub-surface water resources recently in a systematic and in a scientific way. The excavation at Mohenjo-Daro have related brick-lined dug wells existing as early as 3000 B.C. During Indus valley civilization and the writings of Vishnu Kautilya in 300 B.C, indicate how the ground water was being used for irrigation purposes at that time. In recent years there has been an increasing tendency towords revitalization of existing open wells. In Chandragiri mandal due to limited surface water resources available in the form of rainfall, the ground water resources are exploited on a small scale. But unfortunately the major part of the land is covered by hard rock and hilly terrain of unclassified granites of Archaean age and have contributed little to ground water potentialities owing to their poor transmissive properties as the solid igneous and metamorphic rocks are relatively impermeable and hence serve as poor aquifers. So an intense study is necessary to evaluate the ground water resources of the mandal in addition to surface water resources.

MATERIALS AND METHODS

Study Area

Chandragiri Mandal in Chittoor District derives it's name from Chandragiri, its head quarters town. It is located 13°20' to 13° 50' N and 79° 5' to 79° 30' E. It is bordered by Rajampeta Revenue Division of Kadapa district in the north and Penumuru mandal of Chittoor district in the south and Tirupati rural and Vedurukuppam mandals of

Chittoor district in the East and Pulicherla and Y.V. Palem mandals of Chittoor district in the west. It is situated in the northeastern part of the Chittoor district with a distance of 54 Km. from Chittoor town and 10 km. from Tirupati town. It is one of the smallest mandals of the district covering an area of 1,184.52 Sq.km. or 1,12,572 Hectares and a population of 83,987 (2011 provisional figures). It is included in the Survey of India Topographical sheets of $57\frac{o}{2}$ and $57\frac{o}{6}$ on a scale of 1:50,000.

The study area lies in a morphologically transitional zone between the interior Plateau of Karnataka in the west and the Coastal plain of Bay of Bengal in the east which is about 150 Km. from the study area. In addition, the north-south running Eastern Ghat ranges run in the middle of the Chittoor District forming its backbone and the water divide for many streams. It gives off number of branches in and around the district and one such branch by name Seshachalam Hill Ranges passed through the study area. The world famous Lord Sri Venkateswara Temple is situated on the Seshachalam hills. The Temple is situated outside the boundary of the study area on the east. The Mandal slopes down from west to east from an average elevation of about 750 mts. On the west to about 150 mts. on the east Tirupati railway station which is hardly 10 Km from the study area is situated at an elevation of 120 M above MSL. The mandal may conveniently be divided into 3 natural divisions as given below. The Western hilly terrain comprises isolated hills and a hillock of more than 750 mts. of elevation. It is actually the part of Seshachalam Hills. The maximum elevation of 795 mts. above M.S.L is observed in the south eastern part of the study area. The Central Undulating terrain, its elevation ranges from 250 to 400 mts. above M.S.L. It is situated at the foot of the hilly terrain. Plantation crops like mango, citrus etc. are grown here. The Plain region consists of the river plains of Swarnamukhi, Bhima, Kalyani and Dosalavanka etc. They are situated at an elevation of 150-200 mts. or even more above M.S.L. These plains are further designated as Fluvial plains, Pedi plains, Wash plains, Creep built plains and Piedmont plains etc. These plains are good for agricultural operations as they yield copious amounts of ground water. The study area exhibits typical semi arid climatic conditions and the source of the water is the southwest monsoon rainfall, which starts in mid June and extends until the end of September. The average annual rainfall is about 850. 65mm. according to 2011 census records the total population of the mandal is 83,987. The demographic growth rate has been considerably high during the last decade. The economy of Chandragiri mandal is predominantly agricultural and rainfed farming is the characteristics of agriculture. There is a significant fresh water deficit in many villages both for irrigation as well as drinking purposes. Due to scarcity of surface water, people are using ground water through dug and bore wells for irrigation and drinking purposes. This background necessitates proper exploration and evaluation of the available sources of groundwater for better planning and management. Hence the groundwater potential has been evaluated through the analysis of hydrogeomorphic features.

Ground water hydrology is a multidisciplinary subject in the present day contest. Although it has its origin in hydraulics of flow through porus media, now a days the Satellite imagery obtained by Remote Sensing furnishes very useful data related to ground water hydrology. This subject has a common interface with many disciplines i.e. meteorology, geomorphology, hydrology, hydrology of stream flows, geophysics, geochemistry, exploration techniques like drilling, aerial photography and remote sensing, etc. But in the present paper the following geographical technique related to ground water are used.

Drainage and Surface Water Bodies

Chandragiri Mandal is mostly hilly and undulating and hence there is not much scope for large scale development of irrigation. The study area is also devoid of perennial rivers. The following are the minor streams flowing in the study area.

