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# SELECTION OF ARTIFICIAL RECHARGE STRUCTURES USING GIS AND GEO PHYSICAL METHOD IN NELAMANGALA AREA BENGALURU RURAL DISTRICT

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***Abstract***- *Ground water, which is the source for more than 85 per cent of India's rural domestic water requirements, 50 per cent of its urban water requirements and more than 50 per cent of its irrigation requirements is depleting fast in many areas due to its large-scale withdrawal for various sectors. For example, out of a total of 5723 assessment units (Blocks/Mandals/Talukas) in the country, 839 have been categorised as ‗Overexploited ‗as assessed on 31st March 2004, with ground water extraction in excess of the net annual recharge. There are also 226 ‗Critical' assessment units where the ground water draft is between 90 and 100 per cent of the annual replenishment, apart from 30 blocks having only saline ground water (CGWB, 2006).*

*There have been continued efforts in India for development of ground water resources to meet the increasing demands of water supply, especially in the last few decades. In certain high demand areas, ground water development has already reached a critical stage, resulting in acute scarcity of the resource.*

***Key Words*-Watersheds, Rainfall Data, Remote Sensing, GIS, GPS, Ground Water etc**

## 1. INTRODUCTION:

Ground water is important natural resources in present day, but of limited use due frequent failures in monsoons, undependable surface water and rapid urbanization and industrialization have created a major threat to these valuable resources. A ground water development program needs a large volume of multidisciplinary data from various sources .In order to ensure a judicious use of ground water, its proper evaluation is required for optimal utilization. With ground water occurrence being a subsurface phenomenon, its identification and location are based on indirect analysis of some direct observable terrain features like geology, geomorphology and their hydrologic characters in the last few decades, Remote sensing and Geographical information system techniques have been used in different fields of sciences in which it provides an opportunity for better observation and more systematic analysis of various identification and demarcation of ground water resources.

The occurrence, origin and movement of ground water depend mainly on geologic framework, i.e., lithology, thickness, structures and permeability of aquifers. Ground water in hard rock aquifers is essentially confined to fractured or weather horizons.

### 1.1 CLASSIFICATION OF WATERSHED:

Watershed is a natural hydrological entity from which surface runoff flows to a defined drain, channel, stream or river at a particular point. It is also defined as topographically delineated area that is drained by a stream system and is characterized by a common outlet through which excess overland flow collected within the watershed is drained out. A large numbers of terms are very frequently and loosely used to classify watershed in different sizes [based on size].

a. Micro watersheds

b. Small watersheds

c. Large watersheds

a. Micro watersheds:

―The smallest hydrologic unit in the hierarchal system is termed as Micro watershed‖.

b. Small watersheds:

―Small watersheds are those where the overland flow is the main contributor to peak runoff / flow and channel characteristic do not affect the overland flow‖.

c. Large Watersheds:

―Large watersheds are those give peak flows are greatly influenced by channel characteristics and basin storage‖.

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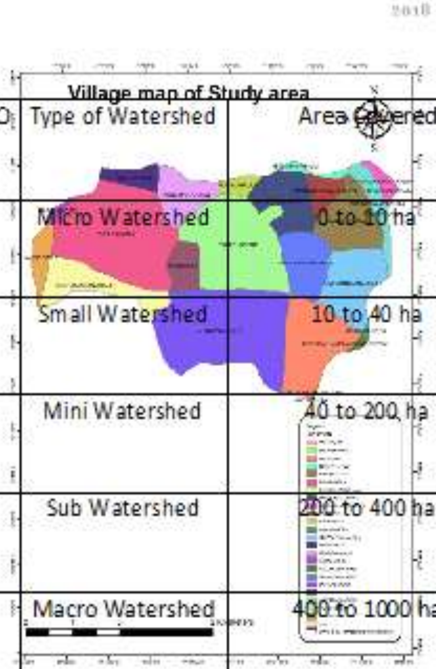
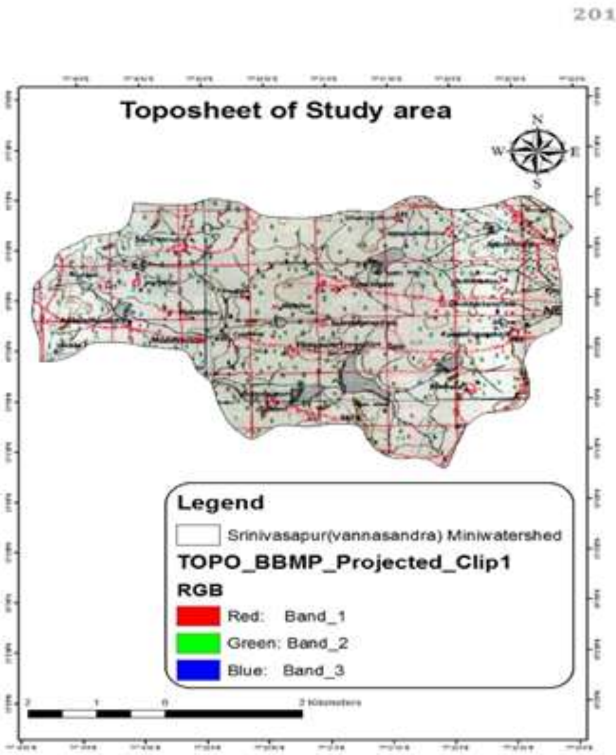
**TABLE 1: Watersheds are also classified into different categories based on area that the watersheds contain:**

