IDENTIFICATION OF GROUND WATER POTENTIAL ZONES USING RS AND GIS TECHNIQUES FOR KUPPAM MANDAL

[1]C.MAHESH BABU, [2]R.KRISHNA MOHAN REDDY, [3]R.BALASUBRAMANYAM

[1]Assistant Professor, [2,3]B.Tech Scholar

Civil Engineering Department,
Kuppam Engineering College, A.P, India
Jawaharlal Nehru technological university

***ABSTRACT*: Groundwater is one of the most valuable natural resources, which supports human health, economic development, ecological diversity and largest available source of fresh water lays underground. Due to its several inherent qualities (e.g. consistent temperature, widespread and continuous availability, excellent natural quality, limited vulnerability, low development cost and drought reliability), increase in the agricultural, industrial and domestic activities in recent years has increased the demand for good quality water to meet the growing needs and it has become an important and dependable source of water supplies in all climatic regions including both urban and rural areas of developed and developing countries. Satellite pictures (DEM) are widely being used for groundwater exploration because of its ability to identify various ground features, which may serve as an indicator of groundwater's presence, Study and analysis of remote sensing data is a fast and economical way of finding and exploring. The Present study, for assessment of groundwater availability in kuppam area (Chittoor district) shows various groundwater potential zones.**

In the present 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 are generated using the satellite data. It is then integrated with weighted overlay in ArcGIS. Suitable ranks are assigned for each category of these parameters. For the various geomorphic units, weight factors are decided based on their capability to store groundwater to generate ground water potential zone map. 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 Kuppam in Chittoor district of Andhrapradesh. This groundwater potential information will be useful for effective identification of suitable locations for extraction of water.

***KEYWORDS*: Remote sensing and Geographical information system, DEM (digital elevation model), Thematic maps.**

I. INTRODUCTION

Groundwater is a form of water occupying all the voids within a geological stratumThe study of ground water is important since it is main source for drinking, irrigation and industry use in all over the world. Water bearing formations of the earth's crust act as conduits for transmission and as reservoirs for storing water.

Of the 37 M km^3 of fresh water estimated to be present on the earth, about 22% exists as groundwater, which constitutes about 97% of all liquid freshwater potentially available for human use (Foster, 1998Thus, groundwater is emerging as a formidable poverty reduction tool in developing countries and can be delivered to poor communities for more cheaply, quickly and easily than the conventional canal irrigation water (IWMI, 2001).An approach for groundwater investigation is very costly, time-consuming and requires skilled manpower (Sander et al., 1996). As Remote Sensors cannot detect groundwater directly, the presence of groundwater is inferred from different surface features derived from satellite imagery such as geology, lineament, and forms, soils, land use/ land cover, surface water bodies, drainage, slope, which acts as indicators of groundwater existence (Todd, 1980; Jha and Peiffer, 2006).

Groundwater potential zones were delineated using Remote Sensing and Geographical information system (GIS) techniques drawing from a database that includes climate, geomorphology, drainage pattern, soil and topographic slope and satellite data.

II. OBJECTIVES AND STUDY AREA

1. GENERAL:

The area of investigation in this research study is the Kuppam mandal of Chittoor district, Andhra Pradesh, India. In this chapter geographical, meteorological and socio-economical features of the study area are explained. It describes the location and extent of study area, topographic characteristics, soil and land, climate and water resources details.

Kuppam is town in Chittoor district of Indian state of Andhrapradesh. The total area of Kuppam is 3.10sq km (1.20sq m) and elevation is 667m (2188ft), population is 21963, density is 7100/sq. km (18000/sq. m). The average rainfall in kuppam is 680mm. the main river in the Kuppamis palar. This river contains 75 Km of flow with 40 water storage structures and 700 small irrigation tanks which can the rain water for better usage.

