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Deciphering of Groundwater Potential Zones in Tuticorin, Tamil Nadu, using Remote Sensing and GIS Techniques

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Abstract: The present study was carried out to decipher the groundwater potential zones in the coastal terrain of Tuticorin using Indian remote sensing satellite IRS-1C, LISS-III data on a 1:50,000 scale and Survey of India (SOI) toposheets. The thematic layers such as lithology, slope, land-use, lineament, drainage, soil and rainfall were generated and integrated to prepare the groundwater prospect and recharge map of the study area. These layers were transformed to raster data using feature to raster converter tool in Arc GIS 9.2 software. Subjective weights are assigned to the respective thematic layers and overlaid in GIS platform for the identification of potential groundwater zones within the area. These potential zones were categorized as 'high', 'moderate', and 'low' zones with respect to the assigned weightage of different thematic layers. The resultant map shows that 10% of the area has highest recharge potentials, this is due to the percolation of precipitated water into the sub-surface rocks, followed by 65% of the area with moderate groundwater recharge potentiality, and rest of the area has low recharge potential. The study highlights that the total average annual precipitated water (877 mm) is responsible for natural recharge of the aquifers in the Tuticorin area.

Keywords: Remote sensing and GIS, Recharge potential, Influencing factor, Groundwater, Tuticorin, Tamil Nadu.

INTRODUCTION

Groundwater plays an important role in drinking, agricultural, and industrial needs as a timely assured source due to non-availability of surface water at times. Rapid growth of population has increased pressure on water resources. On the other hand groundwater is the limited resource and water scarcity is quickly increasing in many regions of the world. The contribution from groundwater is vital; because about two billion people depend directly upon aquifers for drinking water, and 40 percent of the world's food is produced by irrigated agriculture that relies largely on groundwater (Selvam et al. 2012b). To understand the occurrence of groundwater, the distribution of geological materials of varying hydraulic conductivity and porosity is important. Fractures create secondary porosity in the rock. Fracture traces are surface expression of joints, zones of joints concentration, or faults. Surface and sub-surface hydrological features such as geological structures, lineaments, rock types, drainage density, water bodies and thickness of weathered overburden play an important role in groundwater occurrence in different geological formation.

In recent years, digital technique is used to integrate various data to decipher not only groundwater potential zone but also to solve other problems related to groundwater. The application of remote sensing techniques in groundwater study mainly uses visual interpretation of satellite data. It is rapid and cost- effective tool for assessing, monitoring and conserving groundwater resources. Multi-temporal and multi-sensor data cover large and inaccessible area within short span. The concept of integrating remote sensing and GIS has emerged in the last decade as an essential tool for resource planning and management. These various data are prepared in the form of a thematic map using geographical information system (GIS) software tool. These thematic maps are then integrated using "Spatial Analyst" tool. The "Spatial Analyst" tool with mathematical and Boolean operators is then used to develop a model depending on the problem at hand, such as delineation of groundwater potential zones (Magesh et al. 2012).

Applications of remote sensing and GIS for the exploration of groundwater potential zones are carried out by a number of researchers around the world, and it was found that the involved factors in determining the groundwater potential zones were different, and hence the results vary accordingly (El-kadi et.al 1994; Sener et.al 2005). In addition to this, 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). Teeuw (1995) relied only on the lineaments for groundwater exploration and others merged different factors apart from lineaments like drainage density, geomorphology, geology, slope, land-use, rainfall intensity and soil texture (Sander et al., 1996; Das, 2000; Sener et al., 2005; Ganapuram et al., 2008). The derived results are found to be satisfactory based on field survey and it varies from one region to another because of varying geological environments.

In recent years, many workers such as Chatterjee and Bhattacharya (1995), Teeuw (1999), Shahid et al. (2000), Goyal et al. (1999), Selvam et al. (2014a) and Saraf and Choudhary (1998) have used the approach of remote sensing and GIS for groundwater exploration and identification of artificial recharge sites. Imran et al. (2011) and Jaiswal et al. (2003) have used the GIS technique for identification of ground-water prospecting zones for rural development. Krishnamurthy et al. (1996), Murthy (2000), Obi et al. (2000), and Pratap et al. (2000) have used GIS to delineate groundwater potential zone. Srinivasa and Jugran (2003) have applied GIS for processing and interpretation of groundwater quality data. GIS has also been considered for multicriteria analysis in resource evaluation. Mohammed et al. (2003) have carried out hydrogeomorphological mapping using remote sensing techniques for water resource management around paleochannels. GIS has been applied to groundwater potential modeling by Rokade et al. (2007). This paper mainly deals with the integrated approach of remote sensing and GIS to decipher the groundwater potential zones in a coastal terrain of Tuticorin. The remotely sensed data at the scale of 1:50,000 and topographical information available from maps, have been used for preparing various thematic layers, such as lithology, drainage density, lineament density, rainfall, slope, soil, and land-use with assigned weightage in a spatial domain for the identification of potential groundwater zones. The collateral information with necessary ground checks is helpful in generating the baseline information for groundwater targeting.

