DELINEATE GROUNDWATER PROSPECT ZONES AND IDENTIFICATION OF ARTIFICIAL RECHARG SITES USING GEOSPATIAL TECHNIQUE

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ABSRACT

Present study was carried out to delineate groundwater prospect zones and identification of artificial recharge sites using Indian remote sensing satellite (IRS) 1D PAN geocoded data on 1:12,500 scale and Survey of India (SOI) topographical sheets. The information based on lithology, geomorphology, soil, land-use/ land-cover, structures/lineament, slope, drainage and hydrology were generated and integrated to prepare groundwater prospect and artificial recharge site map of the study area.

Geographical Information System (GIS) was used to prepare database in the above layers, analysis of relationship and integrated map preparation. On the bases of hydrology and geomorphic characteristics, five categories on groundwater prospect zones are identified: Excellent, good, moderate poor and very poor. The analysis reveals that the river terraces and water bodies with alluvium has excellent (about 15% area), buried pediplain with black cotton soil have good potential (about 24% areas). These unite has highly favorable for ground water exploration and development. Deeply buried pediment with black cotton soil are marked under moderate ground water prospect zones (about 26% area), shallow buried pediment with Deccan basalt and dykes are grouped under poor ground water prospect zones (about 24% area), except along the fractures/lineaments. Residual hills, dykes, linear ridges and plateau, are group have very poor groundwater prospects (about 11% area). Four-artificial recharge sites ware identify out of witch the moderate and poor categories occupy more than 42% area and these are mainly plateau, ridges and buried pediment shallow. The most suitable artificial recharge sites occupy less area about 19% and mainly confined to buried pediplain and river terraces. The residual hill and linear ridge with steep slope (covering about 39% areas) have not suitable for artificial recharge sites. This vital information could be used effectively for identification of suitable location for groundwater potential and artificial recharged sites. The good interrelationship was found among the geological units, hydromorphological units and lineament density. The field data have further helped in quantifying various lithological and hydromorphological units with reference to their potential for groundwater occurrence.

1. INTRODUCTION

In resent year, the use of remote sensed data and geographic information system (GIS) application has been found increasing in a wide range of resources inventory, mapping, analysis, and monitoring and environmental management. Remote sensing provides very useful methods of survey, identification, classification, and monitoring several forms of earth recourses, and helps in acquisition of data in a time at periodic intervals.

Water has been one of the most important natural resource for the substance of life on the earth. The available surface water resources are inadequate to meet all the water requirements for all purpose, so the demand of groundwater has increased over year. The assessment of quality and quantity of groundwater is essential for the optional utilization. The occurrence and movement of groundwater in an area is governed by several factors such as topography, lithology, geological structures, depth of weathering extent of fracture, secondary porosity, soil, drainage pattern, landforms, land-use/land-cover, climatic conditions and interrelationship between these factor (Roy 1991, Greenbaum 1992, mukhrjee 1996).In addition, quantitative morphomatric parameters of the drainage pattern also play a major role in evaluating the hydrology parameters, which is turn helps to understand the groundwater situation (Krishnamurthy and srinivas

1995). The interpretation of satellite data in conjunction with sufficient ground truth information makes it possible to identify and outline various features such as geological structure, geomorphic features and there hydraulic characters (Das et al. 1997), that may serve as direct or indirect indicators of the presence of groundwater is (Ravindron and jayaram 1997). However, the quality and quantity of groundwater is controlled mainly by the interaction of topographical, geological, meteorological and pedological features. Moreover, groundwater distribution is not uniform and is subject to wide spatio-temporal variations, depending on the underlying rock formation, there structural fabric, geometry, surface expression etc. Therefore, a detailed hydrogeomorphological mapping and groundwater prospect zones and identification of artificial recharge sites as it provides the current spatial deposition of basic information on geology, landforms, soil, land-use/land-cover, surface water bodies, etc. which are indicative of ground water of groundwater movement and localization (Murthy et. Al. 1992). It is obvious that groundwater cannot be seen directly from Remote sensed data; hence, its presence must be inferred from identification of surface features, which act as an indicator of groundwater (Das et.al. 1997, Ravindran and Jayram 1997). Since delineation of groundwater prospect zone and identification of artificial recharge sites his based on the combined role being played by various factors, it is necessary to use Remote sensing and GIS. The present study is an attempt to delineate groundwater prospect zone and identification of artificial recharge sites, North Nasik district, Maharashtra, through hydrological studies using remote sensing and Geographical information system.

2. THE OBJECTIVE OF PRESENT STUDY

1. To understand the hydrological set-up of the area.
2. To investigate the groundwater potential zones.
3. To identified the artificial recharge sites.
4. To suggest water conservation methods in the study area.

3. STUDY AREA

Study area is bounded by north latitudes 20^{o} 30’ to 20^{o} 35’ and east longitudes 73o 50’ to 73^{o} 55’. The area falls in the Kalwan taluka of northern part of Nasik district in the state of Maharashtra and covered by survey of India (SOI) toposheet No. 46H/15. There are a number of small villages in the area like Desgaon, Jaipur, Singhashi, Kanashi, Warkheda, etc, which are well connected by road network. The study area covers about 81 Sq. KM. Study area is connected from Nasik by a state highway going to Surat via Vani and Abona. It can be approached from Nasik road, which lines on the broad gauge railway line of central railway between Mumbai and Delhi. Besides these, there are number of fair weather roads in the area, which help in accessing the various parts of the area. The study area is shown in fig. No.1

