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Hydrogeomorphological mapping using geospatial techniques for assessing the ground water potential zones

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Abstract:

Since the surface water resources are inadequate to meet the needs of the society it is essential to extract ground water and use it instead of the surface water. Hence, we need to find the potential zones of groundwater extraction. The present study is an attempt to delineate the groundwater potential zones in the area mondigere miniwatershed, South India. Using integrated approach of Remote sensing and GIS techniques. various geological and geomorphological factors play a major role in in the movement occurrence and potential of groundwater sources. Survey of India (SOI), Topographic maps and Landsat TM satellite image are used to prepare various thematic layers such as geomorphology, geology, drainage pattern, liniments, slope and soil which are responsible for the occurrence, moment, yield and quality of groundwater. Thematic layers are then integrated by ERDAS image processing software and by employing raster calculator in in arc GIS software. Groundwater potential index for the study area is generated with the help of groundwater potential map.

Keywords — Groundwater, Remote sensing, Ground water potential zones, geomorphology, GIS

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I. INTRODUCTION

Groundwater plays an important role in the food security and economic development in the world and it is essential for human life as increasing population and human activities around the world it is necessary to locate the groundwater potential zones and to study their properties.

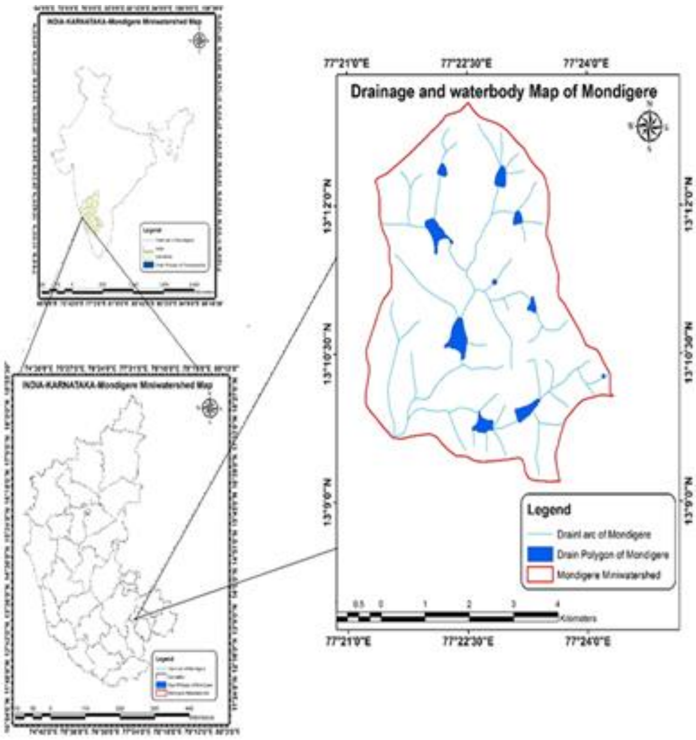
Rapid urbanization on the earth leads to the over exploitation of groundwater resulting in Rapid decline of groundwater levels in the some areas it is crucial to understand the behaviour of groundwater and employing some procedures for management of groundwater resources. As ground water is a main supply for most of population and its use significantly increased during adverse events. There is an immense on Aquafire systems which contributes to rapid loss of groundwater storage, when the balance between recharge and extraction don't reach to the required level.

In a study conducted by NASA reveals that third of vast groundwater resources are in immense stress and they are threatening regional water security. In India major activities like agriculture, industries and drinking water are dependent on groundwater. According to world bank in India 60% of agricultural activities and 85% of drinking water supplies are dependent on groundwater resources, 60% of all aquafires will be in critical condition within 20 years. Therefore knowledge regarding ground water storage plays an important role in in compensation of hydrological cycle connection with changing climate.Remote sensing and GIS are helping in productive delineation of groundwater potential zones over the years

II. STUDY AREA

The Mondigere miniwatershed (study area) forms a part of Cauvery basin and lies between north latitude 13°9′0" to 13°12′0" and east longitude 77°21′0" to77°24′0”. The study area covers an area of 24.97sq km covers major part of Nelamangala taluk and minor part of Doddaballapur taluk of Bangalore rural district. The study area was taken from survey of India (SOI) toposheet no.57G08.It lies in the region of Bay of Bengal and its catchment extends from Krishnarajasagar to Stanley reservoir, its sub catchment is LB Cauvery. Its lies in Kumudvathy watershed and sub watershed is Kempahalli, its mini and micro watershed are Mondigere and Lakkappanahalli.

