Identification of Potential Groundwater Zone by Remote Sensing and GIS Techniques

R. Chandramohan, N. Siva Vignesh

Abstract: ***Water as one of the natural resources required for the survival of man, animals and plants. Water distributed unevenly on the earth's surface and below the earth's surface. Groundwater is one of the original wellsprings of consumable water. Without groundwater, humanity cannot survive in this world. Without any regulation and conditions the groundwater continuously extracted. Due to the continuous extraction of groundwater can cause undesirable environmental consequences. Palani Taluk, India identification of groundwater potential zone is important to overcome the issue. Various thematic maps are used and proper weight and rank has assigned to them for identifying groundwater potential zone. By Remote sensing and GIS tools, study area was labelled as excellent, moderate, good and poor groundwater potential zone.***

Keywords: Groundwater potential zone, Remote sensing, and GIS.

I. INTRODUCTION

"Contaminants accumulated in aquifers and in the soil due to the continuous discharge processes of industrial, agricultural and domestic effluents" described by researchers[1], [2]. Due to the remarkable development of industry and agriculture, the water scarcity become in recent years. The researcher [3] also reported that to evaluate potential groundwater zones of an area various parameters namely geology, slope, lineaments, geomorphology, and etc are required to understand the study region. Researcher [4] states that lineaments are frequently visual on remote sensing data as other valuable data like drainage, vegetation, or land use land cover map. These factors are essential to analysis groundwater potential zone of a region with the help of GPS ground truthing. Thematic maps are needed (which includes geology, geomorphology, hydrogeology/landforms, drainage density, lineament density; lithology, slope and land cover) for calculating and identifying groundwater potential of a study area [5]. In recent years, the importance of integrating Remote sensing and GIS in assessing the potential for groundwater studies have conducted by many authors such as [6] – [10] .

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The study area Palani Taluk is situated in Dindigul District of Tamilnadu, India. Major portion of the area is situated nearer or on the western Ghats of India. But due to geomorphology and slope conditions, its facing a serious problem of water scarcity for irrigation, industrial and residential purposes. The monsoon season was unpredictable in and around the study area for last two decades,. Due to unpredictable monsoon the availability of surface water for irrigation and consumption use was not sufficient during essential time. Study area depends mostly on groundwater, which gained from various factors like geomorphology, slope, land use, land cover, and etc. Excessive pumping of groundwater has decreased the water table level in the review region. During summer, every year, even wells and hand pumps also dried up, and water scarcity issue raise in Palani Taluk [1]. Therefore, the principal intention of this study is to distinguish and identify suitable groundwater potential zone of the study area by Remote sensing and GIS technology.

II. STUDY AREA

The review zone latitudes positioned between 10°20'2'' N to 10°38'24'' N as well as longitudes 77°18'6'' E to 77°35'41'' E. Total study area is 766.83 km^2, Out of which hilly area is 116.85 km^2 as exposed in "Fig.1" [1]. South – West monsoon and rainfall are important resources of aquifers in study area. Average rainfall of study area is 690mm for 33 years (1980 – 2013). The level of water table ranged between 4 to 11.7m in stud area [11,12].

III. METHODOLOGY

Palani Taluk map, study area geological data are collected from SOI (Survey of India) toposheet of scale 1: 50,000**.** Geomorphology, Lineament, Land use Land cover map have primed from LISS III RESOURCESAT – I image, and slope, drainage map have prepared from Cartosat-I satellite image. With the help of collected maps various thematic layer are primed By Remote sensing and GIS programs. Obtained thematic layer have reclassified by using the Re-class tool in GIS program, Re-class tool aid to assign a rank for each class in thematic maps and its convert the map format from vector to a raster image. Assigning rank in Re-class tool has based on the groundwater prospects. The rank from one to five has assigned to the parameters of the thematic layers. Assigning rank based on groundwater prospects has shown in Table I. The methodology to identify groundwater potential zone have indicated in "Fig. 2".