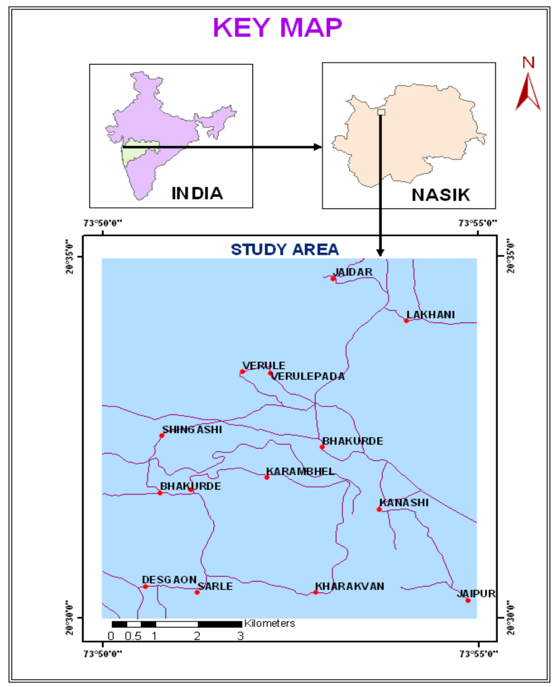


Fig. No. 1Location of the study area

3.1PHYSIOGRAPHHY

The area is hilly and has undulating topography, with the maximum elevation of 1236m in the area is recorded at the Gagarya Dongar lying in the NW of the verulepada. The hilly terrain displayed atypical step like “Trappean” topography while valleys are generally broad in base. The river Girna is the major river flowing through the study area. The largest reservoir of the study area is situated near kanashi village.

3.2 LITHOLOGY

Ranging for lithology is assigned based on mineral assemblage, alteration, fractures and weathering conditions. The rocks, which are more prone to weathering conditions, have high infiltration and high runoff resistance and hence for such rock high value was assigned. Similarly, the rock prone to less weathering has low rank value. Litho-logical unites were not reclassified but ranked from 1 to 5 with alluvium and black cotton soil was assigned a highest rank of 5 and dykes was assigned a lowest rank of 1.(Fig. No.2)

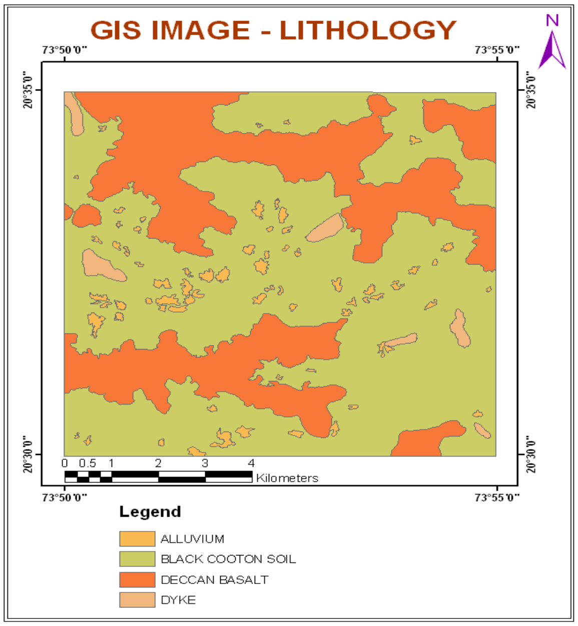


Fig. No.2 Lithological map of the study area

3.3 GEOLOGY

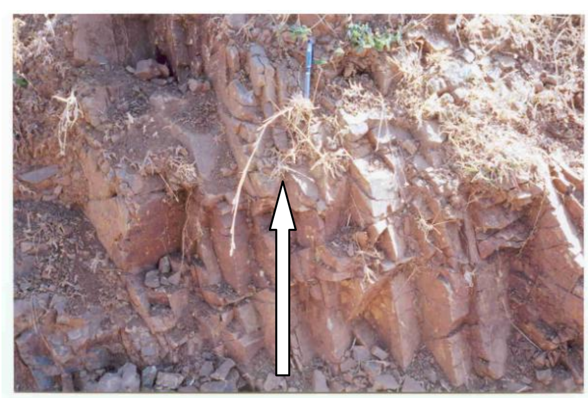
The great volcanic formation of India towards the close of the cretaceous, this great volcanic formation is known in Indian geology under the name of the "Deccan traps". The term "Deccan" is a Dakhan plateau. In addition, "traps" is a step like topography. The steps like topography are called Deccan traps. Four major lithounits have been demarcated in the area. These are Deccan basalts, dyke rocks, Quaternary alluvium and weathered topsoil.

Deccan Basalt- Nearly 90% of the study area is covered by basaltic lava flows. Depending upon the rate of cooling and thickness of the basaltic flow resulted some hard and compact layers. These volcanic flows include basalts of both compact and vesicular and amygdaloidal nature. The Deccan trap of basaltic composition is mostly horizontal and form flat-topped hill with step like terraces produced differential weathering and erosion.

Spheroidal weathering in Deccan Basalt

Quaternary Sediments- the younger alluvium overlaid on the basaltic parent material represents o channel courses and low land areas. This is mainly composed clay, brownish to yellowish color, intercalated with several bands of gravel and sand.

Dyke rocks- Dikes are tabular or sheet like bodies of magma that cut through and across the layering of adjacent rocks. They form when magma rises into an existing fracture, or creates a new crack by forcing its way through existing rock, and then solidifies. Sometimes preferentially along the zones of structural weakness.



Surface expression of Dyke

Weathered top soil (black cotton soil) - black cotton soils mainly occupy the plain and riverbanks in the study area and exhibit a thick profile. These units to be identify by dark tone, smooth texture due to clays and constitute agriculture lands.

3.4GEOMORPHOLOGY

Various geomorphic parameters like landforms, slopes, drainage and lineaments played very important role for ground water prospects. Geomorphology is the science of studying the external expression/and architecture of the planet earth. Geomorphological process is generally complex and reflect interrelationship among the variables such as climate, geology, soil and vegetation (Buol, 1973). The major geomorphic units identified in this area are buried pediplains, buried pediment deep, buried pediment moderate, buried pediment shallow, butte, messa, escarpment, linear ridge, pleatue, and residual hill and river terraces.