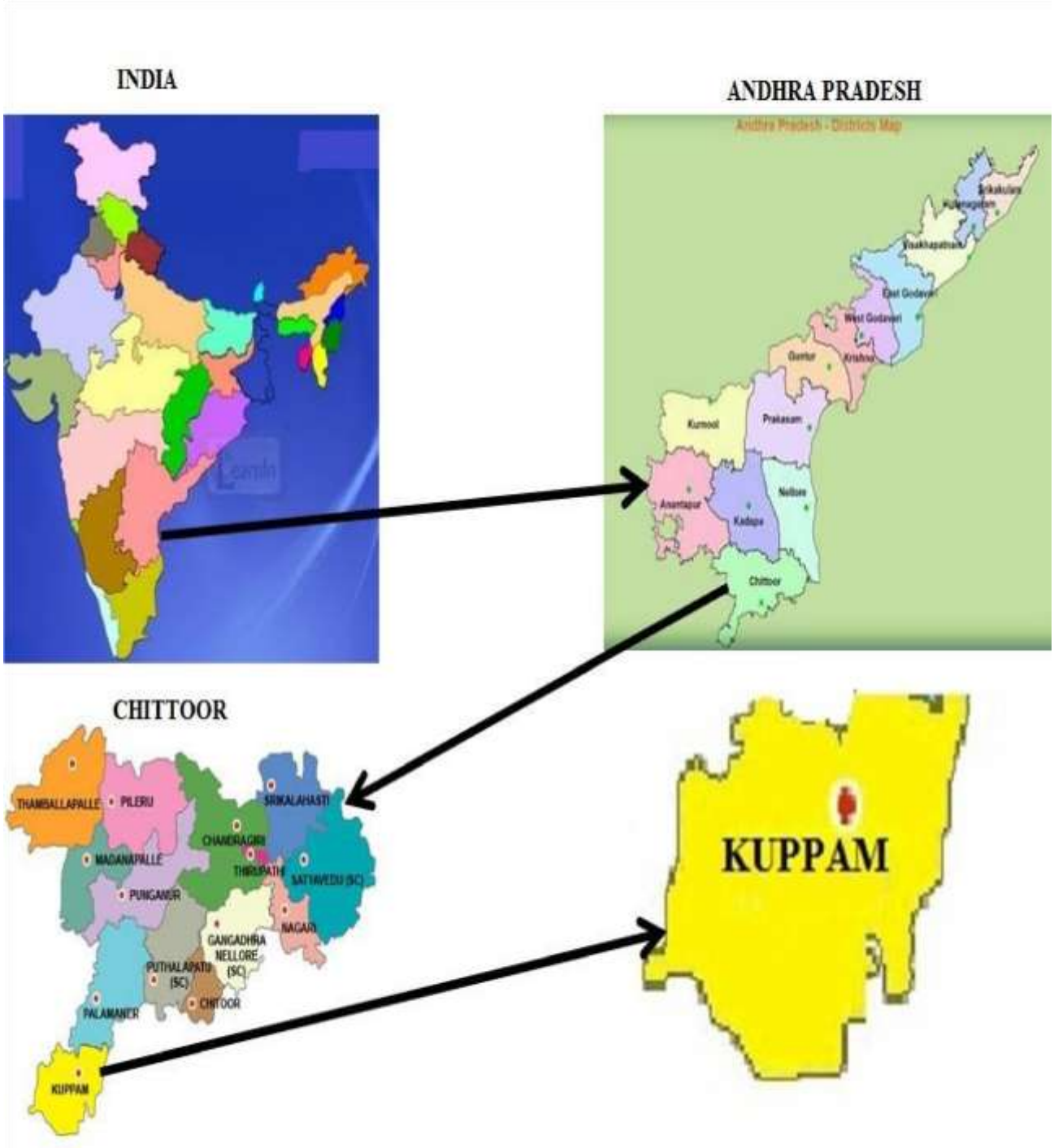


FIGURE 1. STUDY AREA LOCATION

1. LOCATION:

Kuppam is a part of Rayalaseema region of andrapradesh. The kuppam occupies a geographical area of 3.10sq km. the Kuppam lies extreme south of Andrapradesh state approximately between 12^0 37^1-14^0 8^1 north latitudes and 78^0 3^1-79 ^{0}55^1 east longitudes. Thirty percent of the total land area is covered by forest in the area. Kuppam area has 1, 21,000 ha of geographical area out of which 40,000 ha are under forest cover.