1. Swarnamukhi River.
2. Kalyani River.
3. Bhima River.
4. Dosalavanka

The Swarnamukhi river is the major one in the study area. It rises in Chandragiri hills at an elevation of 900 m, which is joined by Bhima river, Kalyani river and Dosalavanka etc. as a tributaries After passing through the broad valley in which the towns of Chandragiri and Tirupati are situated, it reaches Srikalahasthi. After traversing nearly 5 kilometers in the study area it flows in the northeasterly direction into Nellore district and ultimately join the sea near Siddavaram in Guduru taluk of Nellore District. Swarnamukhi was so named due to the fact that minute quantities of gold mineral is observed in the down stream (**"Swarna"** means **"Gold"** in Telugu). It is observed from the drainage map that the entire Chandragiri Mandal is rimmed by the hilly terrain with streams originating in the form of rills and gullies; and finally taken the shape of tributaries to Swarnamukhi. The peculiarity of the mandal is that it was developed in the river valleys of Swarnamukhi and its tributaries from a stage of hamlet. All the settlements are developed in the river valleys only leaving the hilly terrain for forests and pastures for grazing purpose.

The drainage of study area is dendritic to sub-dendritic which is the characteristic feature of granitic terrain. Stream courses are common up to 3rd order. All the tributaries of Swarnamukhi such as Kalyani, Bhima and Dosalavanka consists of loose boulders in their courses. All along the Swarnamukhi valley a number of springs with good discharges were noted until the middle of the century. The ancient rulers like SriKrishnadevaraya has constructed channels to divert this spring water to low lying areas for irrigation. They are very large in number particularly in the plain land in the eastern part of Chandragiri Mandal. Ground water supplies are abundant in recent years and with the help of which one can see the patches of cultivation here and there in the Mandal. The famous temples like Srinivasa Venkateswara swamy and Agastheeswara Swamy are situated in the catchment area of Swarnamukhi river.

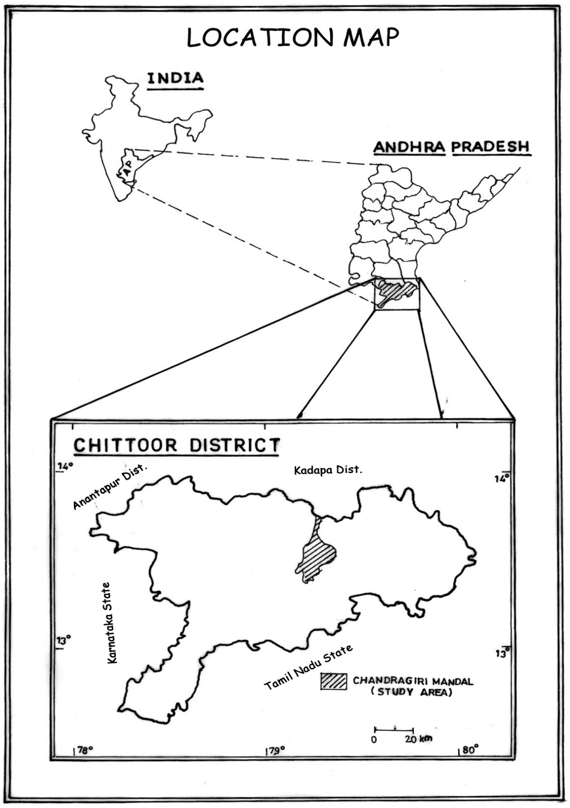


Fig. 1

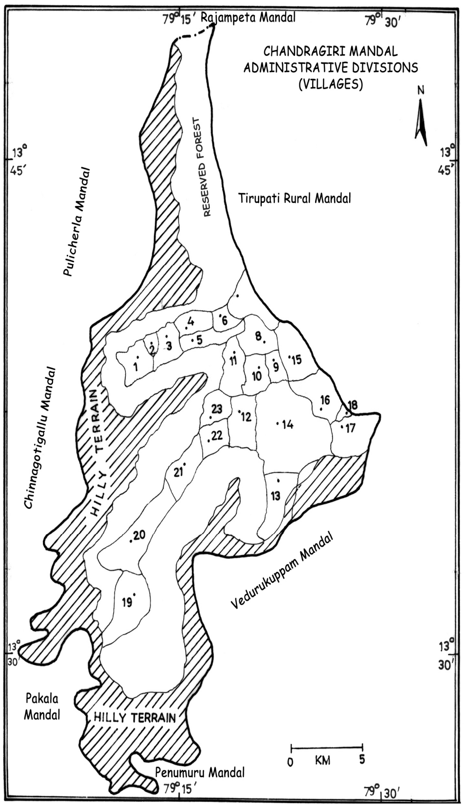


Fig. 2

Kalyani Reservoir is constructed across the river Kalyani in the northern part of the Mandal where a dam is constructed. The waters of Kalyani Reservoir are utilized as drinking water for the Tirupati and Tirumala residents. It acts as a boundary between Chandragiri Mandal and the neighbouring Tirupati rural Mandal where the world famous Lord Sri Venkateswara temple is situated in Tirumala in Tirupati rural mandal on Seshachalam Hills.