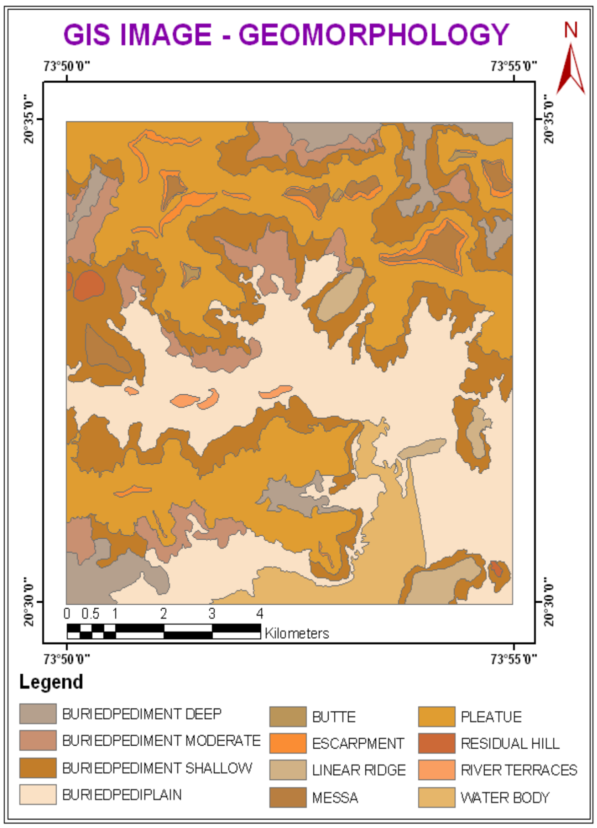


Fig. No.3 Geomorphology of the study area

Buried pediplains – The end of product the cycle of erosion, according to the scheme of (W. apenck and L.S. King). A pediplain refers to a flat or gentle slopping surface that is the end of product of erosion formed by calescence of several pediments at the flat of hill slopes. Buried pediplain in the study area are characterized by a vast area of low-lying flat terrain with a gentle slope, in the study area the buried pediplains are developed over basaltic terrains.

Buried pediments- A plain or eroded bed rock (which may or may not be covered by a thin veneer or alluvium) in an arid or semi arid region developed between mountain and basin areas and are characterized by gentle slope. The hill ranges in the study area are commonly bordered by slopes and veneer soil, which extends downwards the neighboring basin floor. In the study area pediments deep, buried pediments moderate, buried pediments shallow.

Plateau- A term applied to those basaltic lavas that occur as vast composite accumulations of horizontal flows, which erupted in rapid succession over great areas, have at times flooded sector of the earth surface on a regional scale. They are generally believed to be the product of fissure eruption. These are elongated in shape and prograding headword due to upward fluvial erosional processes. Plateau is characterized by strong to moderate slopes and high drainage density.

Linear ridge-Liner ridge are fined to the basaltic terrain and are formed due to detachment and isolation of various fluvial processes, these mainly include elongated.

Residual hills- Residual hills are the product of the process pediplanation, which reduces the original mountain masses into a series of scattered knolls standing on the pediplains (Thonbury, 1990).These are isolated hillock of law to moderate relief with sub-parallel to sub-dendritic drainage pattern. these are formed due to prolonged denudation. Because of their hard and compact nature, they form high resistant hills against erosion.

Escarpments- The escarpment or the vertical wall like surfaces standing out prominently in the top of the hills in general. Such vertical escarpment will normally be formed due to folding, faulting and removal of the segment of block. Such escarpment is also found where competent and incompetent formations of their which the incompetent are erode and competent sand out prominently. In the case of volcanic terrain these escarpment normally observed as step like surface.

3.5SOILS

Soils mainly occupy the plains and stream banks in the area of investigation and exhibit a thick profile. They are compromised of medium to coarse sand pebbles and clays. Very dark brown color, course drainage texture and definite geometrical shapes on the imagery and constitute agriculture lands. The soil map, Geological map, geomorphological map, slope map, drainage map, and lineament map also give different degree of information of runoff, interception, infiltration and storage of ground water. The area is pre dominantly covered by black cotton soil (in buried pediplain and buried pediments deep) and sandy loam (in the river channels).

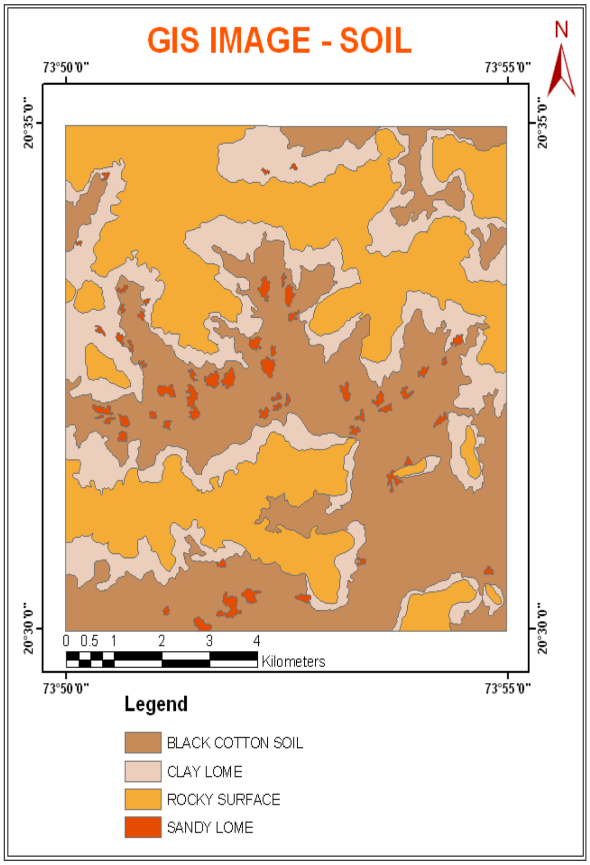


Fig. No. 4 Soil map of the study area

3.6 SLOPE

Slope is a surface feature, which is related to landforms, present material, elevation and landuse. A slop map has been prepared by SOI toposheet no. 46H/14 on the scale of 1:12500. In topographic sheet by rising the distance between two hundred meters contour the slope categories demarcated such as steep, moderate, gentle, Very gentle and plain Fig. No.5