2. GEOGRAPHY AND

3. CLIMATE:

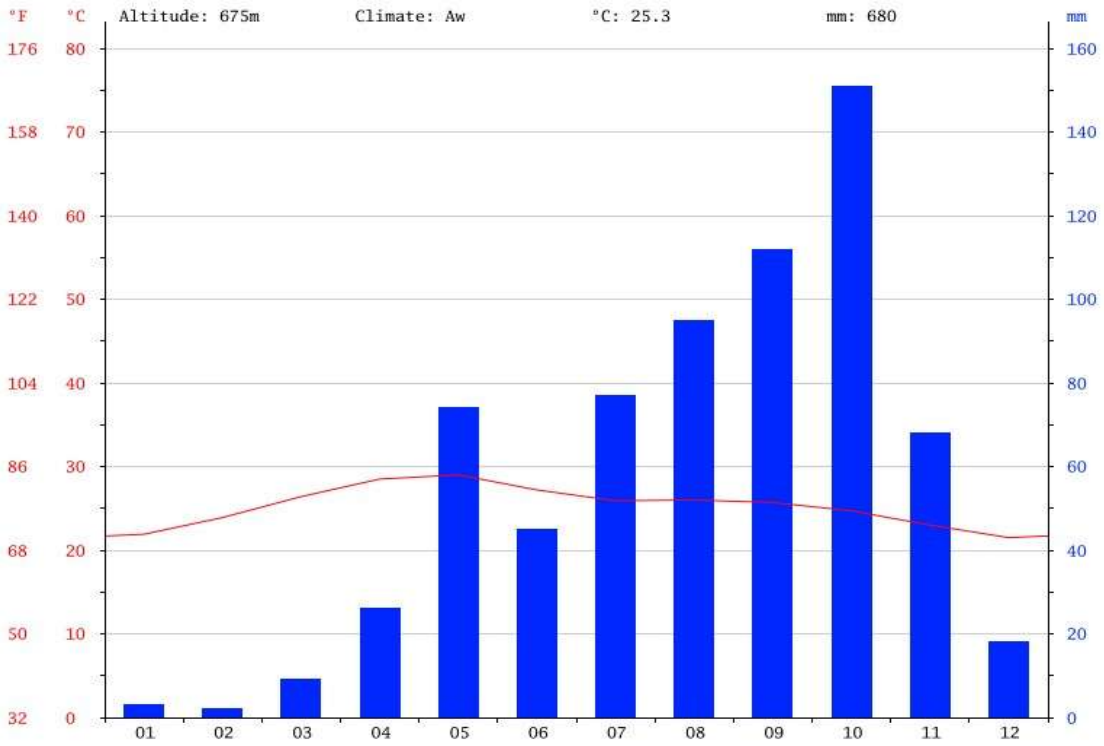


FIGURE 2.CLIMATE

The climate of the study area is quite moderate whole the year with a fairly hot summer and cold winter. March to May are the summer months/Season, June to September are monsoon months/Season, October to December are post monsoon months/Season as well as January to February are winter months/season. The mean maximum temperature is 34.7°C and the mean minimum temperature is 15.3°C.

4. SOILS IN KUPPAM:

Soil is the thin layer on the surface of the earth on which the living beings survive. Soil is comprised of mixture of minerals particles (45%), soil organic matter (SOM,1-5%), water (20-30%) and air (20-30%), broken rocks, (parent materials), mineral and soil organic matter comprise soil solids, air and water is pore space which have been altered by physical, chemical and biological processes that include weathering with associated erosion. Soil is created from the alteration of parent material by the interactions between the lithosphere, hydrosphere, atmosphere, and biosphere.

The soils in kuppam constitute red loamy 57%, red sandy 34% and the remaining 9% is covered by black clay and black loamy, black sandy and red clay.70000 hectares of arable land with fertile soils and balanced soil nutrients with very good drainage system suitable for growing variety of crops.