| Serial NO | Type of Watershed | Area Covered |
|---|---|---|
| 1 | Micro Watershed | 0 to 10 ha |
| 2 | Small Watershed | 10 to 40 ha |
| 3 | Mini Watershed | 40 to 200 ha |
| 4 | Sub Watershed | 200 to 400 ha |
| 5 | Macro Watershed | 400 to 1000 ha |
| 6 | River basin above | 1000 ha |




**1.2 LOCATION AND ACCESSIBILTY OF STUDY AREA:**

- Bangalore district is located in the south-eastern part of Karnataka state. Bangalore is the district headquarters and also capital of the state.
- Bangalore Rural district is located in the south-eastern part of Karnataka state between the north latitude 12° 15‘ and 13° 31‘ and East longitude 77° 04‘ and 77° 59‘, covering parts of the toposheets 57 G and H.
- Bengaluru Rural consists of eight taluks viz., Channapatna, Devanahalli, Doddballapura, Hoskote, Kanakapura, Magadi, Nelamangala and Ramanagaram.
- The district is bounded by Kolar and Tumkur district in the north, Mandya district on the west, Chamarajanagar district on the south and towards southeast by TamilNadu state.
- Bangalore district is well served by road railway and airways. The National Highways passing through the district is connecting the state capital with other major cities like Hyderabad, Pune and Chennai.
- The interior villages are well connected by metalled roads. Bangalore district is also well served by Railways. The railway line connects Bangalore to New Delhi, Hyderabad Bombay and Chennai.
- Nelamangala is located on NH-4, around 27 km away from Bangalore city towards Tumkur and Mumbai. The convenient, fastest and cheapest way to reach from Nelamangala to Bangalore is to take a taxi from Nelamangala to Bangalore.
- The central northern and eastern portion of the district consists of vast stretches of undulating plains.
- The uplands are bare or covered with scrub jungles, whereas low lands are covered with a series of irrigation tanks.
- A range of valleys are formed of clay, sandy loam and Gneisses rock, which is a prominent physiographic feature.

**1.3 AIM AND OBJECTIVES OF PRESENT INVESTIGATIONS:**

The basic aim of present study is to conduct the remote sensing, GIS and Geophysical method in order to select the suitable sites for artificial recharge zones with an integrated approach of remote sensing ,GIS and

Geophysical approach techniques which are followed by these objectives.

1. Use of Remote Sensing, GIS and Geophysical techniques in ground water recharge investigations in the sub watershed.

2. To prepare the ground water potential zone map in sub watershed.

3. To know the inter-relationship of recharge areas with geology, geomorphology, soils and structures of the sub watershed.

4. To suggest suitable sites and methods for artificial recharge to augment ground water recharge with village tank, Nala bund, check dams etc in the sub watershed.

**1.4 LITERATURE REVIEW:**

In this chapter, the available and relevant literature pertaining to the Project study on Evaluation of Ground Water Potential Zone in Sub-Watershed. India Remote Sensing and GIS Approach has been reviewed and presented on the following headlines.

- Land use Land Cover
- Soil
- Geomorphology
- Drainage
- Lithology
- Slope
- Aspect
- Lineament
- Surface Contour
- Ground Water Contour
- Isohyetal

**Pradeep K Jain (1998)** found out in his study of ground water prospecting in upper Urmil river basin of Chotanagpur, central India classified into 3 zones namely good to very good, moderate to good and poor. Finally he reported that lineaments, particularly -joints, frctures and their intersections enhance the potential of the ground water in the region.

