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Identification of Groundwater Prospects zones in T. Narasipura Taluk, Mysore District, Karnataka State Using Remote Sensing & Geographic Information System

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Abstract:
In the view of Groundwater prospects study remote sensing and geographic information system is very useful to delineate groundwater potential zone map of T. Narasipura taluk. Various themes of information such as geology, slope, drainage density, geomorphic units and lineament density are generated using satellite images of Indian Remote Sensing (IRS) 1C and 1D PAN+LISS merged data of Year 2005 (26 mtrs resolution), were overlaid on SOI toposheets, on 1:50,000 scale, constructed through visual interpretation using Arc Map (V 10.30) and Eradas Imagine 9.2 These themes were overlaid to generate groundwater potential zone (GWPZ) map of the area. The final map of the T Narasipura taluk shows the seven different zones of groundwater prospects namely, Very good to Good, (199 km^2) Good, (19.6 Km^2) Good to Moderate, (166.11 km^2) Moderate, (157.5 km^2) Moderate to poor,(9.8 km^2) poor (1.09 km^2) and Poor to Nil.(5.78 km^2).

Keywords: *Remote sensing, GIS, T.Narasipura, Groundwater Potential zonation, Lineaments.*

1. INTRODUCTION

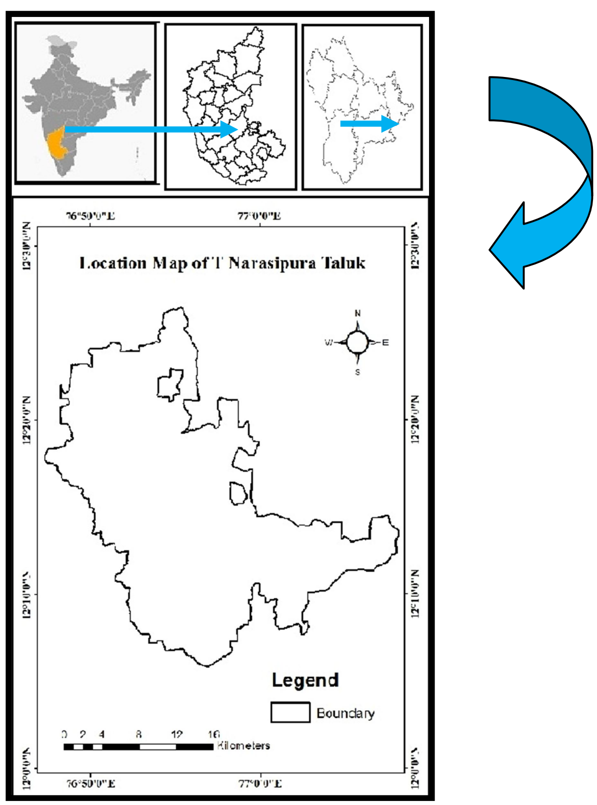
Groundwater is the one of the most natural resource it supports human health and ecological diversity (Waikar & Nilawar, 2014). Protecting it from contamination and carefully managing its use will ensure its future as an important part of ecosystems and human activity. The rate of groundwater flow is controlled by two properties of the rock: porosity and permeability. The main sources of groundwater recharge are precipitation and flow of discharge includes effluent seepage into the streams and lakes, springs, evaporation and pumping. It is estimated that approximately one third of the world's population use groundwater for drinking (Jose, Jayasree, Kumar, & Rajendran, 2012). Groundwater is the source for irrigation and domestic purpose. In which 80% of the rural areas are use groundwater for domestic purpose and 50% of the urban areas use the groundwater for domestic purpose. Due to more dependent on usage of groundwater for domestic purpose and irrigation and for other sectors may results in exploitation of groundwater resources (Shakak, 2015).

Remote sensing data combined with Geographical Information System (GIS) technique is very efficient in identification of groundwater potential of any region. The study results that the integration of thematic maps prepared from remote sensing techniques using GIS gives more and accurate results (Jose et al., 2012). Groundwater is available when water infiltrates below the earth surface and soil beneath the earth surface is porous (Sayeed, Hasan, Hasnat, & Kumar, 2017).