III. METHODOLOGY

The following flowchart will explain the methodology

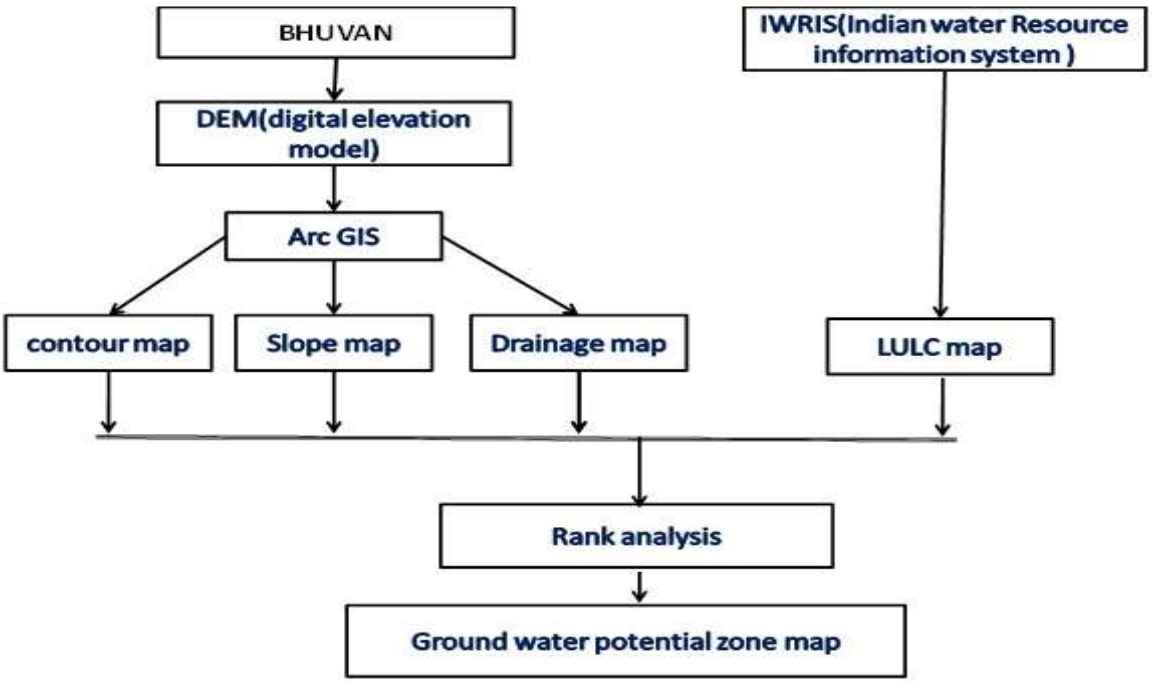


FIGURE 3.METHODOLOGY

The proposed methodology of study involved various activities such as base map preparation, LULC map preparation, Digitization and image processing using software and interpretation of the outputs.
Digital elevation model for kuppam area is collected from bhuvan website of cartosat 2 satellite to create thematic maps like slope, contour, drainage density maps. LULC map for kuppam area is taken from IWRIS (LISS 3).

In first stage GIS and remote sensing technology is applied to prepare various thematic maps with reference to groundwater like drainage density, contour, and stream length. Additionally, the Land Utilization Survey Database, geologic maps and on site investigation are adopted to quantitatively and qualitatively describe the hydro-geo- logical conditions of the area. DEM is used to prepare slope, aspect, flow accumulation and stream order.

Methodology is widely used for preparing runoff potential map for small to medium size engaged drainage basin.

In the second stage the LULC map taken from IWRIS (Indian water resource information system). The study area covered by six different classes such as agricultural land, forest, built-up, water body, waste land and others.

In the third stage, all above themes are further processed and analyzed in overlay and ranking is given to evaluate suitable groundwater potential zone. All the thematic layers will overlay by using GIS to find the final integrated output of groundwater potential zones in the present study, geomorphology, slope, drainage density, Land use and land cover, Geology and lineament density are considered for the identification of groundwater potential.

