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**Identification of Groundwater Potential Prospect Zones in Semi-Arid Region- A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra**

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From

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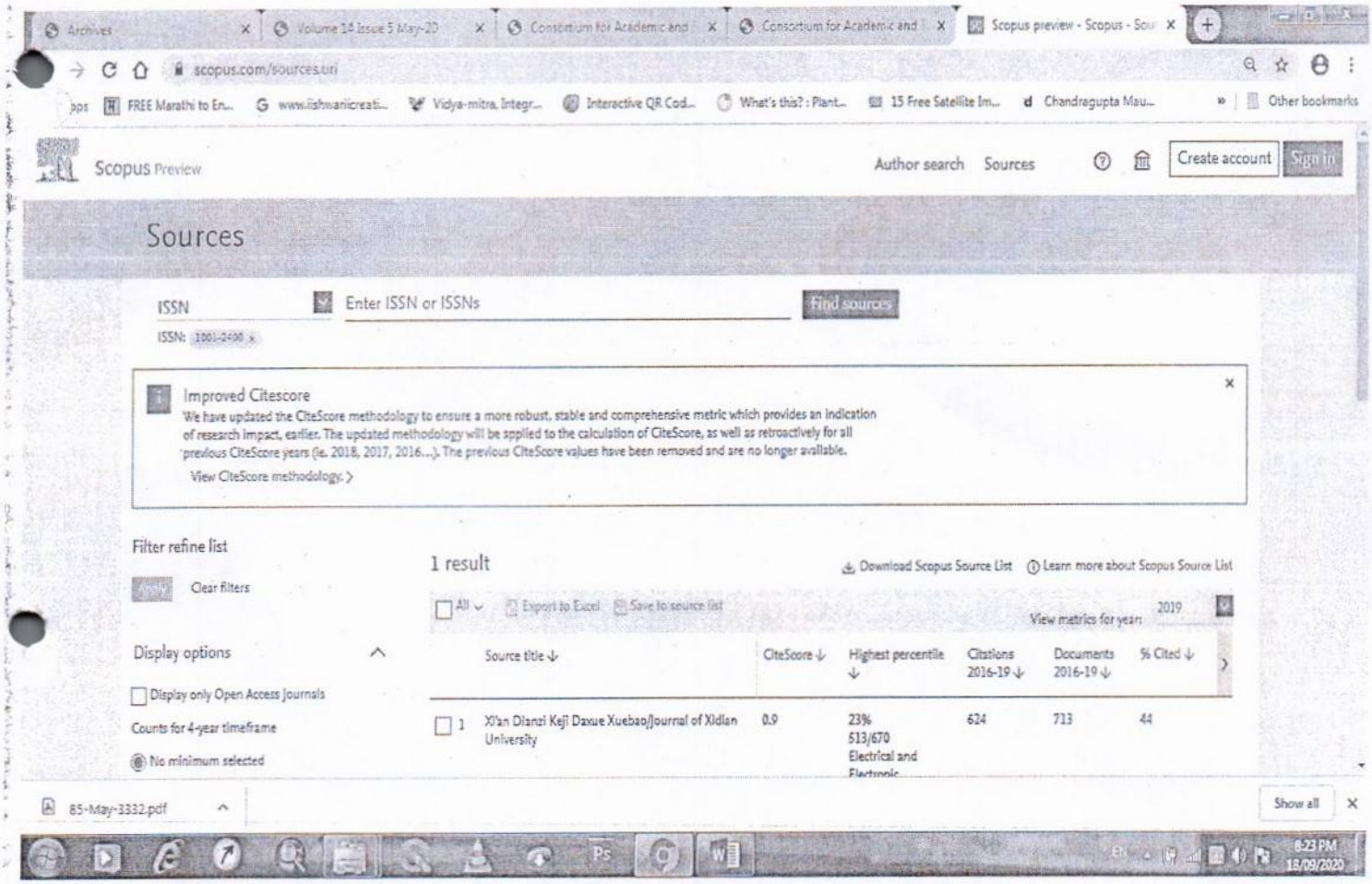

# Identification of Groundwater Potential Prospect Zones in Semi-Arid Region- A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra

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**Abstract-**

**The groundwater is fundamental natural resource which is support to all environmental issues. [7] The search for new groundwater resources is essential to sustained economic development in semi-arid region. [14] The present research work, an attempt has been made to delineate groundwater potential prospect zone in the Karjat tehsil of Ahmednagar by using remote sensing and geographical information system. The several thematic layers is considered in this research are geomorphology, Geology, Soil, Slope, Drainage density, Lineament density and Land Use Land Cover map. Which are prepared by using Bhuvan satellite datasets and survey of India toposheet with help of GIS and RS technique. [3] The thematic layers integrated using Arc GIS 10.1 software and identify groundwater potential zone in Karjat tehsil. The groundwater zones are classified into four categories like good, moderate, poor and nil. The result expresses the groundwater potential prospect zone information, which is used effective planning and management of groundwater resources.**

**Keyword- Groundwater, Geographic Information System, ArcGIS 10.1, Potential Zone, Geomorphology, Land Use Land Cover**

## I. INTRODUCTION

Groundwater is the most widely crucial substance in our planet, the distribution is largely unbalanced. It is found in beneath the surface of the earth in fracture and pore space of soil. [1] Groundwater is crucial source of industrial and agricultural sectors. The availability of the resources was decreased in last few decades. Due to our country has experienced crises of fresh water. Hence scientists acclimatizing numerous techniques for study of groundwater. [12]

The different hydrological, geological and geomorphic parameters play vital role in the movement and occurrence of groundwater in various areas. GIS and Remote sensing techniques have become largely effective tools in field of groundwater exploration and hydro-geological investigation. [1]

In the present study areas having undulating topography and hard rock terrains, due to this area suffers from water scarcity. The research work geomorphological mapping has been carried out in order to identify groundwater potential areas in Karjat tehsil of Ahmednagar District, Maharashtra by a methodological integrated approach based on GIS and RS.

## II. STUDY AREA

The proposed study area is the Karjat Tehsil covers within 18°19'86''N to 18°49'86''N latitude and 74°43'20'' to 75°13'20'' E longitude of geographical location. Study area locating on the number of toposheet these are 47J/11, 13, 14, 15, 47N/1, 2, 3. The area of Karjat Tehsil is 1503.61 Sq. kms. The average height of these from mean sea level is 594 Mts. Administratively this area is Sothern part of Ahmednagar district. The mean annual rainfall in the study area is 540 mm. About 85 percent rainfall is

contributed by south west monsoon from second week of June to September and rest 15 percent is received during non-monsoon months (return monsoon). It is totally depend upon the rainfall but recently some part of Karjat is covered by canal irrigation system. The present study areas belong to drought prone area.

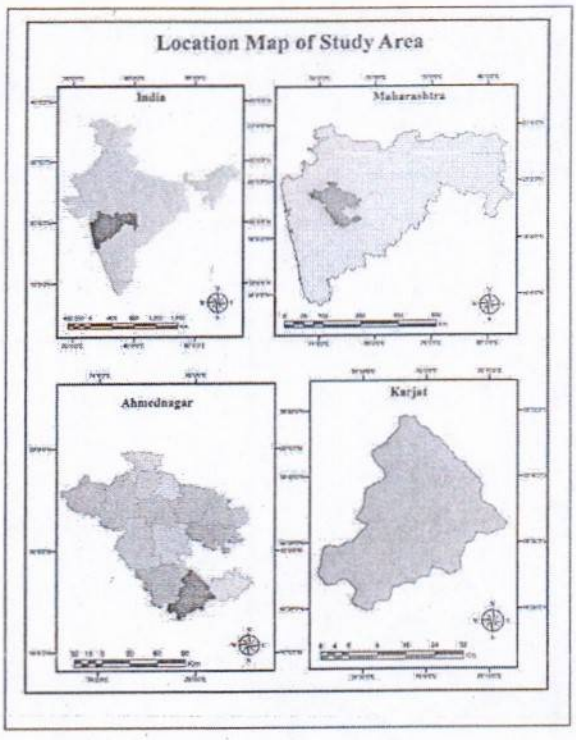


Fig.-1 Location Map of Study Area

## III. AIMS AND OBJECTIVES

The aim and objectives of the present study are,

1. To study the physiographic characteristics in study region.
2. To identify the groundwater potential prospects zones in study area by using GIS & Remote Sensing techniques.

