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ORIGINAL ARTICLE

Groundwater Potential Zone Mapping using Geospatial Technology in Varattar Watershed

M.Balakrishnan
GIS and Remote Sensing Researcher, Coimbatore Tamil Nadu
Email: srikrishna.gis@gmail.com

ABSTRACT
The groundwater is the most valuable resources around the world and is reduction day by day. In connection, there is a need for segregation of groundwater potential zone. As the interest and needs of the common people towards water is rising the estimation of water is felt in all divisions. Simultaneously, surface water assets are getting to be inadequate to satisfy the water request. With the goal that methodical arranging of groundwater improvement utilizing present-day system is essential for the right management and use of this valuable asset. Yet at the same time, groundwater assets have not yet been appropriately abused, keeping this in view, the present investigation has been contained to outline the groundwater potential zones in Varattar river basin Tamilnadu & Kerala by utilizing RS and GIS approach. The geographical information system (GIS) and remote sensing have turned out to be one of the significant instruments in the field of groundwater investigate, which aides in surveying, observing and monitoring groundwater assets. Now to recognize the groundwater potential zone utilized by various topical layers of geology, drainage, soil, land use/land cover and slope with inverse distance weightage (IDW) strategies. From the overall outcome, the potential zone of groundwater in the investigation zone ordered into five classes named as very good, good, moderate, poorand very poor. This research to suggested that very good potential zone of groundwater occur in the areas of south west north central part of study region in the Coimbatore and Palakkad districts. The result displayed that inverse distance weightage method offers an effective tool for interpreting groundwater potential zones for appropriate growth and management of groundwater resources in different hydrogeological surroundings.
Keywords: *Groundwater Potential Zone, Remote Sensing, ArcGIS,QGIS, Geospatial Technology*

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INTRODUCTION

The geographic information system (GIS) and Remote sensing methods have opened new directions in groundwater investigation. The Remote sensing with its advantages of spectral, spatial and temporal accessibility of data covering big and unreachable areas within quick time has develop a very useful tool in gathering, storing, transforming, retrieving, presenting and analysing spatial data and is used for different purposes such as possibility of recharge sites, estimation of ground and surface water resources and finding the polluted sites etc. The satellite images offer fast and valuable baseline information on the parameters similar to lineaments, geology, geomorphology, drainage, land use/land cover, etc. [15-17]. The remote sensing and geographic information system methods have successfully applied for groundwater prospecting and recharge sites [8-11] and integrated remote sensing and GIS techniques have been used to delineate groundwater potential zones [12-15].

The geological map of the area was prepared from Geological Map published by Geological Survey of India (GSI). The other thematic maps like drainage, land use/land cover, slope, and soil were prepared from Survey of India toposheet and satellite imageries using GIS. Hence, by integrating all the above mention thematic layers groundwater potential zonal map was prepared. All the thematic maps were generated using ArcGIS/QGIS software tools by executing digitization of scanned maps, editing/correcting for the errors, topology building for error-free, attribute assignment for spatial information and assign suitable projection. So, we have used the geospatial data validation techniques for the data study area error correction and accuracy [1-4].

The crisp water assets of India are inconsistently dissipated. During the monsoon season and differing physiographic conditions give rise to an inconsistent distribution of water. Over the last decade, population growth, urbanization and agricultural expansion have degraded the state. The unscientific misuse of groundwater is principal towards water scarcity. Even now, some parts of the nation are facing a severe water crisis. Regardless of being a very significant part of the country's development, water resource analysis has been disconnected. So, the main aim of the current study is to demarcate the groundwater potential zone in Varattar basin using the integration of geographical information system and remote sensing techniques. The groundwater prospect map was organized by integrating the geological, slope, land use / land cover and soil maps along with drainage patterns, in the area [6-14]. Used for each theme was measured and allocated a weightage based on its level of influence on groundwater recharge and storage. Hence, by merging all these thematic maps and integrating limited data on groundwater level, groundwater prospect map was generated.