The groundwater potential zone is identified by assigning the weightages to various factors and ranking the hydrogeological units based on integration of thematic layers. The available quantum of groundwater is identified by using groundwater potential map. The integration of the various thematic maps was carried out using GIS in the following steps:

IV.FACTORS INFLUENCING GROUND WATER

1. SLOPE MAP:

Slope is one of the important terrain parameters which are explained by horizontal spacing of the contours. In general, in the vector form closely spaced contours represent steeper slopes and sparse contours exhibit gentle slope whereas in the elevation output raster every cell has a slope value. In the present study, DEM of kuppam area was imported into ARCGIS environment. Slope map was prepared by using **SPATIAL ANALYST TOOL** in arc tool box. Here, the lower slope values indicate the flatter terrain (gentle slope) and higher slope values correspond to steeper slope of the terrain.
The slope map obtained reveals that kuppam area was divided into five classes of slope. The Red color indicates the flatter terrain and it having zero percent slope. The yellow color indicates the mild steeper terrain and it having 15percent slope, green color indicates the moderate steeper terrain and it having 35 percent slope, sky blue color indicates the steep terrain and it having 50

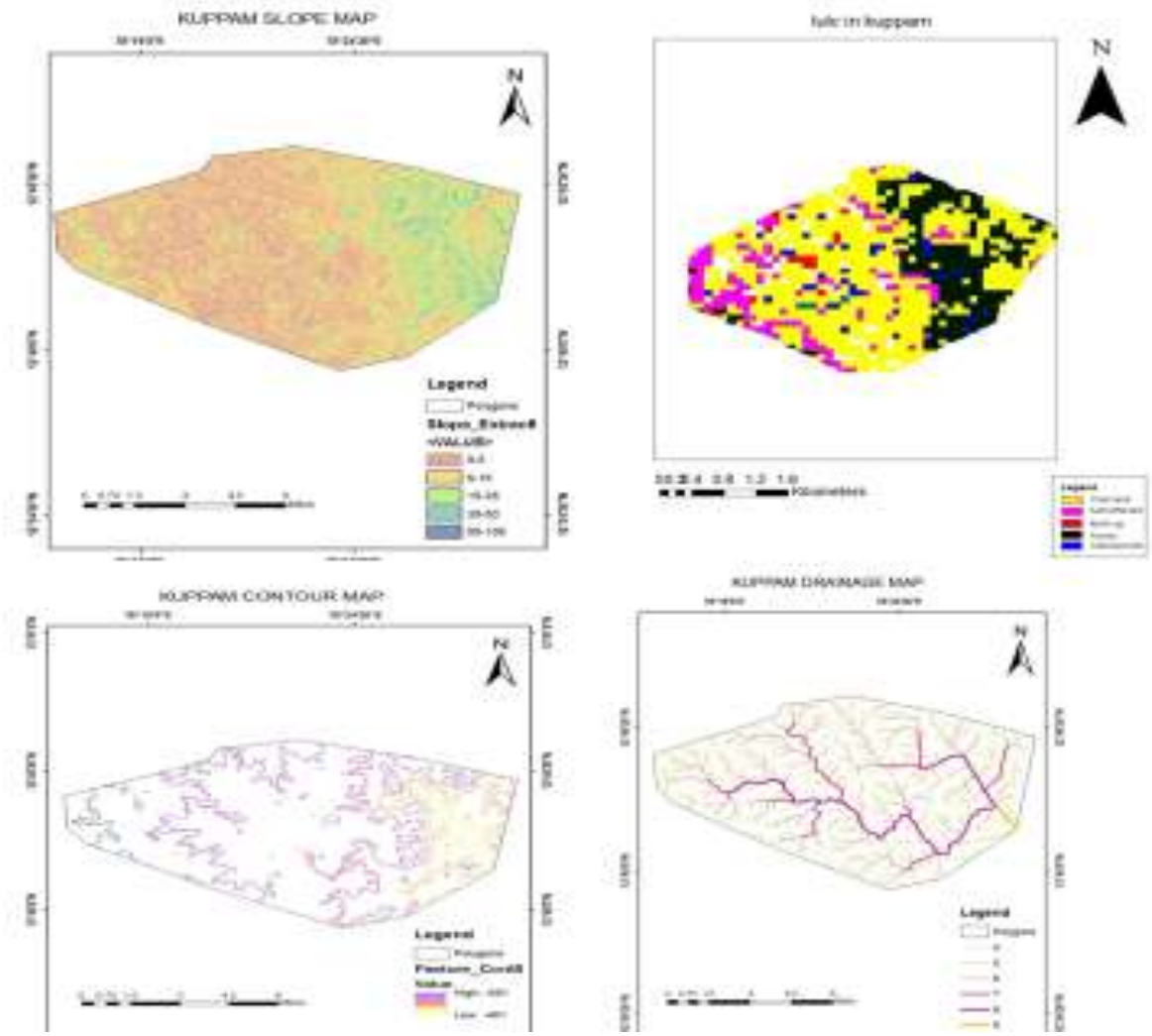
percent slope and blue color indicates the very steeper terrain and it having 100 percent slope. From the above figure, it was observed that most of the area is having flatter terrain.