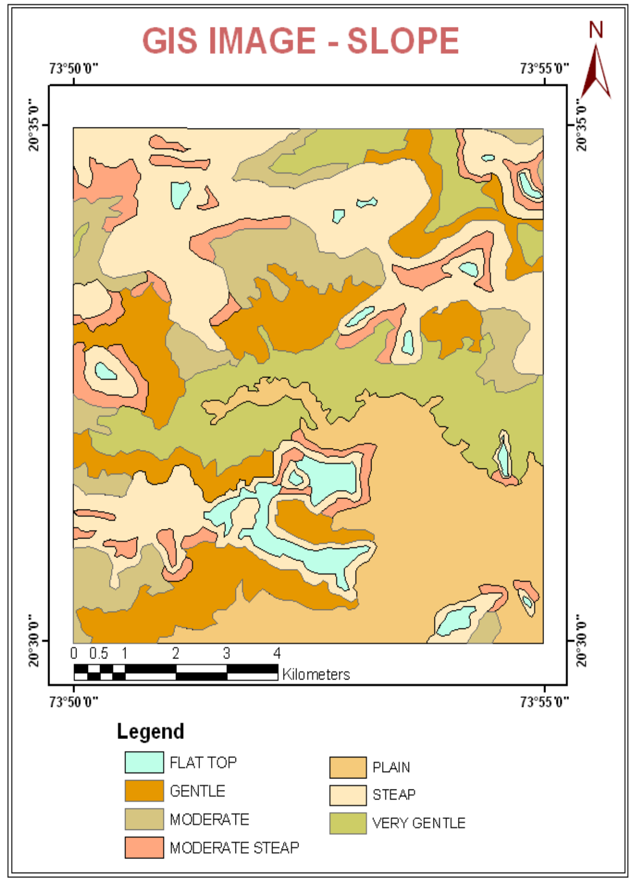


Fig. No.5 Slope map of the study area

3.7 LINEAMENTS

In the study area, major lineaments are identified (fig. no. 6) from the satellite data interpretation, which are surface manifestation of some structural features in the bedrock of fracture and joint developed due to tectonic stress and strain; lineaments were identified in structural hills, pediments and buried pediplain zones of the study area and mainly controlled by the stream channels

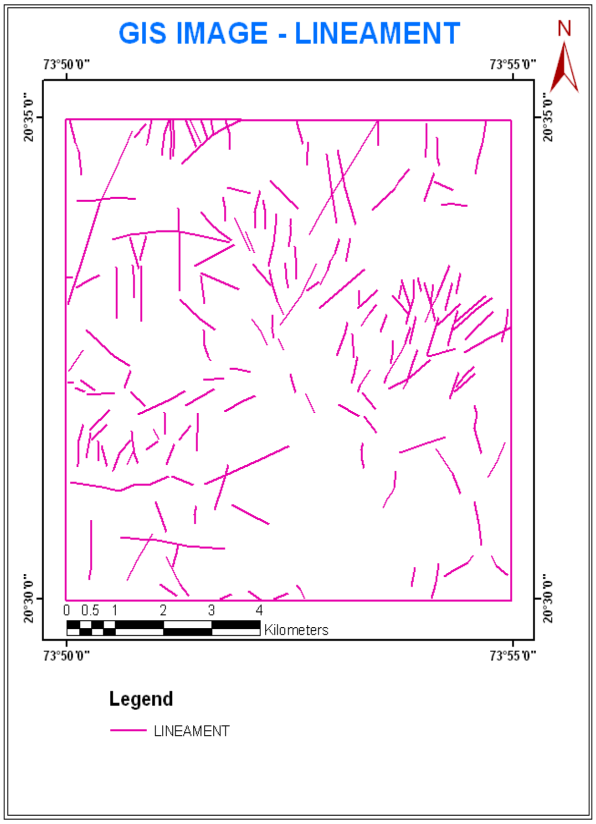


Fig. No.6 Lineament map of the study area

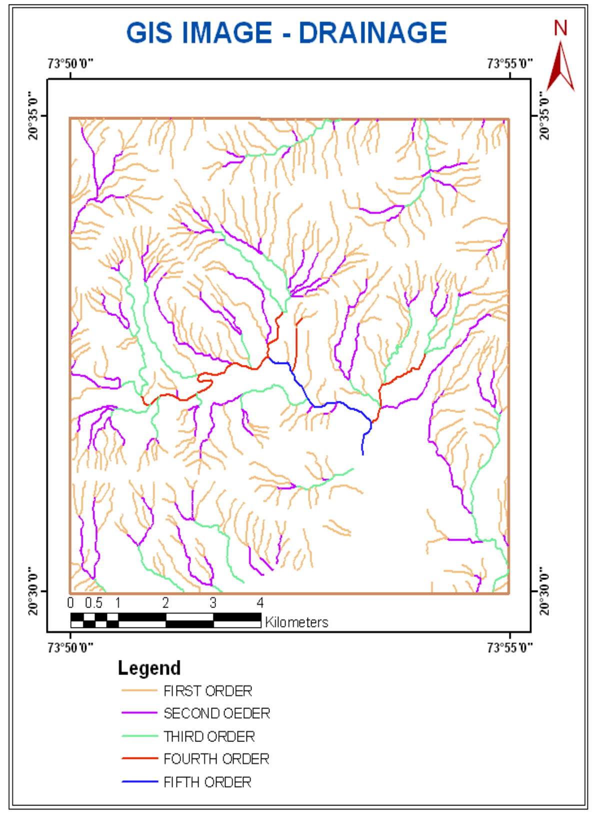


Fig. No.7 Drainage map of the study area

3.8 DRAINAGE

For the surface water and drainage thematic map, all the surface water bodies and the drainages in the topographic sheets are traced on the tracing paper. This has indicated the surface water and drainage condition in the year1970. The thematic map thus produced is scanned and then imported, georefrenced and digitized in GIS environment into digital thematic map. The surface water bodies include dam, streams, river and there tributaries. Sown in fig. no. 7

3.9CLIMATES AND RAINFALL

The climate of the study area is mid-tropical, warm and humid. The area has three distinct seasons viz, summer (from March to mid-June), southwest monsoon (from mid- June to September) and winter (from October to February). Average maximum temperature during summer is 42^{o} c and lowest winter temperature is 9^{o} c. humidity varies from 98% during monsoon months to 50% during summer months. The mean annual rainfall is 2500_{mm}. the average wind velocity varies from 12.5m/sec. during monsoon months to 1m/sec. during winter months.

