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Assessment of Groundwater potential zone using remote sensing and GIS in Varahanadhi watershed, Tamilnadu, India

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Abstract: Groundwater is an important natural resource for its use in domestic, agriculture, and industries purposes. There has been a tremendous increase in the demand for groundwater due to increase in population, advanced irrigation activities and industrial uses. GIS is an effective tool it provides large information with in short period for planning and managing of groundwater related problems. A case study was conducted to find out the groundwater potential zones in Varahanadhi watershed, Tamil Nadu, India. The thematic maps such as geology, geomorphology, soil, land use and drainage map were prepared in the Arc GIS 9.3 for the study area. The thematic layers were first digitized from satellite imagery, supported by supplementary data such as top sheets and field survey data, finally all thematic layers were integrated using Arc GIS software to identify the groundwater potential zones. From the study the groundwater potential zones were classified in to, Poor, Moderate and Good.
Key words: Varahanadhi watershed, GIS, Potential zones, Geology, Tamilnadu.

I. INTRODUCTION

Groundwater resources are an important natural resource for its use in domestic, agriculture, and industries purposes. There has been a tremendous increase in the demand for groundwater due to increase in population, advanced irrigation practices and industrial usages. Groundwater is an significant natural resource in present day, but of limited use due to frequent failures in monsoon, undependable surface water, and rapid urbanization and industrialization have created a major risk to this valuable resource (Ramamoorthy, et al.,2014).

Rapid and advances in the development of the Geographical Information System (GIS) which provides spatial data integration and tools for natural resource management have enabled integrating the data in an environment which has been proved to be an efficient and successful tool for groundwater studies (Meijerink 1996; Nour 1996; Krishnamurthy *et al*., 1996; Smith *et al*., 1997; Edet *et al*., 1998; Jaiswal *et al.*, 2003; Rao and Jugran 2003). The utility and suitability of such integrated studies in delineating groundwater potential zones and identifying recharge sites in a hard rock terrain like the Deccan Volcanic province (DVC) of India is demonstrated by Saraf and Choudhury (1998).

Delineating the potential groundwater zones using remote sensing and GIS is an effective tool. In recent years, extensive use of satellite data along with conventional maps and rectified ground truth data, has made it easier to establish the base line information for groundwater potential zones (Tiwari and Rai, 1996; Das et al., 1997; Thomas et al., 1999; Harinarayana et al., 2000; Muralidhar et al., 2000; Chowdhury et al., 2010).

Remote sensing not only provides a wide-range scale of the space-time distribution of observations, but also saves time and money (Murthy, 2000; Leblanc et al., 2003; Tweed et al., 2007). In addition it is widely used to characterize the earth surface (such as lineaments, drainage patterns and lithology) as well as to examine the groundwater recharge zones (Sener et al., 2005). To understand groundwater prospects of an area, integration of different thematic layers is required. In the hard rock terrain, availability of groundwater is limited and its occurrence is essentially confined to fractures and/or weathered horizons (Krishnamurthy et al. 2000; Chandra et al. 2006; Vijith, 2007; Suja Rose and Krishnan, 2009).

A. Study area

The study area is located in the Tamilnadu and Puducherry state of union territory. It was surrounded by and Bay of Bengal in the east, Nallavur sub basin in the north and Ponnaiyar basin in the south and Varahanadhi sub basin in the west. The study area occupies an area of 539.45 sq.km (Fig.1).