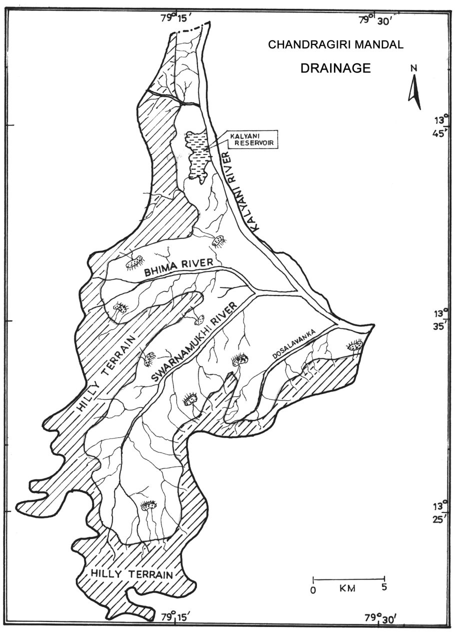


Fig. 3

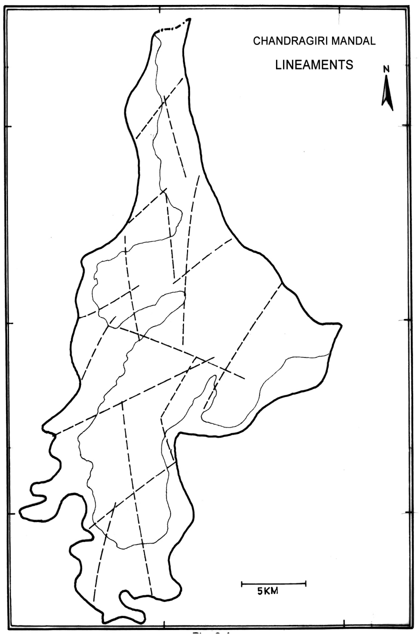


Fig. 4

Geological formations and lineaments

The nature and structure of geological formations have many indirect influences on agricultural land use. Geological formations provide the basic materials and structures for the parent materials of the soils. Though the relief and the geological formations have a strong impact on climate and hydrology, these geological formations were studied in greater depth assuming them as land resources, which is also a land resource.

The rock types met within the study area are of diverse types ranging in age from Archaean to Recent. Most of the area in Chittoor district / Chandragiri mandal is covered by pre-cambrian granites, which are highly magmatised. Cuddapah and upper Gondwanas occur as outliers at one or two places. The geological sequence of the study area is given below.

Age	Formation
Quaternary	
Subrecent –alluvium	Gravels, course to fine sands, silts and clays 3 to 5m thick.
Recent –Talus	Pebbles and other debris in valley fill areas.
Pleistocene-Laterite	Very hard and compact rocks of fine quartz graining in ferruginous material
Upper Gondwanas	Conglomerates of quartzite pebbles embedded in ferruginous matrix.
Lower Cuddapahs – Nagari	Quartzites with intercalating shales.
Archaeans – Dharwars and other Crystallines	Dolerite Dykes, granites and gneisses with (Porphyritic) feldspar, quartz, mica and hornblende.

The Archaeans occupy more than three-fourths of the areas in the Mandal, belonging to the Dharwarian system with basic intrusives. The Mandal is mostly a rugged granitic plain, which gradually rises westward to an altitude of about 750 mts. The granite is fully crystalline (holocrystalline) igneous rock, formed by crystallisation of molten rock (magma) at depths. It is composed of grey or pink felspar which impacts the colour to granite, quartz and muscovite mica. Chandragiri town, in fact, is situated on magmatised granites. The granite rocks are frequently intercapped by innumerable number of doleritic dykes (which represent the last phase of igneous activity of pre-cuddapah period) with narrow width and considerable linear extent. In most cases the granites are characterised by bedding joints and master joints which stand vertical. The pattern of joints and dykes govern the drainage pattern of the study area. The essentially east-west trending joints / dykes are responsible for the easterly course of several minor and major streams including the Swarnamukhi. The west-east trend of several hill streams including Bhima river is essentially controlled by the south-east trending joints and dykes. Owing to deep weathering of Gneiss, the streams on the overlying quartzites create impressive falls at the edge of outcrops. For example, the Talakona falls of Yerravaripalem Mandal and Kapiltheertham water falls near Tirupati rural mandal. These granites which promote mechanical weathering produce dislodgements of blocks and some times the exfoliation produce the sphericity in granites to form dome shaped masses (dome shaped hill of Chandragiri (568 mts.) with practically no vegetation. The further exfoliation of the dislodged blocks produces the soil and Tor and Boulder Topography. The general strike of the bedding varies widely from east and north-west and dips range from 10º to 20º due north or north-east.