Identification of groundwater occurrence location using remote sensing data is based on indirect analysis of directly observable terrain features like geological structures, geomorphology, and their hydrologic characteristics. Also lineaments play significant role in Groundwater exploration in all type of terrain. Application of GIS and RS can also be considered for multi criteria analysis in resource evaluation and hydrogeomorphological mapping for water resource management. The use of remote sensing and GIS tools to extract detailed drainage, slope and geomorphic features in the study area suggests appropriate methods for groundwater potential zone studies.

2. STUDY AREA

Tirumakudalu Narasipura commonly known as T. Narasipura or T.N. Pura is one of the Taluks in Mysore District of Karnataka State. It lies in the East part of Mysore district. It is bounded by Malavalli in East, Kollegal in south, Mysore and Nanjangud in west. And Shrirangapattana in north It Consists of 5 Hobli's namely Kasaba, Sosale, Talakadu, Bannur and Muguru. The study area lies in between 76^0 47′ 52′′ to 77^0 08′ 03′′ East longitude 12^0 07′ 43′′ to 12^0 26′ 33′′ North latitude **(Map.1).** With geographically total aerial extent of 599.66 km^2 comes under the survey of India (SOI) toposheets no 57D/15, 57D/16, and 57H/4, The area is accessible by good road network. It is connected by national highways NH 948 which start from T narasipura - via Malavalli, maddur and ramanagara the nearest railway station is Mysore.

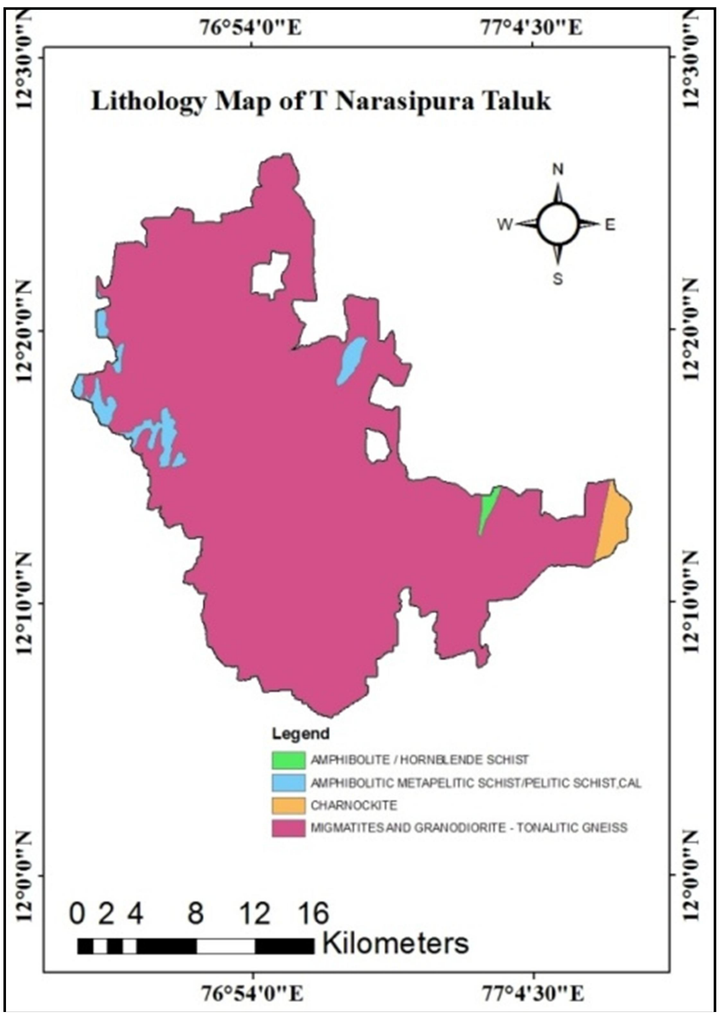


Map 1: Location Map

3. DATA USED AND METHODOLOGY

The survey of India toposheets 57D/15, 57D/16, and 57H/4 have been used as base maps. Digitized using satellite images of Indian Remote Sensing (IRS) 1C and 1D PAN+LISS merged data (26 mtrs), were overlaid on SOI toposheets, on 1:50,000 scale, constructed through visual interpretation using Arc Map (V 10.30) and Eradas Imagine 9.2, and association patterns. GIS and remote sensing technology is applied to prepare various thematic maps Preparation of digital elevation model (DEM) by interpolating contour map that is digitized from SOI toposheets. DEM is used to prepare slope, aspect, flow accumulation and stream order. Methodology is widely used for preparing runoff potential map for small to medium size engaged drainage basin. All the thematic layers will overlay by using GIS to find the final integrated output of groundwater potential zones in the present study, geomorphology, slope, drainage density, Land use/land cover, geology and lineament density are considered for the identification of groundwater potential.