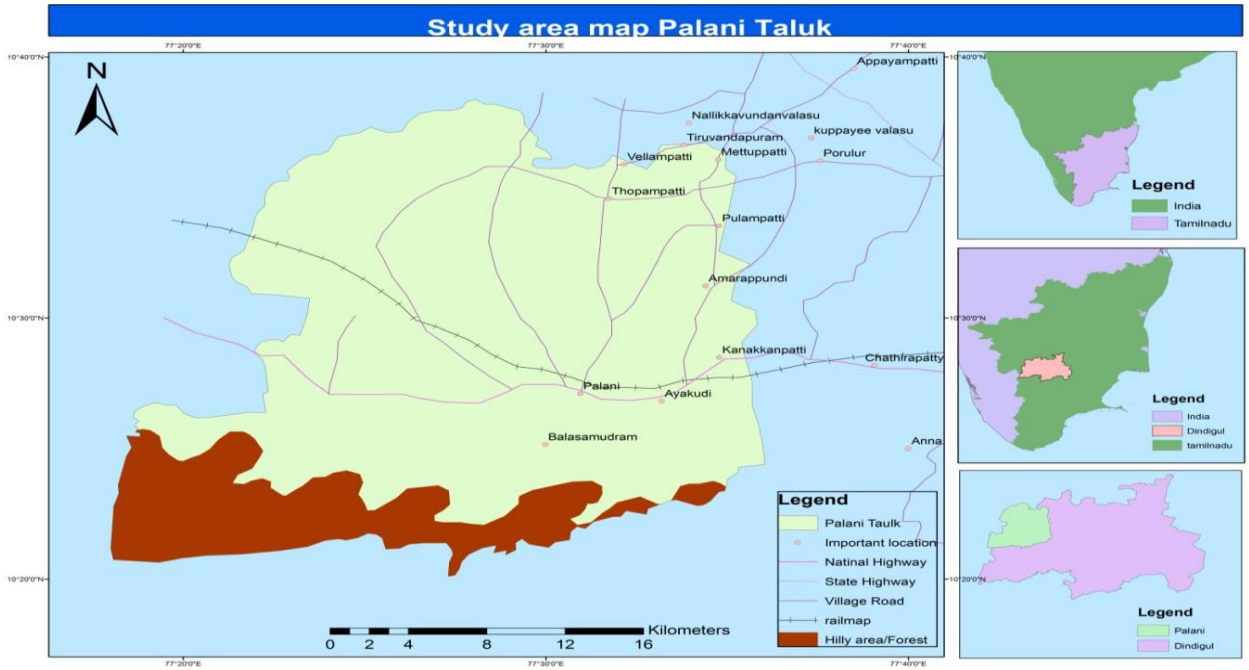

Fig 1. Study area map

Table – I: Assigning rank in each class of thematic layer based on groundwater prospects

S.No	Groundwater prospects	Rank
1.	Very low	1
2.	Low	2
3.	Moderate	3
4.	High	4
5.	Very high	5

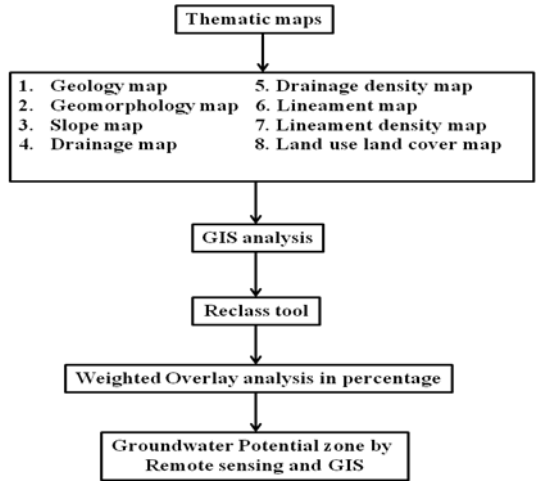

Fig 2. Methodology for groundwater potential zone identification by RS and GIS

A. Geology of Palani Taluk

Palani taluk has 3 main types of geology, which are Hornblende biotite – gneiss, Granite, and Charnockite. They are shown in "Fig. 3" [1]. Table II, indicates the total coverage area of each geological type. When compare to other rock types Charnockite rocks has less holding capacity of water. In study area more lineaments was present in Charnockite, so it has consider as good groundwater holding capacity, when compare to other [11].

B. Geomorphology map of Palani Taluk

Geomorphology map for study area was collected from Resourcesat – I, LISS III satellite imagery. By GIS and Remote sensing programs, geomorphology data are prepared. It was shown in "Fig. 3" [1]. Five different types of geomorphologic data occupied in Palani taluk such as water bodies, Denudational origin, fluvial origin, structural origin, and anthropogenic origin. The total area covered by each type was shown in Table II. When compare to all types water holding capacity is more for fluvial region and very poor for hilly region [11].