The Cuddapah formations noticed in the northern and northeastern parts of the Mandal, as outliners, are mostly quartzites and shales of Cheyair and Nallamala series called Bairenkonda quartzites and Pullampeta shales and slates. These formations are exposed as huge hill ridges near Tirupati, (outside the boundary). The world famous temple of Lord Venkateswara is situated on these quartzite exposures at an altitude of about 1044.24 mts above M.S.L on Seshachalam Hill ranges.

Lineaments of the study area have been traced from the LANDSATS for the extraction of ground water resources. By geological formation in the district / Rayalasema / the study area and its relation between the availability of the ground water has been examined. In brief 1) Igneous, 2) Sedimentary and 3) Metamorphic formation are observed in the study area. The first and third are generally classified as hard rock, while the second i.e the sedimentary as soft rock. An investigation has conducted to explain the nature of occurrence of ground water in these formations and in the lineaments. It is observed that the groundwater occurrence is mainly confined to the joints and fractures in the hard rock and the weathered mantle which is very variable. The approximate area covered by hard rocks in the study areas is 10 to 15%. In hard rocks observed in "Yetikala Bodu", "Panditla Bhavi", "Gundullinakonda", "NallikayalaBodu", "Pedda Durga", "Dornakambala Konda" "Mungilipattu konda", "Pala Konda", "Guntimadugu Gundu", "Mabbukona gutta", "Gurrala Konda" are having very hard and the joints and fractures tend to close at greater depths below, that is about 150 mts to 200 mts. Therefore deep tube wells in such areas are not feasible. Also it is in such area better to have large open dug wells rather than bore wells which provide larger percolation area and storage space. The situation in soft rock areas is very different since bore wells are likely to be successful in those areas. As stated earlier, the lineaments are mostly North-South and East-West in direction.