STUDY AREA

The Tuticorin coastal area extends over approximately 154 sq.km and lies between 8°43' - 8°51' N latitude and 78°5' - 78°10' E longitude in the southern part of Tamil Nadu (Fig.1). The area is bounded by the Gulf of Mannar in the east and is bordered by Tirunelveli district in the west. The population is mainly engaged in agriculture. Numerous salt pans, salt based industries and marine chemical industries are located in this zone. The average annual rainfall of this study area is 877mm (Selvam et.al 2013a). The NE monsoon contributing to 65.4% of annual rainfall is the major component of recharge into the aquifer. The total number of rainy days in a year is only 38.5. Rainfall data from seven stations over the years 2000- 2010 were utilized and a perusal of the data shows that the normal rainfall varies from 599mm to 749mm which is far less than that of the state average (942.8mm). The contribution of SW monsoon is only 8.06%. The maximum amount of rainfall is during November and the minimum is seen during June (Balasubramanian et al. 1993 and Selvam et.al 2013b). In this coastal belt there are two major geological formations with varying hydrologic characteristics. Groundwater occurs mostly under water table conditions and at a few places under semi-unconfined conditions also. The hydraulic properties of aquifers vary both in vertical and horizontal directions. The depth of the water table varies from 1 to 10m bgl in post-monsoon and 2 to 15m bgl in pre-monsoon. The topographic elevation varies from 27 m (amsl) to a few meters (amsl) near Tuticorin town and slopes from west to east (Selvam 2012a). The slope is gentle in the western and the central part and nearly flat in the eastern part.

METHODOLOGY

The Indian Remote sensing Satellite (IRS) 1C, linear image self-scanning (LISS) III of geocoded with UTM projection, spheroid and datum WGS-84, Zone North 44 generated from the total bands 4 on a 1:50,000 scales, was used for the present study. The Survey of India toposheets 58H/13, 58H/14, 58L/1&5, 58L/2 on a scale of 1:50,000 equal to the corresponding imagery were used for the preparation of thematic maps. The imagery was visually interpreted to delineate lithology and land use/land cover with the help of slandered characteristic image interpretation elements like tone, texture, shape, size, pattern and association. The thematic maps so prepared were converted into raster form so that it can be easily integrated using GIS. Each of these thematic maps has been assigned suitable weightage factor. During weightage overlay analysis, the ranking was given for each individual parameter of each thematic map, and weights were assigned according to the influencing factor of that particular feature on the hydro-environment of the Tuticorin coast. These weightage factors

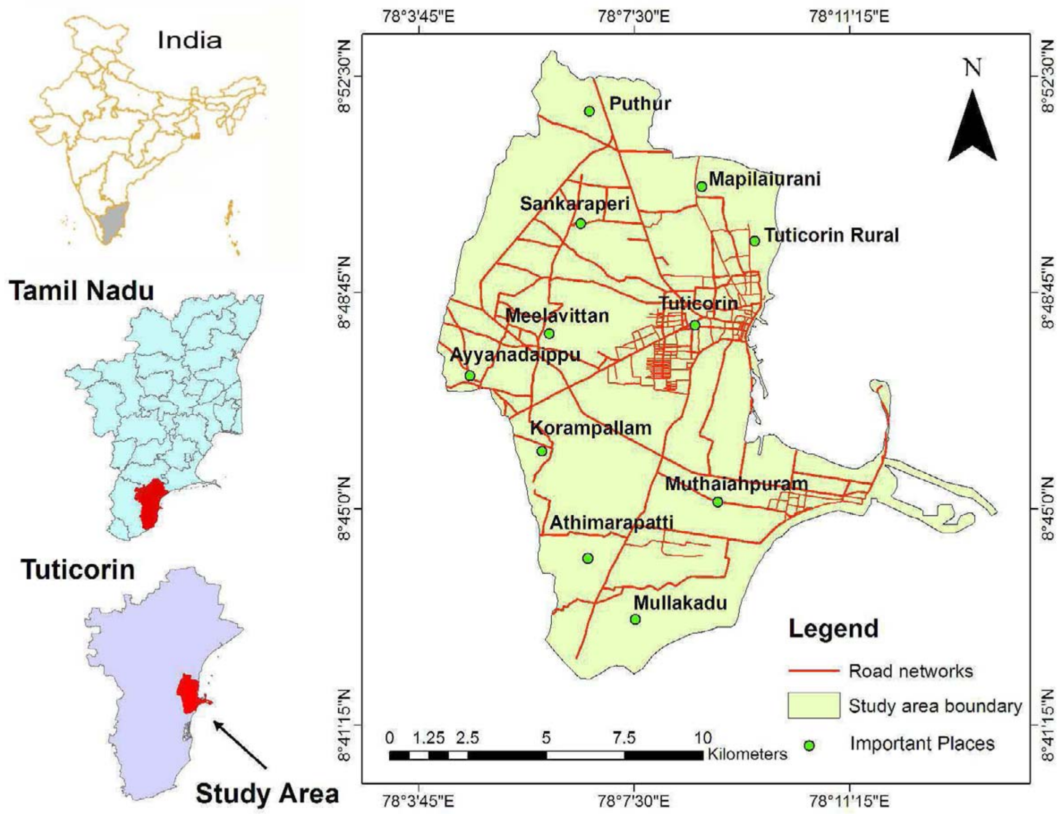

Fig.1. Location map of the study area.

are from the works carried out by Magesh et al. (2012). These thematic maps were then integrated using "Spatial Analysis tool" in Arc GIS 9.2 (Fig. 2).

RESULTS AND DISCUSSION

Factors Influencing Recharge Potential

The occurrence and movement of ground water is influenced by lithology, structure, geomorphology and drainage while replenishment is further affected by land use, precipitation and infiltration rate. In this study, seven thematic layers viz. lithology, slope, land-use, lineament, drainage, soil and rainfall have been generated for analysis and integration into a prospect map.