**Pankaj.K.Srivastava ,et.al,(2000),**in a study the ground water potential zones in a hard rock terrain of bargarh district, Orissa Using IRS-1B-LISS-ll digital data covering an area of about 680 sq km. The Geological – cum-lineaments, geomorphological, LU/LC and drainage maps are prepared and used for integration with the help of GIS and demarcate the poor to excellent ground water potential zones based on the weight age assessment.

**Kadam. A. K, et.al, (2012),** worked on groundwater prospect in the upper Karha watershed of Pune district of Maharashtra state in India using GIS with spatial reference to arc runoff. The spatial database layers like hydro-geomorphology, land use/land cover, soil, slope, geology were used. He concluded that the categorise of prospect zones are excellent (0.4%).

**2.1 REMOTE SENSING:**

Photographs of the earth taken from aircraft or satellite or various electromagnetic wavelength ranges can provide useful information regarding ground water conditions photo geology can differentiate between rock and soil types and indicate their permeability and areal distribution and hence ground water recharge and discharge.

Springs and nearby areas indicate relatively shallow depths to ground water. Phreatophytes, which transpire water from shallow water tables, defined depths to ground water halophytes plants with high tolerance for soluble salts and white effloresce at ground surface indicate the presence of shallow brackish or saline ground water. The major elements of remote sensing are Data acquisition and Data processing and analysis.

**2.2 GEOPHYSICAL EXPLORATION:**

Geophysical exploration is the scientific measurement of physical properties of the earth crust for investigation of mineral deposits or geologic structures. Most commonly measured are density, magnetism, electricity and electrical resistivity. They are in exact and difficult to interpret but can provide useful information in locating the ground water.

Geophysical survey is therefore one of the sub-methods under the surface method of groundwater exploration. This method is very important for both groundwater resource mapping and water quality evaluations. Its application for groundwater exploration purposes has increased over the last few years due to the rapid advances in computer packages and associated numerical modelling solutions.

**2.3 ELECTRICAL RESISTIVITY METHOD:**

Electrical resistivity of the solid rock strata limits the amount of current passing through the formation when an electric potential is applied. It is the resistance between opposite faces of a unit cube of a material. Resistivity of rock formations vary over wide range depending on the material density, porosity, pore size and shape, water content and quality, temperature.

When saturation zone is met the resistivity falls rapidly due to good conductance of water present. This method is popular and widely followed.

**3. GEOGRAPHIC INFORMATION SYSTEM:**

A GIS is an information system designed to work with data referenced by spatial/geographic coordinates. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information system and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes and planning strategies.

A GIS is a computer based system which is used to digitally reproduce and analyze the feature present on the earth's surface and the events that take place on it. GIS constitutes of five key components viz., Hardware, Software, Data, People and Method.

**The Advantages of the GIS are:**

The Geographic Information system has been an effective tool for implementation and monitoring of municipal infrastructure. The use of GIS has been in vogue primarily due to the advantage mentioned bellows:

- Planning of project
- Make better decisions
- Visual Analysis
- Improve Organizational Integration

**Arc GIS 3.1:**

The ArcGIS 9.3 version we organize and edit data stored in a geodatabase, prepare data for analysis, create and edit geoprocessing models using ModelBuilder, and work through a challenging analysis project.

- Add data from different sources to a geo database.
- Work with subtypes to edit data.
- Edit and validate feature geometry and attributes using geodatabase topology.
- Run analysis tools using dialog boxes and models.
- Build a complex model using Model Builder.

- **Getting data into the geo database**: Advantages of migrating data to the geodatabase; File and personal geodatabases; Loading and importing data; Data sources available for conversion; ArcToolbox conversion tools; Importing and exporting data in ArcCatalog; Importing and exporting data using XML; Copying and pasting data between geo databases; Batch and single conversions; Loading data into existing feature classes using the Simple Data Loader; Displaying X,Y coordinate data from a table; Accessing tabular data using an OLE DB connection; Adding data from a GIS server; Working with map projections and datum.

- **Editing GIS data**: Creating new data (digitizing, copying and pasting features, Editor menu commands); Constructing an edit sketch using constraints (direction, length, parallel); Creating adjacent polygons using the Auto-Complete Polygon task; Modifying existing features; Reshaping existing features and boundaries; Exploding multipart features; Editing using domains, subtypes, and topology.