## IV. DATABASE AND METHODOLOGY

*1. Database-*

The data is most significant for desirable conclusions and generalization in research. The present study is based on primary and secondary data which is collected from different data sources and used in present investigation. Primary data was collected through techniques like baseline survey and intensive field work with the help of schedule, interview techniques and survey. Maximum data is collected through visits and surveys or observation of the study area and Secondary data was collected from the following sources S.O.I. Toposheets. Geological Survey of India-map, LANDSAT images, GIS and Remote Sensing Data from Internet. Besides this, the required data and information was collected from various books and journals.

In the present study, tehsil was considered as a basic unit of investigation. The collected data tabulated and analyzed by using statistical techniques, wherever, necessary data is presented with the help of suitable GIS cartographic thematic maps. The Arc GIS 10.1 and QGIS software's are used for the processing and preparation of map.

*2. Methodology*

*Generation of thematic layers-*

The methodology comprises an integrated approach using multi-date (temporal data) satellite data for the preparation of thematic maps of the study area such as geomorphology, land use land cover, soil, geology, slope, lineament density, drainage density, etc. GIS technology was used for mapping locations, finding distances and monitoring change with the help of Arc GIS software.

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 and digital data.

The groundwater potential zones are identified to the help of study the geographical factors and groundwater availability of the study area. The Weightage and ranks were assigned to the themes and units depending upon their influence over recharge. Overlay analysis technique was used for identification of ground water potential zones. Groundwater potential zones were classified in four categories, like good, moderate, low and nil potential etc.

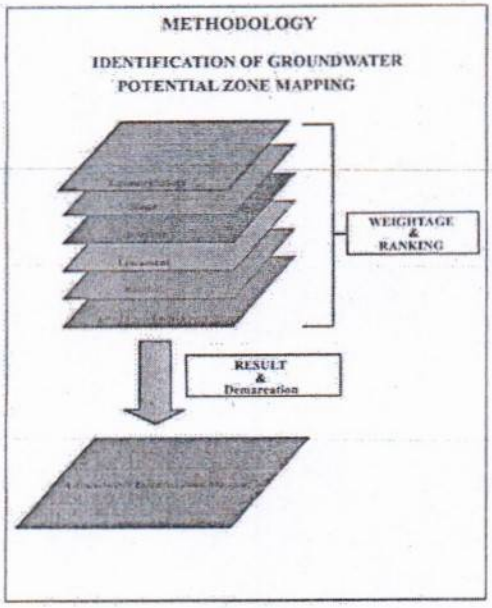


Fig.-2 Methodology

## V. RESULT AND DISCUSSION

*1. Geology:*

It is a well-established fact that geological set-up of an area plays a vital role in the distribution and occurrence of ground water (Krishnamurthy and Srinivas, 1995). Geology is very important to consider for recharging the ground water table through artificially. The geological details of the study area are digitized from the Ahmednagar district resource maps published by Geological Survey of India. Region under the study is relatively a small in area due to prominent features associated with the geology are not found. The region is remarkably free from structural complexity. Deccan Traps occupy total area of the Karjat and it occurs as basaltic lava flows which are normally horizontally disposed over a wide stretch and give rise to table-land type of topography also known as plateau. The total area comes under the Deccan trap it is comprised by basalt rock. The composition of these rocks is very hard. Generally this structure is dividing in three types- Simple flow, Eight Aa Types and Thee Compound Pahoehoe Flows (Diveghat Formation) and Five Aa Type and One Compound Pahoehoe Flows (Indrayani Formation). These layers are comprised by different strata's.

