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Geomatics approach to demarcate groundwater potential zones using remote sensing and GIS techniques in part of Trichy and Karur district, Tamilnadu, India

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ABSTRACT

Water is renewable resource occurs in three forms viz, Liquid, solid, vapor (gaseous), all these tree forms of water are extremely useful to man. No life can exist without water. Since, water is an essential for life as like that of air, it has been estimated that in the human body two-third portion is constituted by water. The water is not only essential for survival of human beings, but also for animals, plants and other living beings. The present study is attempted to identify the groundwater potential zones using remote sensing and GIS techniques. Using sequential by preparing of thematic maps like lineament, geomorphology, land use and land cover, lithology and soil map and managing these GIS layers in Geo-database and assigning weightages based on the correlative factors that appear to be important in holding / processing of recharge of water and ground water potential content. By integration of weightages to acquire more effective score to discriminately demarcate the ground water potential zone in the present land units. The study of soil is added as an important theme/ data since it beholds the infiltration limitation through monsoon precipitation and in granulizing the effect of surface runoff based on their material content.By keeping all these facts a predominant speckle to identify the groundwater potentiality the weightages analysis helped in achieving the goal by the basic hydrological knowledge, through field exploration and GIS capabilities. This study helped to delineate the potentiality as moderate potential, and some part have been classified as high potential zones, low and very low potential zones and only few areas have been classified as very high groundwater potential zones.

Key words: GIS, Groundwater Potential Zone, Surface Runoff, Hydrology

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INTRODUCTION

Water is renewable resource occurs in three forms viz, Liquid, solid, vapour (gaseous), all these tree forms of water are extremely useful to man. No life can exist without water. Since, water is an essential for life as like that of air, it has been estimated that in the human body two-third portion is constituted by water. The water is not only essential for survival of human beings, but also for animals, plants and other living beings.Hydrology is the study of water, in the broadest sense, hydrology deals about the occurrence, distribution, movement, and chemistry of all waters. Hydrology can also defined as the science that deals with the processes governing depletion and replenishment of water resources over and within the surface of earth in any state of its existence.It is evident that with the knowledge of this science, we would be in a position to design with greater reliability in irrigation and the flood control works, power projects, municipal and industrial water supply schemes, navigation works etc., all these projects require a precise assessment of stream flow which could be done with the help of the sciences of hydrology and hydro metrological. The study of the precipitation run off relationship has been one of the primary aims of the science of hydrology.The developmental index and developmental planning of a country/ nation mostly depends on its water resources potential. It is a proven fact that the natural resources and natural disaster are controlled by geo- systems

and the geological processes/ geodynamics.The evolution of such fluvial geomorphic and the geological processes and their temporal changes over a time are difficult as it involves the mapping and modelling of a large amount of multifaceted geospatial databases on various geo-systems viz: Lithology, Structure, geomorphology, Land use/Land cover, Hydrology etc.P.JagadeeswaraRao, P.Harikrishna1(October 2009) Vol.13, No.4, Selection of groundwater potential zones in and around Madhurawada Dome, Visakhapatnam District - A GIS approach.S.Shahid, S.K.Nath and J.Roy remote sensing, 2000, vol. 21, no. 9, 1919–1924A Geographical Information System (GIS) integration tool is proposed to demarcate the groundwater potential zone in a soft rock area using seven hydrogeological themes: lithology, geomorphology, soil, net recharge, drainage density, slope and surface water bodies.Data IRS-1B LISS-II data was used in Midnapur District, West Bengal, India.K. Sankar Vol. 30, No. 3, 2002 Evaluation of Groundwater Potential Zones Using Remote Sensing Data in Upper Vaigai River Basin, Tamil Nadu, Indiaevaluates the potential zones for groundwater targeting using IRS - ID LISS III geocodeddata. The geology, geomorphology, lineament tectonic maps are generated and integrated to evaluate the Hydrogeomorphological characteristics of the upper Vaigai river basin and demarcate the groundwater potential zones.Gupta and Ganesharaj (1989) have used satellite images and bore well data for the demarcation of possible groundwater potential zones by analyzing hydrogeomorphology of the area.Omprakash, Dubey et al. (1989) have evaluated the groundwater resources in part of Indo-genetic plain using LANDSAT CCT,(band 5 and 7 images)SathyanarayanaRao (1983) has developed an integrated deformation model using remotely sensed data for groundwater targeting in hard rock areas for the part of Andhra Pradesh.