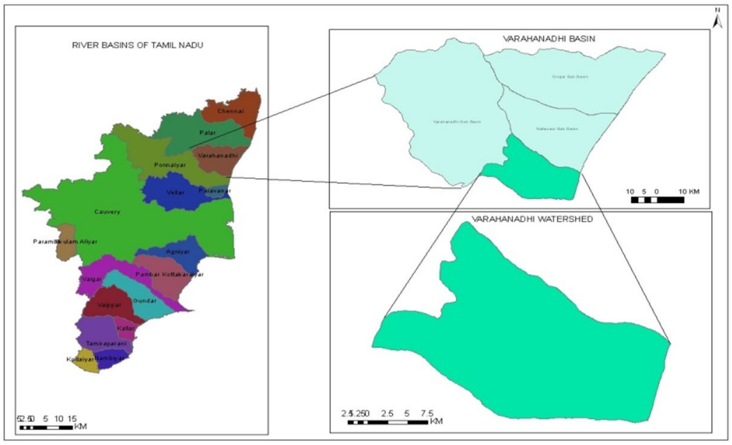

Fig:1 .Location map of study area

II. METHODOLOGY

The base map of study area was prepared under Survey of India Toposheets- 57-P/12, P/16, M/9 & M/13 on 1:50,000 scale. Various thematic maps(geology, geomorphology, soil, lineament, landuse, drainage etc) were prepared and integrated all in Arc GIS. By assigning weightage to each theme a final map was prepared having different categories such as (i) Poor ,(ii) Moderate and (iii) Good.

III. RESULTS AND DISCUSSION

A. Geology and Geomorphology

The study area (Fig. 2) mainly composed of Alluvium and then followed by charnockite, migmatite, sandstone, limestone are distributed in the northern part. Geomorphic features play a vital role in the evaluation of surface and ground water resources. The hydro geomorphic units such as flood plain,valley fill, buried pediment is good sources of groundwater where as structural hills, pediment zone and gullied land are poor recharge zones(Subagunasekar et al.2012). The study area has complex geomorphic features, which are :- Pediment, Burried pediment (deep),Burried pediment(moderate), Burried pediment (shallow),paleo deltaic plain etc(Fig.3).