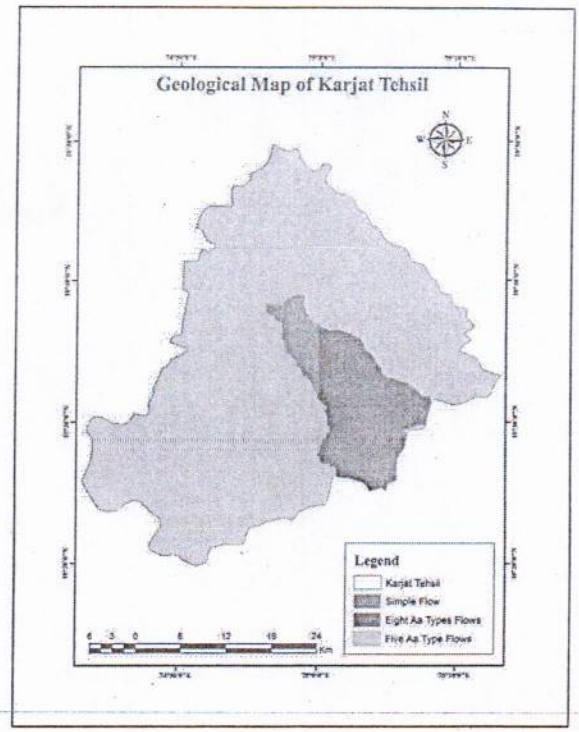


Fig. 3 Geological Map of Karjat Tehsil

## 2. *Geomorphology*

Geomorphology of the study area was divided in to three broad categories. Structural Originated moderately dissected lower plateau cover about 8 percent of the study area and are extended from North West part of the study area.

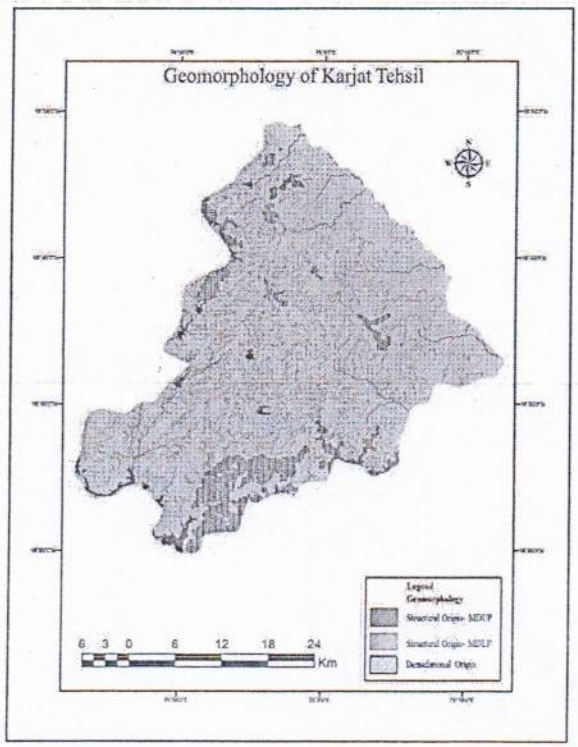


Fig. 4 Geomorphology Map of Karjat Tehsil

Which is good for increasing groundwater level, because of slope was low and porosity high. Near about 12 percent area comes under the Structural Originated moderately dissected Upper plateau covered south and south east part of Karjat tehsil. Remaining 80 % area covered by denudational origin category, in this area weathered material of rocks found largely. Generally landforms serve as moderate potential for groundwater the slightly dissected plateau & pediplains over the study area the undulating plateau offer the best storage zones. The moderately dissected plateau landforms medium storage of ground water appears to be taking place.

*3. Soil Texture:*

Soil is most valuable natural resources which are direct impact on groundwater potential zones because the infiltration of rainwater is primarily influenced by the texture of soil. Figure 1.3 reveal that in the study area, four types of soil is demarcated based on their texture. It is evident from the Table that loamy calcareous is the dominant soil of Karjat tehsil which covers about 41 percent of the total study area. This soil is reddish and brown in color and moderately drained. The figure shows that this soil texture is extended from north to south in the eastern and western part of the study area. Fine calcareous soil covers about 15 percent of the total study area. In this type of soil, due to intensive irrigation salinity/alkalinity occurs and it does not offer good recharge prospect. Patches of this soil texture are observed along the north boundary part of study area as well as in the central part. Clayey soil constitutes about 28 percent of the study area. The high concentration of clay particles in this type of soil make it less porous and it has low recharge prospect. Fine soils cover about 16 percent of the study area. These soils are generally marked by stratified deposition of various agencies at different places and are light colored and well drained. They have comparatively better prospect for artificial recharge.

