IDENTIFICATION AND DELINEATION OF GROUND WATER POTENTIAL ZONES IN AND AROUND RAJAMPET BY USING REMOTE SENSING AND GIS TECHNIQUES

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Abstract : Groundwater is an important resource contributing significantly in total annual supply. However, overexploitation has depleted groundwater availability considerably and also led to land subsidence at some places. Assessing the potential zone of groundwater recharge is extremely important for the protection of water quality and the management of groundwater systems. Groundwater potential zones are demarked with the help of remote sensing and Geographic Information System (GIS) techniques. In this study a standard methodology is proposed to determine groundwater potential using integration of RS & GIS technique. The composite map is generated using GIS tools. The accurate information to obtain the parameters that can be considered for identifying the groundwater potential zone such as geology, slope, drainage density, land use and land cover are generated using the satellite data and survey of India (SOI) toposheets of scale 1:50000. It is then integrated with weighted overlay in ArcGIS. Suitable ranks are assigned for each category of these parameters. For the various units, weight factors are decided based on their capability to store groundwater. The groundwater potential zones are classified into five categories like very poor, poor, moderate, good & excellent. The use of suggested methodology is demonstrated for a selected study area in and around Rajampet in Kadapa district. This groundwater potential information will be useful for effective identification of suitable locations for extraction of water, for sustainable usage of ground water.

Index Terms – Ground water potential zones, ArcGIS, IIRS, DEM, Toposheets, Thematic maps.

1. INTRODUCTION

1.1. GENERAL

Nature has bestowed mankind with many gifts. Amongst all of them ground water is the paramount one. Some of the gifts are non-replenishable, whereas the ground water can be considered as a partly replenishable one. If the monsoon is of considerable magnitude, the ground water gets recharged indicating the partly replenish able nature of the gift. Judicious balance should be maintained between the exploitation and recharge. However, exploitation of the groundwater has increased to a higher degree, resulting in the over exploitation that in turn leads to an environmental problem. Hence, a thorough knowledge of the nature of occurrence of the groundwater is essential to avoid such a baffling situation where man has to look up for the help. However, man has to depend on ground water as the surface water is not sufficient for all his activities.

Groundwater is a precious and the most widely distributed resource of the earth and unlike any other mineral resource, it gets its annual replenishment from the meteoric precipitation. The world’s total water resources are estimated at 1.37×10^8 M Ha-m. Of these global water resources, about 97.2% is salt water mainly in oceans, and only 2.8%, is available as fresh water at any time on the planet earth. Out of this 2.8%, about 2.2% is available as surface water and 0.6% as groundwater. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only 0.01% is available as lakes and reservoirs, and 0.0001% in streams; the remaining being in other forms 0.001% as water vapour in atmosphere, and 0.002% as soil moisture in the top 0.6m of the soil. Out of 0.6% of stored groundwater, only about 0.3% can be economically extracted with the present drilling technology, the remaining being unavailable as it is situated below a depth of 800m.Water could be the only natural resource to touch all aspects of human civilization. It is a well-known fact that portable drinking water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all the human being on the earth. Yet potable drinking water is scarce resource on the earth. No single measure would do more to reduce diseases in the developing world than bringing safe water and adequate sanitation. Therefore, identification of sources of water supply, their conservation and optimal utilization is of utmost importance. Even the present scale of supply to urban and rural population is grossly inadequate and not all communities are provided with safe water supply.

The growth of human civilization, requirement of water has increased many folds due to its multiple uses i.e. agriculture, power generation, industries, navigation etc. intensive agriculture, changing life styles, rapid industrialization and urbanization have all created new demands, which are growing year after year. Rising demand of the water for irrigation, agriculture, domestic consumption and industry is facing stiff competition over the allocation of scarce water resources among both areas and types of use. During past several decades ground water quality has emerged as one of the important and confronting environmental issues. Indiscriminate exploitation of surface and sub-surface water has led to severe water scarcity and environmental degradation. Spatial-temporal variation in rainfall has further increased the problem. In view of the vital importance of water, the principal constituent for subsistence of all living things in the universe and considering its increasing scarcity for maintain ecological balance, economical and equitable use has become a matter of utmost urgency. To meet the challenges of scarcity, increasing demand and depletion of ground water levels, the water resources should be development and managed in an effective manner. Bulk of the minor irrigation programmed in the rural India is achieved through groundwater development. Groundwater system is an instant and reliable source of irrigation. Nearly 50% of the cropped area under irrigation (68 M ha m) is irrigated through groundwater. This dependence of groundwater became a necessity as well as from environmental consideration. This has resulted in a constant increase in the demand of groundwater resources.

The average annual rainfall of India is around 114 cm. Based on this average annual rainfall, the total annual rainfall over the entire country is of the order of 370 M Ha-m and one third of this is lost in evaporation. Of the remaining 247 M Ha-m of water, 167 M Ha-m goes as runoff and the rest of 80 M Ha-m of water seep down annually into the ground, About 43 M Ha-m gets absorbed in the top layer, thereby contributing to the soil moisture; the balance of 37 M Ha-m is the contribution to groundwater from rainfall.

1.2. IMPORTANCE OF GROUNDWATER

Groundwater, as its name indicates, is the amount of water beneath the earth surface. Groundwater is the largest source of fresh water of the planet excluding the polar icecaps and glaciers. The amount of groundwater within 800m from the ground surface is over 30 times the amount in fresh water lakes and reservoirs, and about 3000 times the amount in stream channels. At present nearly one fifth of all the water used in the world is obtained from groundwater resources. Agriculture is the greatest user of water accounting for 80% of all consumption.