**4. GPS:**

GPS is a satellite based navigation system. The present Navigation System with Timing and Ranging GPS was conceived as ranging system, from known positions of satellites in space to unknown positions on land, sea, air and space. It is 24 hour, all weather, and space based navigation system to accurately determine position, velocity and time in a common reference frame, anywhere on or near the earth on a continuous basis. The surveying and mapping community was one of the first to take advantage of GPS because it dramatically increased productivity and resulted in more accurate and reliable data. Today, GPS is a vital part of surveying and mapping activities around the world.

When used by skilled professionals, GPS provides surveying and mapping data of the highest accuracy. GPS-based data collection is much faster than conventional surveying and mapping techniques, reducing the amount of equipment and labour required. A single surveyor can now accomplish in one day what once took an entire team week to do.

GPS supports the accurate mapping and modelling of the physical world — from mountains and rivers to streets and buildings to utility lines and other resources. Features measured with GPS can be displayed on maps and in geographic information systems (GIS) that store, manipulate, and display geographically referenced data.

Governments, scientific organizations, and commercial operations throughout the world use GPS and GIS technology to facilitate timely decisions and wise use of resources. Any organization or agency that requires accurate location information about its assets can benefit from the efficiency and productivity provided by GPS positioning.

### 4.1 INVESTIGATION OF ARTIFICIAL RECHARGE STRUCTURES:

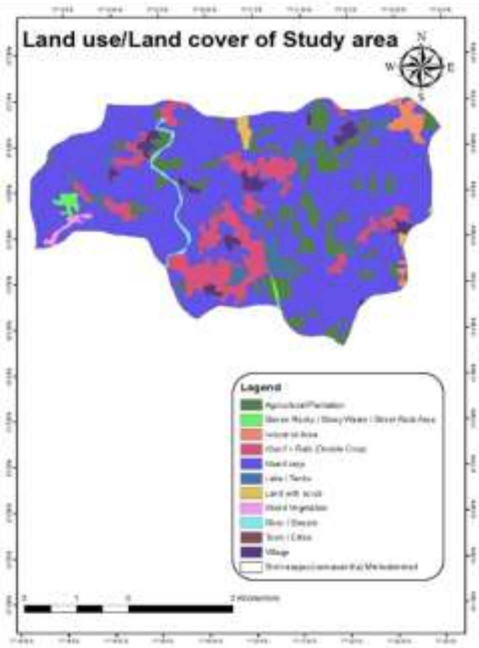
### 4.1.1 LAND USE / LAND COVER:

- The land use maps provide up to date information on the type, location, spatial distribution and extent of land use/land cover at district level.
- These maps and its pattern of change promotes to understand the presents and the past land utilization pattern.
- Up to date information regarding the kind of change is essential for proper land use planning.
- The gross average estimates provided under different categories of land use/land cover will be helpful to the departments like Agriculture, Irrigation , Revenue, forest and Environment, Stae Land Use Boards , Town and Country Planning, Afforestation etc.
- Drought assessment studies.
- Categories like Kharif, Rabi, Net sown area, Fallow and Plantation will be helpful in optimising agricultural planning and production.
- The land use maps can be used for subsequent updating of details on land utilization and their monitoring periodically.
- These maps assist various development programmes such as Waste land Development, Afforestation, Watershed, Fodder and fuel development.
- These maps will help in formulating proper land use policies for district level planning and contribute towards agro-climatic zone planning.
- The majority of the study area of the land use/land pattern map indicates that the regions major cover pattern is of Kharif crops.

### 4.1.2 GROUND WATER FLUCTUATION:

The ground water table is studied through observation Well data obtained from Department of Mines and Geology. 12 years data is collected from 2001-2012, of which 3 years interval is made. The water table fluctuation is observed in three cases i.e. pre-monsoon, monsoon and post-monsoon seasons. The graph shows that there is more fluctuation in between the 3 seasons which is measured in terms of Meters Below Ground Level (MBGL). The total number of Bore wells present in the study area is 1611 (YEAR: 2016-2017). The source of drinking water in the study area is maximum 70.5% using tap, 0.5% use well, 1.6% use Hand pump and 26.8% use Tube wells.