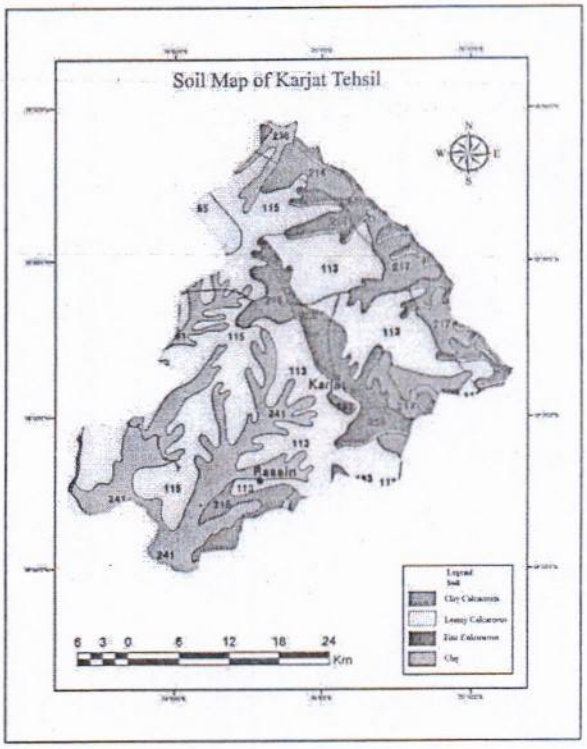


Fig. 5 Soil Map of Karjat Tehsil

*4. Slope Map*

Slope is a crucial factor for identification of groundwater potential zone. The slope is promoting infiltration of groundwater in to subsurface stratum. For the preparation of slope map we are used SRTM data which is analyzed in spatial analysis Arc GIS 10.1. The high slope indicates high runoff and low infiltration rate it means there is low water permeability. The water is directly moves towards lowland area. Slope of study area is divided in to five categories.

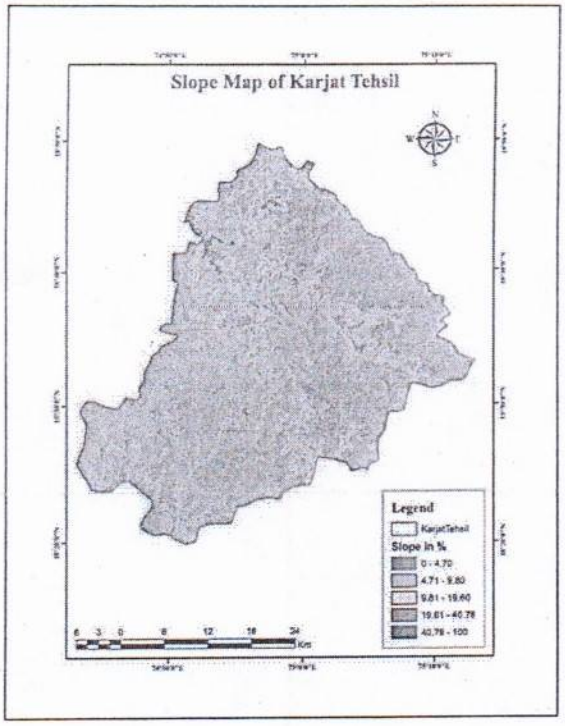


Fig. 6 Slope Map of Karjat Tehsil

The areas having lower value of slope 0 To 4.70%, it is expressed the area comes under flat terrain which is fall in to good categories and higher value of slope indicates 40.79 to 100% the terrain is very steeper it is poor for groundwater potential. The value of slope between 9.81 to 19.61 % is express medium slope which is favorable for moderate prospect zone of groundwater.