Lithology

The study area is underlain by the geological formations comprising of the crystalline Archaean complex, Tertiary and sub-recent to recent sediments. The surface boundary, between the Archaeans and the sedimentary strata is widening towards south from 2 km to 25 km from the coastline. The Tertiary to recent age sedimentary formations overlie the Archaean complex with a marked unconformity. The major rock types are shell limestone and sand, tuffaceous kankar, sand-aeoline deposit (Fig.3). They are fine to medium grained, hard, compact and fossiliferous with shell of gastropods and pelecypods. The thickness of the strata varies from place to place, from a few meters to more than 20m. The formation extends in the NE-SW direction dipping SE with low angles. Sand admixed with clay is the major formation making the aquifer media. The coastal area is underlied by loose textured coarse calcareous grits and shell limestone of sub-recent age. Rocks are horizontal bedded with a low dip of 10° to 15° SE. The remaining area is covered by composite gneiss of Proterozoic age (Selvam, 2012a). From the point of groundwater development only the weathered, well jointed and highly fractured portions of these rocks are important. The peninsular gneisses are the country rocks. The regional foliation is northwest to southeast (Selvam, 2014b).

Lineament Density

Lineaments are linear or curvilinear structure on the earth surface, it depicts the weaker zone of bed rocks and the area is considered as secondary aquifer in hard rock regions. These lineaments are mapped with the help of satellite data and can be correlated with faults, fractures, joints, bedding planes and lithological contacts. The most obvious structural

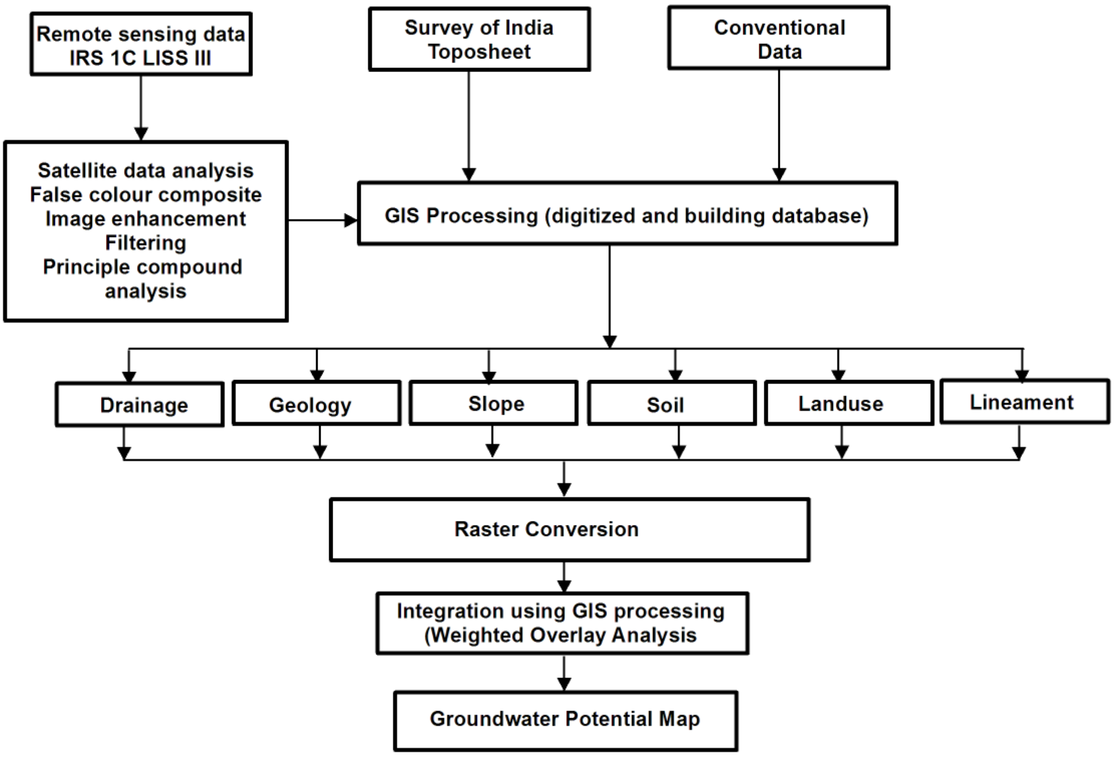

Fig.2. Flow chart showing the methodology adopted.

features that are important from the groundwater point of view are the lineaments which are identified from remote sensing data. Lineament analysis has been carried out to describe the occurrence of lineament in the area and the

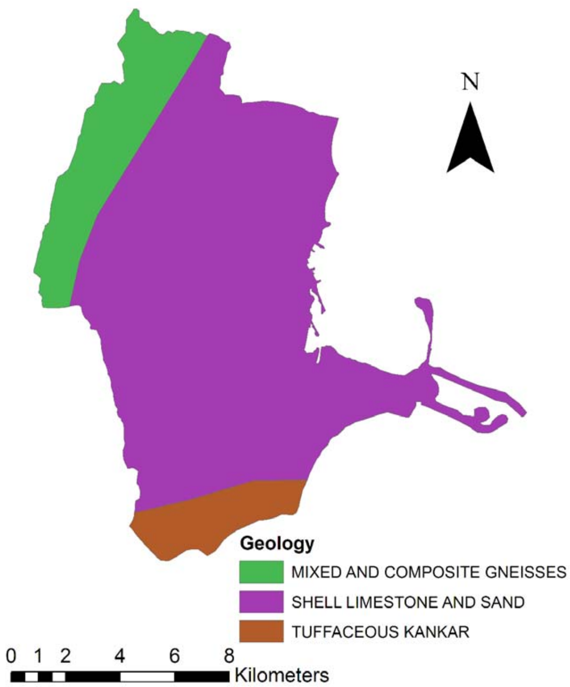

Fig.3. Lithology map of the study area.

major lineaments present are in NNE-SSW, NW-SE and NE-SW directions. Groundwater potential is high near lineament intersection zones. The lineament count density was 2.13 km/km^2 for aeolian deposits and for the rest of geomorphic unit it is found to be very less than 0.0 km/km^2. It is observed that the cumulative length and frequency in the southern region is very less compared to the northern region. The central part has very high groundwater potential as the numbers of the lineaments are more in this region (Fig.4).