The main source of groundwater is precipitation, which may penetrate into the soil directly to the aquifer or may enter surface streams and percolate from these channels to the aquifer. It should be emphasized that the groundwater typically has the lowest priority on the water from precipitation. Interception, depression storage and soil moisture must be satisfied before any large amount of water can percolate to the groundwater by gravity. Further, in case those factors are even satisfied, if the rate of infiltration is less, then the huge amount of rainfall would not go down but overflow on the ground surface to any of the water body nearby. This low priority is an important factor in limiting the rates at which groundwater may be utilized. Except where sandy soil occur, only prolonged periods of heavy precipitation can supply large quantities of water for groundwater recharge.

Rapid industrial development, urbanization and increase in agricultural production have lead to freshwater shortage in many parts of the world. In view of increasing demand of water for various purposes like agricultural, domestic and industrial etc., a greater emphasis is being laid for a planned and optimal utilization of water resources. The water resources of the basins remain almost constant while the demand for water continues to increase. It requires little treatment since it is less polluted. It can often be tapped where it is needed, on a stage-by-state basis. It is less affected by catastrophic events. Scientists estimates that groundwater accounts for more than 95% of all fresh water available for use. Nearly 95% of rural residents rely on groundwater for their drinking supply. About half of irrigated crop land uses groundwater.

In recent years, with increasing industrialized economy and global environmental changes, the climatic changes resulted in imbalances in water resources in many parts of the world creating floods and droughts. Located in south Asian region, the Indian sub-continent also has been affected by these changes. Besides, it has been observed over the years that due to faulty management practice or haphazard management, the watersheds have been deteriorated causing various undesirable effects like silting of rivers, tanks, lakes and channels; poor return from the agriculture, forest, horticulture and grasslands; deterioration of water quality and quantity; depending of groundwater tables, and reduction in biomass production. All these have adversely affect the economy of the region. Groundwater has been the main source for supplying water to the society. For instance, groundwater withdrawals in some of the developed countries account for one-fifth of the total water use. Moreover groundwater is a vital source of water supply in areas where dry summers or extended droughts cause stream flow to reduce. Though it is important for groundwater, it should not play down the role of surface water. On the contrary, many surface streams receive a major portion of their flow from groundwater through interflow. Groundwater table in several parts of India shows a declining trend due to increase in exploitation of groundwater for domestic and irrigational needs. It has therefore, become necessary that the annual replenishment of groundwater reserves is to be quantified.

Over-abstraction of groundwater occurs when the overall rates of withdrawal from aquifers greatly exceeds their replenishment from rainfall and other source. This ‘over-abstraction’ causes many serious problems. Often yield of well is reduced and cost of pumping increases. In extreme cases, this may lead to wells being abandoned, with premature loss of infrastructure investment. In some geological conditions, falling groundwater level induces compaction of underground strata and serious subsidence of the land surface, causing costly damage to urban infrastructure and increasing the risk of flooding. Lowering groundwater level by one meter adds one metric ton of load per square meter to the subsoil. A number of the world’s major wetlands are now under threat from the over-abstraction of groundwater. Spain, Algeria, Cyprus, Tunisia, Egypt and Turkey are among the countries where increasing salinity and falling water levels are leading to vegetation changes in wetlands. On many coasts and small islands, over-abstraction is leading to the intrusion of saline water inland, causing effectively irreversible deterioration of groundwater resources. In metropolitan manila, groundwater abstraction has lowered the water level by 50-80 meters. As a result, salt water has seeped into the Guadalupe aquifer that lies under the city, reaching as far as 5km inland. In Chennai, India salt water intrusion has moved 10km inland, causing many irrigation wells to be abandoned. Groundwater pollution is insidious and expensive, insidious because it takes many years to show its full effect in the quality of water pumped from deep wells; expensive because, by this time, the cost of remedying polluted aquifers will be extremely high. Indeed, restoration to drinking water standards is often practically impossible. Without pro-active management and protection, there is a serious risk of irreversible deterioration on an increasingly widespread basis. Under the pressure of the need to rapidly develop new water supplies, there is rarely adequate attention to, and investment in, the maintenance, protection and longer-term sustainability of groundwater.

1.3. SCOPE OF THE PRESENT WORK

Kadapa district of the state of Andhra Pradesh, India represents a semi-arid drought prone area with heavy dependence on groundwater and tank irrigation. Table 1.1 presents the percent of irrigation by groundwater and surface water in Kadapa district respectively.

Table 1.1 Net area irrigated in Kadapa district

S. No	Source	Area Irrigated (Ha)	Percentage of area
1	Canals	5685	3.88
2	Tanks	16,531	11.31
3	Wells	1,23,875	84.73
4	Other source	106	0.08

The maximum irrigated area in Kadapa district depends on the groundwater. Thus groundwater is the back bone of agriculture economy of the Kadapa district. Farmers are mostly dependent on groundwater for their irrigation purposes. The district receives moderate rainfall. Failure of monsoons during the last few years lead to failure of bore wells and failure of crops. That has created a distress situation in the farming community. Further, absence of credit facilities at lower interest rates, lack of remunerative prices for their produce, negligible/absence of a supplementary income to farmers, indiscrete drilling of additional bore wells and their failure have turned the farmers into debt trap. Prevailing high interest rates by moneylenders have jeopardized.

All rural areas depend on agricultural activity. The lack of knowledge in the utility of the ground water is the main cause of over exploitation. The geological science explains that certain rocks, sensostricto are not suitable for the storage of ground water. But, the critical study reveals that even such rocks that are considered as aquifuge also have considerable amount of ground water. Remote sensing technique has revealed that the correct approach to the problem will definitely will yield fruitful results. In order to mitigate the demand on water resources, the present water resources are to be augmented with new resources. In that direction, the present study focuses on identification and developing new resources.

Therefore, the scopes of presented study are:

- To prepare thematic maps of the study area.
- To identify and delineate groundwater potential zones through integration of various thematic maps with Arc GIS 10.1.
- Integration of different above techniques to develop groundwater potential map of study area.