3.10AGRICULTURE AND VEGETATION

There is one major dam in the area. These are being used to irrigate the west crops during the monsoon seasons and during the rest of the times, the irrigation is done from the dug wells.

The low laying areas are being cultivated for paddy, maize, sugarcane and groundnut. Reserved forests cover the ridges and plateau. The main reserve forest in the area is; Gagarya Dongar forest, Javalya Dongar froest and Padsha Dongar forest. The main vegetation in these forests consists of sandalwood, eucalyptus, and bamboo trees. The moderately and steeply sloping ridges are covered by open forest, which mainly consist of trees like tectona granddis (teak), bambusa arudinaceae (bamboo). Dalbergia sisco (sisa) etc. At many place complete deforestation has occurred.

3.11LAND-USE/LAND-COVER

The term and land cover relates to the type of feature present on the surface of the earth where as landuse refers to the human activity associated with the specific piece of land (Lilesand and Kiefer, 1979) initially, the survey of India (SOI) topographical sheet and Satellite data used for information of various land use and land cover information in the study area. The stydy area is classified into a number of land use and land cover based on different spectral signatures of the surface features in the imagery. Although supervised classification served as a very good helping tool for the interpretation of landuse classes, the thematic map was generated by satellite imagery and digital data. The landuse and landcover map thus produced from satellite data is shown in fig.4 the various landuse/landcover unites thus classified in the study area are 1) barren rocky land 2) buildup land 3) deciduous dense forest 4) dense forest 5) scrub forest 6) land without crop 8) land without scrub 9) plantation 10) reservoirs etc.

3.12 GROUNDWATER CONDITION

Almost the entire study area is covered by black cotton soil profile is from 3 to 30m at different levels of plantation. Alluvium is the most important water bearing formation, cover major portion of the study area. The heavy monsoon rainfall results in quick recharge of the alluvium aquifers and water levels attain their highest elevation during July-august period, they start declining from October with the rate increasing after November. The saturated thickness of alluvium aquifer is very little during the period March to May. Groundwater occurs in an intricate network of sinuous conduits and in weathered mantle of the alluvium. Almost all the dug wells inventoried in the study area penetrating in alluvium (which from the main aquifer) having the water level fluctuation between 0-20 ft.

4. DATA USED

In any scientific research involving application of integrated remote sensing techniques for obtaining maximum geological and hydrological information, following data are mainly used :-

4.1ANCILLARY DATA

Ancillary information regarding any area such as topography, drainage, forest cover, slope and cultural features can be obtained from survey of India (SOI) topographical sheets. The other useful information related to meteorological data and hydrology that finds application in any study related to ground water prospect zones and artificial recharge sites can be obtained from observatory stations or published reports.

- **Survey of India (SOI) toposheet**

From the survey of India toposheet no.46h/14 on the scale of 1:12,500 have been used. The following information can be extracted:-

- Preparation of base map.
- Preparation of contour map.
- Drainage map.

Apart from the data generate from the survey of India toposheet other auxiliary data on the following aspects were also collected from different department/organization or institutions such as rain fall, water level data and surface runoff in pre monsoon and post monsoon periods.

4.2SATELLITE DATA

Indian remote sensing satellite (IRS) linear imaging self-scanning (LISS-III) data and IRS 1D PAN imagery and digital data (with a spatial resolution of 5.8m) along path number 94 and row number 58 have been used in this study.

- **Data processing**

The processing was carried out using on ERDAS 8.6 and ARC – GIS 9.1 software's**.**

- **Fieldwork**

The fieldwork consist of geology, land use/land cover, geomorphology and major lineaments studies visit to filed and seen landforms and conformation of lithounits and taking photographs.

- **Fields methods**

At every site, the field procedure below was followed:-

- Geographical location of the road intersection and nala cutting center was determined by a Global Positioning Systems (GPS) at an accuracy of <±5 m horizontal.
- Rock samples were collected across the nala cutting, hillside and dykes for laboratory analysis.
- Brocken samples of surface rock (as weathered as possible) were collected for geological description.
- Properties of the alluvium, blank cotton soil and under laying parent material were recorded in notes and GPS.

5. METHODOLOGY

Since the prime objective of the study was to evaluate the surface and subsurface water potential of the region, the approach was to evaluate all the relevant factors viz., geological, geomorphological, meteorological, geophysical and hydrological, in detail.

The methodology adopted in the present study is presented schematically in figure 5 and described in the following steps:-

- The various thematic maps such as Base map, geology, Geomorphology, Soil, Land-use/cover, Lineament, Drainage, and contour maps are generated through conventional field methods using the Survey of India (SOI) toposheet and IRS LISS-III imagery hard copy and IRS PAN imagery and digital data.
- The thematic maps were converted into the vector format using digitization in Arc GIS and ERDAS software.
- The Weightage and ranks were assigned to the themes and units depending upon their influence over recharge.
- Overlay technique using Geographic information system (GIS) and Zones Favorable integrated the maps for artificial recharge and ground water potential zones were delineated.