2. LAND USE/LAND COVER:

LULC map taken from IWRIS website. From the LULC map it was observed that due to anthropogenic activities the land surface has been modified enormously in the recent years. The surface covered by vegetation like forests and agriculture traps and holds the water in root of plants whereas the built-up and rocky land use affects the recharge of groundwater by increasing runoff during the rain, so it is necessary to study what kind of features are covered the study area's land surface.

The LULC image from IWRIS (INDIAN WATER RESOURCE INFORMATION

SYSTEM) has been used for the study to find out the land use and land cover of study area. The result of the study found that the study area covered by different classes such as crop land, forest, built-up, lakes and ponds, and others. The weight assigned based on water logging and runoff properties of LU/LC. Land use/land cover is one of the important parameter for the geohydrological study because the land use pattern of any terrain is a reflection of the complex physical processes acting upon the surface of the earth. The major land-use/land-cover type in the study area are crop land, built up area, agriculture and settlements.



3. DRAINAGE DENSITY:

Drainage pattern reflects the major characteristic of surface as well as subsurface formation. More the drainage density, higher would be runoff. Drainage density of the study area is calculated using line density analysis tool in ArcGIS software. The suitability of groundwater potential zones is indirectly related to drainage density because of its relation with surface runoff and permeability. In the present study, DEM of kuppam area was imported into ARCGIS environment. Drainage density map was prepared by using **SPATIAL ANALYST TOOL** in arc tool box. From the map, it is observed that the yellow color indicates 1st order stream, blue color indicates 2nd order stream and the light-yellow color indicates the 6th order stream. The 6th order stream will influence recharge of ground water when compare to 1st order stream.

4. CONTOUR MAP:

The contour map was prepared using Arc Map of Arc GIS 10.2. Contour map is a useful surface representation because they enable to simultaneously visualize flat and steep areas, ridges, valleys in the study area.

Contour lines connect a series of points of equal elevation and are used to illustrate topography, or relief, on a map. They show the height of ground above Mean Sea Level (M.S.L.) in either feet or meters and can be drawn at any desired interval. In the present study, DEM of kuppam area was imported into ARCGIS environment. Drainage density map was prepared by using **SPATIAL ANALYST TOOL** in arc tool box. The kuppam area having elevation ranges between 401mts to 651mts from the mean sea level.

IV. WEIGHTED INDEX OVERLAY ANALYSIS

The groundwater potential zones are obtained by overlaying all the thematic maps such as drainage density, slope, soil and land use/land cover in terms of weighted overlay method using the spatial analysis tool in ArcGIS (Samake et al 2010). The Weighted Overlay tool applies one of the most used approaches for overlay analysis to solve multi criteria problems such as site selection and suitability models. Weighted Index Overlay analysis (WIOA) is a simple and straight forward method for a combined analysis of multiclass maps. The method has the advantage that the human judgment can be integrated with this analysis. Aweight represents the relative importance of a parameter and the objective. There is no standard scale for a simple weighted overlay ethod. For this purpose, criteria for the analysis are defined and each parameter is given its due importance (Saraf & Choudhury 1998). During the weighted overlay analysis, the ranks have been given for each individual parameter of each thematic map and the weight is assigned according to the influence of the different parameters. The weights and rank have been taken considering the works carried out by researchers such as (Krishnamurthy et al 1996, Saraf & Chowdhury 1998). All the thematic maps are converted into raster format and superimposed by weighted overlay method (rank and weight wise thematic maps and integrated with one another through GIS).