*5. Lineament Density*

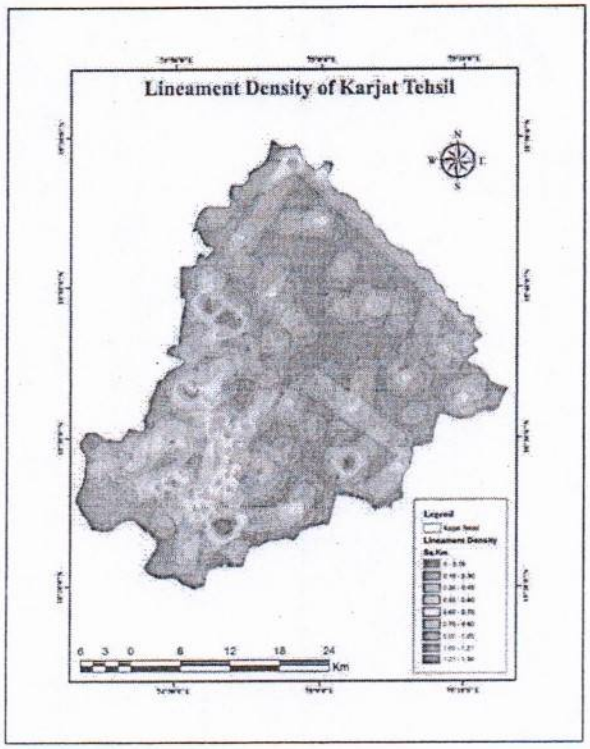


Fig.7 - Lineament Density Map of Karjat Tehsil

Lineaments are large scale linear, rectilinear or curvilinear structures on the earth surface, which expresses themselves in terms of topography. Lineaments generally developed due to tectonic stress and strain and are responsible for infiltration of surface runoff into sub surface and also for movement and storage of ground water, especially in hard rock areas (Kumar et al 2008). They generally follow the stream courses and are the expression of the underlying structural features. Therefore, they could be utilized for identifying suitable sites for artificial recharge of ground water through rainwater harvesting. The lineaments are providing the flow ways for groundwater movement and are hydro-geologically very important.

The intersection of lineament areas is considered as good groundwater potential zones. Lineament density map is prepared from structural map prepared by IIRS BHUVAN (Indian Institute of Remote Sensing), using line density tool in Arc GIS 10.1. The study area is covered by geomorphic and structural lineament. Highest lineament density found in southern part of study area, which is covered by geomorphic lineament. The highest density of lineament is 1.21 to 1.36 Sq. Kms. and lowest density was 0 to 0.15 Sq. Kms. The lineament density decreases towards the north and north eastside. Southern part is indicating high possibility of potential for groundwater zone. Most of lineaments are parallel to streams.

### 6. *Drainage Density*

Drainage pattern reveals the major characteristics of subsurface as well as surface formation. Drainage density factor is related to relief, types of rocks, infiltration capacity, vegetation covers and climatic condition. Highest drainage density indicates high overland flow. The drainage density directly effect on side suitability for groundwater potential zones, Because of the drainage density direct related with surface runoff and permeability. Drainage line ware digitized from the drainage map. The eight stream orders found in study region. The drainage density of Karjat tehsil was classified in eight categories. Drainage density expresses runoff generation capability of terrain. The highest drainage density of study area is 6496 which found in southern part and lowest (727) in north eastern and eastern part.

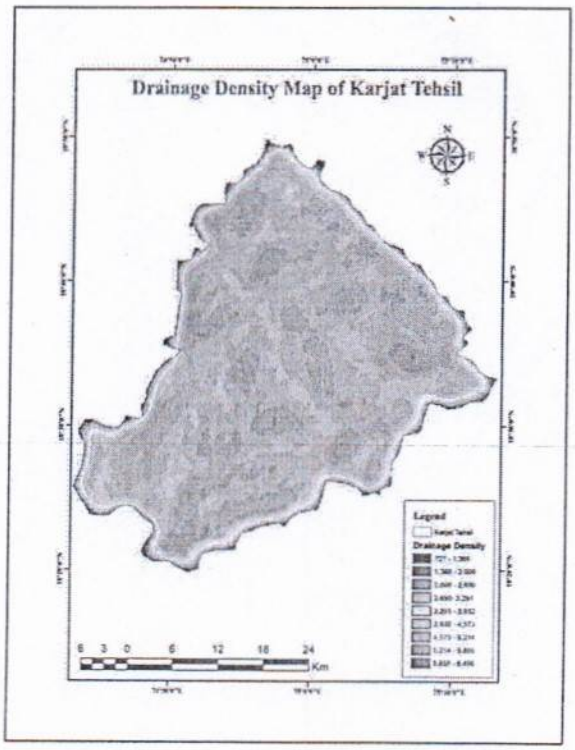


Fig.8 Drainage Density Map of Study Area

*7. Land Use Land Cover*

The land use land cover is main features in the progress of groundwater resources; it is controlled runoff, evapotranspiration and infiltration. The tendency of agricultural lands, they reduce discharge and increase infiltration rate.