4. GEOLOGY OF THE STUDY AREA:



Map 2: Lithology map

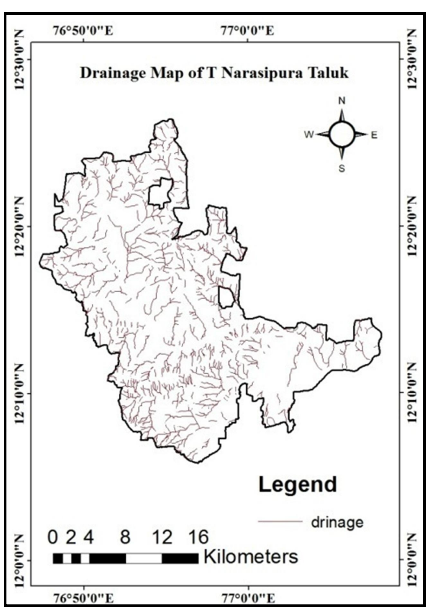
Table 1: Distribution of Lithology of T. Narasipura taluk in sq km and percentage

Sl No.	Description	Area in Sq kms	%
1	Amphibolite / Hornblende schist	1.85	0.3
2	Migmatites and Granodiorite - Tonalitic gneiss	575.9	96.02
3	Amphibolitic Metapelitic schist/Pelitic schist	14.91	2.49
4	Charnockite	7	1.19
Total	**599.66**	**100**	

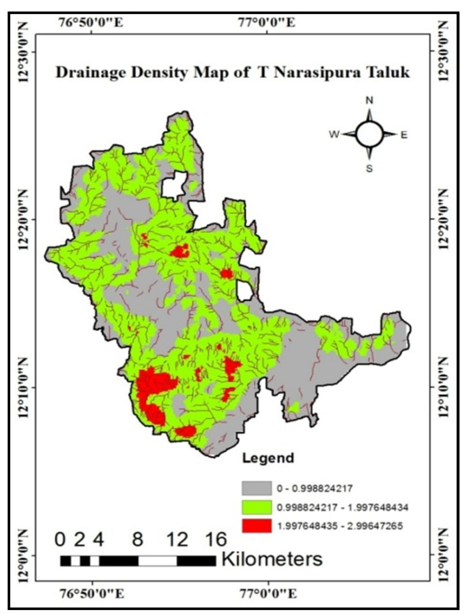
Geologically the study area falls in Archean age of metamorphic terrain. The major rock types are noticed in Migmatites and Granodiorite - Tonalitic gneiss, it covers geographically around 575.9 km2 (96.02%). Mineralogicaly tonalite is igneous plutonic rock; in felsic composition with phaneritic texture feldspar is present plagioclase with 10% or less alkali feldspar. Quartz is present as more than 20% other rock type amphibolites or Hornblende schist 1.85 km^2 (0.3%). Amphibolites Metapelitic schist/Pelitic schist 14.91 km^2 (2.49%) and charnockite covers an area of 7 km^2 (1.19%) **(Map no.2 Table.1)**

5. DRAINAGE AND DRAINAGE DENSITY MAP

Drainage map consists of rivers, tributaries, perennial & ephemeral streams. The study area is fourth order basin joining the rivers, tributaries based on topography. Drainage density is the total length of all the streams and rivers in a drainage basin divided by the total area of the drainage basin. Drainage density depends upon both climate and physical characteristics of the drainage basin. Low drainage density is more likely to occur in region and highly resistant of highly permeable subsoil material under dense vegetative cover and where relief is low. High drainage density is the resultant of weak or impermeable subsurface material, sparse vegetation and mountainous relief. Low drainage density leads to coarse drainage texture while high drainage density leads to fine drainage texture. The drainage density characterizes the runoff in an area or in other words, the quantum of relative rainwater that could have infiltrated. Hence the lesser the drainage density, the higher is the probability of recharge or potential groundwater zone. The study area drainage density map is divided in to 3 classes shown in **(Table.2 Map.3 and Map.4)**