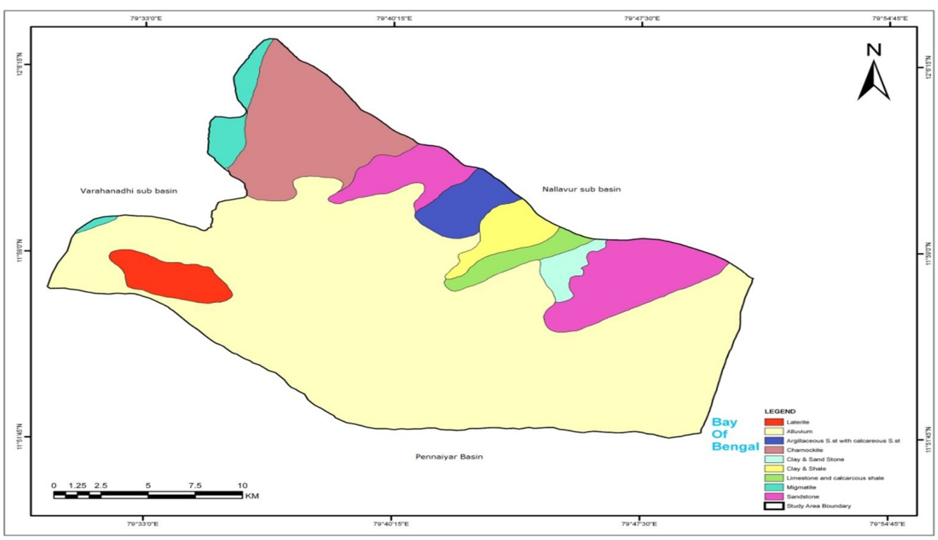

Fig:2. Geology map of study area

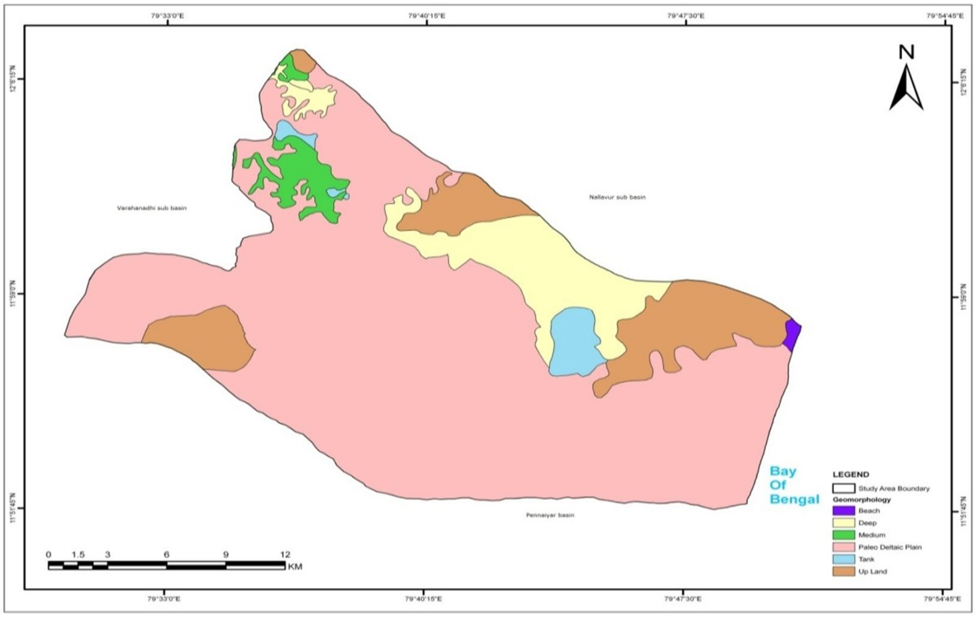

Fig:3. Geomorphology map of study area

B. Soils

Soil is one of the natural resources, which has the most direct impact on agricultural development. In an agrarian country like India, it becomes necessary to take steps for its proper conservation and management. Soil surveys provide nature of soils, their extent physico chemical characteristics etc. The soils of the study area have been shown in Fig. The major soils types found this river basin is Inceptisols, Alfisol, Entisol and Vertisol. Due to different stage of weathering of parent material, the above soil types are met with in combination.

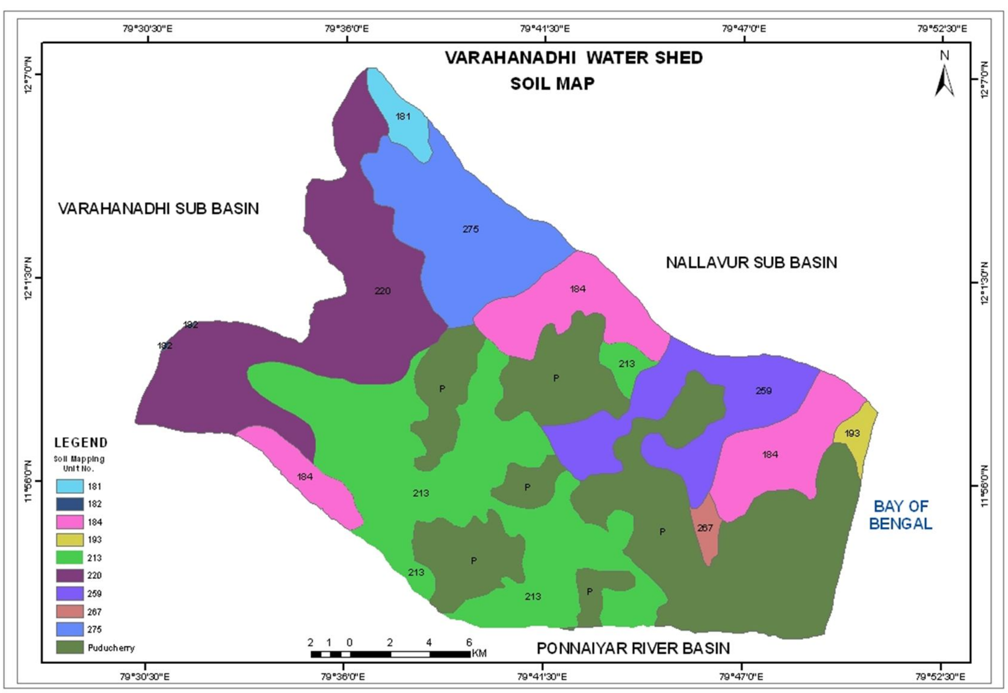

Fig:4.Soil map of study area

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C. Lineament

Lineaments are large-scale linear features which expresses itself in terms of topography which is in itself an expression of the underlying structural features. From the groundwater point of view, such features includes valleys controlled by folding, faulting and jointing, hill ranges and ridge lines, abrupt truncation of rocks, straight segments of streams and right angled offsetting of stream courses as these linear features are commonly associated with dislocation and deformation they provide the pathways for groundwater movements. Lineaments are important in rocks where secondary permeability and porosity dominate the intergranular characteristics combine in secondary openings influencing weathering, soil water, and groundwater movements. The fracture zones forms an interlaced network of high transmissivity and acts as groundwater conduits in massive rocks in interfractured areas. The lineament intersection areas are considered to be good groundwater potential zones (Pothiraj and Rajagopalan,2012). The lineament trending NE-SW,NW-SE, East to West and NS are identified in the study area indicating regions of good groundwater availability(Shown in fig.5).