STUDY AREA

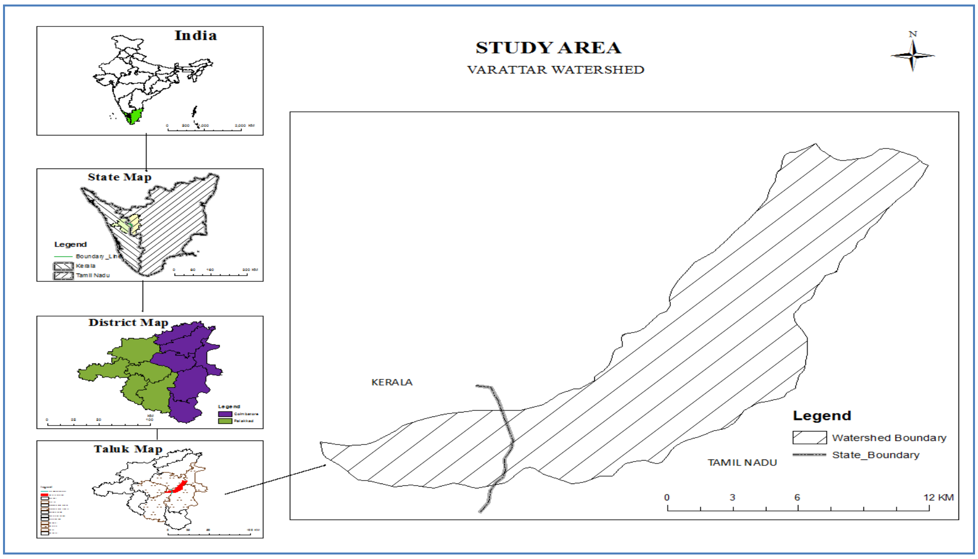

Fig 1: Selection of Study Area

The Varattar river is one of the important tributaries of the river Koraiyar. It originates from near to Othakalmandapam, Chettypalayam, Orattukuppaiand Myleripalayam villages in Tamil Nadu and flows through Coimbatore, Palakkad districts, finally drains into the Koraiyar river. The research area is a coved of the Varattar basin which lies between 10°44'77" N to 10°56'02" N latitude and 76°48'95" E to 77°04'41" E longitude, covering an area of 175.77 Km2. The study are covers in 31 administrative villages in Part of Coimbatore and Palakkad districts. The river crosses for a distance of 46.4 km within the study boundary. It is in the mid-western part of the Coimbatore district in Tamil Nadu, India and mid-eastern part Palakkad district in Kerala. The water flow in the river is seasonal and depends both on the northeast and south-west monsoons which has a good flow during these seasons. In any case, the study area has received higher precipitation throughout the southwest monsoon. Occasionally, flash floods happen when there is heavy rain in the catchment areas.

MATERIAL AND METHODS

The Integrated Remote Sensing and Geographic Information System techniques were used to demarcate groundwater potential zones in the Varattar river. We have used the Survey of India (SOI) topographic sheets number as 58 F/1, 58 B/13 and 58 B/14 on 1: 50,000 scale were used to prepare the base map of the study area. The Geology map was obtained from the Geological Survey of India (GSI) map and digitized the study area. The Soil map was prepared by digitizing the geo-referenced soil map obtained from National Bureau of Soil Survey (NBSS) and Land Use Planning (LUP). The geology, land use/ land cover map was obtained from NRSC Bhuvan-Thematic Services and digitized the same for the corresponding study area. The slope map was created from elevation data using shuttle radar topography mission (SRTM) Data. The drainage map generated from the Survey of India (SOI) topographic sheets.

These all vector data and raster data prepared/created using ArcGIS and QGIS software. To produce the groundwater possibility map of the Varattar river, all the distinctive thematic layers were incorporated with weighted overlay in GIS. The weight for every individual highlight of a theme was given during weighted overlay studies which were basically founded on the effect towards groundwater development and penetration rate, every one of the subjects was given positioned dependent on appropriateness for groundwater event. All the thematic layers were interrelated to each other which give important data regarding the groundwater event, accordingly, supportive for the creation of groundwater potential map of the study area. In GIS condition, each subject was covering to each other to distinguish the interconnecting polygon. By this way, a new map was created by incorporating two thematic maps. Further, a composite map was overlaid on a third subject map, etc. In this procedure, the last composite map was created. In this way, the groundwater potential map was created. In light of this map, the study area was classified into five groundwater potential zones as namely very good, good, moderate, poor very poor.