2018



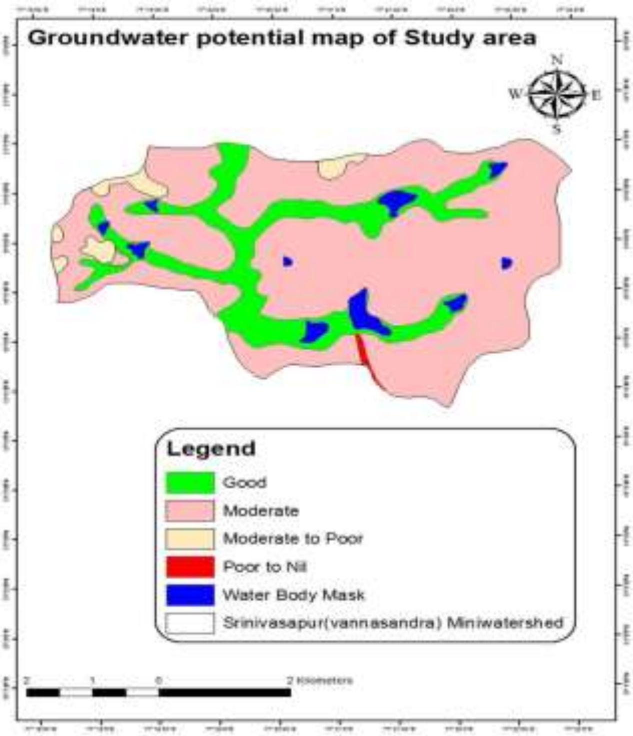

2018

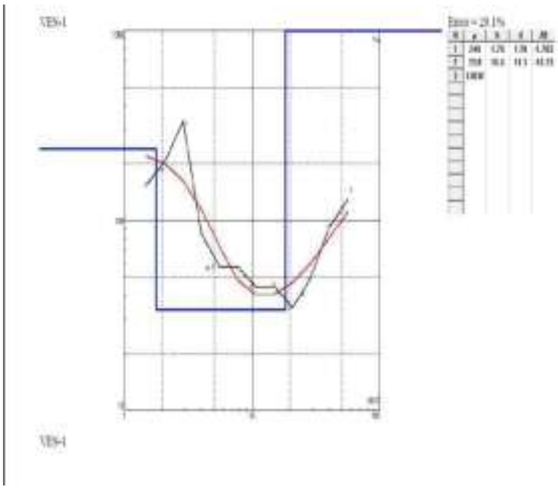
BOREWELL POINT

WELL NEAR THE WATERSHED REGION

### 4.7 GROUNDWATER POTENTIAL ZONE MAP:

The ground water prospect map of the Srinivasapura Sub-watershed area in Bangalore district reveals that potentially it varies from place to place w.r.t variations in the morphology, lithology, slope, porosity and permeability of litho-units, geological structures and present land use pattern. The Good Ground water potentiality covers an area of 4.75 sq.km, Moderate ground water potentiality area covers 19.6 sq.km. Poor ground water potentiality area covers about 710 sq.km and remaining area that is Very poor in run off zone, covers an area about 0.8055sq.km.



### VES DATA

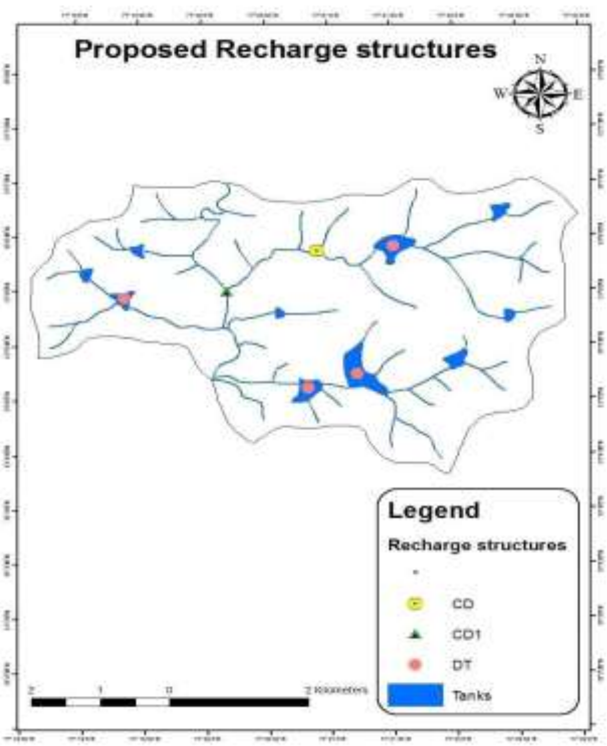
The Vertical Electrical Soundings were carried out at the selected areas. A total of eight VES points were surveyed. The UTM coordinates, i.e., Easting and Northing, of the sounding points were obtained with the help of a GARMIN II GPS receiver.

