Identification of Groundwater Potential Zones using Geospatial Technologies: a Case Study

M. Hanisha, P.J. Chandrasekhara Rao, S.S. Asadi

Abstract:.--- Economic deeds ranging from agriculture to industry, Water is one of the key resources. In all climatic regions of India, ground water has become a very important source of water supplies due to its inherent qualities. To understand the occurrence, distribution and movement of ground water, mapping of geomorphological characteristics of the study area is important . This paper deals with a range of ground water potential zones in Amaravati capital city, Andhra Pradesh, India, for the estimation of ground water availability. In this work Remote sensing and GIS technique like overlay analysis is used to evaluate the ground water potential zones by using Landsat-8 2018 image and Toposheets from Survey Of India (SOI). By performing this analysis different phases of ground water potential zones will be identified i.e., good, moderate and poor. The results shows that the groundwater potential zones in the capital city are found to be useful in better improvement and managing of groundwater resources.

Index terms: Ground water, Remote sensing, GIS, Overlay analysis.

I. INTRODUCTION

Transportation The most existing and essential resource on the earth is water. Ground water is a god gifted natural resource for all the creatures on earth. It is a valuable resource which is widely distributed among the earth unlike any other mineral resources. Water resources of about 97.2% is salt water mainly in oceans and only 2.8% is available as fresh water among the worldwide at any time on the planet earth[4]

Groundwater, One of the most important natural resources which supports human health, economic development and ecological diversity. In all climatic regions of India, ground water has become a very important source of water supplies due to its inherent qualities. In a geological layer, ground water is a form of water occupying all the voids. Due to drought problem ground water is gaining more attention in present days.

risky, as there is no direct method for easy observation of water below the surface[5].Only by studying the geological and surface parameters the presence or absence of ground water can be identified indirectly.

Remote Sensing and GIS techniques are used to delineate ground water potential zones by overlaying thematic maps[3].Integration of remote sensing and geographic information system has proven to be quick and cost effective technique producing valuable data on geology, geomorphology, lineaments, slope, land use/land cover and drainage.

II. DESCRIPTION OF STUDY AREA

Amaravati is the new capital city of Andhra Pradesh, India. This planned city is located on the southern banks of the Krishna River in Guntur district, with in the Andhra Pradesh Capital Region, being built on a 233 sq km. It is designed to have green spaces of 51% and water bodies of 10%. Amaravati capital city is comprised of 26 villages. Capital City is being constructed to serve as the new capital city of Andhra Pradesh, after Telangana was split off as a separate state in 2014. The study area is covered in part of Survey of India toposheet number 65D/6, 65D/7, 65D/10, 65D/11 and is situated between 160 50' N, 800 15' E. The study area map of capital city is shown in Fig. 1.

III. OBJECTIVES

- To identify and delineate suitable ground water potential zones through integration of various thematic maps i.e., land use/land cover, slope, drainage, geomorphology, soil, rock map….etc, using GIS technique.
- To generate a GIS model from which the ground water potential zones will be delineated.

IV. METHODOLOGY

The methodology adopted to delineate ground water potential zones is shown in Flowchart 1.

A. Data Collection

The Different data products were collected for the study include SOI toposheets number 65D/6, 65D/7, 65D/10, 65D/11 on 1:50000 scale, Satellite data Landsat 8 downloaded from USGS website and collateral data collected from related Government organizations and demographic data. Here Fig. 4 shows the Mosaicked Toposheet of study area and Fig. 5 is Landsat - 8 2018 image.

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B. Preparation of thematic maps

Different thematic maps have been prepared from toposheets and satellite imagery by georeferencing them using ArcGIS 10.2 and ERDAS Imagine 2014 like Base map, Soil map, Geology map, Slope map, Geomorphology map, Drainage map, Land use/Land cover map and Drainage density map.