2. THE STUDY AREA AND DATA COLLECTION

Presence of groundwater is an intermittent and irregular process. Geological conditions determine the path by which water from precipitation reaches the zone of saturation. If the water table is near the surface, there may be considerable percolation through the soil. Relatively impermeable layer above the water table may prevent such direct percolation. The rate of percolation from such an influent stream is limited by the extent and character of the underlying material.

2.1. THE STUDY AREA LOCATION AND ACCESSIBILITY

The study area is Rajampet in Kadapa district, Andhra Pradesh (Figure 2.1.). It has a hilly topography with its elevation of 139 meters above mean sea level. There are number of drainage channels within the area. The major part of study area is covered by Rajampet mandal. It is located $14^{0}06'$ to $14^{0}15'$ North latitude and $79^{0}02'$ to $79^{0}13'$ East longitude and covering an area of 219.73 Sq.km. It is included in the Survey of India Topographical sheets of 57N/4 on a scale of 1:50,000. It is by the side of the road on way to Tirupati, the abode of Lord Venkateswara, from Kadapa. Location of the study area is shown below in Figure II.I.

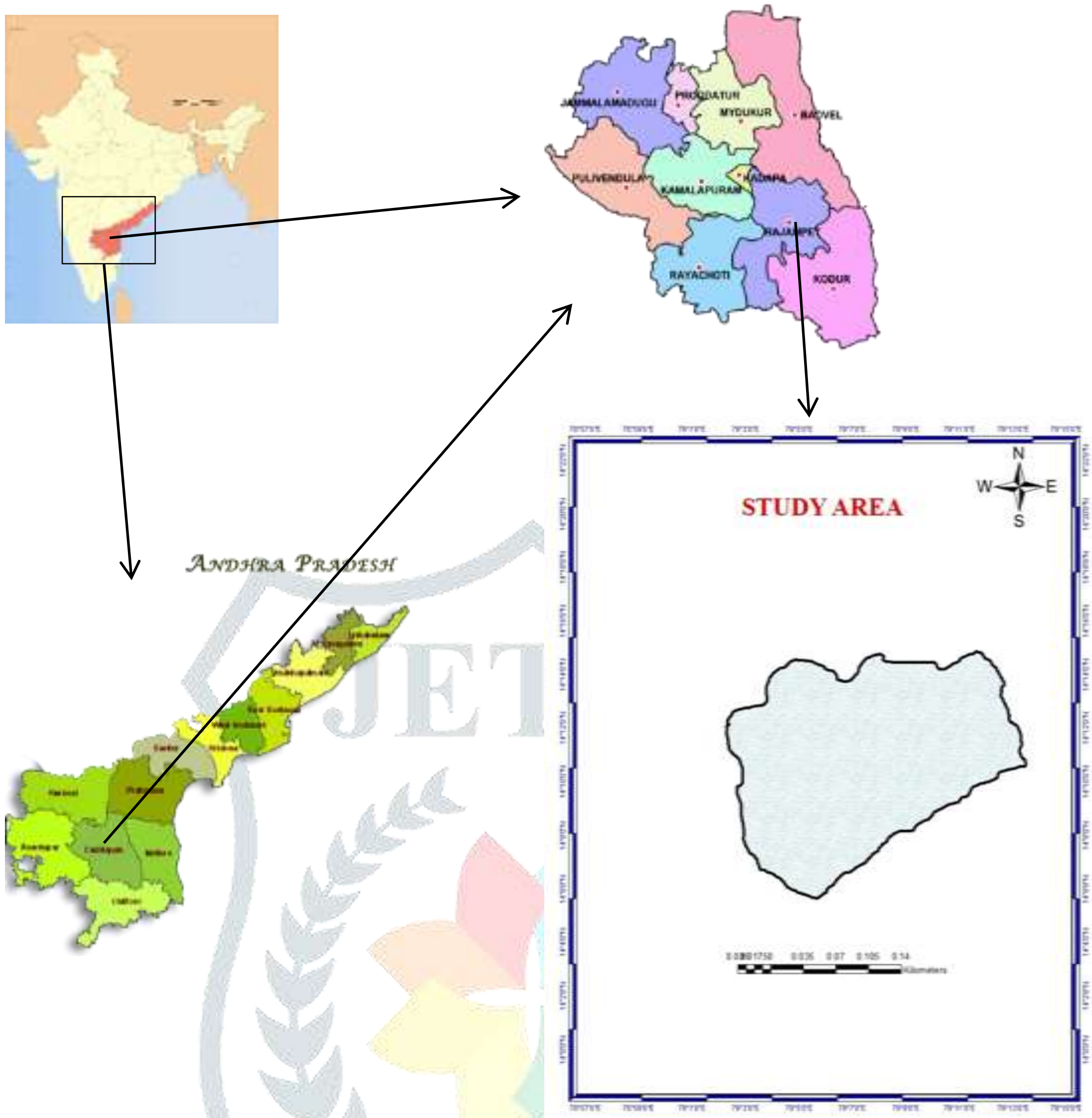

Fig:- 2.1. Location of study area

2.2. PHYSICAL CHARACTERISTICS

Physical Characteristics of any study area described the natural environment of the place. They include the following parameters:

2.2.1 PHYSICAL FEATURES

The physical features of any geographic area mainly consider with the landforms and water bodies, it has a hilly topography with its elevation varying from 690 m above mean sea level to 840 m above mean sea level. Entire area is covered by undulating hilly tract intersected by gorges and passes. There are many seasonal canals in the region along with some artificial structure for rainwater harvesting act as the only source of water bodies.

2.2.2 SOIL

Soil of entire area is less fertile. The area is fully occupied by red shallow gravelly loamy soils, red shallow gravelly clayey soils and red gravelly clay soils. It contains a large quantity of iron because of these are generally deficient in nitrogen and phosphorous. Soil in that area was general loose in texture and well drained. Large quantity of iron concentrations is present in the soil.