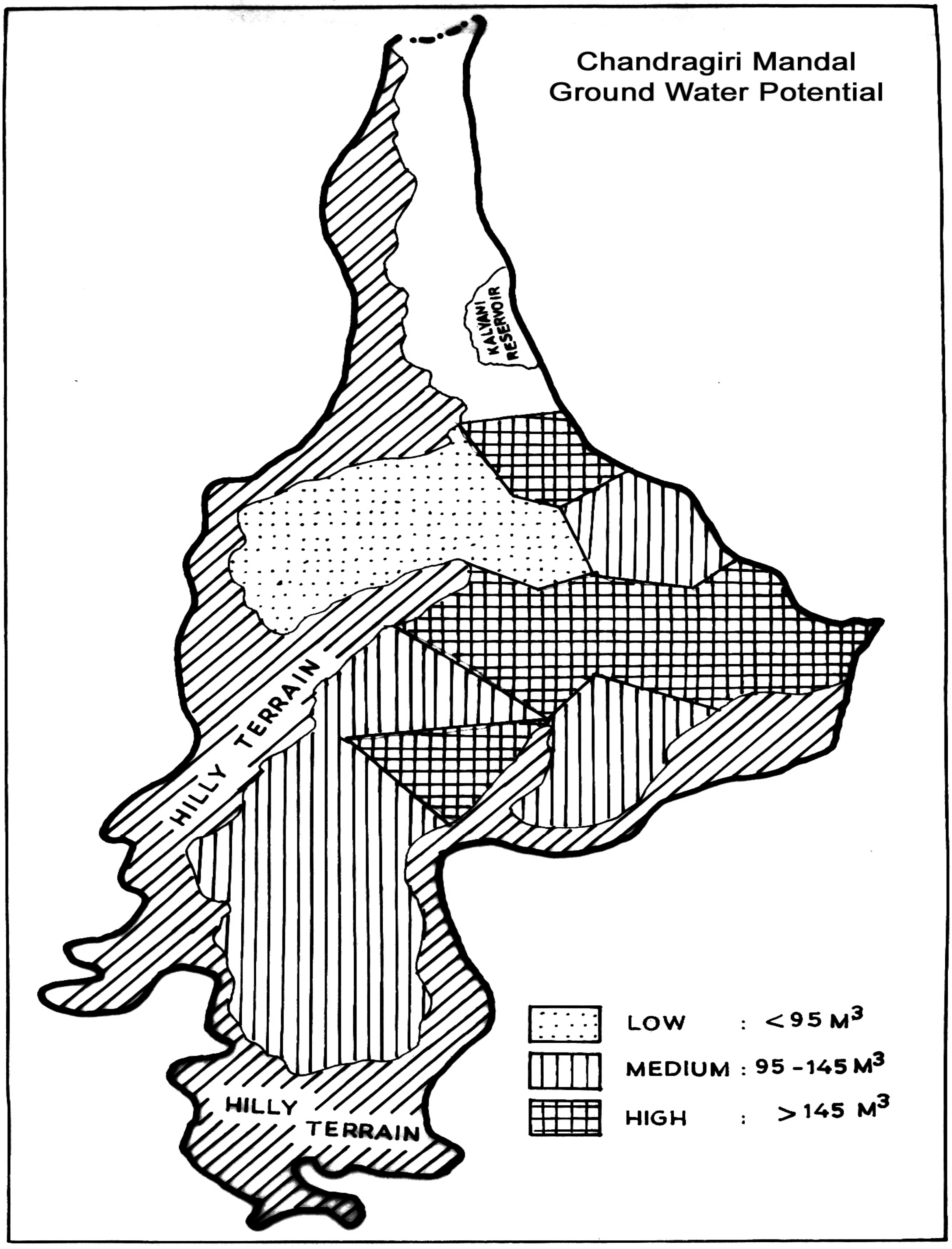
Hydrogeomorphology

The Physiography of a region is not as simple as it appears. The general processes of landform development are complex and they are affected by a variety of major and minor factors by a variety of major and minor factors like location, climate and geological setup in terms of lithology and structure, denudational agencies etc. since the ground water prospects of an area and depend on its lithology, structure and geomorphology mapping geomorphic features of an area is essential to appreciate and manage this precious resource. The erosional and depositional landforms identified in the study area are structural hills, inselburgs, linearridges, weathered pediments, and weathered pediplains. The inselburgs and residual hills are the remnants of weathering and denudational action. Gently sloping rock cut surfaces formed due to erosion of the rock units existing in this area have been classified into two categories based on the thickness of weathered zone, i.e., shallow weathered pediplains and moderately weathered pediplains. The vectorised thematic maps of geomorphology, geology, lineaments, drainage and surface water bodies have been integrated using overlay technique. Hydrogeomorphic map has been generated based on the analysis of the said multilayered information. On the basis of hydro geomorphologic characteristic the study area has been classified into nine hydrogeomorphic units. They are flood plains, Moderately Weathered Pediplain, Shallow Weathered Pediplain, Residual Hill, Denudational Hill, Structural Hill, Inselberg, Pediment, Bajada,

Ground Water Potential

Relief, slope, depth of weathering, type of weathered material, thickness of alluvium, nature of the deposited material and the overall assemblage of different landforms play an important role in defining the ground water regime, especially in the hard rocks and the unconsolidated aquifer. Ground water potentiality has been qualitatively assessed by analyzing the derived hydrogeomorphic units after considering the field information. The groundwater potential (table. 1) varied due to changes in the aquifer and orientation of bedrock, lineaments, general slope, thickness of weathered zone and type of soils throughout the area. The hydrogeomorphic units were qualitatively visualized into one of the categories like very good, good, moderate and, poor in terms of their importance with respect to their ground water potential level and detailed under the following heads.

Floodplain: It is a flat surface adjacent to a stream/river, composed of unconsolidated fluvial sediments like gravel, pebbles, sand and silt. It is found in the southern part of the study area in Dornakambala, Shanambatla and Thondawada villages etc and occupies an area of 310 sq.km. Generally the ground water prospects are very good because of unconsolidated material on the river bed, accumulation of water during floods in the aquifer, and slope gradient towards the river bed from the higher reaches.



Moderately Weathered Pediplain: It is a very gently sloping flat and smooth surface made of granitic gneiss with more than 5 mts. deep weathering, generally covered with red soil. In general the ground water prospects are good to very good. Good yields are expected along fractures/lineaments. They are found in the south central parts of the Mandal and accounts for about 21 per cent of the geographical area.

Shallow Weathered Pediplain: It is a gently sloping smooth surface of granitic gneiss with less than 5 mts. depth of weathered material, generally covered with red soil. The ground water prospects in a shallow weathered Pediplain are moderate to good. Good yields can be expected along fractures/lineaments. 85.72 sq.km of area i.e. 33 per cent of the geographical area is classified under this category. Most of the eastern and north central parts of the Mandal which covers Bhimavaram, Seshapuram and Chinnarama puram etc., villages are included in this zone.