Map 3: Drainage map



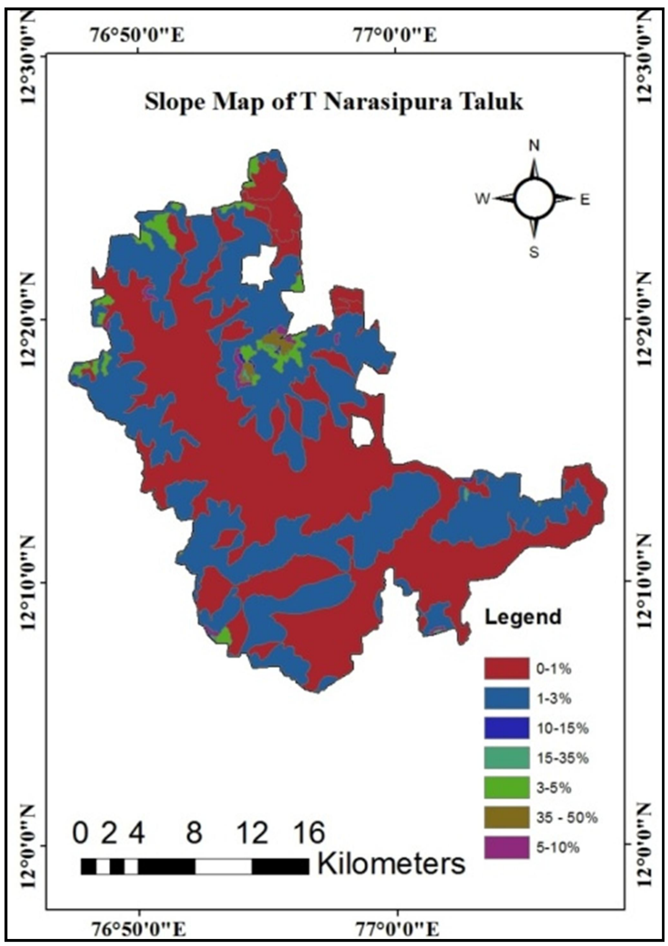
Map 4: Drainage Density Map

Table 2: Drainage density classes

Class	Km/Km^2	Drainage Density Classes
1	0.99	Low
2	0.99 – 1.99	Medium
3	1.99 – 2.99	High

6. SLOPE

Slope is a measurement of steepness from the ground surface. The slope map has been prepared from Survey of India (SOI) Toposheets on 1:50,000 scales based on the guidelines of All India Soil (AIS) and Land use Survey (LUS, 1995) slope class between 0-50 percent. On the basis of slope classes the area can be divided in to seven slope classes. **(Table. 3 Map .5)** namely 0-1%, 1-3%, 3-5%, 5-10%, 10-15%, 15-35% and more than 35 %. Most parts of the study area have slope within the range of 0-1% to 3-5%. Shows lower slope is good for groundwater as run off. While hilly region steeper slopes are not good for groundwater. The slope of the area has a large impact on the amount of water infiltration into the ground and amount of water lost as run off.