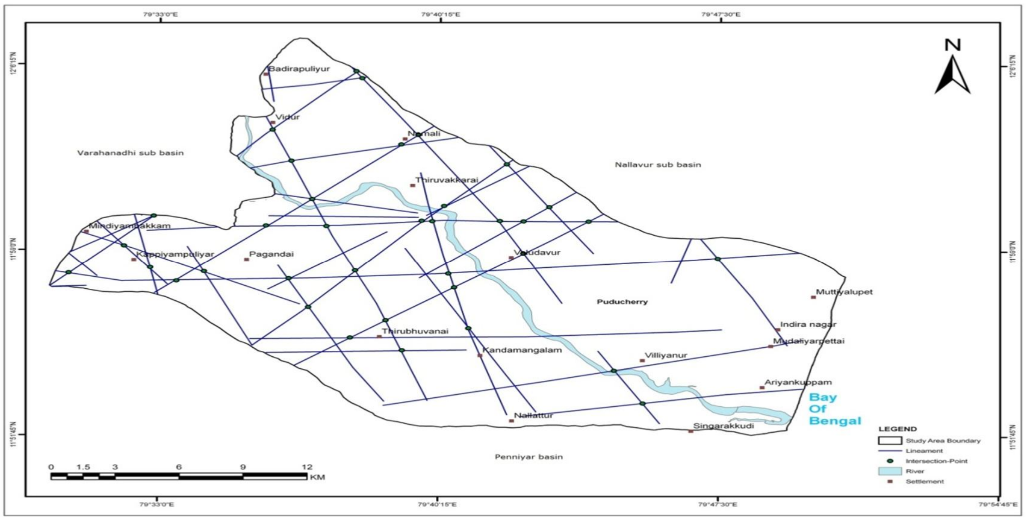

Fig.5.Lineament map of study area

D. Drainage

This map is also prepared from survey of India toposheets on 1:50,000 scale. Drainage map (Figure-6) of the study area reveals only two types of drainage patterns viz. dentritic pattern and few locations have trellies pattern. Radial type of drainage patterns are also seen at some places.