RESULT AND DISCUSSION

GEOLOGY

The geology is playing asignificant role in occurrence of groundwater. The quality and running of groundwater depend on both the physical and chemical properties of the rocks. The geology of the study area comprises mainly Garnet biotite gneiss, Migmatite complex, Pegmatite and quartz veins, Pyroxene granulite and Quartzofeldspathic gneiss/ granite gneiss/ Pink and grey gneiss. The Migmatite complex is covered the maximum part of the study area. The Garnet biotite gneiss is situated in middle south part of the study area as coved of 12 Sqkm. The Pyroxene granulite is found as patches in the north-eastern regions of the study area as covered of 5Sqkm area and the Quartzofeldspathic gneiss/ granite gneiss/ Pink and grey gneiss covered in 4 Sqkm area in south part of the study area. The Migmatite complex of Hornblende – biotite gneiss occupies in 154 KM2.

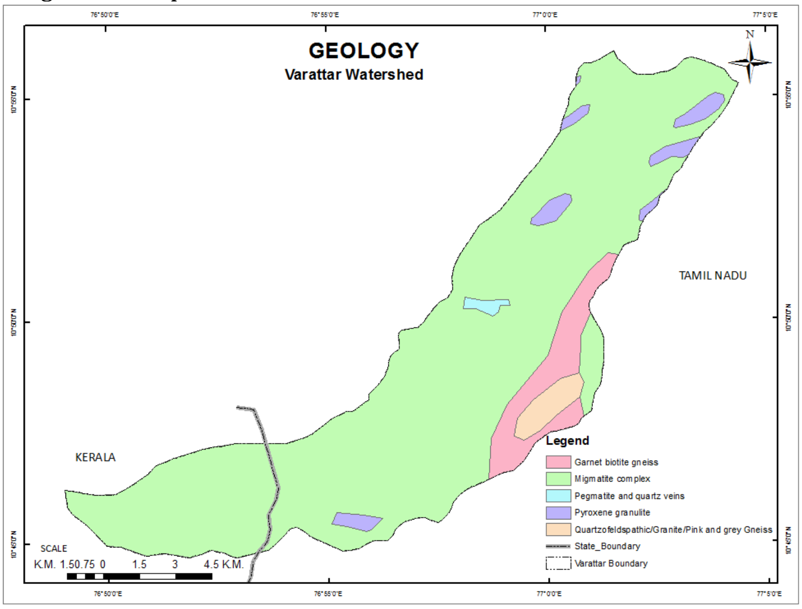

Figure 2. Geology Map

SOIL

The soil is playing a vital role in representing the groundwater quality and quantity dependent on the soil. Subject to the soil types, it likewise gives a proof around the groundwater holding limit and penetration rate.

In view of the qualities and various kinds of soil present in the Varattar river area, it is arranged into five main categories, such as loamy soil on gently sloping lands, loamy soil on undulating lands, loamy mixed lithic ustorthents, calcareous gravelly loam soil on gently sloping lands and gravelly loamy soil on moderately sloping. The study area consumes Calcareous gravelly loam soil on gently slope consume 37.06 Km2 like Shallow moderately well drained, calcareous gravelly loam soil on gently sloping lands, slightly eroded and associated with; very deep, well drained, calcareous, stratified loamy soils. The Drained loamy soil on undulating lands have 98.19 Km2 like Very Shallow somewhat excessively drained loamy soil on undulating lands, moderately eroded and associated with; shallow, well drained, gravelly loamy soils on gently sloping with slight erosion of the area. The Gravelly loamy soil on undulating lands takes 40.06 Km2 as Shallow well drained gravelly loamy soil on undulating lands, moderately eroded and associated with moderately shallow, somewhat excessively drained, loamy soils on gently sloping with slight erosion. The Gravelly loamy soil on gently sloping lands consume 0.44 Km2 like Shallow well drained gravelly loamy soil on gently sloping lands, slightly eroded and associated with moderately shallow, well drained, calcareous, gravelly loamy soils. Where these soils are related with rock outcrops may have controlled penetration to underneath following in poor groundwater plan of the territory.