2.2.3 MINERALS

In the study area the deposits of white clay are situated near Hastavaram. White clay which could be used as filler in paper, textile industries etc.

2.2.4 LAND USE/LAND COVER

Around 30% of the area covered with agricultural fields. Moderate development is been primarily seen in the villages of this study area. Forests are present about 15% and scrub lands about 40%. Surface water bodies are covering 5 % area and 10% of built up area. Now a days the forest cover is been gradually decreasing due to rapid development activities.

2.2.5 AGRICULTURE

With adverse climate, having hilly topography, unreliable precipitation and light soil texture, the cropping pattern of the district mainly depend on rainfall, as it is the main source of irrigation along with medium irrigation, minor irrigation and lift irrigation. People mainly grow paddy as the major crop in their fields in Kharif season. Banana, Papaya and Sapota fruits are also grown by farmers of this region.

2.2.6 TEMPERATURE

The study area fall along the sub-tropical climatic region. The climate of the area is been aggressively hot during summer with high humidity. The maximum temperature begins to rise rapidly during the month of May. During the summer maximum temperature is recorded around 40°C. The weather becomes more pleasant with the approach of the monsoon in June and remains as such up to the end of October. The temperature during the winter i.e. for the month of December is around15°C- 20°C.

2.2.7 RELATIVE HUMIDITY

According to the data obtained it was found that high monthly relative humidity occurs between the month of June to October was that average values at 8.30 hrs. and 17.30 hrs. are 75% and 56% respectively.

2.2.8 RAINFALL

The study area experiences sub-tropical climate with abundant rainfall during monsoon months. The seasons of the study area mainly divided into four seasons. The hot season lasts from March to May; period from June to September is the south-west monsoon season. October and November constitute the post monsoon season and the cold season is from December to February. Average rainfall in the study area is 800-1000 mm.

2.2.9 DRAINAGE

As the study area has a hilly topography. Elevation varies from 840 MSL to 690 MSL. There are number of valleys with dry drainage channels within the area. Entire area is covered by undulating hilly tract intersected by gorges and passes. There are many seasonal canals in this region. Basically it’s a rugged mountainous region being bisected by number of geomorphic valleys.

2.3 DATA COLLECTION

Different types of data was been collected for the present study purpose; such as satellite data, topographic maps, groundwater data, metrological data.

2.3.1 SATELLITE DATA

Different types of satellite data was been used for Remote sensing analysis purpose, most of the thematic maps were derived from the IRS-LISS III satellite data. The IRS-LISS III data were procured from NRSC, India and other datasets were downloaded freely from their respective websites for free.

Cartosat-1(DEM) data was downloaded from the NRSC site (open data download) for developing the Satellite image of the study area and groundwater map have been downloaded from Central Groundwater Board, Bhubaneswar site. Survey Toposheets was also used. Geographic Information System and Image Processing (ARC GIS 10.1 software) have been used for analysis and mapping of the individual layers. A satellite image of the study area was obtained from geology dept. of Yogi Vemana University, Kadapa, A.P .

2.3.2 TOPOGRAPHICAL DATA ANALYSIS

A topographical map was derived from the satellite data. Concern office in order to obtain various maps for cross verification with the satellite data which was used. In this study, ARCGIS 10.1 version software has been used to delineate different thematic following maps: (1) Drainage map, (2) Drainage density map, (3) Soil map, (4) Geology map, (5) Slope map etc. ARCGIS 10.1 version was used for GIS analysis.

2.3.3 GROUND WATER RESOURCES

The common revive of ground water happens through permeation from area after rain events. The quantum of dynamic ground water, which might be yearly concentrated is by and large figured as ground water potential. The ground water assets evaluations are constantly completed at an interim of five years succeeding on the standards and technique recommended by the Ground Water Estimation Committee (GEC) of Government of India. According to the most recent appraisal (2008-09), the State has net dynamic ground water resources of 16.69 lakh ha.m (BCM). Out of which, investigation to the degree of 4.36 lakh ha.m (BCM) has been made for different employment.

3. METHODOLOGY

It describes about the different methodology adopted for present study; regarding the preparation of a report on groundwater potential and scarcity, application of remote sensing and GIS techniques for remote sensing analysis, performing the resistivity survey in the field, for deigns and development of soil moisture sensor. The details methodologies are described below.

3.1. DEVELOPMENT OF DIFFERENT THEMATIC MAPS BY USING ARC GIS TOOLS

Cartosat-1 Digital elevation model (DEM) data were collected (Source: http://bhuvan3.nrsc.gov.in/). Area of interest was extracted from the DEM data and was imported to Arc GIS. Overlaying was done with the previously drawn boundary map which was done using the toposheets. Then the required digital elevation model for the study area was developed.

3.2. PREPARATION OF THEMATIC MAPS

The IRS P6 LISS III dataset which is geocoded False Color Composite, having the band consolidation of 1, 2, 3 was acquired from NRSC, Hyderabad India. Than the IRS FCC was outwardly translated focused around picture understanding keys i. e., tone, composition, size, shape, design, waste, cooperation and so forth (Lillesand and Kiefer, 2002). FCC was deciphered for the recognizable proof and depiction of distinctive hydro geomorphological units. The study territory was concentrated from the cartosat-I DEM and thusly redesigned from the toposheets of 57N/4 S.O.I. with 1:50000 scale. The seepage guide was digitized physically as well as a line scope demonstrating the whole stream system. Calculation based network estimations of DEM system joined on Arc/Info GIS programming was utilized for making stream system of the study zone. For making stream system; stream course, filling, sink, stream amassing, stream requesting was utilized (Strahler 1952, Jenson and Dominguez 1988, Tarboton et al. 1991).