Fig1. Study area map



III. LITERATURE REVIEW

1. A.C. Pandey, R.D. **Garg “Ground water prospects evaluation based on hydro geomorphological mapping using high resolution satellite images”**: A case study in Uttarakhand” (2007 JISR) This paper deals with Hydrogeomorphological mapping using remote

sensing data has been used conventionally for delineating ground water prospect zones in many regions.

2. Binay Kumar, Uday Kumar **"Integrated approach using RS and GIS techniques for mapping of ground water prospects in Lower Sanjai Watershed, Jharkhand"** (2020 IJGG)This paper deals with present information, depicted in the form of a prospect map would provide first-hand information to local authorities and planners about the areas suitable for searching ground water followed by its suitable exploration based on information given for type of well, well depth, water quality and success rate of wells.

3. Adiat, K.A.N, Abdullah, K. **"Assessing the accuracy of GIS-based elementary multi criteria decision analysis as a spatial prediction tool"** (2012 Journal of hydrology) this paper deals with the case of predicting potential zones of sustainable groundwater resources.

4.S Suganthi,L Elango,S K Subramanian **"Groundwater potential zonation by Remote Sensing and GIS techniques and its relation to the Groundwater level in the Coastal part of the Arani and Koratalai River Basin, Southern India"**(2013 ESRJ) this paper deals with the preparation of a map of groundwater potential zones using seven thematic layers, geology, geomorphology, soil, lineament density, drainage density, rainfall and land use.

5. G R Senthil Kumar, Shankar Karuppannan **"Assessment of Groundwater Potential Zones Using GIS"** (Frontiers in Geoscience 2014) This paper deals with the effectiveness of remote sensing and GIS in the identification and delineation of groundwater potential zones of study area.

6. N K Narayanaswamy,H C Vajrappa,Shivanna S,S B. Bramhananda **"Remote sensing and hydro geomorphological studies to evaluate ground water potential zones of dakshinapinakini river basin,chikkaballapura and Bangalore districts, Karnataka"** (July 2016 IJRET) this paper deals with the Detailed observation on the hydro-geomorphological conditions of the basin, it is possible to decipher the groundwater occurrence is moderate to good.

7. S.Hema,T. **Subramani "Application of remote sensing and GIS for demarcation of ground water potential zones in a part of Cauvery river basin, South india-Acase study"** (2017 Ecology, Environment and Conservation)this paper deals with the utility of remote sensing and GIS technique in delineating groundwater potential zones in highly variable terrains representing various geomorphic features/landforms.

8.Arjun Doke **"Delineation of the ground water potential using remote sensing and gis :a case study of Ullas basin, Maharashtra, India''**(2019 Sciendo)this paper deals with the different factors such as lithology, geomorphology, soil, drainage density, lineament concentration, slope, rainfall and land-use pattern used for identification of potential ground water zones.

9. Rayees Ahmad Shah, Suhail Ahmad Lone **"Hydrogeomorphological mapping using geospatial techniques for assessing the groundwater potential of Rambiara river basin, western Himalayas"** (2019 Applied water science) This study has recognized the interrelationships between the groundwater recharge potential factors and the groundwater recharge potential scores from the general hydrology characteristics of Rambiara river basin.

10. Khalid Benjmel, Mohammed Ouchchen **"Mapping of Groundwater Potential Zones in Crystalline Terrain Using Remote Sensing, GIS Techniques, and Multicriteria Data Analysis"** (2020 Water) this paper deals with the precise location of the boreholes and the determination of the most suitable operating flows.