Drainage Pattern and Drainage Density

Drainage pattern depict history of the evolution of the earth crust. The density of the drainage network as well as the occurrence of lineaments, faults, fractures, major or minor joints can have a major influence on groundwater recharge and movement, also provides path ways for groundwater movement and is hydraulically very important (Kumar et al. 2007). The drainage pattern map of the study area is drawn with the help of Survey of India topographic map and updated from satellite data. The drainage density map was developed in three stages. In the first stage drainage map was prepared from the SRTM DEM; next the watersheds were delineated based on Geological survey of India topographic reference maps using SRTM DEM; and finally drainage densities were calculated in each

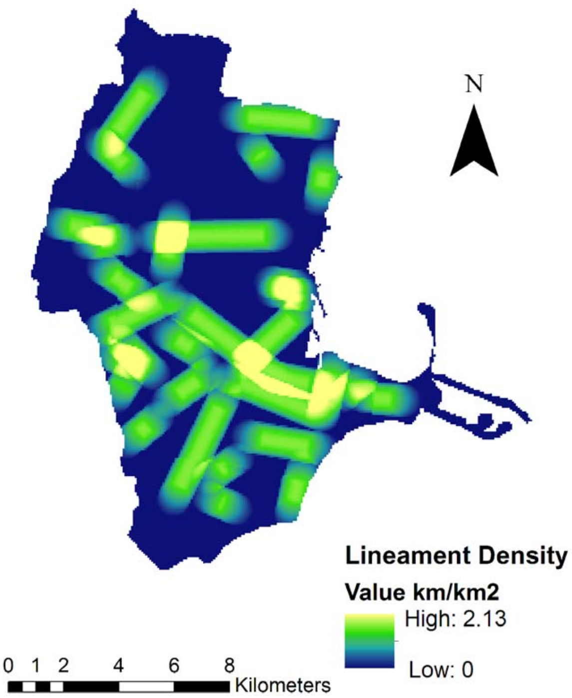

Fig.4. Lineament density map of the study area.

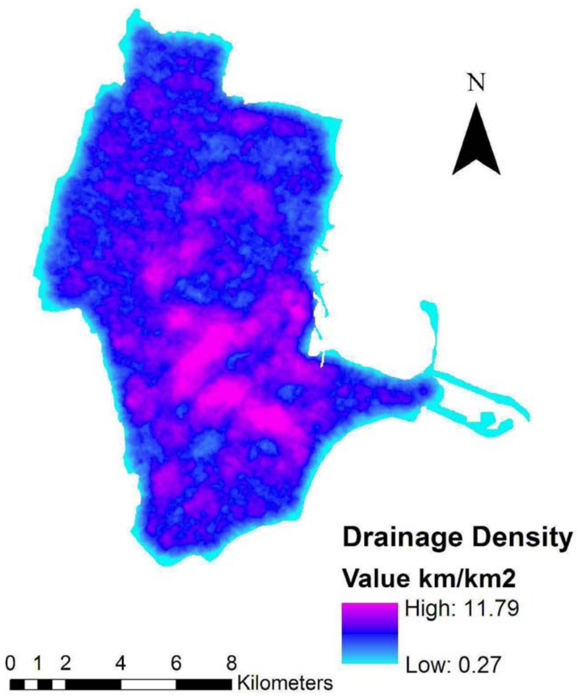

Fig.5. Drainage density map of the study area

of the grid square using formula as given below (Murthy 2000).

$$DD = \sum \frac{LWS}{AWS}$$

where DD = drainage density; LWS = total length of streams in watershed and AWS = area of the watershed

The drainage density map reveals that density value range from 0.27 to 11.79 km/km^2. For analysis purposes they were regrouped into four category i.e 12-8 high, 8-6 medium, 6-3 low and 3-0 very low km/km^2 (Fig.5). Considering from recharge point of view more weightage is assigned to very low drainage density regions, whereas, low weightage assigned to very high drainage density.

Land Use/ Land Cover

Remote sensing and GIS technique provide reliable basic information for land use/land cover mapping which play very important role in determining land use pattern by visual interpretation (John Prince Soundranayagam et al. 2011). Land use/ Land cover is a significant factor affecting the recharge process. This factor involves a number of elements and the major ones are soil deposits, human settlements and vegetation cover. The major effect of soil on water percolation through the sub-surface media is attributed to its clay content as it controls the retention capacity of water. The human settlement has a definite role in retarding the recharge process. Man-made construction, such as concrete embankments, buildings, hangers, roads etc. create a compacted terrain that seals the ground surface, thus preventing recharge of water easily.

Land use/land cover patterns of study area were analyzed and mapped using IRS-1C, LISS-III satellite data followed by intense field verification. Water bodies and cultivated lands were assigned a high weightage factor because it is mostly associated with water body, which has been identified by the light blue tone, fine/medium texture. One of the dominant land use/land cover categories in the area is saltpans with water followed by land with shrubs that has been identified in uplands and plains with gentle to moderate slopes, uplands and plains with cultivable lands and it appears light yellow to greenish blue tones and irregular shapes (Fig.6). The land use/land cover such as barren lands and settlements which have poor water holding capacity have been given a medium weightage factor. The saltpan gives light white and fine to medium texture with regular shape and varying size.