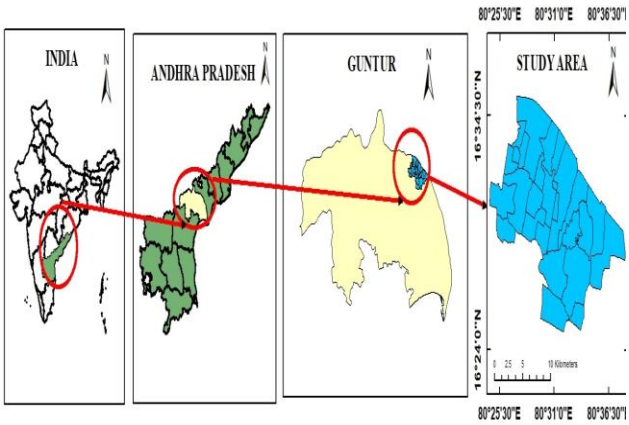

Fig. 1: Map showing Study Area

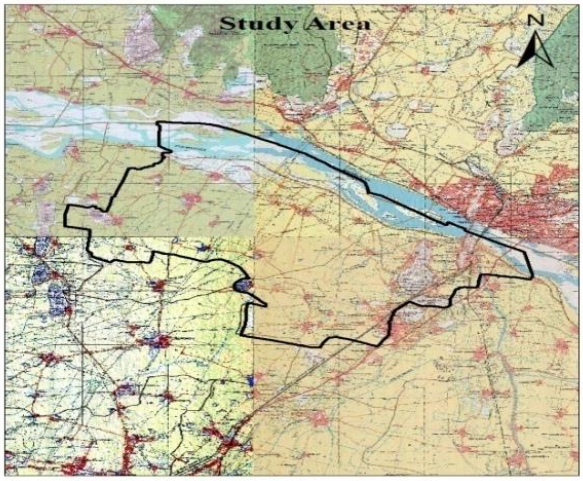

Fig.2 : Mosaicked toposheet of study area

C. Database development

The thematic maps generated were subjected to supervised classification in ERDAS Imagine 2014 and attributes were generated for each thematic map and the prepared thematic maps are overlayed using weighted overlay analysis tool in spatial analyst tools in Arc toolbox in ArcGIS 10.2.

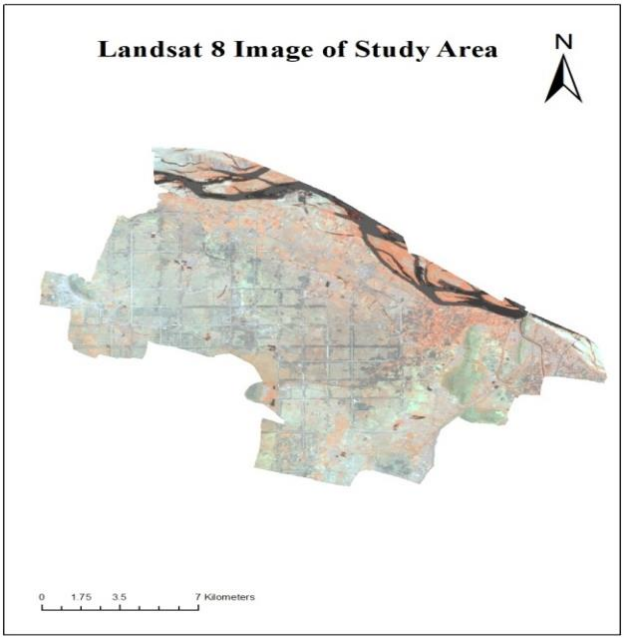

Fig.3: Landsat-8 2018 Image

D. Evaluation of groundwater potential zones

Ground water potential zones in the study area are evaluated by overlaying all the thematic maps using weighted overlay tool in ArcGIS 10.2. During the weighted overlay analysis, the ranking has been given for each individual parameter of thematic map and the weights were assigned according to the influence of their parameters. Table I indicates weights of parameters in weighted overlay analysis.