IV. OBJECTIVES

- The main objective of this study is to evaluate the ground water occurrences in the study area using geospatial techniques like GIS and remote sensing.
- The present study is undertaken to prepare hydro geomorphological map and their characteristics.
- To identify and delineate suitable ground water potential zones through the integration of different thematic layers.
- To prepare a different thematic layer maps

V. METHODOLOGY

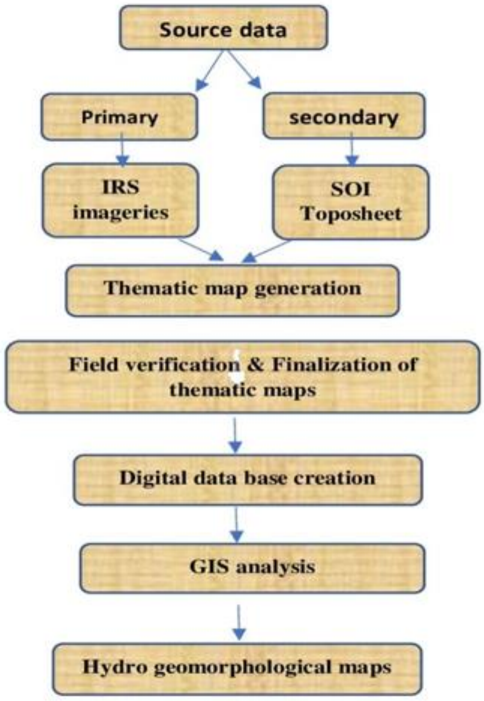


Fig2. Methodology

The methodology adopted in the current study area is shown in the above fig2. The base map of Mondigere mini watershed was prepared by using Survey of India(SOI), topographic maps on an average scale of 1:50000. The slope map of the study area was prepared from ASTER DEM in Arc GIS. Drainage map was also prepared in arc GIS 10.4.1 using Arc hydro tool. Drainage density, liniment density, and Lithological maps were prepared using the line density analysis tool in arc GIS software. Satellite data on a scale of 1:50000 is used for preparation of the thematic layers such as land-use/land cover, lithology and liniment maps These thematic layers were transformed into a raster format and brought into GIS environment. By using all these maps, the potential groundwater zones in the study area are located.

VI. RESULTS AND DISCUSSIONS

Groundwater potential zones were delineated by using various factors, for instance, geology, slope, geomorphology, drainage density, land use and land cover, soil texture and soil depth. The details about various influential factors have been discussed below.

1. Geomorphology

The geomorphic units Identified in the study area are Shadow weathered/Shallow buried pediplain, Valley fills, pediments, water bodies and residential hills as shown in the figure. Most of the study area is covered with shallow weathered/shallow burried pediplain covering 17.82sq km(71.37%)of total area, valley fills covers 4.148sq km(16.61%)of total study area, pediments covers an area of 1.60sq km(6.43%),water bodies covers an area of 0.78sq km(3.123%) and residual hill area covering an area of 0.614 sq km (2.46%). Shallow weathered /Shallow buried pediplain is a basement landform of the mondigere miniwatershed. Therefore, it is classified as moderate ground water possible zone.

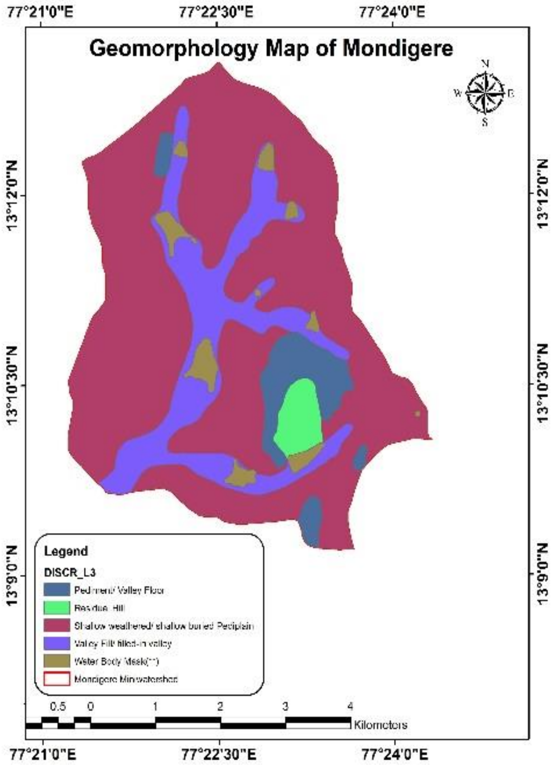


Fig3. Geomorphology map of mondigere miniwatershed

2. Land use/land cover

Land cover is defined as the physical characteristics of the earth such as vegetation, water, soil, and other physical features of earth. Land use is defined as the land used by humans for different activities. Changes in land use/land cover is one of the most important indicators for assessment of groundwater status in any part of the world. The different land use/land cover features observed in the study area are Agricultural Plantation, Barren Rocky / Stony Waste / Sheet Rock Area, Fallow land, Forest Plantations, Industrial Area, Kharif + Rabi (Double Crop), Kharif crop, Lake / Tanks, Land with scrub, Mining / Industrial Wasteland and Village.