Other thematic layers were prepared; for present study different themes were evaluated: (i) drainage, (ii) drainage density, (iii) soil, (iv) Geology, (v) slope on the raster GIS platform. Raster GIS model was embraced since it was enhanced spatial determination for pictures and for expansive region scope. Crude pictures were digitally handled utilizing look-up table stretch, histogram leveling, key part investigation and 363 high-pass directional separating systems for making geomorphology and lineament thickness maps. Soil maps was digitized and changed with support of satellite symbolism and put away as topical maps.

Stream heading guide was created from DEM; the DEM of the study range was used as an info. It has given a reasonable picture about the stream heading in the study range. Considering stream heading guide as information, stream collection guide was produced utilizing Arc GIS instruments.

Area utilization/area spread information was gathered. Chose part of the study territory was transported in to Arc GIS and the area utilization/area spread guide was produced. The diverse topical maps was utilized as a part of depicting groundwater prospective zones which were given weights and positioning focused around their impact in groundwater prospects as indicated in (Table 3.1).

Table 3.1: Weighted and % influence of different thematic layers

Sl. No.	Theme	% influence	Class	Rank
1	Slope	30	0-5	5
			5-15	4
			15-30	3
			30-40	2
			>40	1
2.	Drainage Density	25	0-1.15	4
			1.15-3.02	3
			3.02-6.54	2
			6.54-14.01	1
3.	Land use/Land Cover	25	Forest	5
			Agriculture	4
			Water bodies	3
			Settlement	2
			Waste lands	1
4.	Soil	10	Red shallow gravelly loamy soil	3
			Red shallow gravelly clay soil	2
			Red gravelly clay soil	1
5.	Geology	10	Shale with lime stone	3
			Shale with dolomite	2
			Shale with phyllite	1

4. RESULTS & DISCUSSIONS

The results obtained from different objective were analyzed and the results are properly discuss below.

4.1 REMOTE SENSING & GIS ANALYSIS FOR GROUNDWATER POTENTIAL ZONE

The data required for remote sensing and GIS was downloaded from NRSC Hyderabad, various thematic maps were delineated using Arc GIS software. The different thematic maps are given below.

- Slope map

- Drainage map
- Drainage density map
- Land use/Land cover map
- Soil map
- Geology map

Each thematic map is prepared individually discussed and shown below. These maps are prepared by using toposheets and satellite data by using Arc GIS 10.1 software.

4.2 THEMATIC MAPS

4.2.1 SLOPE MAP

Slope map was generated from **Cartosat-1**DEM data from NRSC, Hyderabad India was used in the present study which is freely available. Greater portion of the area has very flat terrain except the upper part, which is a hilly terrain with a steep slope varying from 50% to 60%. Slope range was differentiated into five groups. Finally, five classes of slopes (0-5, 5-15, 15-30, 30-40, >40) were differentiated and shown in (Figure 4.1). Higher slope will produce more runoff with lesser infiltration, and it will have a poor groundwater prospects contrasted with low slope region. The higher weight has been assigned to gentle slope and lesser weight to higher slope, as shown in (Table 3.1).

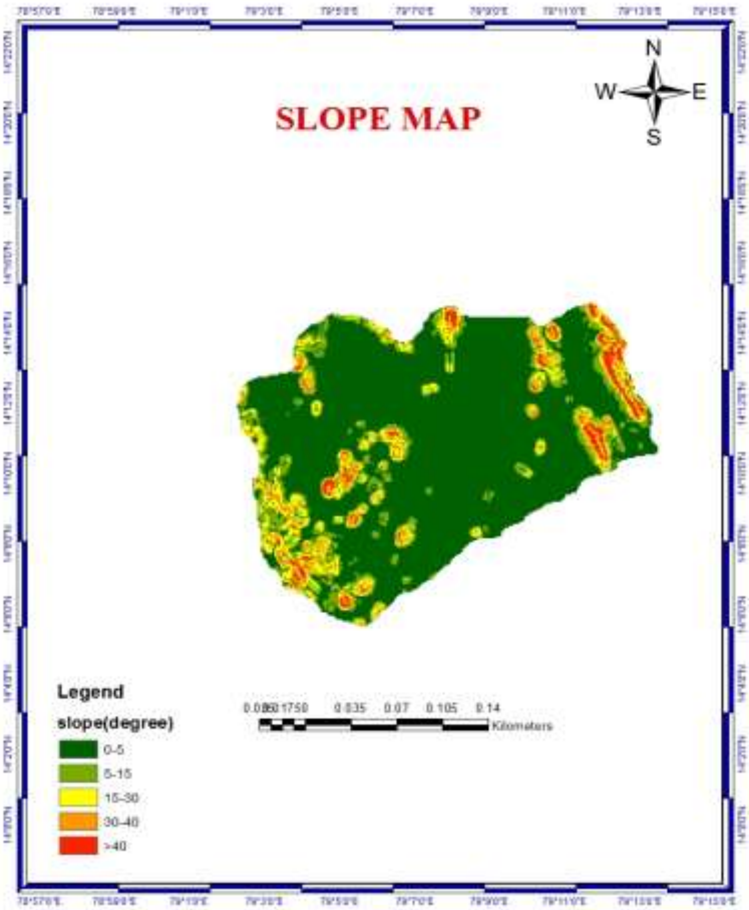

Fig. 4.1 Slope map

4.2.2 DRAINAGE MAP

As the study area has a hilly topography. Elevation varies from 840 MSL to 690 MSL. There are number of valleys with dry drainage channels within the area. Entire area is covered by undulating hilly tract intersected by gorges and passes. There are many seasonal canals in this region. Basically it's a rugged mountainous region being bisected by number of geomorphic valleys.