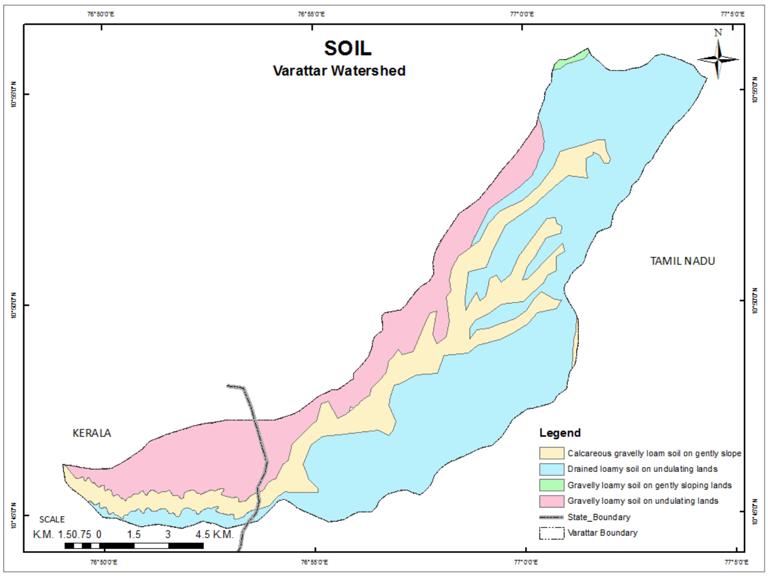

Figure 3. Soil Map

SLOPE

The slope is one of the important factors which is interconnected to groundwater recharge. It controls the percentage of penetration and surface spill-over. It gives an awareness about the amount of groundwater revive dependent on the slope angles. The steep slope causes less penetration due to fast surface runoff while, level and mild slope areas encourages minimum runoff, accordingly allowing additional time to infiltrate rainwater and helps large groundwater recharge. The level and moderate slopes are considered as great groundwater recharge. The slope of the study area was prepared from SRTM (Shuttle Radar Topography Mission) DEM. This data use to extract the study area and created the slope map and categorized based on the degree of slope. The maximum of study area has moderate and level slopes found except Mutthumalai Murugan temple hill.