STUDY AREA

The area chosen for the study comprise of part of Trichy and Karur Districts of Tamilnadu, India. The study area covers approximately (625.306 sq.km).The study area is a part of Trichy and Karur, which is bounded by Namakkal district in the North, Dindigul district in the South, Erode district in the West, and Thanjavur district in the East. Latitude: 78^{o} 15' -78^{O} 30'Longitude: 10^{O} 30' -10^{0} 45'the distribution of rainfall in the study area is only due the north east monsoon and minimum during winter.The mean temperature ranging from 38.2^{o}C to 40.4^{0}C during March to September and the area experience cool climate during December to February.The area is composed both of hilly as well as plain terrain. Denudation hills can be seen in the North- South part and some residual hills were distributed along the area. The drainage pattern is finer the hills and lesser along the plains.Cauvery is the major river flowing N-S along thearea.Mamundyar is the other river which comes from Southern side, flowing towards North and finally joined with Cauvery River. The Dam also been seen the Kadavur sector.Proposed Large Scale Industries in Karur District, Thogaimalai –Granite Mining activity and Cement Factory ActivityKadavur –Cement Factory Activity.

MATERIALS AND METHODS

The main objective of the present study is to identify the Groundwater potential zones of Trichy and Karur District (SOI Toposheet: 58 J / 6, 1:50,000 scale) using remote sensing and GIS techniques.The sequential steps in the study areaIdentification of the boundaries of the study area. Preparation and conversion of prepared thematic maps into computer digital format by digitization technique.Using SOI Toposheet 58 J/6 the Base Layer and the drainage map were prepared.From the satellite imagery (IRS 1C LISS – III, Path -101, Row -066) the lineament map, Geomorphology map, and Land use and land cover map were prepared.Geology map of the study area is prepared using the Geological Survey of District Resource map.Based on the character, the features in different thematic layers were assigned with different weightages values according to the potential for groundwater.After the layers were integrated using GIS and then the area can be classified as high, moderate and low groundwater potential zones. The choice of software packages selections generally based on the user requirement. There are standard commercial GIS packages now available in the markets (Arc GIS 9.3+).ENVI 4.6.

The following schematic diagram shows the methodology of the present work.