Table1: Weights of parameters in weighted overlay analysis

S. No	Parameters	Weights
1.	Land use/Land cover	28
2.	Slope	20
3.	Drainage Density	15
4.	Hydrogeomorphology	10
5.	Soil	14
6.	Geology	13

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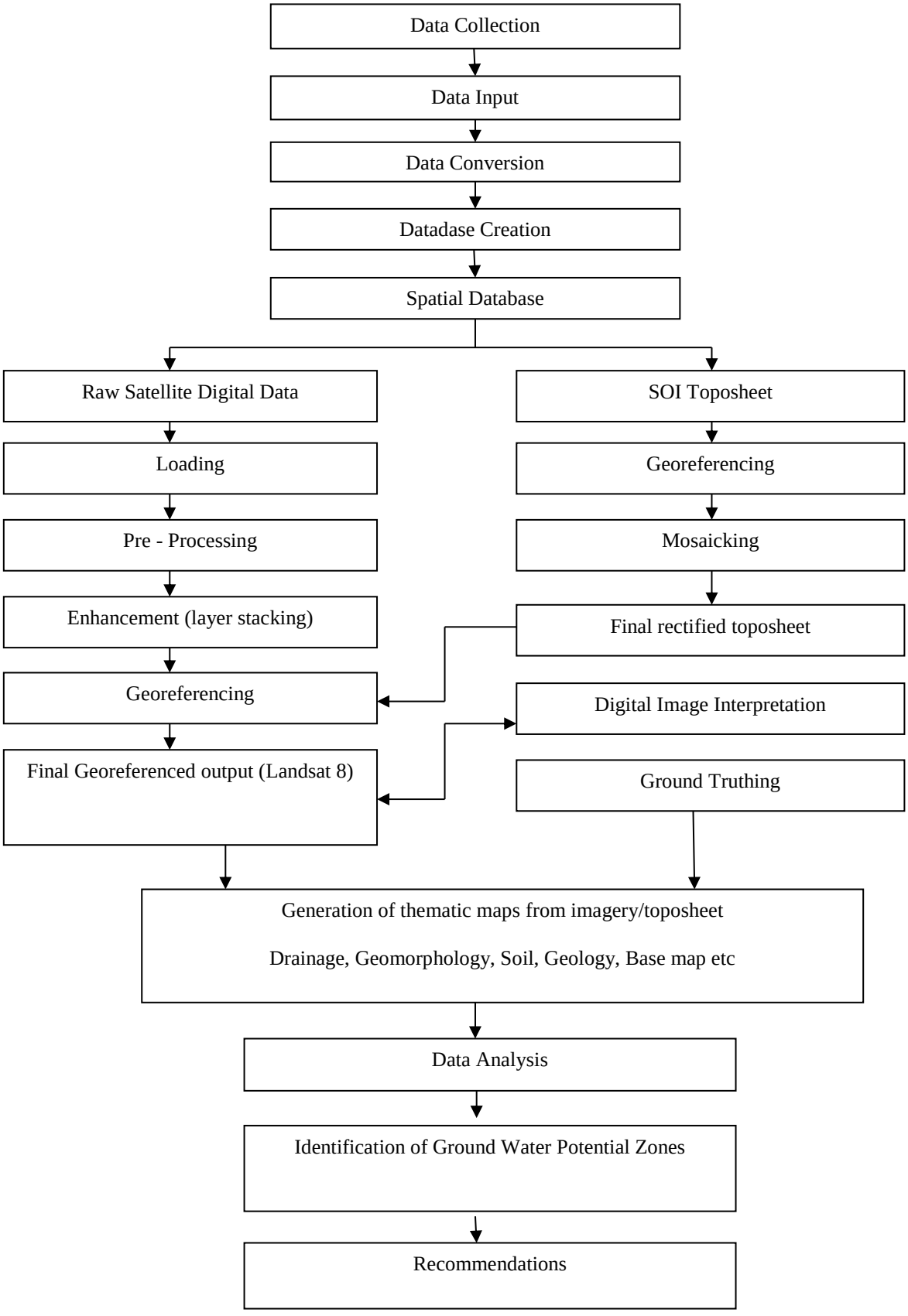

Flowchart 1: Flow chart showing methodology adopted for the present study

V. RESULTS AND DISCUSSIONS

The maps collected were geo-referenced and supervised classification was adopted to prepare different thematic maps using ArcGIS 10.2.