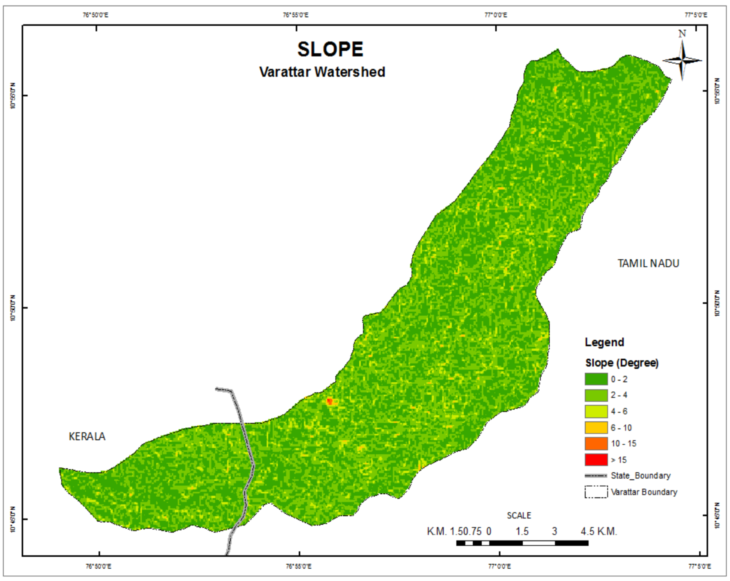

Figure 4. Slope Map

DRAINAGE

The drainage pattern decides the physical appearance of both surface and sub-surface developments. The drainage network gives the pathways for the runoff and storage volume of groundwater. The region with maximum drainage concentration designates the huge runoff while the smaller the drainage density, the minimum runoff and the maximum prospect of groundwater occurrences. The drainage map says the drainage pattern of the Varattar study area is originated mainly from the north east and eastern part of the study area where more elevation is placed. Generally, the type of drainage pattern is dendritic. The dense drainage pattern is mostly located in the north eastern part of the study area than the rest. According to Meijerink [9], drainage density is a measurement of the total length of all the streams and rivers per unit area. It suggests that permeability relates to low drainage density. The drainage density of the study area is classified into five classes as shown in stream order figure. The first order streams flowing 85.41 Km, second order streams running 44.54 Km, Third order streams running 18.52 KM, fourth order streams flowing 17.22 and fifth order streams running 24.11 Km distance of the study area.