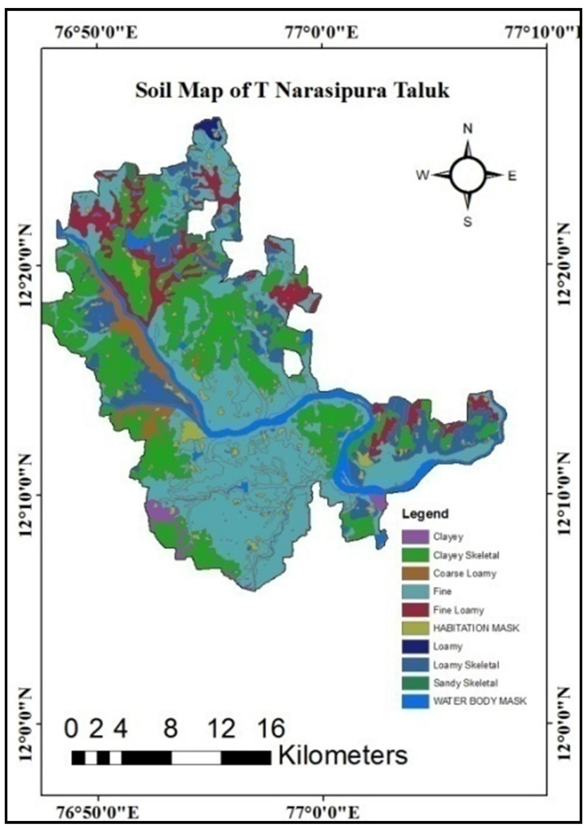
Map 5 slope Map

Table 3: Slope class and area

Sl No.	Slope class	Area in Sq kms	%
1	0-1%	315.11	52.54
2	1-3%	262.94	43.84
3	3-5%	13.99	2.3
4	5-10%	3.36	0.56
5	10-15%	0.87	0.1
6	15-35%	0.78	0.01
7	35-50%	2.61	0.65
Total		**599.66**	**100**

7. SOIL MAP OF THE STUDY AREA:

Soil plays an important role in groundwater recharge and run-off. The water holding capacity of the area depends upon the soil types and their permeability. The soil in this region is often divided into clay loam, Gravelly loam, Gravelly sand, Gravelly sandy clay, Gravelly loamy sand, Gravelly sandy loam, Clay, Loamy sand, Sand, Sandy clay, Sandy clay loam and sandy loam. On the basis of soil texture, major part is covered by gravelly and sand soil (**Map.6 Table.4)**. Sand and Sandy loam soil is very good water holding in view of groundwater.



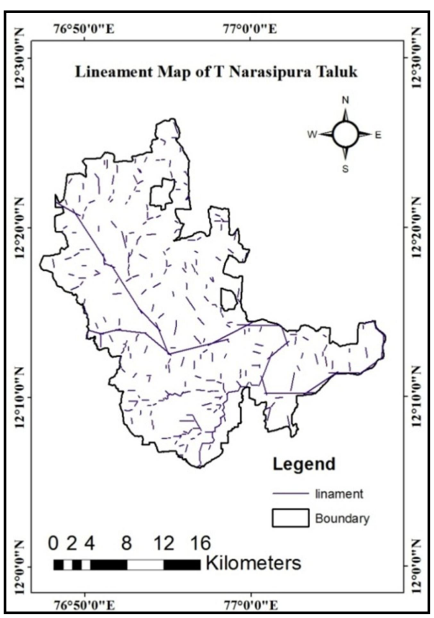
Map 6: Soil map

Table 4: Soil types and area in sq kms and percentage

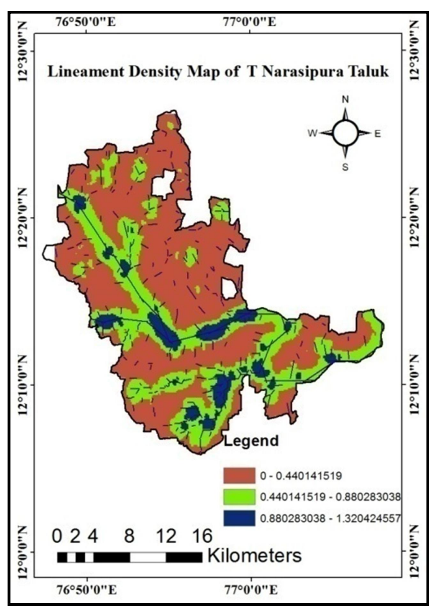
Sl No.	Soil types	Area in Sq kms	%
1	Clay loam	2.49	0.4
2	Gravelly loam	8.17	1.3
3	Gravelly sand	2.09	0.34
4	Gravelly sandy clay	1.54	0.25
5	Gravelly loamy sand	22.74	3.78
6	Gravelly sandy loam	69.04	11.51
7	Habitation mask	19.94	3.32
8	Water body mask	40.48	6.75
9	Clay	143.69	23.96
10	Loamy sand	70.95	11.83
11	Sand	24.13	4.02
12	Sandy clay	33.29	5.55
13	Sandy clay loam	50.2	8.4
14	Sandy loam	110.91	18.59
Total		**599.66**	**100**