Table.1 Groundwater Prospects of Hydrogeomorphic Units

Hydrogeo-morphic unit	Characteristics	Slope	Soil	Land use	Quality of ground water	Approximate Area
Flood plain	Unconsolidated Fluvial sediments	Very gentle	Alluvial	Intensive agriculture	Very good	6.71
Moderately weathered Pediplain	Granitic gneiss Weathered up to 5m depth	Very Gentle	Alluvial and clay	Dry crops	Very good	58.33
Shallow weathered Pediplain	Granitic gneiss Weathering <5m	Gentle	Sandy & clayey	Dry crops	Good to moderate	85.72
Residual hill	Low relief relict hill	Steep	Brown sandy loam		Poor	1.16
Denudational hill	Intrusion formed due to differential weathering and erosion	very steep	Shallow brown sandy clayey barns	Forest & Horticulture	Poor	7.75
Structural hill	Arcuate hill associated with faults, folds, fractures and joints	Moderate – steep	Shallow brown sandy clayey loam	Horticulture	Poor	15.78
Inselberg	Isolated residual hillock	Moderate	Very sandy loam	Quarry	Poor	0.17
Pediment	Rock cut surface of granites and gneisses	Gentle	light brown sandy clayey loams	Quarry	Runoff	8.1
Bajada	Talus and scree	Gentle - moderate	Brown sandy clayey barns	Horticulture Social forestry.	Ground water recharge	16.48

Source: *Computed from the data collected.*

Residual Hill: They are isolated low relief relict hills, occupying considerably small area in the study area. The ground water prospects in a residual hill are poor. This is found in the western corner of the study area.

Denudational Hill: They are formed due to differential erosion and weathering so that a more resistant formation or intrusion stands as hill occupying large areas. These hills consist of highly fractured granites covered with big boulders and sparse vegetation. They are found in small extent in the southern part of the study area in Panapakam and Kalroad palli villages. The groundwater occurs under semi-confined to unconfined conditions and ground water potential is moderate to poor.

Structural Hill: They are linear to arcuate hills with definite trend, and associated with faults, folds, fractures and joints. They are found in the western part of the study area, and are associated with Charnockite rocks. The ground water prospects in structural hill are poor as the runoff is more due to steep slopes.

Inselberg: It is an isolated residual hillock and the renmants of weathering and denudation. Inselbergs are mostly met with in the granitic terrain. The inselbergs act as run off zone so that the ground water prospects are poor. Only two numbers of insignificant aerial extent are identified in Chandragiri and Ithepalli villages.

Pediment: Groundwater potential in pediment zone depends upon the thickness of debris. The thicker the debris, the greater is the ground water potentiality. Pediment is developed around the structural hill (Charnokitic origin) in

Ithepalli and Chandragiri villages towards west. It is a gently sloping rock-cut surface of granites and gneisses with thin veneer of detritus. Hence the ground water prospects are poor.

Bajada: A series of adjacent alluvial fans and alluvial cones merge to form a bajada. It consists of talus and scree material, which are derived from the hilly areas. This material of coarse pebbles and finer material favours ground water recharge. Considering the adverse conditions like slope and unconsolidated material, this zone is unsuitable for landfill site. Bajadas are formed at the foothill and spread over 16.5sq.km of area in Chandragiri, Ithepalli and Mamandur villages.

The ground water potential zones were checked against the bore well yield data which reflects the actual groundwater potential and it is found that groundwater potential zones identified from the multilayered information are in good agreement with yield data. The depth of aquifer varies between 4.2m to 8.8m in the study area.

General Geohydrological Conditions of Study Area

With few exceptions, in general, drought-prone areas in India fall under arid and semi-arid climatic conditions, characterized by meager and highly variable rainfall on one hand, and high rate of evaporation on the other. In such regions surface water resources in terms of river flow and small surface reservoir, are undependable and highly restricted. Ground water, thus, becomes the main reliable source of water supply in arid zones in particular and in drought prone areas as a whole in general, even though this source, too, presents qualitative problems at many places. The ground water conditions in the drought prone areas is analyzed here.