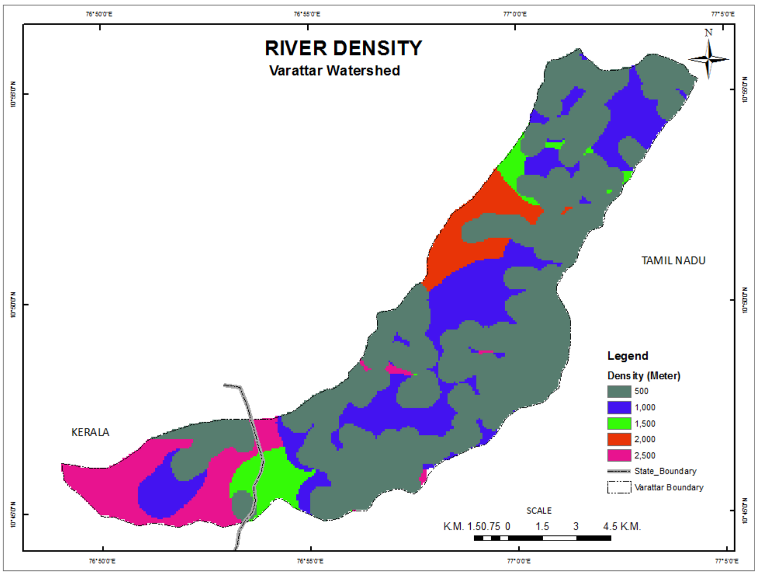

Figure 5. River Density Map

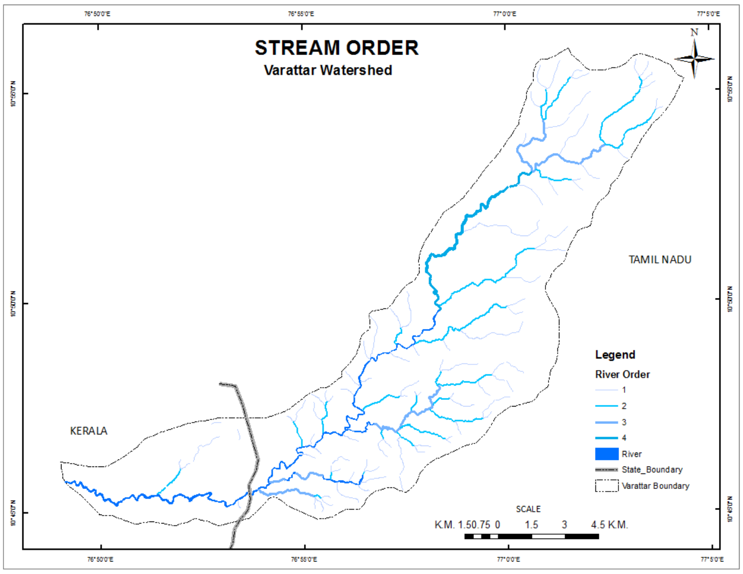

Figure 6. River Density Map

LAND USE AND LAND COVER

The land use represents the human actions and many other uses which are carried out on land, example cultivation, built-up area or industry, though land covers incorporates common natural vegetation, water bodies, rock/soil, artificial cover, and others resulted due to land transformation that is present on the earth surface. The land use/land cover is categorized by a combination of forest covers, cultivation activities, built-up area, water bodies etc. The Remote sensing and geographic information system (GIS) method provide the consistent information for land use/land cover mapping [16, 5]. Here we have totally six different types of land use/land cover been delineated in the study area LU/LC Map. The figure shows that the large area belongs to the Agriculture - Crop land area has 64.75 Km2, Agriculture - Fallow area consume 35.62 Km2, Agriculture - Plantation occupied 63.96 Km2, Barren/Uncultivable/wasteland, Scrubland area have 3.054 Km2, Built-up Land consume 6.71 Km2 and Water Bodies have 0.77 Km2 area.

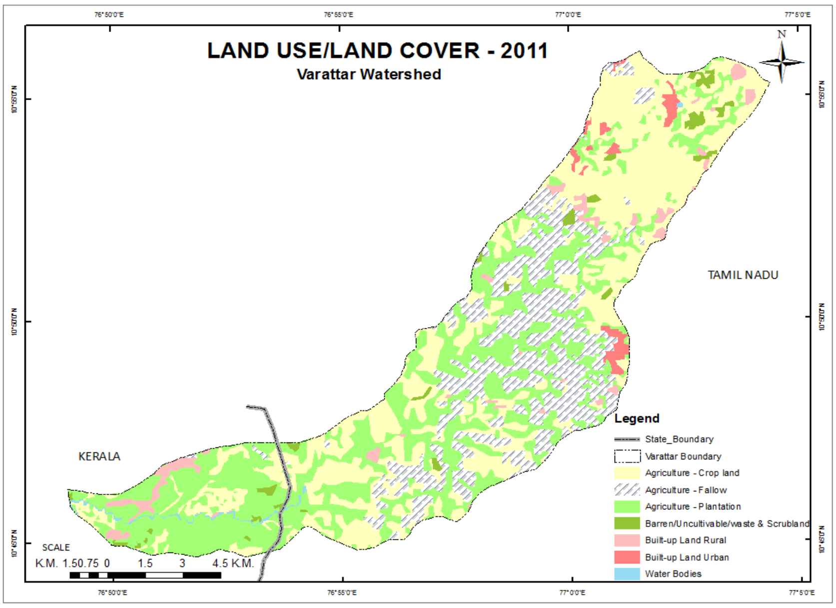

Figure 7. Land use/Land coverMap

OVERLAY ANALYSIS

The purpose behind for usefulness of weighted overlay analysis is having the option to make spatial complexity to simplicity in suitability analysis and site selection are mainly based on general measurement of dissimilar and diverse impacts [11, 13]. To demarcate groundwater possible zone, all the thematic layers were given reasonable weight utilizing the strategies of weighted overlay in ArcGIS/QGIS programming. The weightage and ranking for every individual element of the thematic layers were allocated dependent on their effects towards the groundwater recharge. All the thematic vector layers were converted into raster format layer and overlaid in ArcGIS/QGIS software. The parameter which has high weight value speaks to vital impacts in the groundwater probability. Among the thematic layers, geology was given uppermost weight, due to the important role play for groundwater recharge event. To get a final output map of groundwater potential zone, every individual components of the thematic layers were superimposed to each other.

Table 1: Weights assigned for preparation of Ground water potential zone map

THEMATIC MAP	WEIGHT ASSIGNED (%)
SOIL MAP	20%
GEOLOGY MAP	10%
LAND USE AND LAND COVER MAP	25%
DRAINAGE DENSITY MAP	20%
SLOPE MAP	25%