Land use land cover has direct influence on the runoff, evapotranspiration and infiltration, it is varies from one class to another. The LULC plays an crucial role for the identification and evaluating groundwater potential zone.

It is observed from Figure 2.4 that in the study area six types of land use land cover classes has been detected and mapped by visually interpreting the IRSP6 LISS III satellite data. Agricultural land is the major land use land cover class in the study area as it occupies about 76.32 percent of the total study area. This class is followed by built-up land and vegetation cover. Agricultural land has very gentle to nearly level slope which provides more time for rainwater to infiltrate. This category has a good potential for ground water recharge.

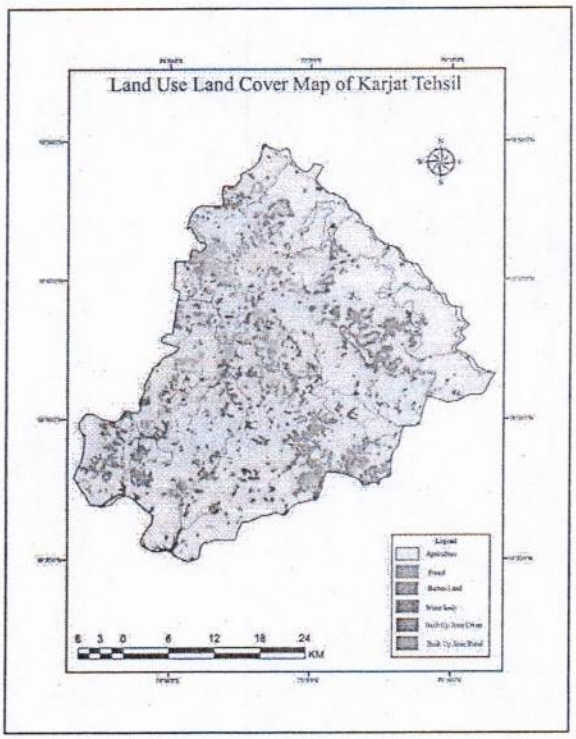


Fig.9 - Land Use Land Cover Map of Karjat Tehsil

Vegetation cover including open and dense forests along with social forestry occupied about 8.69 percent of the study area. This category is mainly located near the areas from where maximum runoff is generated and therefore provides excellent potential for arresting the runoff to augment the ground water storage. Built-up area occupies about 1.32 percent of the study area and due to the dominance of paved surface; it has very poor potential for ground water recharge. Barren land is another important category of land use land cover which covers about 12.20 percent of the study area. Due to the sufficient space and less public interference, this category provides excellent potential for the construction of artificial recharge structures though it is moderately favorable for artificial recharge. Remaining 1.47 percent of the land is occupied by water bodies and rocky waste. Rocky waste land has moderate potential for ground water recharge.

*Identification of Groundwater Potential Zones*

The groundwater potential zones for the study area were generated through the integration of various thematic maps such as geology, geomorphology, landuse and land cover, Lineament density, drainage density, slope, Soil etc. by using GIS and Remote sensing techniques. All thematic layers comprises of a number of polygons, which relate to different features.

The groundwater potential prospect zones are gained by using weighted overly analysis method by using of spatial analysis tool in Arc GIS 10.1. In the weighted overlay analysis, the rank has been given for each distinct parameters of the each and every thematic map and weight is allotted according to the influence of the different parameters. The weights and rank have been taken considering the works carried out by researchers (Krishnamurthy *et al* 1996) to the influence of the different parameters.