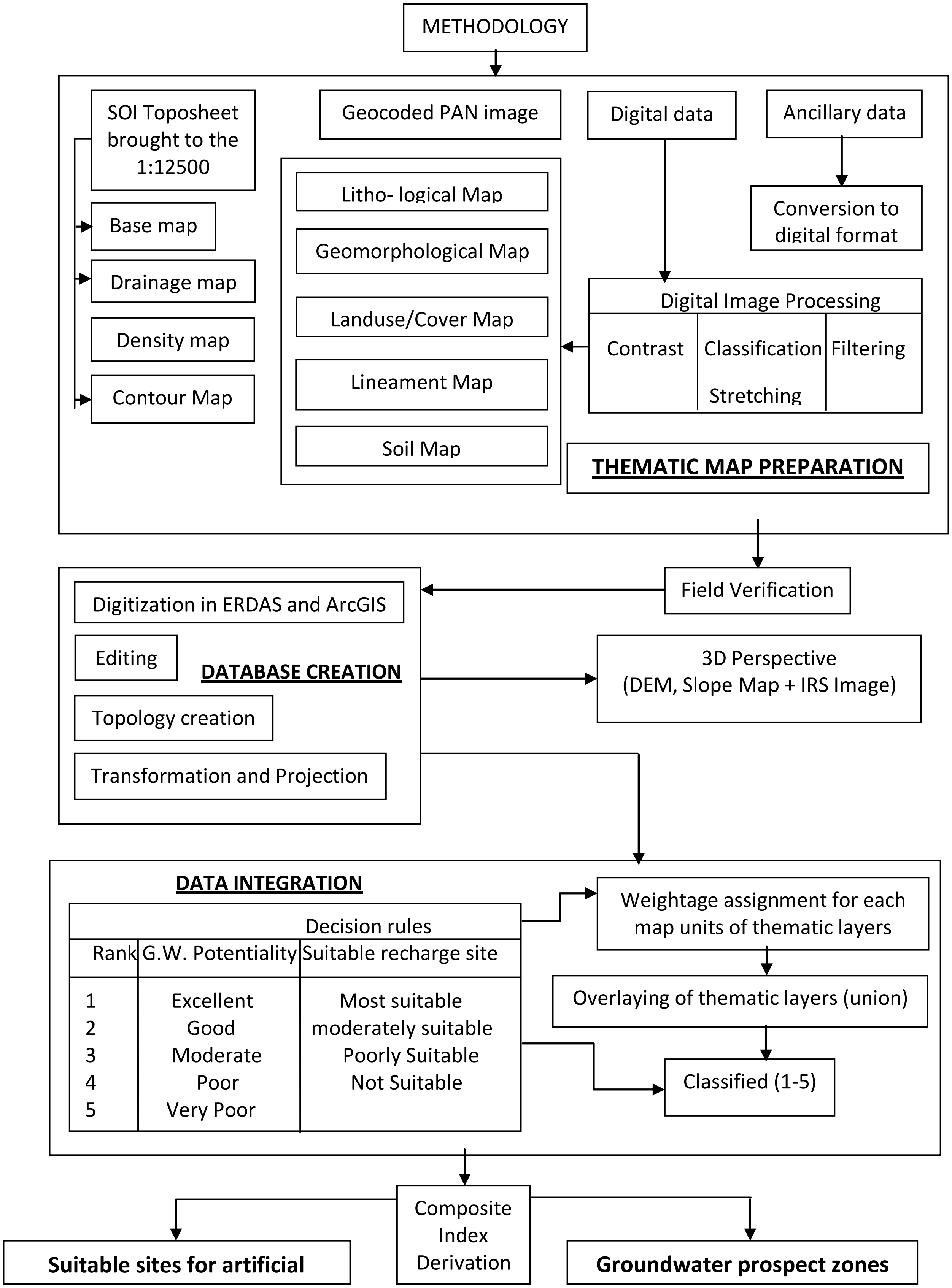


Fig. No. 8 Flowchart showing data flow and different GIS analysis operations followed in the present study.

6. GIS ANALYSIS AND MODELING

GIS works with two fundamentally different types of geographic models such as the vector model and the raster model. The vector model is useful for describing direct features, but less useful for describing continuously varying features, where as raster model describing the continuously varying features. In vector model, information about points, lines and polygon is encoded and stored as a collection of x, y, co-ordinates. The location of point features such as borehole can be described by a single x, y, co-ordinates. Linear features such as road and rivers can be stored as a collection of points. Polygon features are stored as a closed loop of co-ordinates. A raster image comprises a collection of grid cells. The integration of geographical maps and field information with various thematic maps prepared from remote sensing and toposheet was carried out using ERDAS 8.6 and ArcGIS 9.2.

7. WEIGHTAGE ASSIGNMENT

In hard rock terrain such as the present one, the occurrence of ground water is confined to certain zones only. In order to delineate the ground water potential zones and artificial recharge sites, integrated analysis were carried out using semi-quantitative and univriate statistical analysis. Digitized thematic maps such as geology, geomorphology, soil, land use / land cover, slope, drainage density, lineament density, lineament frequency, lineament intersection and depth of water table. Numerical approach, which is better, suited for quantitative and computer aided integrated analysis of multi thematic information was adopted in this study. The attributes are assigning Weightage (Wk) depending on their relative influence of ground water potential and recharge sites. Similarly the category of each attribute were also assigned numerical values (Vjk) based on their influence. This enabled in performing numerical integrated analysis and semi-quantitative evaluation. (chow et al, 1964) have used the underlying principle of cock's method in determining the co-efficient of runoff. This methodology was also adopted in the landslide hazard zonation studies (Venkatachalam et al, 1993) and multifactor cost models (Gopal Rao 1980)used in highway route location studies. A similar numerical weighted approach was developed during the present study called the "Numarical analysis of multi-thematic information (NAMTI)". The Weightage values for attributes and classes were assigned based on relative influence on ground water potential: since the area is underlain by rock, the occurrence of ground water is greatly controlled by the nature of bedrock, geomorphology, soil, slope, land-use,lineament and drainage density. The Weightage have been given each maps such as 20 for geology, 20 for geomorphology, 15 for soil, 15 for slope, 10 for drainage density, 10 for lineament density, 5 for lineament frequency and 5 for lineament intersection respectively. The classes (categories) in each map were given class values in such a way that the class, which is highly favorable for ground water potential, was given the highest value i. e., of the attribute itself. The Weightage given for the attributes and the values corresponding to classes are shown in table 1. Weightage assignment is an important task in gis spatial analysis. The integration analysis was carried out by superimposing all the nine maps (attributes) by multiplying the Weightage for each map with corresponding Weightage for each class. Here in this analysis geology and geomorphology are considered to be the most important parameter for ground water potential and slope is considered to be the most important for artificial recharge sites and hence value 20 was assigned. The product of Weightage factor (Wk) for all the maps and the class values (Vjk) of each pixel are summed up and 100 divided the sum, i.e.,

$$GWP = \left[\sum_{k=1}^{nk}(Wk\ Vjk)\right]/100$$

Where nk = number of attributes

Wk = Weightage of attribute k

Vjk = value assigned to class jof attribute k

The resultant output values were regrouped into five different ground water potential zones.