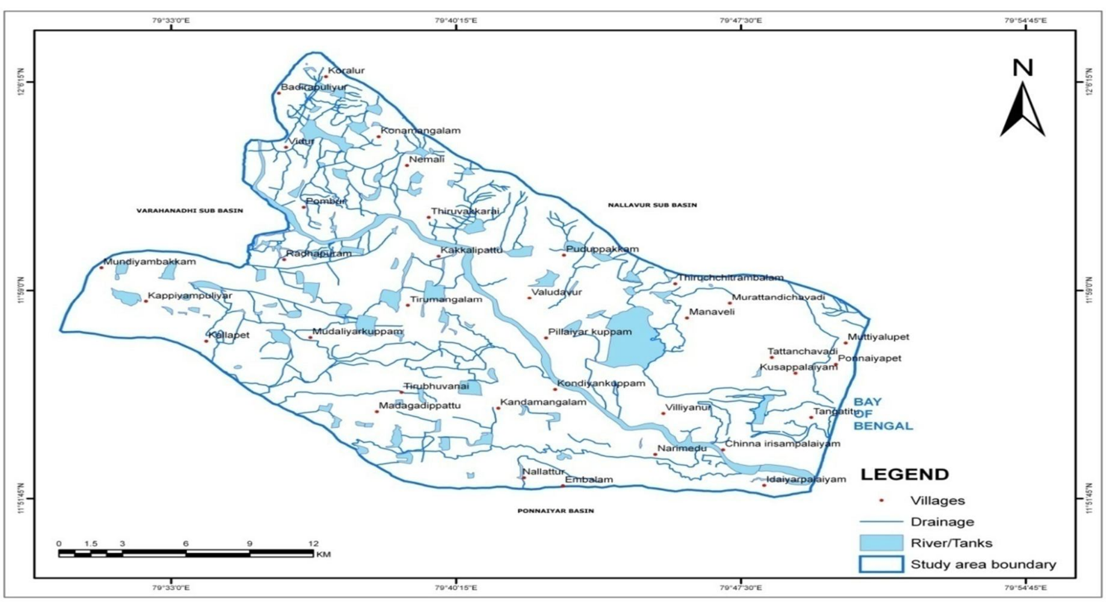

Fig.6.Drainage map of study area

E. Land use/ Land cover

Land use/land cover mapping is one of the important applications of remote sensing. Land use plays a significant role in the development of groundwater resources. It controls many hydrgeological processes in the water cycle viz., infiltration, evapotranspiration, surface runoff etc. surface cover provides roughness to the surface, reduce discharge thereby increases the infiltration. In the forest areas, infiltration will be more and runoff will be less whereas in urban areas rate of infiltration may decrease. Remote sensing provides excellent information with regard to spatial distribution of vegetation type and land use in less time and low cost in comparison to conventional data (Waikar and Aditya P. Nilawar, 2014). The study area shows that major portion in land use is covered by cropland 368.12 sq.km, barren land covering an area 35.765 sq.km, settlement covered in area 31.071sq.km and dry crop covering area 28.438 sq.km.