The Vertical Electrical soundings were made using the following equipment:

- Wires and Reels
- Stainless steel electrodes
- Accessories such as alligator clips and hammer

The Schlumberger electrode configuration with maximum half current electrode separation (AB/2) of 100 to 150 m was used for the sounding survey. Current is injected into the ground using two current electrodes, A and B, placed at a distance AB/2 apart; and the potential drop that occurs between two other electrodes, M and N, placed near the centre of the current electrodes is measured. The current electrode separation, AB/2, is progressively increased in steps so as to increase the depth of investigation, and at each step the measured current and potential readings are used to obtain the apparent resistivity of the ground.

### 4.9 PROPOSED RECHARGE STRUCTURES:




The proposed recharge structures such as check dams (CD) in the study area indicated by CD & CD1 lies in the region of Yalachigere and Hajipalya. The 2 check dams proposed in this region lies on the valley fill portion i.e, the drainage of the study area. These check dams are proposed based on the base maps which were prepared such as the lithological map, geomorphological and hydrological map and on the field observations. The visual interpretations of satellite image also were selected based on the field visits, incorporating of field observations and on the conduction of electrical resistivity. Incorporating of field observations, the base maps are overlaid and the details of VES data are analysed and are transferred into the proposed map. By this study, all possible sites in the study area were explored for the presence of ground water. The study could come to a positive conclusion, whereby potential areas for sustainable water supply were delineated. The water table of this terrain from the well is found and its texture is identified. The desiltation of tanks represented by DT needs to be desilted regularly to maintain the maximum water level in the tanks. By this water level in the check dams is not reduced. The check dams in study area represented by CD lies at a latitude of 77�0`54.034``E and a longitude of 13�`21.727``N. The CD 2 lies at a latitude of 77�0`10.42``E and a longitude of 13�`58.491``N.

### SUMMARY AND CONCLUSION:

Remote sensing and GIS tools are less time consuming and cost effective which provides sufficient support in ground water studies where the region lacks previous hydrological investigations and data. The Overall results demonstrates that remote sensing and GIS provide potentially powerful tools for studying ground water resources and designing a suitable exploration plan .The integrated map could be useful for various purposes such as sustainable development of ground water as well as identification of priority areas for implementation of water conservation projects and programmes in the area. The Remote sensing, Geophysical and GIS approach is very constructive because it integrates all geospatial information to delineate ground water potential zones. The proposed methodology, which is generic in nature and based on logical conditions and reasoning, can be useful for the other regions of the world as well. More interestingly the methodology is less expensive and more suitable for developing low income countries where advocate and good quality hydrogeological data are often lacking for ground water evaluation by data intensive Techniques.

### REFERENCES:

1. Md. Surabuddin Mondal. A.C.Pandey .R.D.Garg .Groundwater Prospects Evaluation Based on Hydro geomorphological Mapping using High Resolution Satellite Images .Indian Soc.Remote Sens. Vol.36:69-76

2. International Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue 6, June 2015 Groundwater Potential Recharge Zonation of Bengaluru Urban District - A GIS based Analytic Hierarchy Process (AHP) Technique Approach .

3. Sander, P. (2007). ―Lineaments in groundwater exploration: a review of applications and limitations.‖ Hydrogeology Journal, 15(1), 71-74.

4. Jackson, T. J. (2002). ―Remote sensing of soil moisture: implications for groundwater recharge.‖ Hydrogeology Journal, 10(1), pp. 40-51.

5. Krishnamurthy J., Venkatesa K.N., Jayaraman V. and Manivel M., (1996). ―An approach to demarcate ground water potential zones through remote sensing and a geographical information system.‖Intl. J. Rem. Sen., 7(10), pp. 1867-1884.

6. N.Lokesha, G.S. Gopalakrishna, H. Honne Gowda and A.K.Gupta,(2005), ―Delineation Of Ground Water Potential Zones In A Hard Rock Terrain Of Mysore District, Karnataka.Using IRS Data And GIS Techniques‖. Journal of Indian Society of Remote Sensing, Vol.33, No.3:405-412

7. Md. Surabuddin Mondal . A. C .Pandey .R. D.Garg. Groundwater Prospects Evaluation Based on Hydro geomorphological Mapping using High Resolution Satellite Images : A Case study in Uttarakhand‖.J.Indian Soc.Remote Sens.Vol.36:69-76