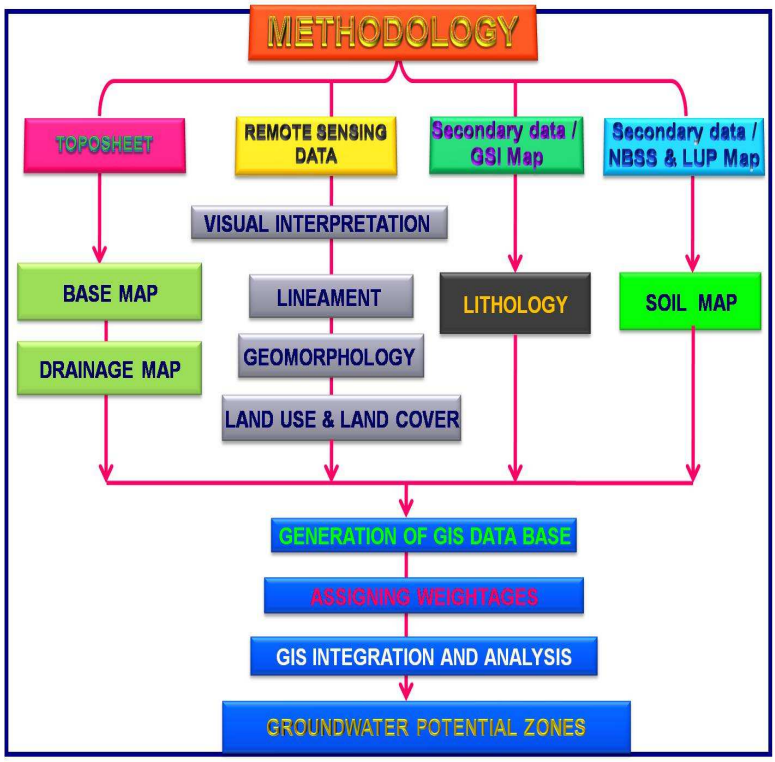


Fig 1.methodology flow chart

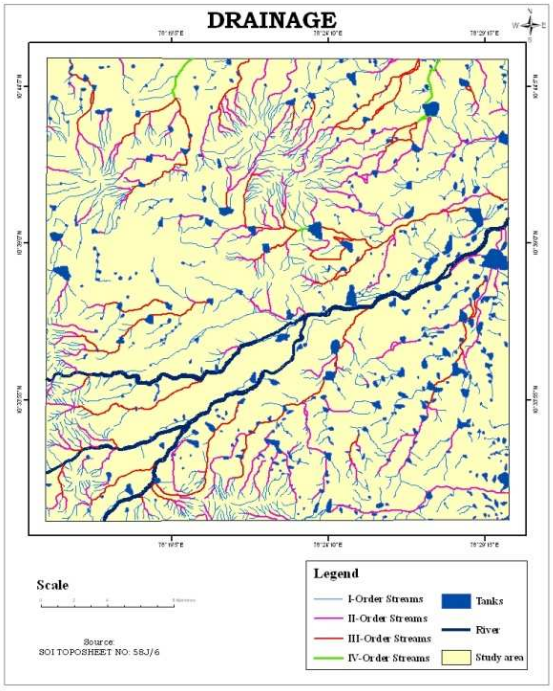


Fig2 Drainage map

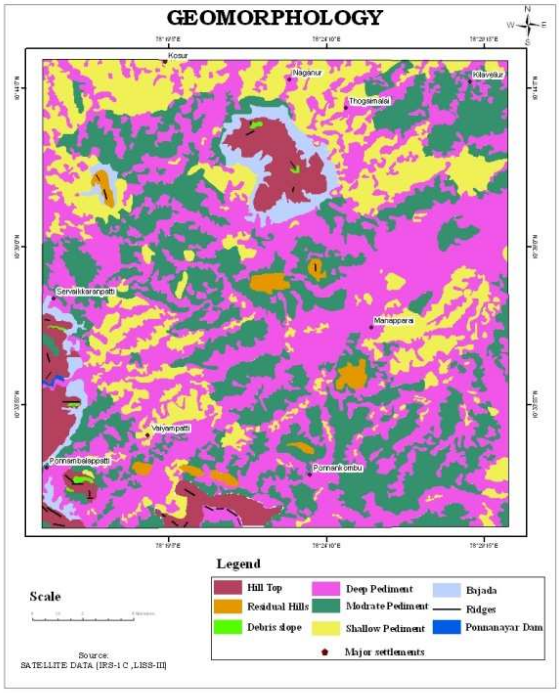
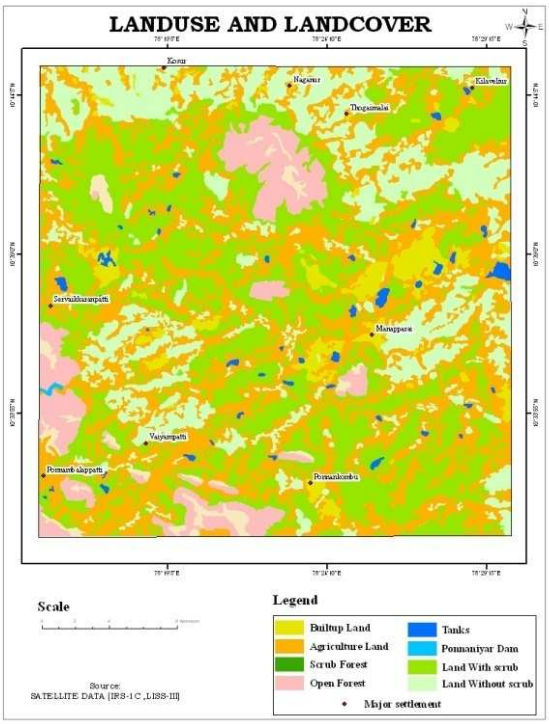