Table no.1 Weightage assignment of various thematic maps for ground water prospect zones

THEMATIC MAP	CLASS	CATEGORY	CATEGORY	WEIGHTAGE
1.Geology	Dyke	Very Good	1	20
	Deccan basalt	Good	2	
	Black cotton soil	Poor	4	
	Alluvium	Excellent	5	
2.Geomorphology	Pleatue, Messa, Butte Escarpment, Linear ridge and Residual hill	Very poor	1	20
	Buried pediment shallow Buried pediment moderate and Water body	Poor	2	
	Buried pediment deep	Moderate	3	
	Buried pediplain	Good	4	
	River terraces	Excellent	5	
3.Soil	Rocky soil	Very poor	1	15
	Clay loam	Moderate	3	
	Black cotton soil	Good	4	
	Sandy loam	Excellent	5	
4.Slope	Steep, flat top	Very poor	1	15
	Moderate, Gentle	Moderate	3	
	Very Gentle	Good	4	
	Plain	Excellent	5	
5.Drainage density	Very high, High	Poor	2	10
	Medium	Moderate	3	
	Low, very low	Good	4	
6.Lineament density	Very low	Very poor	1	10
	Low	Poor	2	
	Medium	Moderate	3	
	High	Good	4	
	Very high	Excellent	5	
7. Lineament frequency	Very low	Very poor	1	5
	Low	Poor	2	
	Medium	Moderate	3	
	High	Good	4	
	Very high	Excellent	5	
8. Lineament intersection	Very low	Very poor	1	5
	Low	Poor	2	
	Medium	Moderate	3	
	High	Good	4	
	Very high	Excellent	5	

Table no.2 Weightage assignment of various thematic maps for artificial recharge sites

THEMATIC MAP	CLASS	CATEGORY	CATEGORY	WEIGHTAGE
1. Slope	Steep, Flat top	Very Poor	1	20
	Moderately steep	Poor	2	
	Moderate	Moderate	3	
	Plain	Good	4	
	Very gentle and Gentle	Excellent	5	
2.Geomorphology	Pleatue, Messa, Butte Escarpment, Linear ridge and Water body	Very poor	1	15
	Residual hill	Poor	2	
	Buried pediment shallow and Buried pediplain	Moderate	3	
	Buried moderate	Good	4	
	Buried pediment deep and River terraces	Excellent	5	
3.Geology	Dyke	Very poor	1	15
	Deccan basalt	Moderate	3	
	Black cotton soil	Good	4	
	Alluvium	Excellent	5	
4.Land-use/cover	Barren rocky land, Built up land and Reservoir	Very poor	1	15
	Dense forest and Plantation	Poor	2	
	Land without scrub and Land without crop	Moderate	3	
	Land with crop and Land with scrub	Good	4	
5.Soil	Rocky soil	Very Poor	1	10
	Black cotton soil	Moderate	3	
	Clay loam and Sandy loam	Good	5	
6.Drainage density	Very low	Very poor	1	10
	Low	Poor	2	
	Medium	Moderate	3	
	High	Good	4	
7.Lineament density	Very low	Very poor	1	5
	Low	Poor	2	
	Medium	Moderate	3	
	High and Very high	Good	4	
8. Lineament frequency	Very low	Very poor	1	5
	Low	Poor	2	
	Medium	Moderate	3	
	High	Good	4	
	Very high	Excellent	5	
9. Lineament intersection	Very low	Very poor	1	5
	Low	Poor	2	
	Medium	Moderate	3	
	High	Good	4	
	Very high	Excellent	5	

8. GROUNDWATER PROSPECT ZONES AND SUITABLE SITES ARTIFICIAL RECHARGE

In basaltic terrines, primary features such as vesicles and inter-flow contacts control occurrence of groundwater and secondary features like fractures and weathered zones. In order to determine the groundwater prospects in the study area, thematic maps generated from Remote Sensing data have been interfaced with DEM, surface drainage and water maps using GIS. The groundwater flow direction closely flows the direction of river flow indicating that streams in the area are influent. It also matches with the prominent direction of lineaments in the area suggesting that the lineaments act as pathways for groundwater movement.

8.1Groundwater Potential Zones

The potential zones for groundwater exploration were identified and delineated after integrating the information on geology, geomorphology, hydrology and recharge condition of the terrain. Five groundwater prospect zones (Excellent, Good, Moderate, Poor, very Poor) have been identified (table) in the study area. In each zone, the prospect of groundwater has been described in relation to its geomorphology and hydrological characteristics.

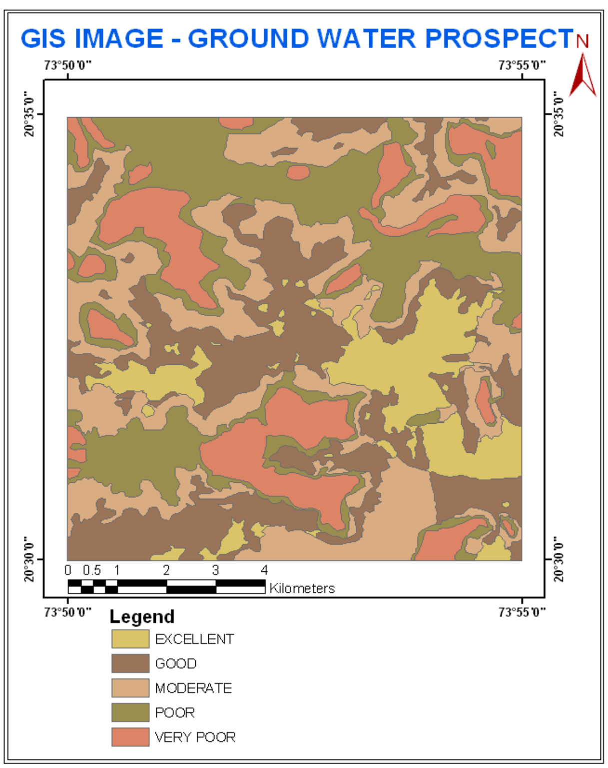


Fig. no. 9 Groundwater Prospect map

8.2Excellent Groundwater prospect zones

The major geomorphic units in this zone are buried pediplains and river terraces spread over 8.83 sq. km. (15%) area. This zone is mostly influenced by quaternary alluvium and black cotton soil. Major part of this zone exists in central part of the study area.