C. Landuse landcover map of Palani Taluk

Satellite image of Palani taluk was primed from Resourcesat – I, LISS III. Remote Sensing software was used for geo referenced the satellite data. Supervised classification of collected satellite image was performed for identification of various Landuse and Landcover map. By Remote Sensing classification techniques and the study area was easily distinguish by its infiltration capacity. If the discharge is more, infiltration of water is less, and if there is a reduced in discharge, infiltration is more on that surface. For example, in vegetation areas infiltration is more, and in urban areas infiltration is less. The landuse landcover map was shown in "Fig. 3" and the total area occupied by each type represented in Table II [11].

D. Lineament map of Palani Taluk

Resourcesat–I satellite images was used to collect Palani Taluk lineaments data. Majority portion of study area was associated with geomorphic lineament. Lineament length of study area varies from 0.11km to 3.25km. Lineament has been digitised with the help of GIS program. The density of the lineament was calculated by GIS spatial analysis tool.

Depends upon the lineament density it was divided into five different types, shown in "Fig. 3". Lineaments was expressed in (Km/Km^2). Table - II, represents total area covered by each lineament density [11].

E. Slope map of Palani Taluk

CARTOSAT-I, satellite image was used to collect DEM data for Palani Taluk. DEM data was converted into slope map By Remote Sensing program. The slope map of Palani Taluk has been classified into five types based on the prospects of aquifers. The steepest slope indicates a mountainous terrain and a slight slope indicates flatter terrain. The slope map is shown in "Fig. 3" and is expressed in degrees. The total area governed by each type was exposed below in Table II.

F. Drainage map of Palani Taluk

Cartosat – I DEM image was used to gather drainage map. Later by using GIS spatial analysis tool, Drainage stream order and drainage density has generated. "Fig. 3" shows the drainage density map of Palani taluk. In Palani taluk, drainage density values occurred from 0 to 7.1 ranges. Based on the drainage density value the map has categorised into five different types, and it expressed in Km/Km^2. The five types of drainage density value, as well as the area occupied (in percentage) by each drainage density ranges, as shown in Table II.

IV. RESULTS AND DISCUSSION

Based on water holding capacity, proper rank has assigned to each legend of every thematic map. The rank was assigned from 1 to 5 for each of every legend in the thematic map. In this ranking 1 indicates very poor groundwater potential zone, and 5 indicates excellent groundwater potential zones. Based on ranking, the thematic maps have reclassified. By using overlay tool in GIS software, proper weight in percentage has allotted for each thematic map. The weight and rank for distinguishing groundwater potential zone shown in Table- II. In Palani taluk, when compare to all other types the moderate groundwater potential zone occupy more area. Excellent groundwater potential zone covers very less area. The total area occupy by various groundwater potential types are shown in Table- III. The groundwater potential output map was represented in "Fig. 4".