S. NO.	Themes	Weightages	Feature Class	Ranks	Score
1	Slope	10	0 – 5	1	10
			5-15	2	20
			15-35	3	30
			35-50	4	40
			50 – 100	5	50
2	Contour	10	401	1	10
			651	2	20
3	Drainage Density	30	1st order	6	180
			2nd order	5	150
			3rd order	4	120
			4th order	3	90
			5th order	2	60
			6th order	1	30
4	LULC	50	Agriculture Land	1	50
			Water Bodies	2	100
			Waste Land	2	100
			Built-Up Area	5	250
			Forest Area	3	150

TABLE NO.1 WEIGHTED INDEX OVERLAY ANALYSIS

For assigning the weight, LULC and drainage density assigned higher weight, whereas the slope and contour were assigned equal weights. After assigning different weights to parameters, individual ranks are given for sub variable as per their influence on ground water potential. Then score was calculated by the following equation,

$$SCORE = W*R$$

The following map represents the ground water potential zone map of kuppam area. In the figure, green color indicates excellent potential, yellow color indicates good potential and red color indicates poor ground water potential. From the figure, it was observed that most of kuppam area has excellent ground water potential.

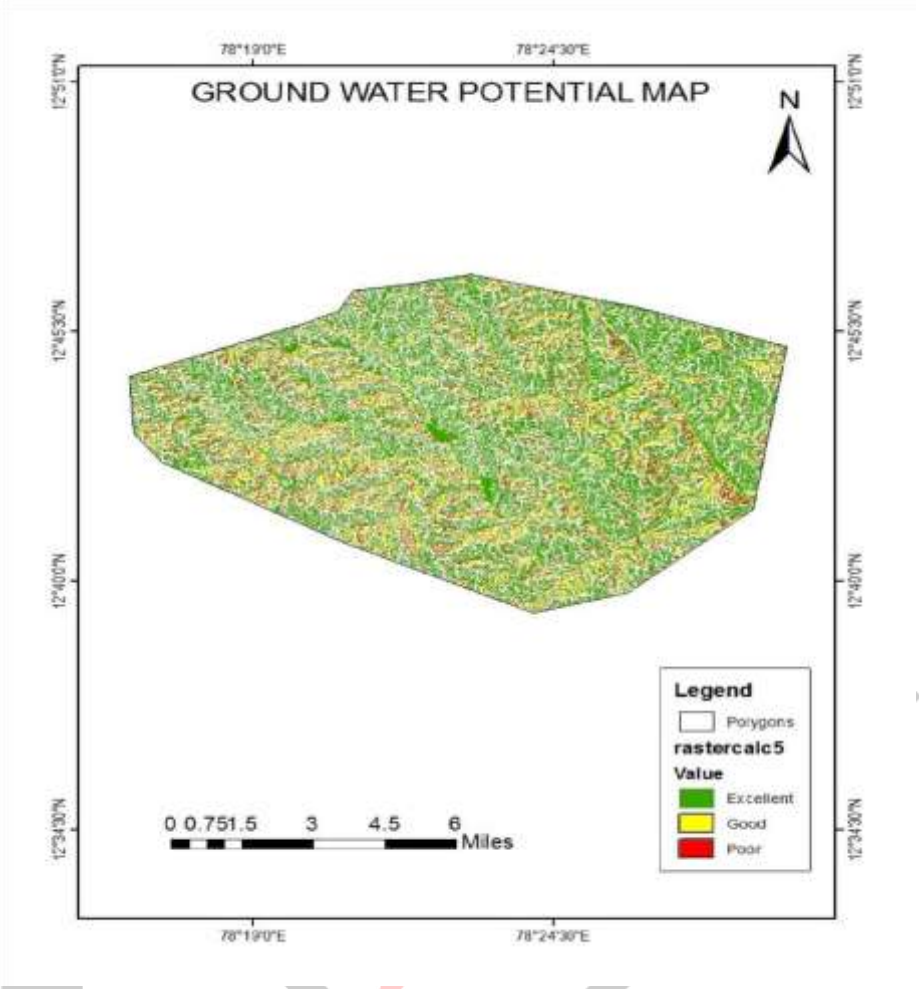


FIGURE 4 .GROUND WATER POTENTIAL MAP

The following map represents the ground water potential zone map of kuppam area. In the figure, green color indicates excellent potential, yellow color indicates good potential and red color indicates poor ground water potential. From the figure, it was observed that most of kuppam area has excellent ground water potential.

V. CONCLUSION

Geographical information system and remote sensing has proved to be powerful and cost effective method for determining groundwater potential in parts of Chittoor district. The study reveals that integration of thematic maps such as drainage density, slope, land use/land cover gives firsthand information to local authorities and planners about the areas suitable for groundwater exploration. The given study area is classified in to excellent, good, moderate, poor and very poor groundwater potential zones.

The result of the study shows that GIS could be successfully employed in identification of ground water potential zones in Chittoor district and this result will help to their management. Ground water being a dynamic and replenish able resource is generally estimated based on the component of annual recharge, which could be subjected to development by means of suitable ground water structures.Ground water became a precious commodity and its quantity and quality is threatened by various factors such as Deforestation, Urbanization, unscientific agriculture practices, land use, Pollution etc. Groundwater forms the principal source of water for majority of people in Chittoor district and most of the people are dependent on wells to meet all their water needs.