8.3Good Groundwater potential zones

This zone is dominated by geomorphic units like buried pediment deep and buried pediplains. Mostly developed under Deccan basalt and black cotton soil having very gentle slope covering nearly 18.84 sq. km. (24%) area.

8.4Moderately Groundwater potential zones

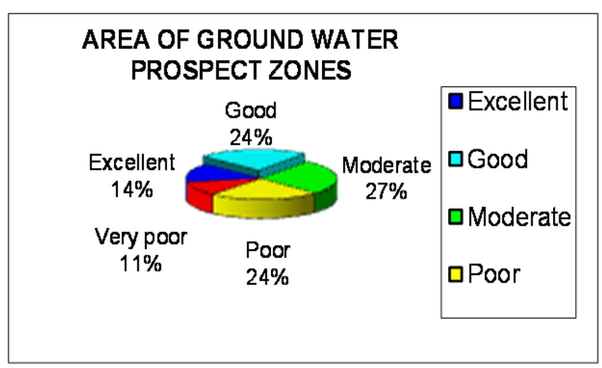
This is mainly a pediment zone (buried pediment shallow and buried pediment shallow), which occupies area about 21.57 sq. km. (26%).

8.5Poor Groundwater potential zones

Buried pediment shallow and buried pediment moderate with Deccan basalt and dykes are grouped under poor groundwater prospect zone covering area about 18.82 sq. km. (24%).

8.6Very Poor Groundwater potential zones

This is mainly a rocky terrain having plateau, mesa, butte, escarpment and linear ridge developed under Deccan basalt. Accordingly, these potential unites have been mapped as very poor groundwater potential zone covering area about 11.56 sq. km. (11%). Because of the surface characteristics, these are act mainly as runoff zone and are not suitable for groundwater exploration.



8.6Suitable sites for Artificial Recharge

In order to increase the natural supply of groundwater, people artificially recharge ground water basins. Artificially recharge may be defined as augmenting the natural movement of surface water into underground formations by some method of construction. Recharged ponds and check dams provide a good measure of artificial recharge in hard rock terrains by collecting surface runoff and increasing the surface area of infiltration. Suitability of these structures depends on various factors, which can be identifying using GIS techniques (Novaline Jaga et. al. 1993). Considering the hydro-geomorphic conditions of the area, Weightage indexing has been adopted (table) to suggest the ideal locations for artificial recharge using 9 parameters namely geology, geomorphology, soil, land use / land cover, slope, drainage density, lineament density, lineament frequency, and lineament intersections. This suitability analysis has been performed purely from a groundwater point of view and does not include geotechnical considerations.

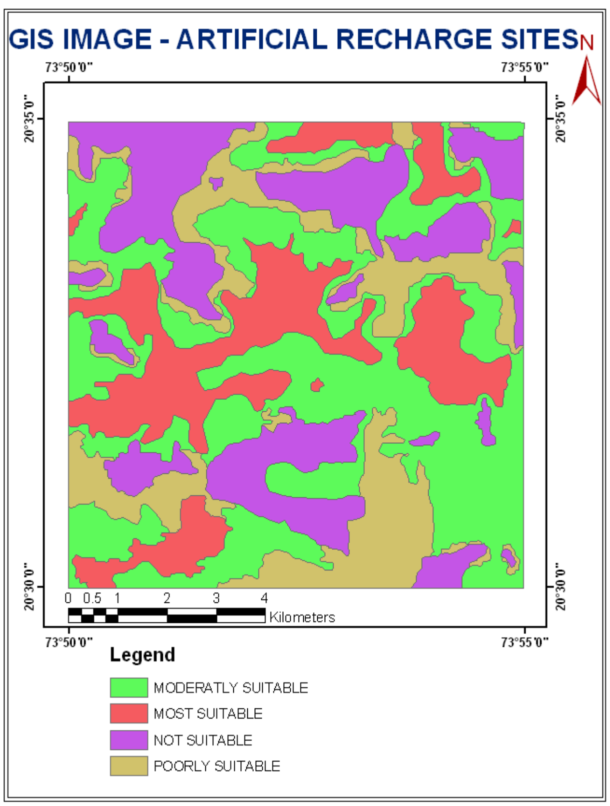
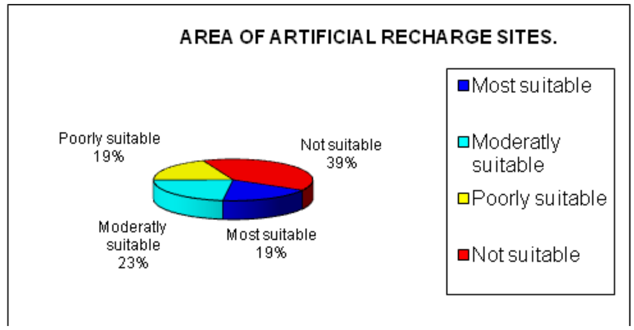


Fig. no.11 Artificial Recharge Sites



9. RESULT AND CONCLUSION

υ As Remote Sensing and GIS have proven their credibility beyond out in natural resources. An attempt has made to prepare groundwater potential zone and artificial recharge sites of the study area.

υ An integrated maps has been derived showing Ground water potential zones and artificial recharge sites which were reclassified into

☐ Excellent
☐Most Suitable
☐ Good Suitable
☐ Moderate
☐Moderately Suitable
☐ Poor
☐Not Suitable
☐ Very Poor

υ Detailed image interpretation was carried out and various thematic maps were prepared. GIS images were generated using ERADSA 8.6 and ArcGIS 9.2.

υ In spite of the fact that the study area is dominated by hard rock's such as basalts, and dyke which are generally known to be poor aquifers, the moderate to high degree of weathering, moderate density of joints, fractures and flow contacts are the favorable sites for groundwater occurrences.

υ The study has shown that the integrated spatial information analysis using parameters of geology, geomorphology, soil, landuse and landcover, slope, drainage and lineament density, frequency and intersections along with remotely sensed data has great promise and potential for identifying and delineating the favorable zones for exploration and artificial recharges.

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