- Agricultural plantation: it is the area under agriculture plantation.Trees such as coconut, vegetable garden,arecanut etc. are grown in this area.it is found to be 3.175sq km and comprises about 12.71% of the total area.
- industrial area: human activity in the form of industries like heavy metallurgical industry,thermal,cement plants come under this category.it was observed that the study area had 0.0133sqkm of industrial area which was 0.053% of the study area.

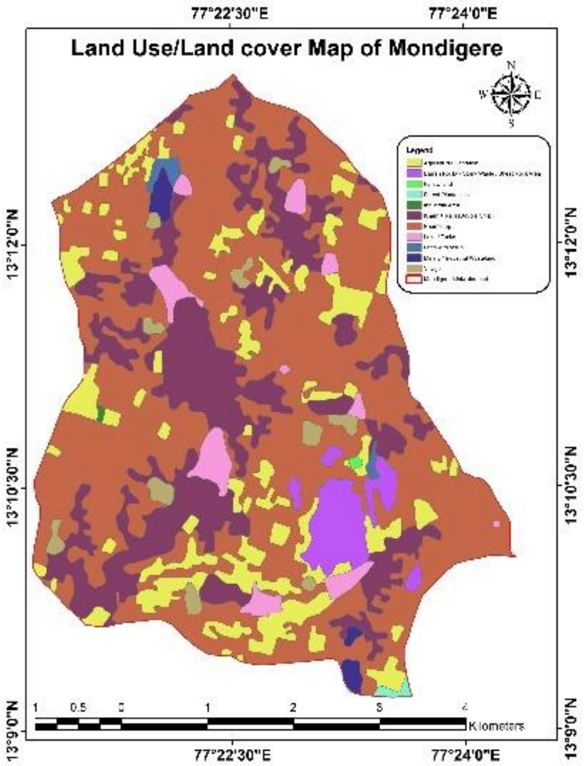


Fig4. Land use/land cover map

- Kharif and Rabi (Double Crop): These were the areas that were cropped during both kharif and rabi seasons that were often seen associated with irrigated areas. The study area highlighted that it had 5.356 sq km area (21.44%).
- Barren rocky: Barren rocks covers an area of 0.8638sq km (3.45%) of total study area.
- Kharif Crop: the crops which were sown during the kharif season comes in this area which is 13.983 sqkm(55.98%).
- Lake/Tanks: it is seen that study area has 0.7801 sq km of lakes/ tanks which is 3.12% of total area.
- Land with scrub: it is an area of land which is covered with low trees and bushes. It is covered for an area of 0.117 sqkm (0.468%)
- villages: it comprises an area of 0.443sqkm which is 1.776% of total area.
- Fallow land: fallow land comprises an area of 0.0169sq km which is 0.067% of total study area.
- Forest plantation: it is an area of land which is covered with planted trees.which covers an area of 0.0429sq km(0.067%) of total 24.97sq km area.
- Mining: mining covers an area of 0.213sq km (0.855%) of total study area.

3. Soil texture

Soil structure is defined as the proportion of sand, silt and clay sized particles that make up the mineral fraction of the soil. The overall study region covered by Fine covering 18.67sq km (74.78%), Clayey Skeletal covering 4.38sq km(17.55%), Habitation mask covering 0.663sq km (2.65%), water body mask covering 0.568sq km (2.275%), Sandy Skeletal covering 0.513sq km (2.12%) and rock outcrops covering 0.128sq km (0.51%) of total area 24.977sq km. The major part of the study area is covered by fine