Finally, Karjat tehsil has been classified into four zones on the basis of their groundwater potential zones such as good, moderate, poor and nil yield characteristics along with geological, geomorphological and hydrogeological information.

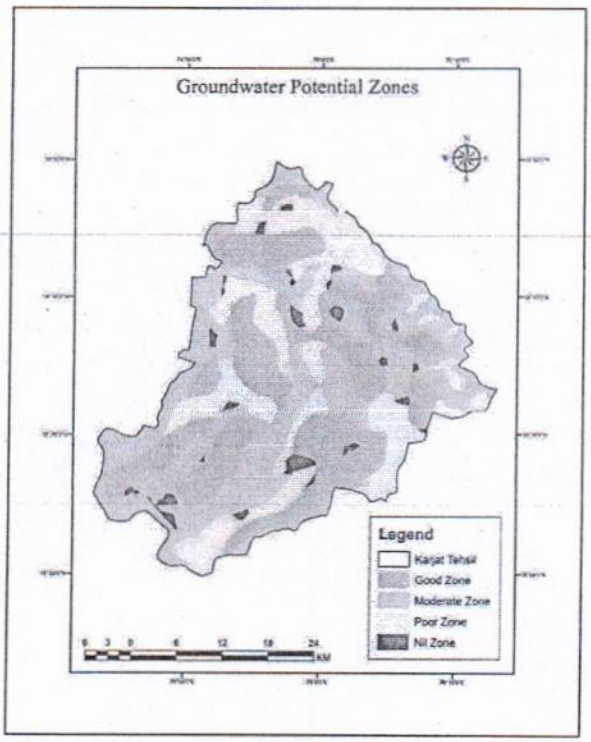


Fig.10- Groundwater Potential Zone Map of Karjat Tehsil

On the basis of hydrogeological, hydro-geomorphological studies, the study area can be broadly classified into four categories Good, moderate, poor and nil or very poor potential zone. The groundwater potential map shows the good potential zones are seen in southern; this area covered by agriculture, which have very high infiltration rate. Eastern and south western part of study region depict moderate potential zone.

Table No. 1 Groundwater Categories and Weight Value

| Sr. No. | Groundwater categories | upper weight value |
|---|---|---|
| 1 | Good | 121-Above |
| 2 | Moderate | 81-120 |
| 3 | Poor | 41-80 |
| 4 | Nil | 0- 40 |

The northern and central area was covered by poor groundwater potential zones. Negligible small areas are found everywhere they indicates nil or very poor groundwater potential zones. The groundwater potential zones are shown in figure no. 2.5

## VI. CONCLUSION

Identification the groundwater potential zones in Karjat tehsil of Ahmednagar district, Maharashtra. The groundwater potential zone map is produced by using six thematic maps from satellites images, exiting data and field data. It is identified as the groundwater potential zone which result mapping shown in four category- Good, Moderate, Poor and Nil. This study has shown that huge spatial variability of groundwater potential. This variability closely followed variability in the structure, geology, geomorphology, soil, slope and land use and land cover in the research area. The most securing potential zone in the area is associated to geomorphology of which is effected, by distribution of rainfall, runoff, drainage density, water percolation etc. Most of the zones with Good to Nil groundwater potential lie in the plain geomorphic feature.

This study normally reveals that GIS and RS techniques in combination with field survey data could be utilized for the identification of groundwater potential zones in an area. It can be considered as a time and cost-effective tool for demarcations and identification of high groundwater potential target area.

The final normalized weight of each pixel in the resultant integrated layer is the result of the combined effect of the weights of each thematic layer and their sub categories. These weights of the integrated layer are used to classify the study area into 'Good' (121-Above), 'Moderate to Good' (81-120), 'Poor Favorable' (400 – 80) and 'Nil Favorable' (00 – 40) zones for artificial recharge. It is found that about 38.14 percent of the study area comes under good, 26.52 percent has moderate, 32.00 percent area has poor conditions and 3.37 percent area Nil for artificially recharging the ground water. The analysis further reveals that the good and poor favorable zones are mainly characterized by the dominance of unconsolidated material deposition fluvial origin with loamy calcareous and clay textured soil and agricultural land. It provides high primary porosity leading to the generation of favorable condition for artificial recharge.

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