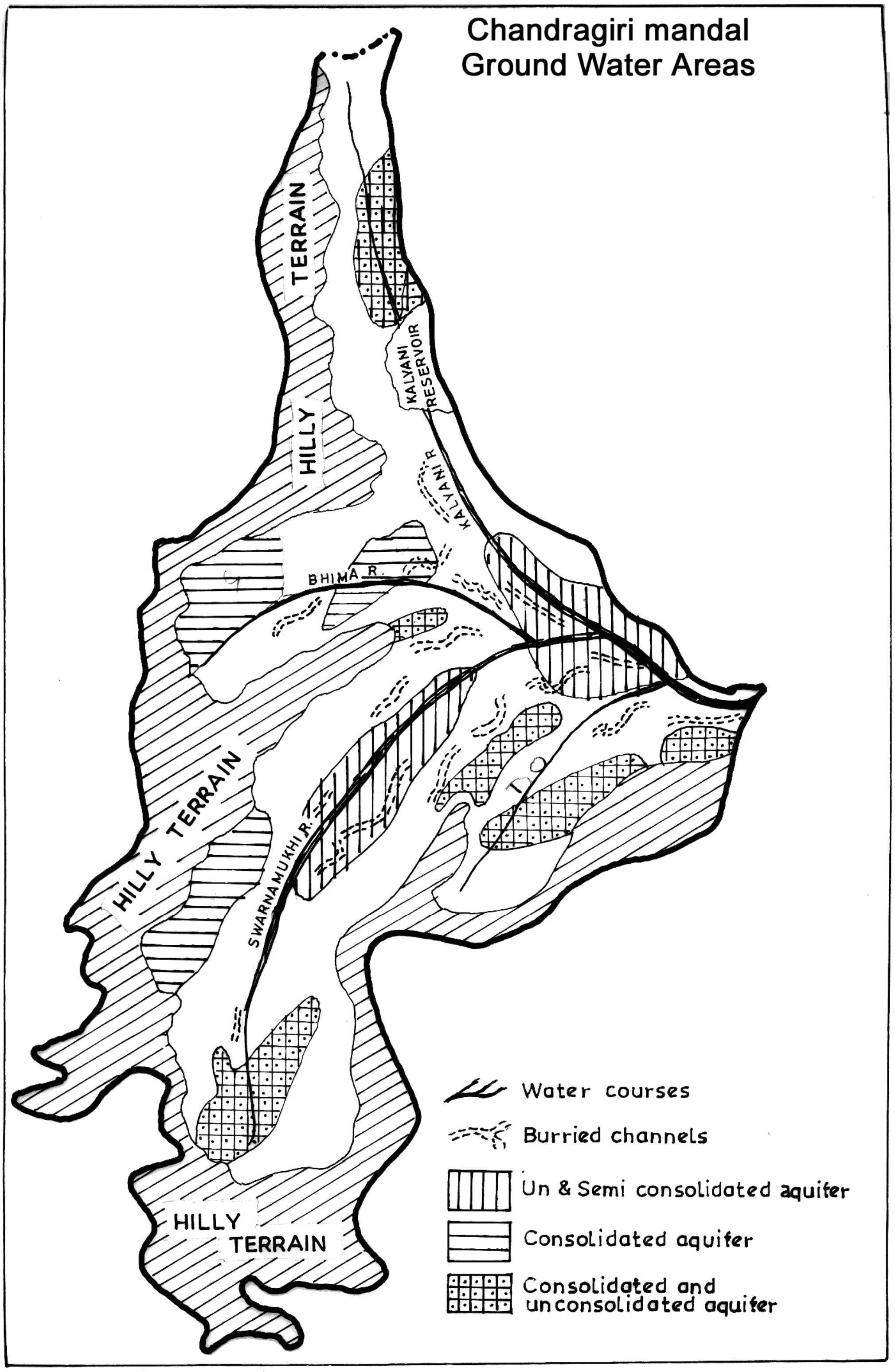
Till recently no systematic geohydrological investigations were made on a regional basis. Whatever ground water explorations had been made were confined to localised areas needing the augmentation of water supply for specific purposes. Only when devastating drought hit hard the Indian economy in the mid-sixties, the importance of systematic regional geohydrological studies was realized. However, only few regions are so far covered with detailed geohydrological maps and even many of these maps and accompanying reports are not published. So the authors have to depend on the papers submitted at the symposiums[1] on ground water resources development.

Factors influencing occurrence of Ground Water

Generally the occurrence, distribution, movement and quality of ground water is controlled by the geological factors, i.e., ages, lithology and structure, relief and its evolution of the different geological formations which form the water bearing horizons. The above noted geological characteristics will not be given separate space for explanation but will be explained here and there with the spatial distribution of geohydrological conditions of the droughtsprone areas in the foregoing paragraphs.

Geohydrological Conditions of Drought prone Areas

The geohydrological studies show that for ground water study the rock formation (aquifers) can broadly be classified into the following three groups.



1. Consolidated aquifers,
2. Semi-consolidated aquifers, and
3. Unconsolidated aquifers

The consolidated aquifers include gneisses, schists, quartzites, phyllites, slates, shales, limestones, dolomites, sandstones, granites, basic acid intrusives and Deccan traps ranging in age from Pre-Cambrian to Tertiary.