8. LINEAMENT AND LINEAMENT DENSITY

Lineaments map was prepared by using satellite imagery, geological maps. Lineament can be defined as linear or curvilinear geomorphic and tectonic structural features representing discontinuity of the area (El Hadani, D., 1997). Lineaments are the result of topographic depression, subsurface anomaly, anomalies of vegetation and hydro-system (Kassou at al., 2012). Lineament density map is a measure of quantitative length of linear feature expressed in (Km/Km2). Lineament density of an area has direct influence on groundwater prospectiveness of that area. In present study area with high lineament density (1.6-2.4) having good groundwater potential where as area with very low lineament density (0-0.8) having poor groundwater potential. The entire map classified in three categories **(Table.5 Map 7 & 8)**



Map 7: Lineament map



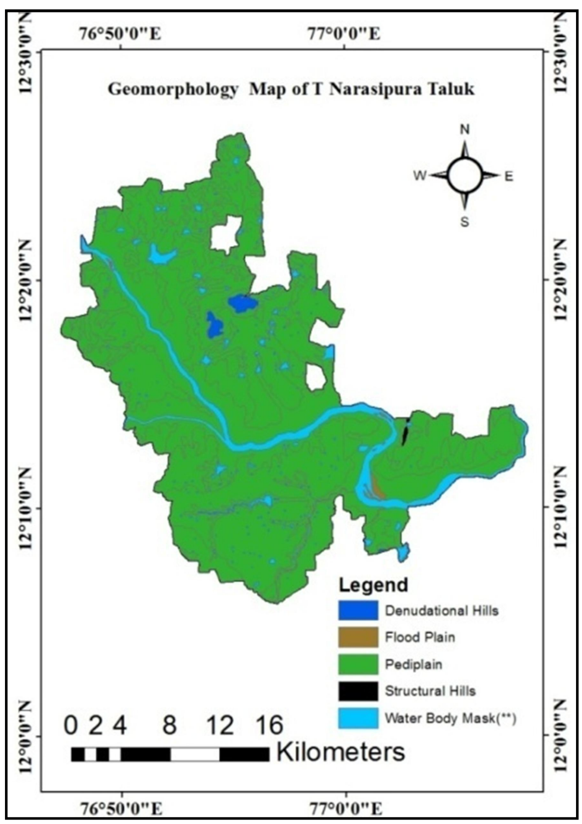
Map 8: Lineament density

Table 5: Lineament density Category

Class	Km/Km2	Lineament density category
1	0-0.44	Low
2	0.44- 0.88	Medium
3	0.88-1.32	High

9. GEOMORPHOLOGY

Geomorphology is the scientific study of landforms and landscapes. It is closely related to soil science, hydrology, geology and environmental science, Geomorphology of an area depends upon the structural evolution of geological formation. Geomorphology reflects various land form and structural features. Many of the features are favourable for the occurrence of groundwater and classified in terms of groundwater potentiality. The geomorphic units of the basin can be divided into five categories namely Flood Plain, denudational hills, Structural hills, Pediplain, and Water body mask. **(Map.9 Table.6)** major portion of the area covers pediplain. The pediplain is characterized by a gently undulating to flat topography occupies 552.24 sq kms (92.45%) of the study area and this zone act as good infiltration zones **(As per CGWB, 2012 report)**