Slope

The SRTM DEM data were used to derive a slope map presented in terms of percentage using the SLOPE function in Arc GIS 9.2. The gradient of slope is one of the factors that directly influence the infiltration of rainfall. The steeper slopes generate less recharge because water runs off the

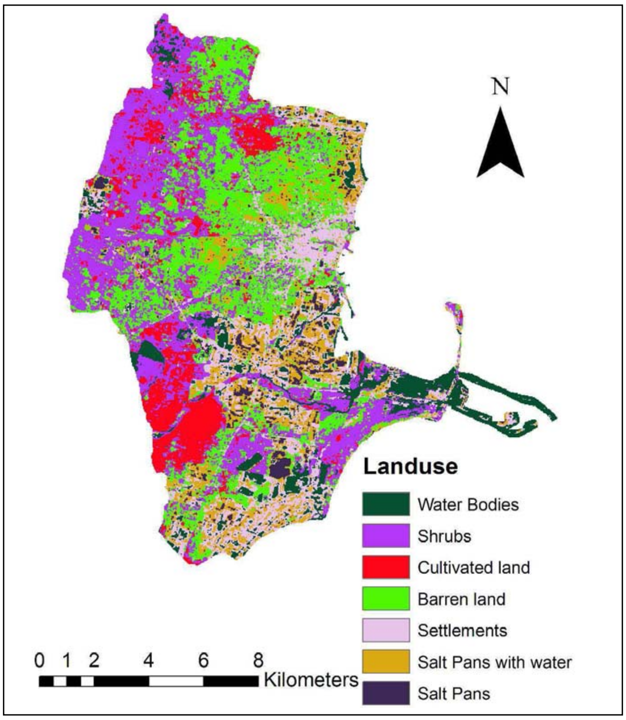

Fig.6. Land use map as obtained by the aid of remote sensing with respect to recharge potential of the study area

surface rapidly during rainfall, allowing insufficient time to infiltrate the surface and recharge the saturated zone. Slope is classified into five categories along with their weightages and weights which were assigned according to the slope aspect. A slope <1° is regarded as plain region with lower slope because of low runoff and is usually a very good recharge zone. The areas having 1-2° slopes are considered good for groundwater storage due to slightly undulating topography with little run off. The areas having a slope of 2-3^0 cause relatively moderate runoff, and hence are categorized as 'moderate'. Slopes having 4-5^0 are almost considered as poor and the areas having a slope >5^0 are considered as 'very poor' due to higher slope and rapid runoff. Figure 7 illustrates the range of slope in the study area.

Soil

Soil types of the area are more important, since it is the main factor for the recharge of groundwater and agricultural production. Soil characteristics invariably control the infiltration of surface water into an aquifer system and they are directly related to rates of infiltration/ percolation and permeability. The area is covered with sandy clay in the western part (Sankarapari area) red soil (Sandy loam to Sandy soil) in the central part and alluvial sandy soils (Coastal area) in the eastern part (Fig. 8). The maximum soil thickness is about 3m. The sandy soil originated from sandstones and these have low soil moisture retentivity. The alluvial soils are wind- blown and the shells constitute beach sand and coastal dunes, which have very low soil moisture retentivity. The porous formation in the study area includes sandstone and clays of recent to sub-recent (Quaternary) and Tertiary age (Selvam et.al 2013).