Ground water is, therefore, available in limited quantity either in the weathered mantle or in lineaments like joints, fissures and fractures, etc. in the rock systems. In the volcanic effusion such as trap formations water is also available in the intertrappen sedimentary rocks and in the vesicles of certain lava flows. In some cases the vesicular traps have been observed to form good aquifers. Some recent investigations revealed the possibility of exploiting large reserves in such aquifers, particularly in certain parts of Andhra Pradesh. The semi-consolidated aquifers include limestone, sandstone, shale, conglomerates, etc., ranging in age from Upper Palaeozoic to Tertiary. Some major part of the country, particularly the entire Peninsular India, consists of hard-rock formations (aquifers). The possibility of occurrence of large ground water reservoir in these regions is rather remote. Moreover, practically all the droughtprone areas lie in the regions of consolidated rock formations (aquifers). Thereby augmentation of water supply from ground water sources is very much limited. The unconsolidated aquifers include clay, silt, sand, gravel, pebble, cobbles and boulders, ranging in age from Upper Tertiary to Recent. Thus hard and consolidated rocks cover a major part of the state and spreads in the Rayalaseema districts of Kadapa, Chittoor, Anantapur and Kurnool. In general, this area has poor ground water reservoirs.

Ground water in consolidated aquifers occurs primarily in the weathered zones, joints, fissures, fractures, cavities and vesicular basalts.

Semi-Consolidated Aquifers

Semi-consolidated aquifers include grits, sandstones, siltstones, shales, conglomerates, limestones, etc. Such formations are encountered in the droughtprone areas like Rayalaseema.

The semi-consolidated formations, particularly Mesozoic sedimentary rocks, are well represented in arid zones of Rayalaseema and adjoining Karnataka. Particular mention should be made of Jurassic and Cretaceous sandstones which form dependable source of ground water in the arid zone of Andhra Pradesh in general and Rayalaseema in particular. They proved to be the most prolific aquifers for large-scale exploitation of ground water. The areal extent of these sandstones is approximately 1,000 sq.km., extending from parts of Karnataka and Rayalaseema districts. Ground water occurs under confined conditions in this formation.

Unconsolidated aquifers

The unconsolidated aquifers are the most extensive in the semi arid zones in Rayalaseem. Generally they comprise alluvial and aeolian deposits of sands, clay and kankar. Large variation in the degree of mineralization makes the prediction of ground water condition difficult. The younger alluvium in river basins and in buried channels has moderate ground water potentialities. Fresh water occurs in the flood deposits of Swarnamukhi and its tributary rivers in Chittoor district, generally parallel to the river channels. Local fresh water is also found to occur in piedmont fans and valley fills in many parts of the study area. These may cater the domestic water need.

The piedmont alluvial tracts of the study area, i.e., Chandragiri Mandal extending from Gundullina Konda (687 mts.) to the eastern part near Peddadurga Hill (791 mts.) offer scope for further development of ground water. Detailed studies of the ground water conditions in Bhimavaram village area has shown that there are three major aquifer groups occurring at depths of 15 to 30 m, and below about 100 m. Most existing wells tap the upper aquifer and a large number of flowing wells are found west of Seshapuram village area. Thus it appears as a general rule that the droughtprone areas in India in general and Rayalaseema in particular are made up of hard rock formations and exhibit poor ground water availability. But recent exploration conducted by the Geological Survey of India (G.S.I) has revealed that for millions of years ground water had been stored in the soil in the Great Indian Desert in abundance which can be utilized for hundreds of years to come. This kind of healthy sign has also been reported form many other parts of Rayalaseema also.

The Geohydroligical conditions in the study area are mapped basing upon the data available on LANDSAT (F.C.C's). Such maps are popular in United States and one such map is given in the text book entitled "Modern Hydrology" by Raphael G, Kazmann, Harper and Row Publishers, (1965) New York, Page No. 136. Such a mandal map of Chandragiri on a larger scale, can be used as a point of departure for the selection of plant sites for industries that need water, for steam-electric generating plants, or for military camps or ordinance plants.

CONCLUSION

The information generated on prospects and quality in a singal map will healo the planners and decision makers for devising sound and fesible ground water development plans. The analysis shows a relationship between geomorphic units and ground water resources. The systematic study of various hydrogeomorphic units help to demarcate the potential zones of ground water in the study area.

The occurrence of ground water is primarily controlled by degree and depth of weathering and jointing or fracturing. It also varies from granitic terrain to conglomerates which are the main geological formations of the mandal, the ground water level in the wells is deeper in summer and southwest monsoon seasons and shallow in the northeast monsoon followed by winter. The ground water levels of eastern villages are much shallow than the central and western villages.

The quality of the ground water is said to be 'good' or 'permissible' both for irrigation and domestic purposes except some minor hazards of alkalinity and salinity. So it can be concluded that the water resources of the mandal are satisfactory for further utilization. As per the quality of water are concerned the water of this mandal are generally 'good' to 'permissible' for drinking and irrigation purposes. So, they are suitable for all purposes. In general most of the study area from centre towards east has good ground water potential. But the western parts and a small pocket in the north western part have poor ground water prospects essentially due to steep slopes and the structure. Occurrences of ground water in the study area are confined in secondary permeable structures i.e., fractured and weathered horizons and in upper unconsolidated materials.

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