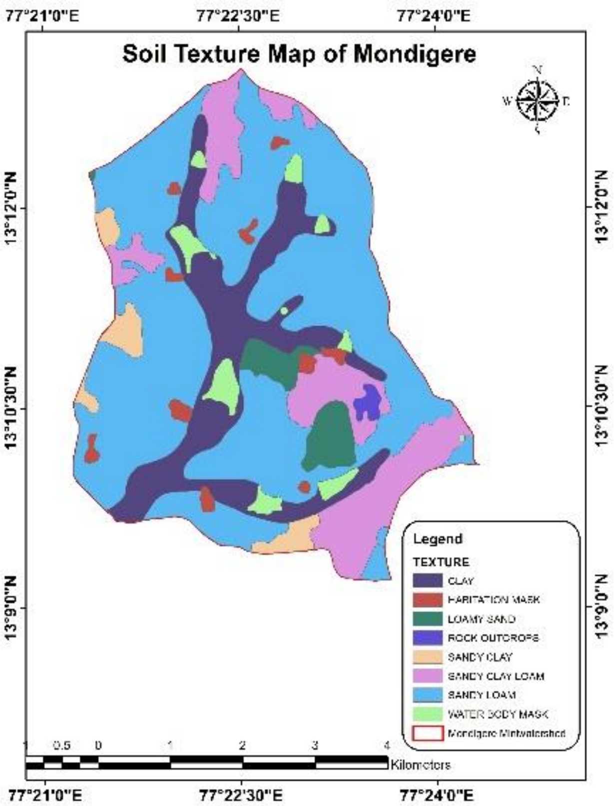


Fig5. Soil texture map of mondigere miniwatershed

4. Soil slope

The soil slope affects the flow of water on the earth surface, infiltration capacity and land stability of the soil. The different soil slopes in the study area are

Nearly level slope: The land having 0-1% slope is described as nearly level land. This class is mainly observed in plain areas with least undulations. About 8.41 sq km covers nearly level sloping out of 24.97 sq km of study area. Which is 33.68% of total area.

very gentle slope: This class covers the land with 1-3% slope and found mainly in plains, and it is associated with the nearly level slope. Very gently sloping occupy9.36 sq km (37.48%) out of 24.97 sq km of the study area. Major portion of the Mondigere miniwatershed falls under very gentle slope

Gentle slope: This class covers the land with 3-5% slope is described as gentle slope. This classis mainly observed in flat plains. About 6.23 sq km (24.94%) covers gentle sloping out of 24.97 sq km of study area.

Moderate slope: This class covers the land with 5-10% slope and it occupies 0.146 sq km (0.58%) out of 24.97 sq km of the total area.

Strong slope: This class covers the land with 10-15% slope and it occupies 0.339 sq km (1.33%) out of 24.97 sq km total area.

Moderate steep to steep slope: The surface with a slope of 15-35% is described as moderate steep to steep slope. This class occupies an area of 0.482 sq km (1.93%) of total study area.