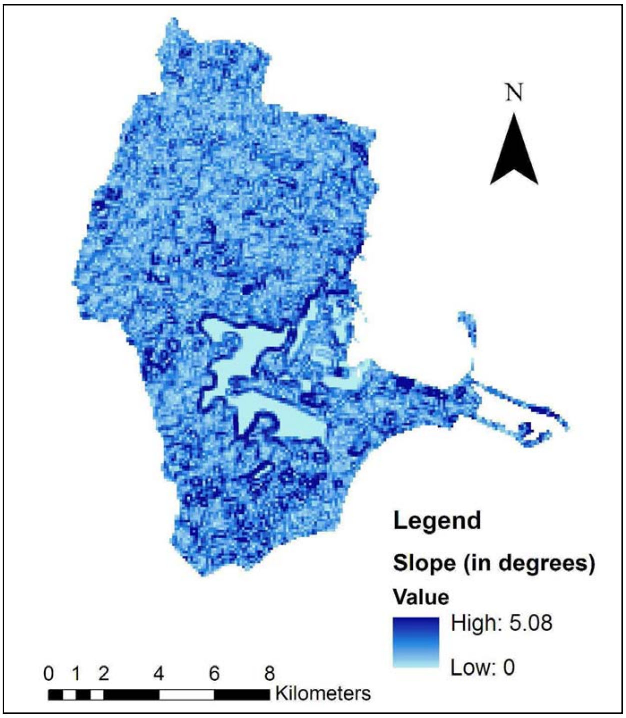

Fig.7. Slope map of the study area

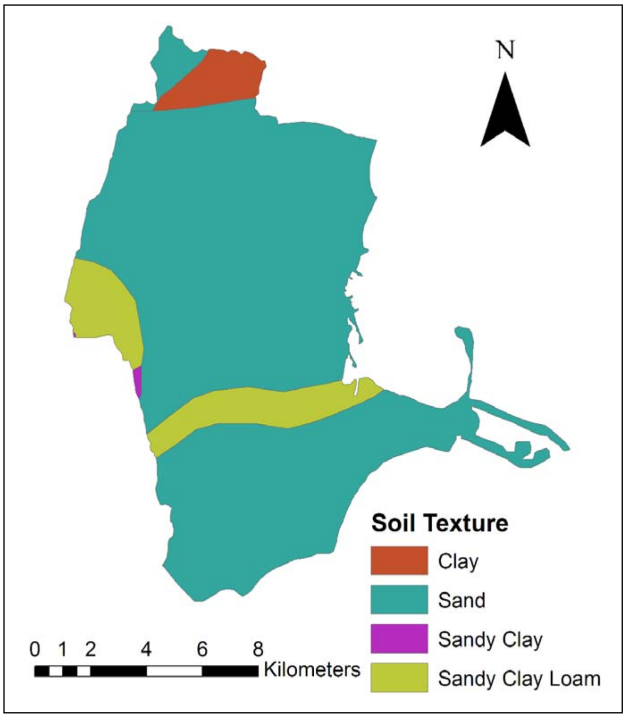

Fig.8. Soil map of the study area

Soils, such as clay and sandy clay loam, have poor water-holding capacity and have been given a low weightage. Such soil types are located in the western regions of the study area. Sand and sandy clay have high water-holding capacity and have been given a high weightage. These soil types are located in upper east, northern parts, and in small portion of the southern region of the area.

Rainfall

The long-term average annual rainfall of Tuticorin town is 592 mm (IMD data). The area receives rainfall during the northeast monsoon season, which is active during the months of October, November, and December (Mondal et.al 2010). Daily rainfall of the year 2011 recorded at the SIIL rain gauge station indicated that rainfall was above normal with significant high intensity rainfall as compared to the past years since 2000. The area experiences semi-arid tropical conditions; and falls in east coast plains and hilly region agro-climatic zone as classified by Indian Council of Agricultural Research (ICAR, India). Rainfall data were classified into four categories and its spatial extent shown in Fig. 9. Tuticorin is divided into five categories of rainfall zones ranging from <400 to >750 mm. The area receiving less than 400 mm of rainfall was given a score of one assuming a poor potential zone, which are mainly located in western and middle south regions while the area receiving greater than 750 mm of rainfall was assigned a score of nine assuming very good water potentiality. These areas are located in southeastern, central, northeast and eastern parts of the Tuticorin.

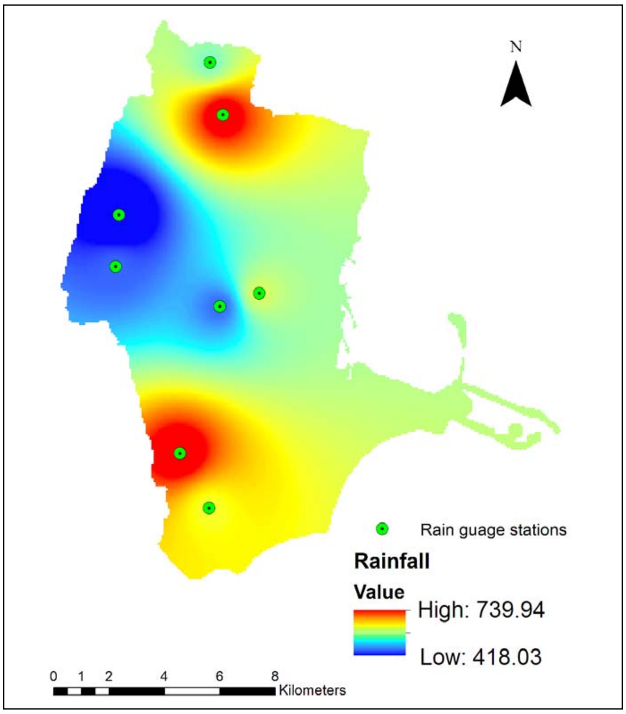

Fig.9. Rainfall map of the study area.

Deciphering of Groundwater Potential Zones

In the study area, maps were plotted for each factor based on synoptic classification of seven categories. Contributing factors are: lithology, slope, land-use, lineament, drainage, soil and rainfall that have different levels of effect and is expressed in numerical values. For the numerical values the ranges are based on the resultant domains, which provide specific information about the recharge or infiltration of water. Based on the resultant domain that ranges between the maximum and minimum values, where each factor influences mainly the recharging processes.

For purpose of analysis, the lineament map has been prepared and categorized into four classes. Therefore, weightage is assigned high for higher density and low for lower density, the average frequency values ranging from 0-2.13 km/km^2. The lithology domain can work from high to low depending upon the type of rocks such as sand, shell limestone, taffaceous kankar. High weightage was given to higher water bearing formations and lower weightage to low water bearing formations. Similarly land use/land cover map is analyzed based on urbanization, vegetation and land cover containing different values of water percolation and the values ranges from very high to low.