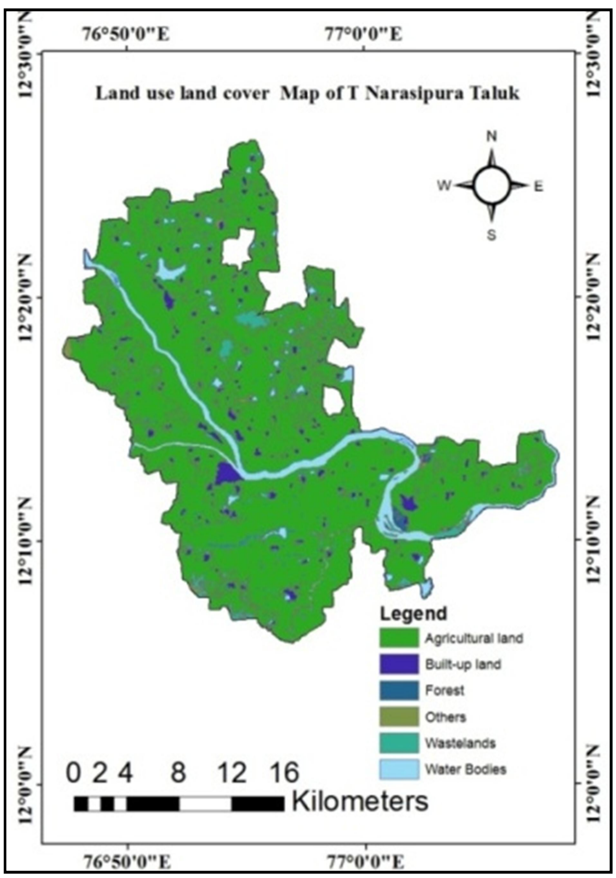
Map 9: Geomorphology Map

Table 6: Geomorphological features in sq kms and percentage

Sl no	Description	Area in Sq kms	%
1	Flood Plain	1.87	0.32
2	Denudational Hills	4.5	0.9
3	Structural Hills	0.62	0.1
4	Pediplain	552.24	92.45
5	Water Body Mask(**)	40.43	6.23
Total			

10. 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. The study area covering an area of 527.1 sq kms agricultural land, 20.08 sq kms built up land, 1.74 sq kms forest, 9.85 sq kms waste land 39.05 sq kms water bodies (Map.10 Table.7)



Map 10: Lulc map

Table 7: Land use land cover class in sq kms and percentage

Sl no	**Description**	**Area in Sq kms**	**%**
1	Agricultural land	527.1	87.9
2	Built-up land	20.08	3.3
3	Forest	1.74	0.3
4	Wastelands	9.85	1.64
5	Others	1.84	0.3
6	Water Bodies	39.05	6.56
Total		**599.66**	**100**

11. WEIGHTAGE OVER ANALYSIS

The groundwater potential zones are obtained by overlaying all the thematic maps in terms of weighted overlay method using the spatial analysis tool in Arc GIS 10.30. During the weighted overlay analysis, the ranks have been given for each individual parameter of each thematic map and the weight is assigned according to the influence of the different parameters. The weights and rank have been taken considering the works carried out by researchers such as (Krishnamurthy et al 1996, Saraf & Chowdhary 1998).

All the thematic maps are converted into raster format and superimposed by weighted overlay method (rank and weight wise thematic maps and integrated with one another through GIS (Arc/Info grid environment).For assigning the weight, the slope and geomorphology were assigned higher weight, whereas the lineament density and drainage density were assigned lower weight. After assigning weights to different parameters, individual ranks are given for sub variable. In this process, the GIS layer on lineament density, geomorphology, and slope and drainage density were analyzed carefully and ranks are assigned to their sub variable (Butler et al., 2002, Asadi et al., 2007, Yammani, 2007).

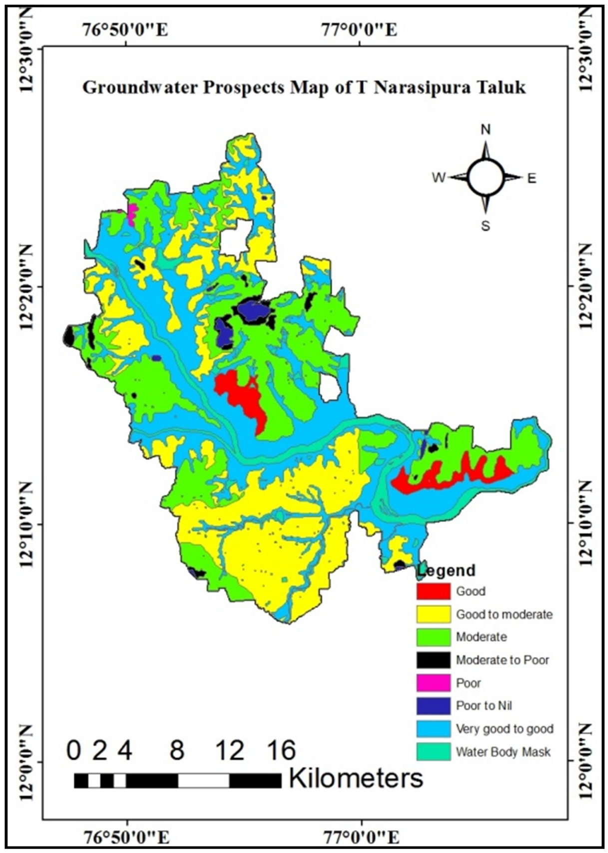
The maximum value is given to the feature with highest groundwater potentiality and the minimum value given to the lowest potential feature. The landforms such as pediplain given highest rank and lower value are assigned for denudational hill. As far as slope is concerned, the highest rank value is assigned for nearly slope and low rank value is assigned to Precipitous slope. The higher rank factors are assigned to low drainage density because the low drainage density factor favours more infiltration than surface runoff. Lower value followed by higher drainage density. Among the various lineament density classes the very high lineament density category is assigned higher rank value as this category has greater chance for groundwater infiltration. Lower value is assigned for very low lineament density. In Lu Lc high rank is assigned to crop land and low value is assigned to waste land.