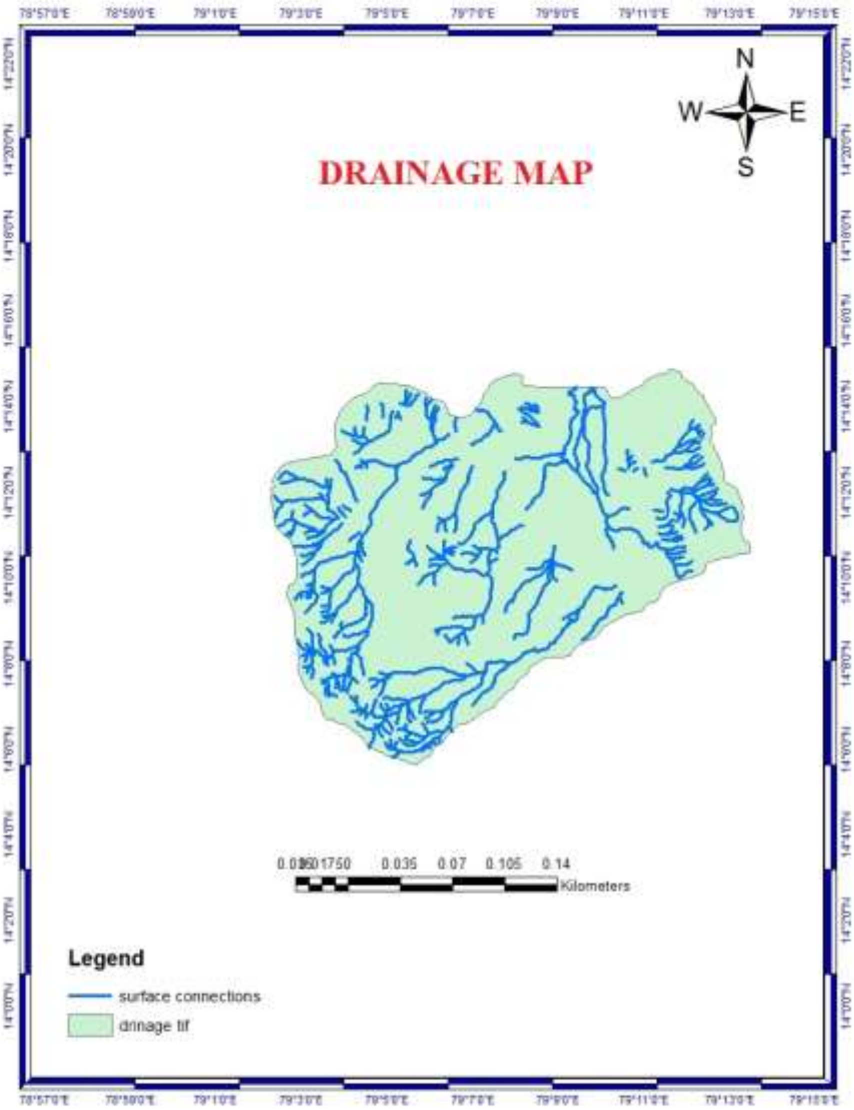

Fig. 4.2 Drainage map

4.2.3 DRAINAGE DENSITY MAP

Drainage density of the study area was calculated as the 'total length of streams in the sub basin area' and expressed as km/km^2. The drainage density was found to be 0.024 m^{-1} (Figure 4.3). Drainage density value was grouped into four groups: 0.0-1.15, 1.15–3.02, 3.02-6.54 and 6.54-14.01. A low drainage density region causes higher infiltration and it yields in better groundwater potential zones as correlated to a high drainage density region. The higher weight was given to the low drainage density regions and the lower weight to the high drainage density areas, shown in (Table 3.1).

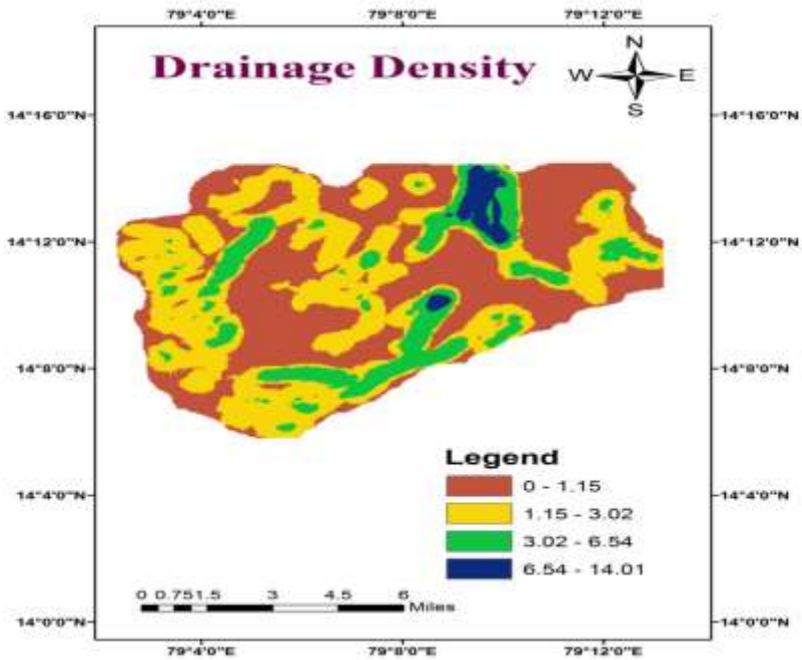

Fig. 4.3 Drainage density map

4.2.4 LAND USE / LAND COVER MAP

Land use/Land cover map (Figure 4.4) was prepared from NRSC Bhuvan satellite dataset and district profile map of Kadapa district. The following classes are distinguished: (i) water bodies, (ii) Built up area, (iii) Crop land, (iv) Forest, (v) Fallow. Different Land use/Land cover classes were weighted based on their water requirement. The water bodies were given the highest weight over other land use features since its incessant recharge to ground, ensued by green forest only, which pull maximum amounts of water from the deep root zone for sustaining, resulting the present of water below the ground surface. Forest was weighted higher than crop which required huge amount of water and thus it act as a good groundwater recharge. Scrubland is a land that is covered with small bushes and tree where as current fallow land is a land which was periodically left idle i.e. land that is not planted of any crop; that is why it was given less weight than scrubland. The lowest priority was given to waste Land as it lacks a vegetation cover. The various weighted of land use/land cover classes are presented (Table 3.1).