Therefore, seven major descriptive levels were plotted ranging from very high to very low, also including some interrelated levels. The weightage from 30 points i.e., very high range is assigned as 30 points and the minimum level as 1 points. All these factors are integrated to obtain a recharge potential map. Assessing the effects of each factor only the recharge potential was not give in the required

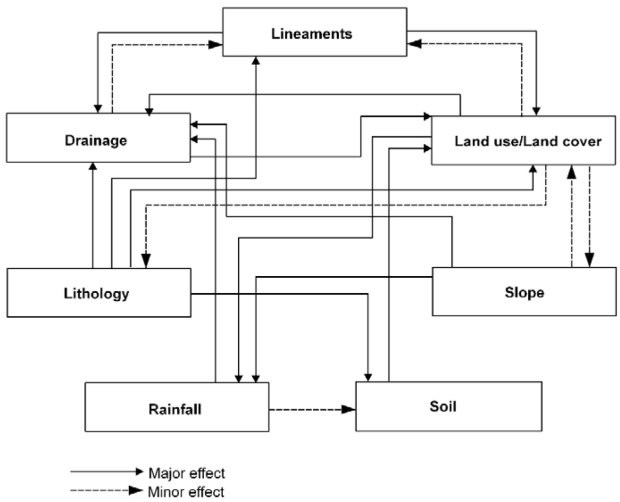

Fig.10. Schematic sketch showing the interactive influence of factors concerning recharge properly

complementary picture. The integration of all factors together was necessary in order to obtain a recharge potential map. Based on the degree of influence in the recharge potentiality, a weightage approach is incorporated and the factor on each other is presented as schematic sketch (Fig. 10).

Each influencing factor may contribute to delineate the groundwater potential zones and these factors have a relative value of 1 or 0.5 based on major or minor effect between different layers. The major effect was given 1 point, while the minor effect was given ½ point. The cumulative weightage of both major and minor effects are considered for calculating the relative rate. This rate is further used to calculate the score of each influencing factor. Figure 10 shows that the lithology was the most influential one having 4 major effects namely effect on lineaments, land use, slope, drainage, rainfall and soil (Table 1).

Table 1. Effect of influencing factor, relative rates and score for each potential factor

Factor	Major effect (A)	Minor effect (B)	Proposed relative rates (A+B)
Lineaments	1+1	0	2
Landuse	1+1	0.5+0.5+0.5	3.5
Lithology	1+1+1+1	0	4
Drainage	1	0.5	1.5
Slope	1+1	0.5	2.5
Rainfall	1	0.5	1.5
Soil	1	0	1
			16

Based on relative rates for each influencing factor, this is expressed in points as follows,

= lineament: 2 major = 2 (1) = 2 points
= land use: 2 major + 3 minor = 2 (1) + 3 (0.5) = 3.5 points
= lithology: 4 major = 4 (1) = 4 points
= drainage: 1 major + 1 minor = 1(1) + 1 (0.5) = 1.5 points
= slope: 2 major + 1 minor = 2 (1) + 1 (0.5) = 2.5 points
= rainfall: 1 major + 1 minor = 1 (1) + 1 (0.5) = 1.5 points
= soil: 1 major = 1 (1) = 1 points

The effect of influencing factor, relative rates and score for each potential factor of the study area is categorized (Table 2). Now to obtain a comprehensive evaluation of each influencing factor on recharge potentiality the rates and weights are integrated and thus total weighting assessment, after rounding off values is shown in Table 3

Table 2. Classification of weighted factors influencing the potential zones

Factor	Descriptive scale	Domain of effect	Proposed weight to effect
Lineament density	Very High	1.5-2.0	13
	High	1.0-1.5	9
	Moderate	0.5-1.0	6
	Low	0.0-0.5	2
Land-use	Very High	Water Bodies	22
	High	Cultivated Lands	20
	High - Moderate	Saltpans with water	15
	Moderate	Shrubs	10
	Moderate - Low	Saltpans	8
	Low	Barren Lands	5
	Very Low	Settlements	3
Geology	High	Shell limestone and sand	20
	Moderate	Tuffaaceous kankar	15
	Low	Mixed and composite genesis	10
Drainage density	High	0-3	9
	Moderate	3-6	6
	Low	6-8	3
	Very Low	8-12	1
Slope gradient	High	0-1	16
	High - Moderate	1-2	12
	Moderate	2-3	8
	Low	3-4	4
	Very Low	4-5	1
Rainfall	High	650-750	9
	Moderate	550-650	6
	Low	450-550	3
	Very Low	400-450	1
Soil	High	Sand	4
	Moderate	Sandy Clay	3
	Low	Sandy Clay Loam	2
	Very Low	Clay	1

(Khawlie 1986; Shaban et.al 2001; Shaban, 2003). The grand total weight in this case was equal to:

= lineament density (60) + land use (290.5) + lithology (180) + drainage density (28.5) + slope gradient (102.5) + rainfall (28.5) + soil (10) = 700

Based on the given value following calculations are made using the formula,

$$\left(\frac{\Sigma(X \times Y)}{\Sigma(\Sigma(X \times Y))}\right) \times 100$$

where X is weight and Y is rate. The concerned score for each influencing factor was divided equally and assigned to each reclassified factor (Table 3). The percentage of factor effect on the recharge potential capacity is as follows,

= lineament = $\frac{60}{700}$ x 100 = 9%

Table 3. Weight evaluations of factors influencing recharge potential capacity

Factor	Descriptive scale	Weight (X) (1-30)	Rate (Y) (1-4)	Weighted rating (X xY)	Total Σ(X x Y)	Factors on recharge potentiality capacity in %
Lineament density	Very High	13	2	26	60	9
	High	9		18		
	Moderate	6		12		
	Low	2		4		
Land-use	Very High	22	3.5	77	290.5	42
	High	20		70		
	High - Moderate	15		52.5		
	Moderate	10		35		
	Moderate - Low	8		28		
	Low	5		17.5		
	Very Low	3		10.5		
Geology	High	20	4	80	180	26
	Moderate	15		60		
	Low	10		40		
Drainage density	High	9	1.5	13.5	28.5	4
	Moderate	6		9		
	Low	3		4.5		
	Very Low	1		1.5		
Slope gradient	High	16	2.5	40	102.5	15
	High - Moderate	12		30		
	Moderate	8		20		
	Low	4		10		
	Very Low	1		2.5		
Rainfall	High	9	1.5	13.5	28.5	4
	Moderate	6		9		
	Low	3		4.5		
	Very Low	1		1.5		
Soil	High	4	1	4	10	1
	Moderate	3		3		
	Low	2		2		
	Very Low	1		1		
Grand Total					700	100