E. Base Map

Base map of the study area is prepared using toposheets collected from Survey Of India on 1:50000 scale using ArcGIS 10.2. Various features like water bodies, settlements, canals, road networks, contours, railway line, forest, bunds, grass lands. Base map of capital city is shown in Fig 4.

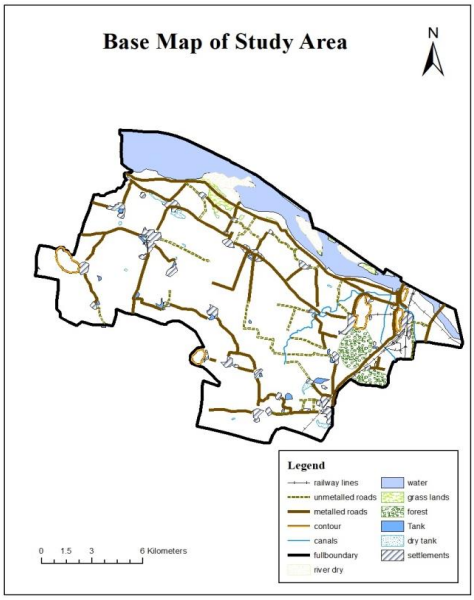

Fig. 4: Base map

F. Soil Map

Mostly clayey soils are observed in study area. Data has been obtained from Government Organization and spatial map has been prepared using ArcGIS 10.2. Clayey soils classification in the study area are clayey to gravelly moderately deep dark brown soils, loamy to clayey skeletal deep reddish brown soils, moderately deep black clayey soils. Due to presence of clayey soils infiltration will be less and runoff will be more. Soil map of capital city is shown in Fig. 5.

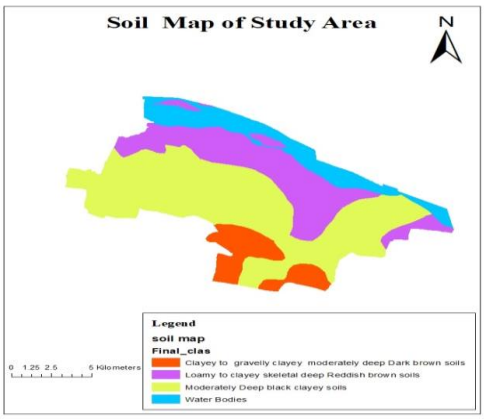

Fig. 5: Soil map

G. Geology Map

The rock formations founded in the area are metamorphic like charnockite, khondalite and alluvium sand/silt dominants. Rock data has been obtained from WRIS website. Rock data like major rock type has been identified and spatial map has been prepared using ArcGIS 10.2. Geology map of capital city is shown in Fig. 6.

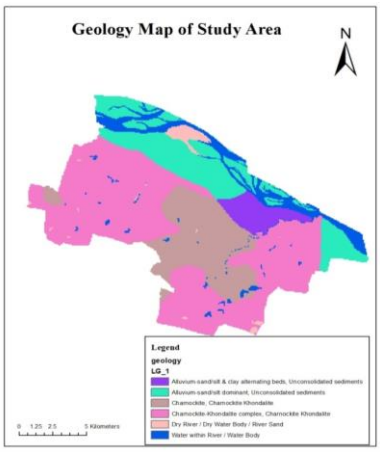

Fig. 6: Geology map

H. Land use/Land cover Map

Supervised classification has been done for Landsat – 8 image and the classes has been given using ERDAS Imagine 2014. Five classes of Land use/Land cover patterns are identified in the study area such as Forest, River dry, Settlements, Vegetation, Water. The major class occupied in the study area is vegetation. LU/LC map of capital city is shown in Fig. 7.