Fig3 Geomorphology map



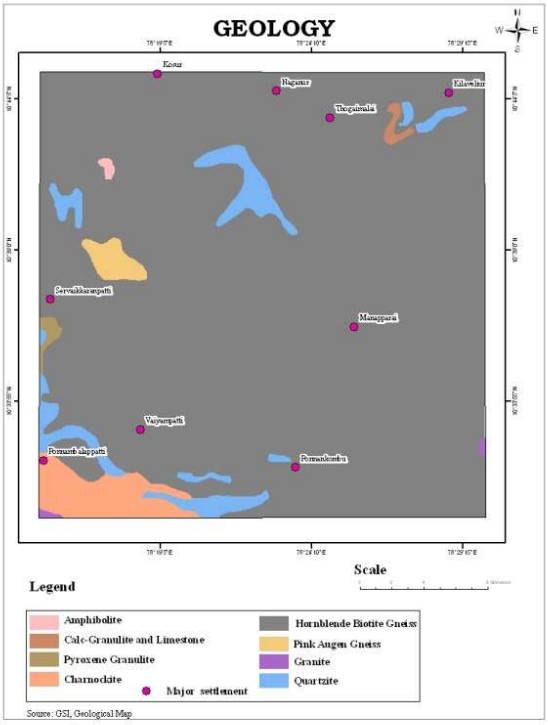


Fig4 Land use /Land cover map **Fig5 Lithology map**

TABLE1: WEIGHTAGE FOR GEOMORPHOLOGY BASED ON GROUNDWATER PROSPECTS

S. No	Criteria	Features	Weightage	Rank
1.	Geomorphology	Hill Top	1	Low
2.		Residual Hill	1	
3.		Debris slope	1	
4.		Ridges	1	
5.		Shallow Pediment	1	
6.		Moderate Pediment	2	Medium
7.		Bajada	2	
8.		Deep Pediment	3	High
9.		Water body	3	

TABLE2: WEIGHTAGE FOR LANDUSE / LANDCOVER BASED ON GROUNDWATER PROSPECTS

S. No	Criteria	Features	Weightage	Rank
1.	Land use/ land cover	Land Without scrub	1	Low
2.		Built-up land	2	Medium
3.		Scrub forest	2	
4.		Open forest	2	
5.		Agriculture land	3	High

TABLE3: WEIGHTAGE FOR SOIL BASED ON GROUNDWATER PROSPECT

S. No	Criteria	Features	Weightage	Rank
1.	Soil	Clayey soil	1	Low
2.		Calcareous clay soil	2	Medium
3.		cracking clay soil	2	
4.		Gravelly loamy soil	2	
5.		Gravelly clayey	3	High

Drainage map was prepared from the SOI Toposheet (58 J / 6). Here all the possible rivers, streams and tanks were digitized. Mamundyar River, Kodamurutyar River was the major rivers flowing in the area. Mamundyar and KodamurutyarRiver flows NE –SW. we can identify a major Ponnaniyar Dam in the W – E central part.Drainage

map (fig-2),Geomorphology is the science of studying the external expression and architecture of the planet earth when the terrestrial rocks are exposed or various or the crust of the earth exposed. It is subjected to external morphodynamics and morphotectonic processes such as horizontal convergent and weathering process due to temperature variants, biotic interference, hydrological interference etc., and the destructive and constructive processes and the related interactive processes. Wind erosion and the construction and the deformation of the earth crust volcanic eruptions, geothermal processes etc.,hence the art of geomorphic mapping has only increased for the last six or seven decades especially the geomorphic mapping has gained great importance after the advent of modern remote sensing technology.Geomorphology map (fig-3), IRS 1C LISS III imagery was used for preparing land use / land cover map on 1:50,000 scale by visual interpretation methods. In this study area, land use categorized into various categories like Built up land, Agriculture land, scrub forest, Open forest, Tanks, Ponnaniyar Dam, Land with scrub, Land without scrub, Major settlements.,The land use and land cover pattern are classified based on the NRSA nomenclature. The land use / land cover patterns of the study area is classified from the satellite imagery based on the image interpretation techniques by suing the tonal variations, texture, pattern, size, shape and association etc., and digitized through ArcGIS software. Land use/Land cover map (fig-4).Using the district resource map the lithology of the area has been mapped as a layer. Granite, amphibolite's, hornblende Biotite Gneiss, Calc- Granulite and Limestone, Pyroxene granulite, Pink Augen Gneiss, Quartzite and Charnockite rocks etc., were the rocks found in the area. Granite Mining also can be seen the area in Thogaimalai. Geomorphology map (fig-5).

DATA INTEGARTION

Weighted Index Overlay Analysis

Weighted Index Overlay Analysis (WIOA) is a simple and straightforward method for a combined analysis of multi-class maps. The efficiency of this method lies that human judgment can be incorporated in the analysis. A weight represents the relative importance of the parameter vis-à-vis the objective. WIOA method takes into consideration the relative importance of the parameters and the classes belonging to each parameter. There is no standard scale for a simple weighted overlay method. For this purpose, criteria for the analysis are defined and each parameter is assigned importance (Saraf and choudhury,1997 and saraf and Choudhury, 1998). Determination of weightage of each class is the most crucial in integrated analysis, as the output is largely depends on the assignment of appropriate weightage. Consideration of relative importance leads to a better representation of the actual ground situation (choudhury, 1999). Considering the hydro- geomorphic conditions of the area, weighted indexing has following parameter namely Geology, Geomorphology and land use / Land cover the weightage values were assigned and integrated in GIS environment.