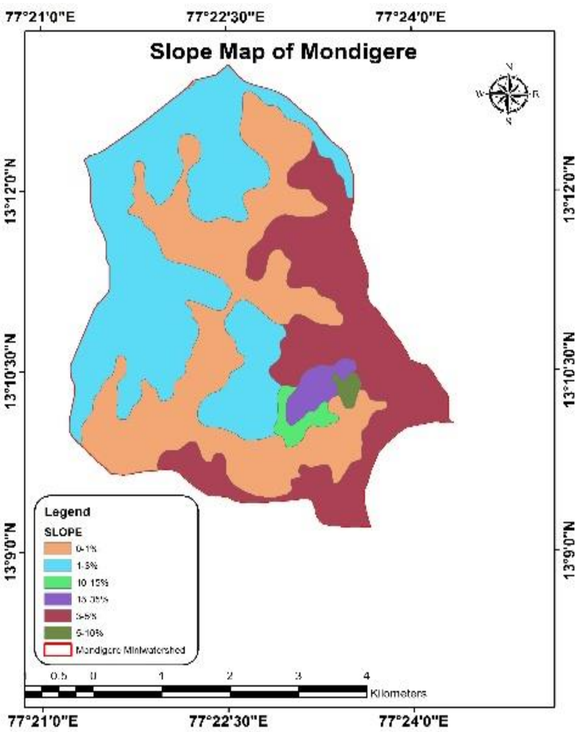


Fig 6. Slope map of mondigere miniwatershed

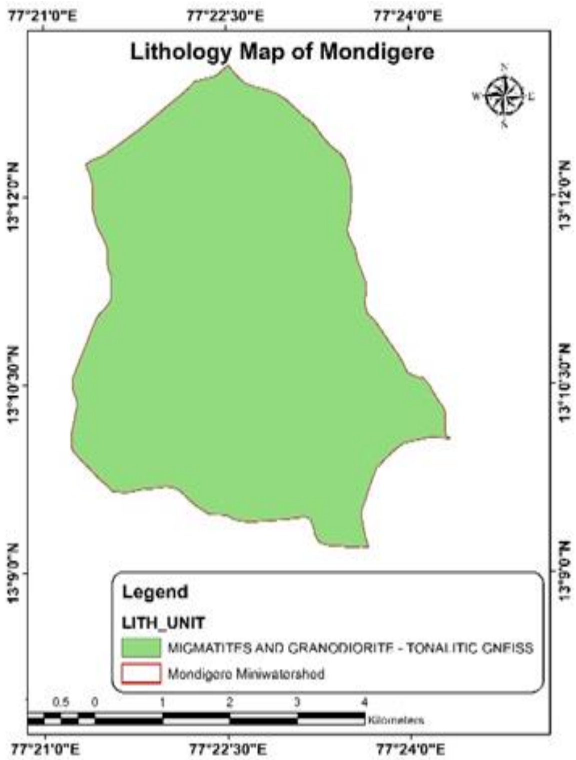


Fig7. Lithology map of mondigere miniwatershed

5. Lithology

Lithology is another important factor controlling the quality and quantity of ground water occurrences in the mondigere miniwatershed region. The lithology of the study area affects the hydrological properties of the aquifers. The lithology map of the study area is shown in the fig7. The study area is fully covered with migmatites and granodiorites – tonalitic gneiss.

6. Groundwater potential zoning

A distinctive analysis of the map indicates that the distribution is a considerable consequence of the lithological influence. Geomorphological units have remarkable impact on ground water potential zones valley fills indicate good ground water occurrence in the area. The groundwater potential areas were recognized by integrating different potential factors, including geological structures, lithology, geomorphology, slope, land use/land cover drainage in GIS environment. For the present study, the groundwater prospect map of the study area was prepared by integrating different thematic layers in GIS environment and is presented in Fig8. The study results show that the groundwater recharge potential zone of mondigere miniwatershed are into good, moderate, moderate to poor and poor.

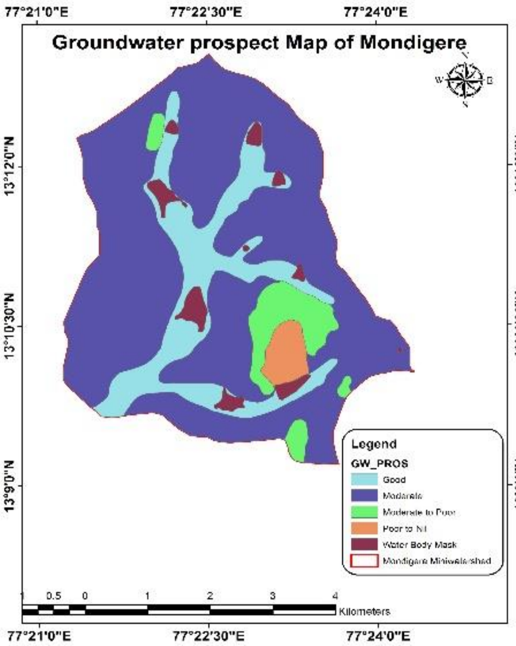


Fig8. Ground water prospect map

VII. CONCLUSION

A map of groundwater prospect map is prepared and the occurrence of groundwater in the Mondigere miniwatershed are are located. The groundwater prospect map is studied and it is observed that 16.61% of total study area is occupied with good groundwater,71.37% is occupied with moderate groundwater, 6.43% is covered with Moderate to Poor groundwater, 3.19 is covered with water bodies and 2.46% is covered with Poor to nil ground water. The most of mondigere miniwatershed is having moderate groundwater.

Groundwater potential zones	Area in sq km	% occupied
Good	4.148831	16.61
Moderate	17.827476	71.37
Moderate to Poor	1.606594	6.43
Poor to Nil	0.614575	2.46
Water Body Mask	0.797169	3.19
total	24.97762	100

Fig9. Ground water potential zones and corresponding area occupied

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