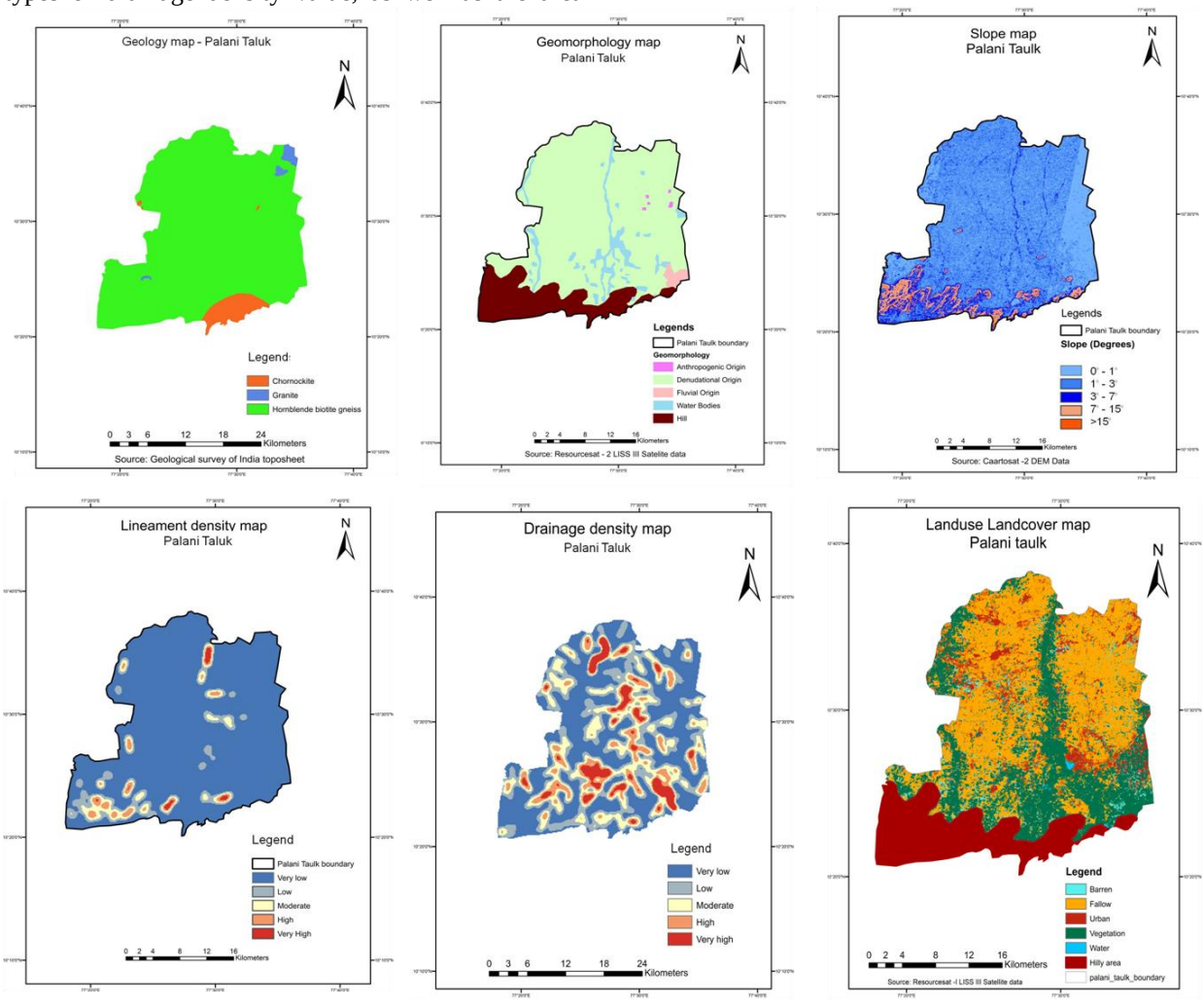

Fig 3. Thematic maps required for evaluating groundwater potential zone by Remote sensing and GIS

TABLE-II: Assigning rank and weight for thematic layers to identify groundwater potential zone

Parameters	Classes	Area covered (in %)	Rank	Weight (in %)
Geomorphology	Fluvial origin	1.6	5	30
	Anthropogenic origin	0.2	4	
	Waterbody	7.2	4	
	Denudational origin	75.7	3	
	Structural origin	15.3	1	
Slope classes	Nearly level (0°-1°)	41.6	5	20
	Very gently sloping (1°-3°)	43.6	4	
	Gently Sloping (3°-7°)	5.7	3	
	Moderately sloping (7°-15°)	6.5	2	
	Strong sloping (>15°)	2.6	1	
Drainage density Km/Km^2	0 - 1.0	43.8	5	15
	1.0 - 2.3	24.8	4	
	2.3 - 3.8	17.9	3	
	3.8 - 6.3	8.3	2	
	> 6.3	5.3	1	
Lineament Density Km/Km^2	0 - 0.6	87.7	1	15
	0.6 -1.17	6.7	2	
	1.17 - 1.76	3.4	3	
	1.76 - 2.34	1.7	4	
	> 2.34	0.5	5	
Land use / Land cover	Vegetation	26.4	5	15
	Waterbody	0.4	4	
	Fallow land	43.4	3	
	Urban	8.6	2	
	Barren land / Hill	21.2	1	
Geology	Charconite	4.4	5	5
	Hornblende biotite gneiss	94.4	3	
	Granite	1.1	2	