Table 8: Rank and weight for different parameter of groundwater potential zone

Parameter	Classes	Groundwater prospect	Weight (%)	Rank
eomorphology	Denudational Hills Dissected pediment Flood plain Pediment inselberg complex Pediplain eroded Pediplain weathered / buried Residual hill Structural hill	Nil Moderate Good Moderate Good Very good Poor Poor	30	1 3 4 3 4 5 2 2
Slope Classes	Nearly slope 0-1% Slightly sloping 1-3% Gently Sloping 3-5% Moderately Sloping 5-10% Strong Sloping 10-15% Moderately steep to steep 15-35% Precipitous sloping > 35%	Very Good Good Moderate Moderate to poor Poor Poor Nil	20	5 4 3 2 1 1 0
Drainage density (Km/Km2)	0-1.5 1.5- 3 3-4.5 4.5- 6	Very Good Good Moderate Poor	10	5 4 3 1
Lineament density (Km/Km2)	0-0.8 0.8-1.6 1.6-2.4	Poor Good Very Good	15	1 4 5
Land use/ land cover	Agricultural land Built-up land Forest grass/ grazing land others waste land water bodies	Very Good Poor Moderate Poor Poor Poor Good	15	5 1 3 1 1 1 4
Geology	Charnockite Epidote / Hornblende gneiss Magnatite quartzite Migmatites and granodiorite - tonalitic gneiss Pink granulite Pyroxene granulite	Moderate Moderate Moderate Moderate Moderate Moderate Moderate	10	3 3 3 3 3 3 3

8. CONCLUSION

Remote sensing and Geographic Information System (GIS) approach is very constructive because this integrates various geospatial information especially for groundwater potential zone mapping. Study has focused on the effectiveness of remote sensing and GIS in the identification of groundwater potential zones of study area. The study reveals that integration of seven thematic maps such as drainage density, slope, geology, geomorphology, lineament density, soil and land use/land cover gives first hand information to local authorities and planners about the areas suitable for identification of groundwater potential zone. The present study area is classified in to Very Good to Good, Good, Good to Moderate, Moderate, Moderate to Poor, Poor and Poor to Nil groundwater potential zones **(Map.11 As per Table 7 and 9)**, it can be seen that the Area having slope 0-1% to 3-5%. lineament density 0.88 to 1.32, drainage density 0 to 0.99 under pediplain and cover with agricultural land is observed as Very good to Good groundwater potential zone and covers an area of 199 sq kms. 19.6 sq kms covers good, 166.11 sq kms covers good to moderate, 157.5 sq kms covers moderate, 9.8 sq kms covers moderate to poor, 1.09 sq kms covers poor and 5.78 sq kms covers poor to nil



Map.11 Groundwater prospects

Table 9: Distribution of Groundwater Prospects area in sq.km and percentage

Sl No.	Description	Area in Sq kms	%
1	Good	19.6	3.2
2	Good to moderate	166.11	27.71
3	Very good to good	199	33.2
4	Moderate to Poor	9.8	1.6
5	Poor to Nil	5.78	0.95
6	Poor	1.09	0.18
7	Moderate	157.5	26.36
8	water body mask	40.43	6.8
Total		**599.31**	**100**

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