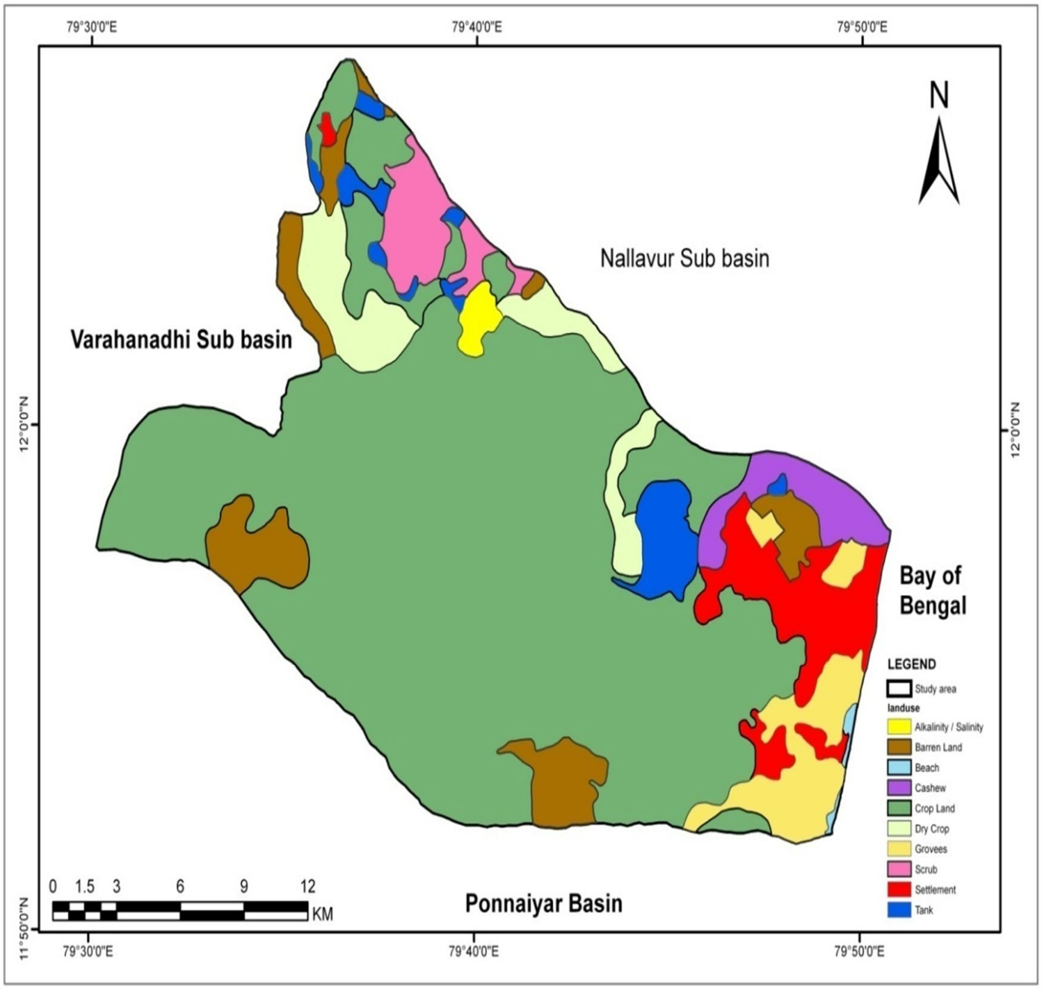

Fig.7:Land use/Land cover map of study area

F. Groundwater potential zones

The thematic maps such as geology, geomorphology, soil, lineament, drainage, are integrated with Arc GIS 9.3software and assigning the weighted values and rank (Table:1) The weightage of each criterion was finalized on the basis of the ranges of the maximum and minimum values within each theme. The groundwater potential zone map was prepared by weighted overlay analysis using the thematic maps on geology, geomorphology, lineament, soil, Landuse/Landcover. The groundwater potential zones map (Fig:8) was prepared and classified as (i)Good (ii) Moderate(iii) Poor

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TABLE: 1- Ranks and weightages for various parameters for groundwater potential zone

Layer Name	Class (category)	Weightage	Rank
Geomorphology	Alluvial Plain	9	High
	Flood plain	8	
	Deep Burried Pediment	7	
	Moderately Burried pediment	6	Medium
	Shallow Burried Pediment	5	
	Tertiary upland	4	Low
Geology	Alluvium	9	High
	Clay & Sst	6	Medium
	Sandstone	6	
	Migmatite	5	
	Clay & Shale	4	Low
	Argill.Sst with Calc.sst	4	
	Limestone &Calc.shale	3	
	Charnockites	3	
Land use/Landcover	Crop Land	9	High
	Beach	8	
	Tank	8	
	Dry Crop	5	Medium
	Barren Land	2	Low
Lineament	Present	9	High
	Absent	3	Low

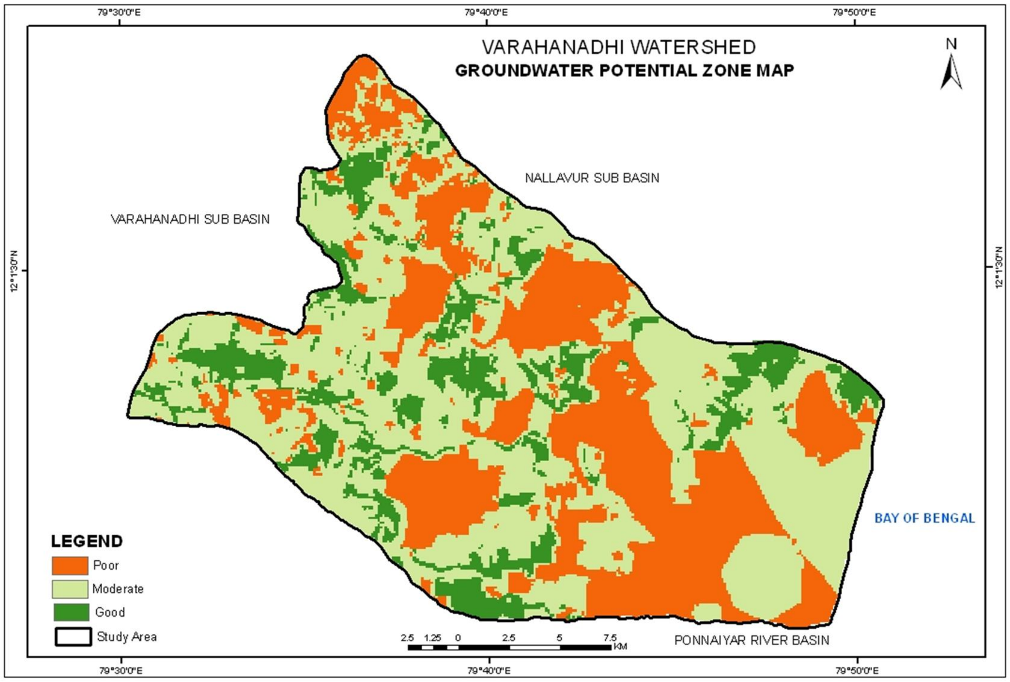

Fig.8: Groundwater potential map of study area

IV. CONCLUSION

The remote sensing and GIS is a effective tool for developing water resources management. It plays an important role in integrating all the data to generate various thematic maps in the study area such as geomorphology, geology, lineament, drainage and land use/land cover for preparing groundwater potential zone map. The geomorphic units viz. alluvial plain, flood plain and burried pediment(deep) are good prospective zones for groundwater exploration. Presence of lineament and fractures indicate the good supply of groundwater. It is clear that good and moderate sources of groundwater potential zones are confined to the southwest and North east part of the study area. The Potential zone map could be used for various purposes like irrigation, drinking and management of groundwater etc.