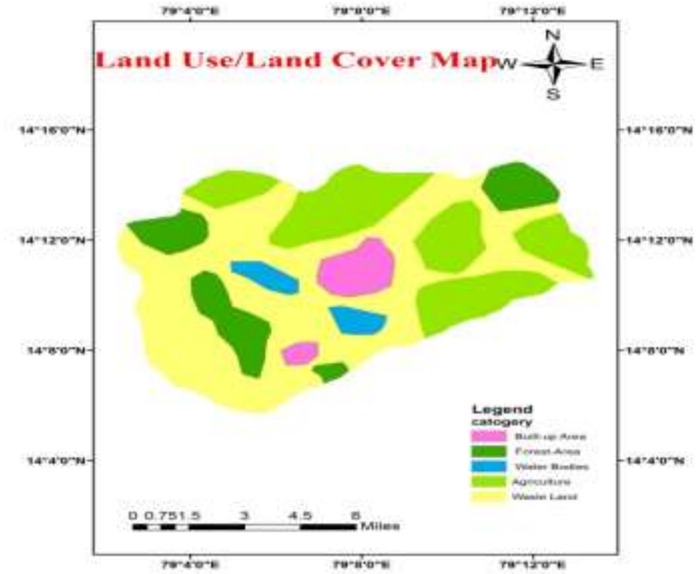

Fig. 4.4 Land use/Land cover map

4.2.5 SOIL MAP

The soil map is prepared from district soil map of agricultural department, A.P. Soil of entire area is less fertile. The area is fully occupied by red shallow gravelly loamy soils, red shallow gravelly clayey soils and red gravelly clay soils. It contains a large quantity of iron because of these are generally deficient in nitrogen and phosphorous. Soil in that area was general loose in texture and well drained. Large quantity of iron concentrations is present in the soil.

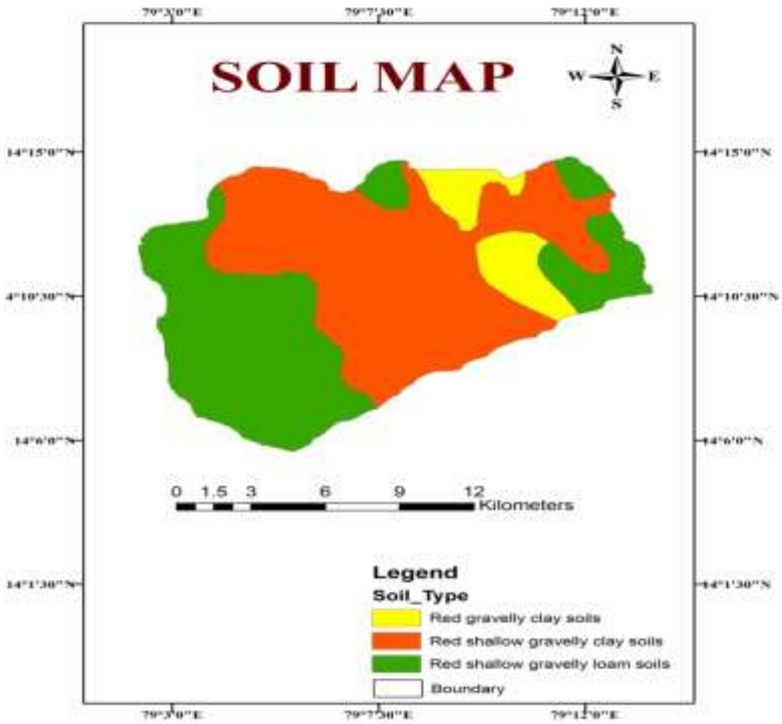

Fig. 4.5 Soil map

4.2.6 GEOLOGY MAP

Geology is an earth science comprising the study of solid earth, the rocks of which it is composed and the processes by which they change. The geology map is prepared from district geology map of Geology department, Y.V.U Kadapa. Geology of entire area is shale. The area is fully occupied by red shale with dolomite, shale with lime stone and shale with phyllite. Lime stone intrusions in shale offer more storage capacity because it has more infiltration capacity. Shale with dolomites has less infiltration capacity and shale with phyllite have very less infiltration capacity.