$= \text{land use} = \frac{290.5}{700} \times 100 = 42\%$

$= \text{lithology} = \frac{180}{700} \times 100 = 26\%$

$= \text{drainage density} = \frac{28.5}{700} \times 100 = 4\%$

$= \text{slope gradient} = \frac{105.5}{700} \times 100 = 15\%$

$= \text{rainfall} = \frac{28.5}{700} \times 100 = 4\%$

$= \text{soil} = \frac{10}{700} \times 100 = 1\%$

Grand total percentage = 9 + 42 + 26 + 4 + 15 + 4 + 1 = 100%

The final map obtained from each factor was considered as layer. The overlapping of these layers, each with its own weight together in a GIS system, resulted in different polygons of special characteristics with respect to the overall recharge potential of the area. After considering rate assessment, the ESRI'S Arc view software was applied to manipulate the data, through superimposing of the different layers of recharge potential after considering the weight rate assessment.

Finally, recharge potential zone map was prepared and divided into three descriptive levels (Fig.11). The descriptive levels are 'high', 'moderate', and 'low' occupying areas of 10%, 65%, 25% respectively. The resulting map was compared with the obtained standards by the UN (1967) and these levels are categorized (see Table 4).

The resulting measures revealed optimistic values of recharge potential. However, a quantitative estimation of recharged water to sub-surface media in Tuticorin, a

Table 4. Recharge potential categories and their quantitative estimation

Recharge potential category	High	Moderate	Low
Estimate according to FAO (1967)	>30%	10-30%	5-10%
Average % from the study area	65%	25%	10%
Area Extant (Km^2)	99.81	38.94	15.25

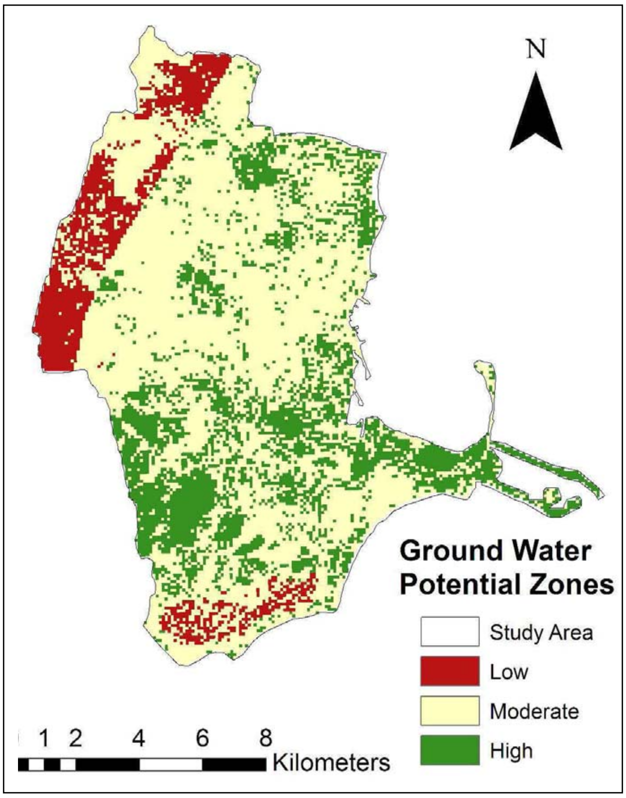

Fig.11. Groundwater recharge potential zones map of the study area

simplified calculation for the proposed recharges rates (adapted from UN 1967). The estimation of recharged water volume (W) will be calculated by the following formula,

$$W = P \times R \times \% A$$

where, W = Recharge water volume;P = Preciptated volume; R = Recharge ratio; % A = Percentage of the area

$$W = 1350 \times 10^4 (0.252 \times 0.25 + 0.648 \times 0.65 + 0.09 \times 0.10)$$

$$W = 1350 \times 10^4 (0.063 + 0.4212 + 0.009)$$

$$W = 1350 \times 10^4 (0.4932)$$

$$W = 665.82 \text{ X } 106 \text{ m}^3/\text{year}$$

From this study, we can conclude that 49% of the received precipitation percolates downward to recharge the aquifer, and the rest of the precipitation goes as surface runoff or evapotranspiration.

CONCLUSION

As Remote Sensing and GIS techniques have proven their credibility in the management of natural resources, an attempt has made to prepare groundwater potential zone and artificial recharge sites of the study area. These techniques have been used to integrate various thematic maps viz., lithology, slope, land-use, lineament, drainage, soil and rainfall, which plays important role in the occurrence, quality and movement of groundwater in the area. The various thematic maps were assigned with different weightage of numerical value to derive groundwater potential area. The weightage values assigned are brought into the raster function of spatial analyst for integration of influencing factor. These factors have an increasing or decreasing effect on recharge potential, but each of them has its own weightage values that must be created for factor integration. The resulting map shows that about only 10% of Tuticorin coastal terrain with high recharge potential and the rest 90% has moderate to low recharge potentiality. Whereas, the low effective recharge potential zones (25%) falls in the northwest portion. 49% of the total precipitation water (665.82 x 106 m^3/year) is infiltrated downward to recharge the groundwater, while the rest is lost either as evapo-transpiration or surface run off.

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