GROUND WATER POTENTIAL

The ground water potential map is prepared subject to the study of various topics geology, land use/land cover, soil, slope, stream order and density sustains by using consolidating verification thought, other than the collected data gained from State Ground Water Board with major field/ground checks. The ground water potential maps disclose the available volume of ground water. This map is showed into five zones as Zone I, Zone II, Zone III, Zone IV and Zone V likely very good, good, moderate, poor and very poor ground water potential zones. The Good and moderate zones address zones with adequate ground water resources, poor and very poor zones address where superfluous with drawls may prompt ground water exhaustion. The Groundwater potential zone mapping is finished utilizing weighted overlay in ArcMap/QGIS Tool. The various weights are given dependent on the variables affecting the groundwater. The ground water potential map illustrated the groundwater potential zone map of the study area was classified into five zones – very good, good, moderate, poor and very poor. The maximum study area falls under moderate potential zone which covers 75.33 km2 area, spreading all over the entire study area and found largely in the flat terrain, next zone will be Good potential zone covers 52.06 km2. The very good potential zonearea8.04 km2 were mainly found close to the waterbodies (lakes, rivers, etc.) where major cultivation is practiced and covered by fallow land. The poor potential zone covers in 18.32 km2 and very poor potential zone in 21.97 Km2 was found in the hilly terrain of upstream region and granitic terrain in the downstream region, indicating high runoff and less infiltration of the area.

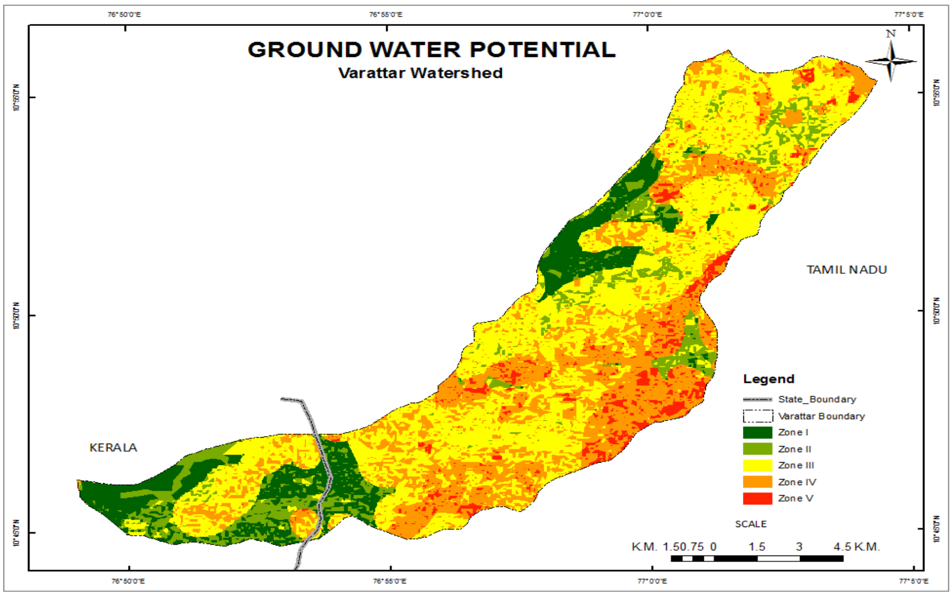

Figure 8. Ground Water Potential Map

CONCLUSION

The Integrated use of GIS and Remote sensing methods demonstrated to be a powerful tool for delineating various groundwater forthcoming zones in the study area. The thematic maps are geology, drainage and drainage density, slope, soil map, and LU/LC were created from the geospatial environment which plays an important role in storage and transmit the groundwater. Every one of the maps are incorporated with weighted to create a Ground water potential zone map. Considering the Ground water potential zone map, the study area was delineated into five zones, viz., Zone I, Zone II, Zone III, Zone IV and Zone V likely very good, good, moderate, poor and very poor. The present study shows that 8.04 km2 out of the total study area are identified as very good groundwater potential zones. The purpose behind favourable of groundwater occurrence the study area is because of the components like the occurrence of highly weathered, low level incline bringing about moderate surface spill-over which means moderate penetration pace of the region. It likewise demonstrates that a considerable measure of groundwater occurrence is highly possible because of very low drainage density and contiguous the stream channels. The geospatial is advances proof of the significant role being taken to investigate and demarcate groundwater recourses in any regions to a large extent with minimal effort, minimum time and low labour work. The map obtained by this technique gives data about subsurface water level of the region. The investigation proposed that the Ground water potential zone map produced will fill in as helpful rules for organizers, designers and leaders giving quick decision- making in the administration of groundwater assets, site determination for Ground water investigation and exploitation.