REFERENCES

[1] Deepesh M, Madan K, Jha, Bimal C., "Assessment of groundwater potential in a semiarid region of india using remote sensing, GIS and MCDM techniques". Water Resource Manage 25:1359-1386, 2011.

[2] Murugesan B, Thirunavukkarasu R, Senapathi V, Balasubramanian G "Application of remote sensing and GIS analysis for groundwater potential zone in kodaikanal Taluka, South India". Earth Sci. 7(1): 65-75,2012.

[3] Prabir Mukherjee, Chander Kumar Singh and Saumitra Mukherjee "Delineation of Groundwater Potential Zones in Arid Region of India, A Remote Sensing and GIS Approach". Water Resource Manage 26:2643–2672,2011

[4] Krishnamurthy J., Venkatesa K.N., Jayaraman V. and Manivel M., (1996). "An approach to demarcate ground water potential zones through remote sensing and a geographical information system." Intl. J. Rem. Sen, 7(10), pp. 1867-1884.

[5] Krishnamurthy J., Arul Mani M., Jayaraman V. and Manivel M., (1997). "Selection of Sites for Artificial Recharge towards Groundwater Development of Water Resource in India." Proceeding of the 18th Asian Conference on Remote Sensing, Kuala Lumpur. 20 - 24 October.

[6] Minor et al., (1994) "Ground water for exploration by using RS &GIS" Field observations and several remote sensing platforms are essential to create GIS based hydrogeological model on any study area.

[7] Kamaraja et al., (1996) "Delineation of ground water "The overlay analysis resulted in demarcation of groundwater units where each unit has the characteristic combination of groundwater controlling parameter Index (GWPI) values.

[8] Jayakumaret al., (1996) Used the dynamic range of data analysis for groundwater investigation in hard rock areas in the Kallar, Velar Sub-basin of Tamilnadu.

[9] Shanta, kumaret al., (1996) remote sensing and GIS technique for delineating potential areas for groundwater recharge for the entire state of Tamil Nadu.

[10] Sarkar et al., (2000) A Groundwater potential map was generated for micro watershed by using thematic maps of drainage, lineament, lithology, slope and land use.

[11] Krisingh, Ameresh and Ravi, prakash., (2006) for groundwater examination in hard shake zones, a coordinated methodology of remote sensing, geoelectrical and GIS was utilized.