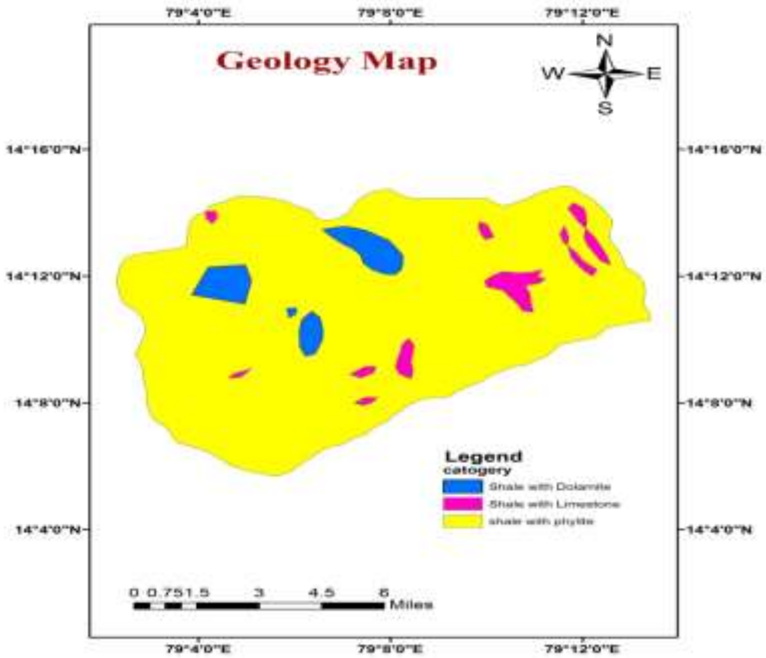

Fig. 4.6 Geology map

4.3 INTEGRATION OF THEMATIC LAYERS FOR MODELING USING GIS/ WEIGHTED INDEX OVERLAY MODEL

Depending upon the groundwater potentiality, each class of the main six thematic layers (slope, drainage, drainage density, land use/land cover, soil, geology) are roughly placed into one of the following groups viz., i. Very good, ii. Good, iii. Moderate, iv. Poor, v. Very poor. Suitable weighted on a scale of '0 -8' has been given to each class of a particular thematic layer based on their contribution towards ground water potentiality. The % influence of each thematic map is been given based upon its contribution toward ground water. The weighted and % of influence assigned for various classes on all thematic layers are shown in the (Table 3.1). All the thematic maps have been integrated. A final groundwater potential map (Figure 4.7) is prepared with application of above technique.

Table 4.1 Areas of various Groundwater potential Zones in study area

S. NO	Ground Potential Zones	Area(km^2)	% Total Area
1	Very Poor	11.46	5.21
2	Poor	46.24	21.02
3	Moderate	66.30	30.14
4	Good	55.57	25.26
5	Very Good	40.41	18.37

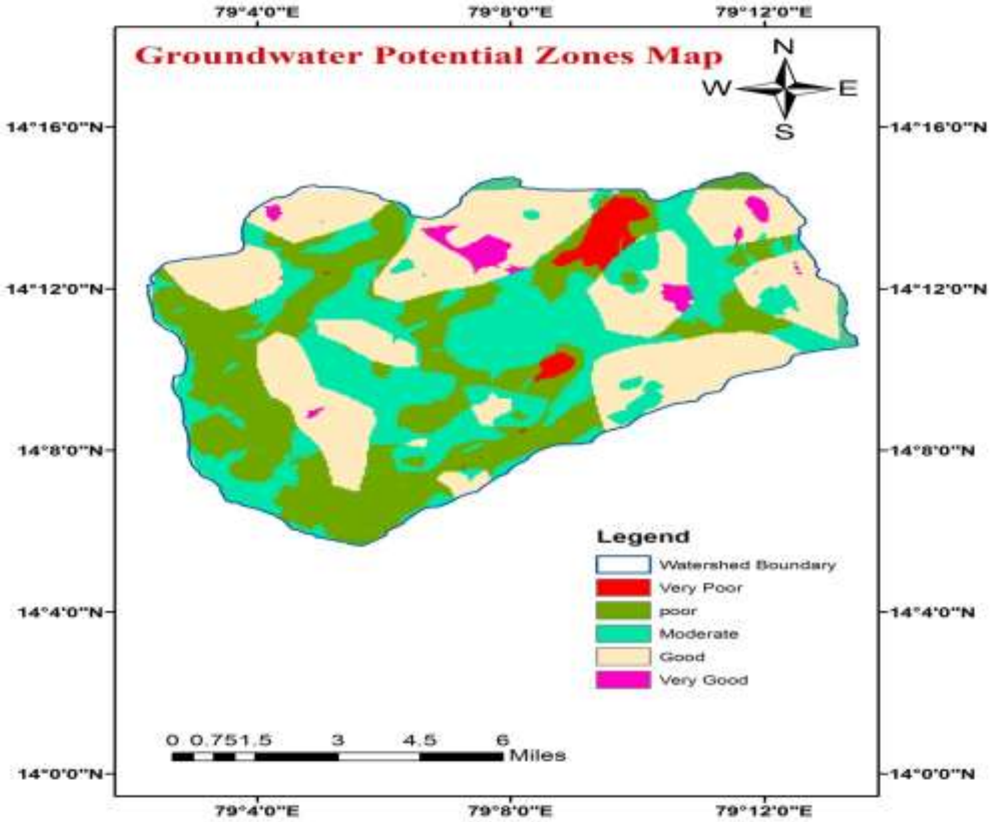

Fig.4.7 ground water potential zones map on study area

5. CONCLUSION

Geographical information system and remote sensing has proved to be powerful and cost effective method for determining groundwater potential zones in and around Rajampet. The study reveals that integration of six thematic maps such as slope, drainage, drainage density, land use/land cover, soil, geology gives first-hand information to local authorities and planners about the areas suitable for groundwater exploration. In this present study, from the first objective it can be concluded that the Rayalaseema region of Andhra Pradesh state are found to be utilizing groundwater more than other districts of the State. The successful use of the remote sensing data on GIS platform has helped in obtaining detailed scenario of groundwater situation in the study area. The required thematic maps for the groundwater prospecting zones of the study area were directly generated by remote sensing data using the software ARCGIS 10.1. Various algorithms which were essential for the hydrological application was used in Arc/Info GIS which were useful in creating study area boundary, stream network and drainage density maps. The integration of all the thematic maps result five groundwater potential zones – very poor, poor, moderate, good, very good and the areas of various groundwater potential zones of study area as-Very Good 5.21%, Good 21.02%, Moderate 30.14%, Poor 25.26%, Very Poor 18.37%. The Very poor zone was indicating the least favourable area for groundwater prospect; whereas Very good zone indicates the most favourable area for groundwater prospect. The results which were secured from the integration of various thematic maps were shown in the final map. This groundwater potential information will be useful for effective identification of suitable locations for extraction of water. Further, it is felt that the present methodology can be used as a guideline for further research.

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