REFERENCES

1. Anji Reddy, (2001). Text book of Remote Sensing and Geographical Information systems, Second edition, B.S Publications, Hyderabad.

2. alakrishnan.M,Ilanthirayan. A (2017).“Land Use/ Land Cover Mapping With Change Detection Analysis of Walayar Watershed Using Remote Sensing and GIS” Indian Journal of Natural Sciences (IJONS), Vol. 08, Issue 43 , ||V3|| Page Number 12581-12588.
3. Balakrishnan.M,Ilanthirayan.A (2017). “Ground Water Management and Soil Conservation of Koraiyar Watershed through Remote Sensing and GIS” International Journal of Engineering Research and Modern Education (IJERME), Special Issue 1, Page Number 265-268.
4. Carver S (1991) Integrating multi-criteria evaluation with the geographic information system. Int. J Geogr Inf Sci5 (3):321-339.
5. Deepa S, Venkateswaran S, Ayyandurai R, Kannan R & Vijay Prabhu M (2016). Groundwater recharge potential zones mapping in upper Manimuktha Sub basin Vellar river Tamil Nadu India using GIS and remote sensing techniques. Model. Earth Syst. Environ. 2:137 DOI 10.1007/s40808-016-0192-9
6. Edet AE, Okereke CS, Teme SC, Esu EO (1998). Application of remote sensing data to groundwater exploration: a case study of the Cross-River State, southeastern Nigeria. Hydrogeol J 6:394-404;
7. Fathy Abdalla (2012). Mapping of groundwater prospective zones using remote sensing and GIS techniques: A case study from the Central Eastern Desert, Egypt. Jour. of African Earth Sciences 70 (2012) 8-17.
8. Ghosh Prasanta Kumar, Bandyopadhyay Sujay, Jana Narayan Chandra (2016).Mapping of groundwater potential zones in hard rock terrain using geoinformatics: a case of Kumari watershed in the western part of West Bengal. Model Earth Syst Environ 2:1. doi:10.1007/s40808-015-0044
9. Meijerink AMJ (2007). Remote sensing applications to groundwater. IHP-VI, series on groundwater no. 16, UNESCO 2007.
10. Magesh NS, Chandrasekar N, John (2012). Identification of groundwater recharge zones in Vaigai upper watershed, Tamil Nadu, using GIS-based analytical hierarchy process (AHP) technique. M. S. U. Centre for Geotechnology, Tirunelveli, Tamil Nadu 627012, India, Arabia Geosciences.
11. M.Balakrishnan “Geospatial Data Validation Procedure and Techniques (2019). “International Archive of Applied Sciences and Technology [IAAST]. Vol 10 [1], 148-153.
12. Pradhan, B. (2009a). Groundwater potential zonation for basaltic watersheds using satellite remote sensing data and GIS techniques. European Journal of Geosciences, 1(1), 120-129.
13. Rao YS, Jugran DK (2003). Delineation of groundwater potential zones and zones of groundwater quality suitable for domestic purposes using remote sensing and GIS. Hydrol Sci J 48 (5):821-833
14. Rokade. VM, Kundal. P, Joshi. AK (2007). Groundwater potential modelling through remote sensing and GIS: a case study from Rajura Taluk, Chandrapur, Maharastra. J GeologySociety India 69:943-948
15. Saraf AK, Chaudhuray PR (1998). Integrated remote sensing and GIS for groundwater exploration and identification of artificial recharge sites. Int J Remote Sens 19(10):1825-1841
16. Selvam S, Magesh N S, Sivasubramanian P, John Prince Soundranayagam, Manimaran G and Seshunarayana T (2014). Deciphering of groundwater potential zones in Tuticorin, Tamil Nadu, using remote sensing and GIS techniques; J. Geol. Soc. India 84(5) 597-608.
17. Thilagavathi N, Subramani T, Suresh M and Karunanidhi D (2015). Mapping of groundwater potential zones in Salem Chalk Hills, Tamil Nadu, India, using remote sensing and GIS techniques, Environ Monit Assess (2015) 187: 164.