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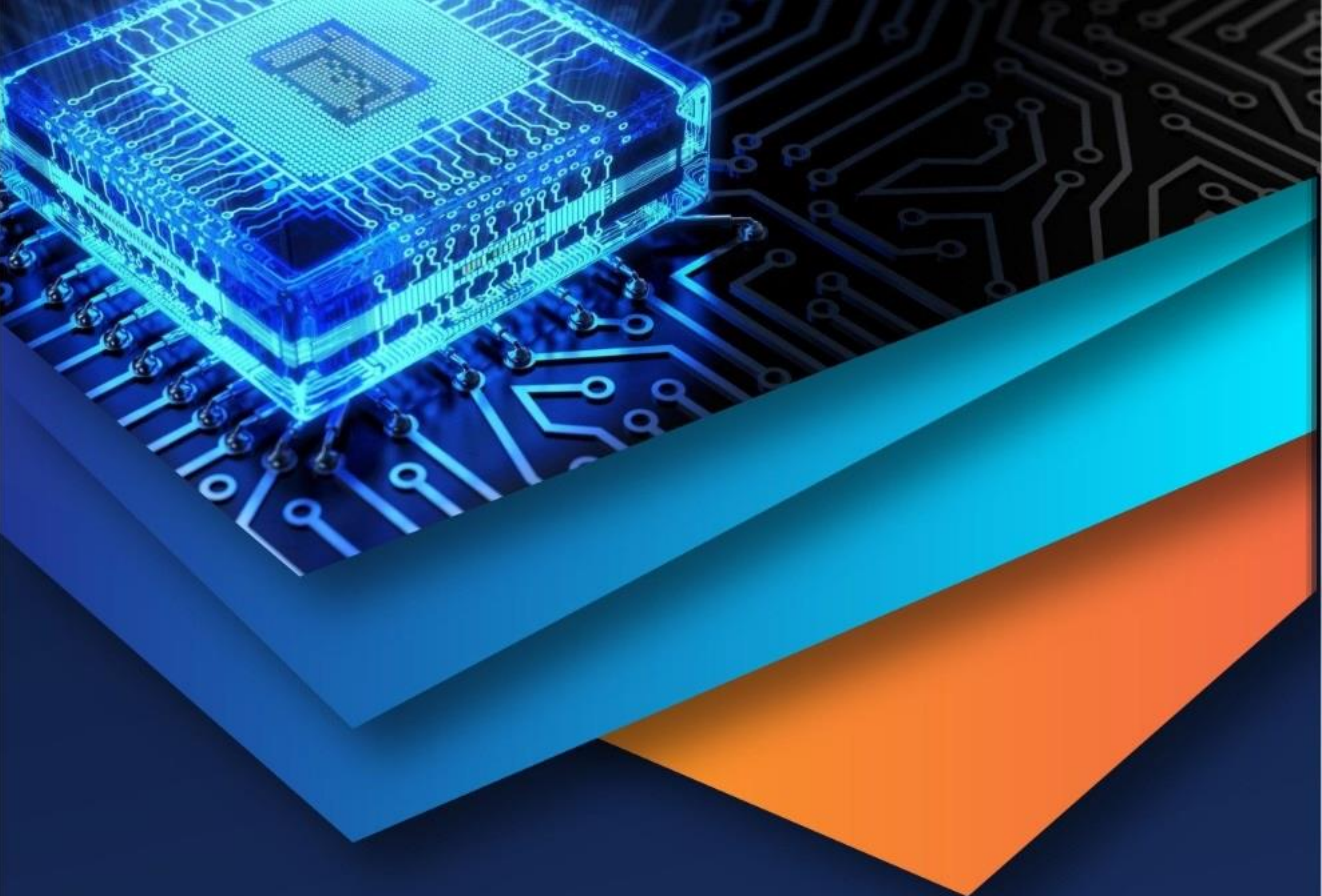

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