CONCEPT OF GROUNDWATER MAPPING

Almost all groundwater resources are vulnerable to various degrees. The accuracy of its assessment depends, above all, on the amount and quality of representative and reliable data available. The required data is often not available and thus the scale of mapping is often limited to broad scale maps.The original concept of groundwater vulnerability was based on the assumption that the physical environment may provide some degree of protection referred to as the barrier zone with regard to contaminations (the threat) entering the sub-surface water(groundwater resource). The earth materials may act as natural filters to screen out some contaminates. Water infiltrating at the land surface may be contaminated but is naturally purified to some degree as it percolate through the soil and other fine grained materials in the unsaturated zone.Hence a groundwater potential map has been generated for the study area using geographical Information System (GIS. In order to achieve this, a number of spatial attributes need to be mapped, such as geology; Geomorphology, land use/ land cover etc. then these are weighted and prioritized.

RESULTS AND DISCUSSION

On the basis of weightages assigned to each and every thematic layer, unique polygons were identified having their own relative weightage combinations. Now, for each and every polygon combinations, all the weightages were cumulated and these values and ranging from5 to 118. Based on the range of cumulative values the area has been categorized into three priority zones. They are…….1.4-24.6 (Very low potential zone)21.7-48.7 (Low potential zone)48.8-72.8 (Moderate potential zone)72.9-96 .9 (High potential zone)96.10-121(Very high potential zone)

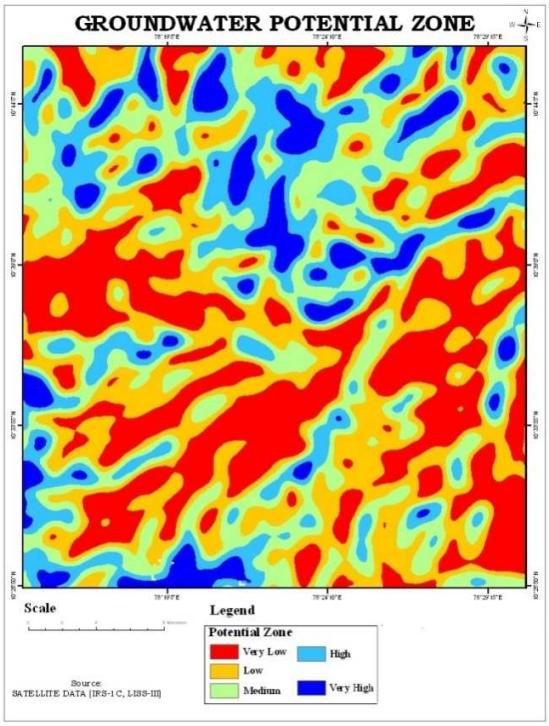


Fig6 Groundwater Potential Zone map

CONCLUSION

The present study reveals that remote sensing is a splendid technique for natural resource assessment for terrain analysis. Remote sensing provides information of an area within a short time at low cost. It is an indispensable tool for environmental monitoring, climatic condition, geographical, Geomorphologic mapping, hazard management, resource estimation, urban planning, and to study the agriculture practices remote sensing technique is suitable technique. By this technology information on a terrain can get for a micro level of all aspect. The data obtained from this technology is user friendly and multidisciplinary. All the thematic maps were converted into grid (Raster format) and superimposed by weighted overlay method (rank and weightage wise thematic maps). From the analysis the groundwater potential zones in-terms of very low, low, moderate, high and very high groundwater potential zones.In order to learn the basic knowledge of visual interpretation and image processing, I have taken this area to identify the area potential for the occurrence of groundwater, by using different thematic layers pertaining to geomorphology, and land use / land cover, Geology, Slope and Soil were assigned with weightage values according to their favourness for groundwater and integrated in GIS environment and classified into very low, low, moderate, high and very high groundwater potential zones. In this study, major part of the area have been classified as moderate potential, and some part have been classified as high potential zones, low and very low potential zones and only few areas have been classified as very high groundwater potential zones (Very High Ground Water Potential Zones present near to Kumaravadi, Manapparai, samudram, Muttapudaiyanpatti, Amaiyapuram, and Aniyapur villages in Trichy District.Nallampillai, Thogaimalai and Thondamanginam villages in Karur District.)Because according to the geology as the area mainly composed of hard rock's the weightage values assigned to the feature were very small so that major part of the area comes under low.Here in this study concern, only five layers have been utilized for identifying the potential zones for groundwater this may be a meager quantity. If it is necessary of accuracy for groundwater potential zones we can go for further more deeper in narrower classifications for weightage values and taking some more thematic layers into consideration.

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