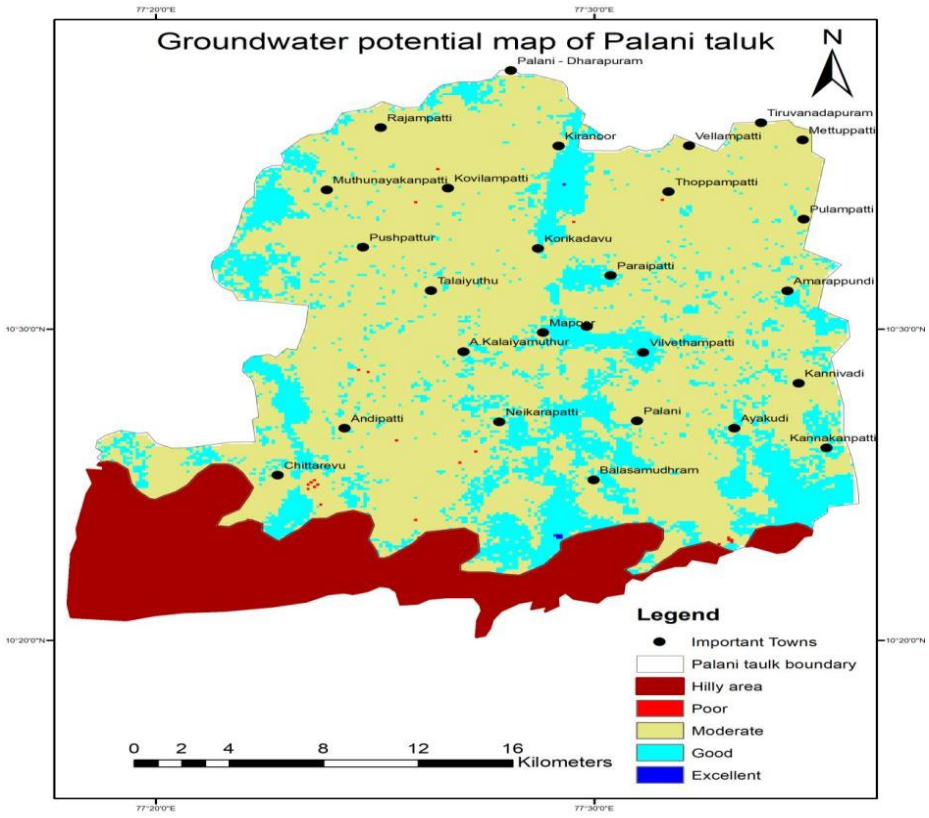

Fig 4. Groundwater potential zone of Palani Taluk by Remote sensing and GIS

TABLE – III: Groundwater Potential regions type and area covered in percentage

S.No	Groundwater Potential region type	Area covered in percentage
1	Excellent	0.01
2	Good	15.33
3	Moderate	67.72
4	Poor	1.64
5	Hilly area / Restricted area	15.30

V. CONCLUSION

The mapping and identification of potential groundwater region in an area helps for planning the exploitation and sustainable management of groundwater. In Palani taluk, the demand for groundwater resource is high in study area because of agriculture activity. Beneficial areas for groundwater occurrence and storage were identified in Palani Taluk based on slope, geology, land use, drainage density lineament density and geomorphology maps of study area. The best suitable areas identified were mainly in fluvial region with minimum slope and water bodies features. Groundwater development possibility was high for areas with agricultural land use with high lineament and low drainage density. Study area occupies 15 percentage of good groundwater potential region. Remote sensing and GIS methods lead to identify groundwater potential zones of arid and semi arid areas. When compare to other methods determining groundwater potential zone by GIS and Remote sensing is a cost effective method, and this results helps to built suitable recharge structures in good and excellent groundwater potential zone region and construction of recharge structure need to be restricted in poor groundwater potential zone

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Dr.R.Chandramohan, I completed my PhD in REMOTE SENSING and GIS in 2018 at Vels Institute of Science, Technology & Advanced Studies (VISTAS), Chennai and completed my M.Tech REMOTE SENSING in 2008 at PSNA College of Engineering and Technology, Dindigul. I have 8 years of teaching experience and 1 year of industrial experience. My PhD thesis work is related to groundwater studies. As of now I have published 4 Scopus indexed journal, 4 conferences, and published 5 books in Remote sensing and GIS domain. My publication reflects my research work like groundwater studies like groundwater potential zone, Geophysical method, groundwater fluctuations, groundwater artificial recharge zone and structures, Land use Land cover classification, and Land Information System and etc.

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