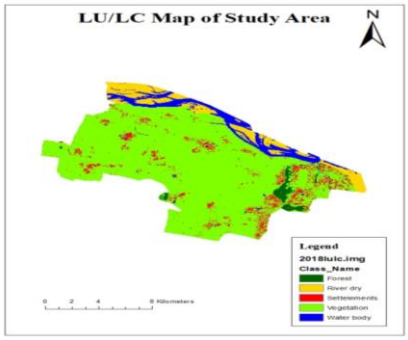

Fig. 7: Land use/Land cover map

I. Slope Map

Slope is the main factor which affects the ground water infiltration. If the slope is steep, runoff is more. If the slope is moderate runoff will be less and infiltration will be more. ASTER GDEM's .dem file is given as input to develop slope in ArcGIS 10.2. Five slope classes are identified in the study area i.e, Very steep slope, Very gentle slope, strongly sloping, Moderately to steep slope, Moderately slope. Slope map of capital city is shown in Fig. 8.

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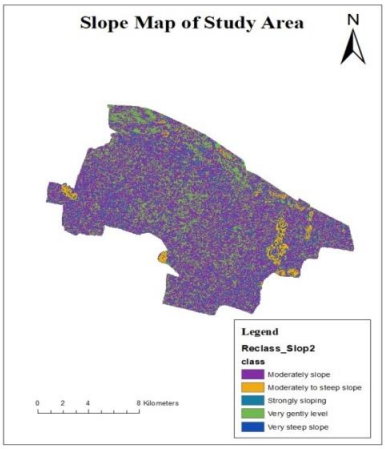

Fig. 8: Slope map

J. Drainage Map

Drainage map has been prepared by using hydrology tools in ArcGIS 10.2. ASTER GDEM's .dem file has been given as input and the drainage map is developed. The drainage pattern has been identified as Dendritic in the area. Drainage map of capital city is shown in Fig. 9.

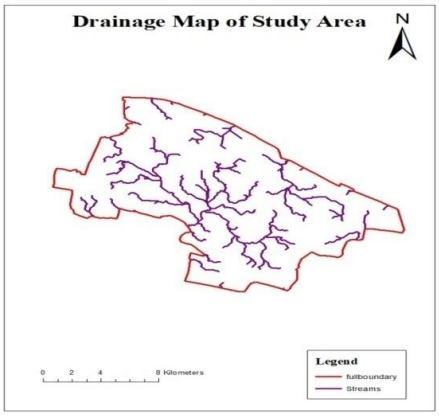

Fig. 9: Drainage map

K. Drainage Density Map

It is the ratio between the total length of all the streams and rivers in a drainage basin to the total area of the drainage basin. Density map is prepared in ArcGIS 10.2 by going to spatial analyst tool (Density – Line density) by giving drainage map as input. Drainage density map of capital city is shown in Fig. 10.

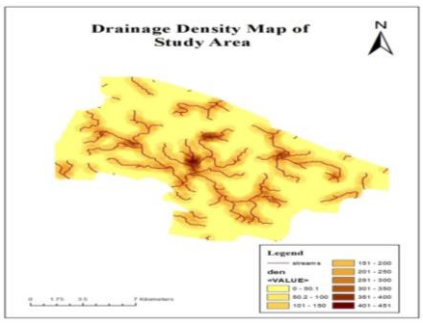

Fig. 10: Drainage Density map

L. Hydrogeomorphology Map

Hydrogeomorphological features in the study area found to be Channel Bar, Denudational Hill, Flood Plain Deep, Flood Plain Moderate, Inselberg, Paleochannel, Pediment, Pediplain Moderate Weathered, Structural Hill, Waterbody.

Channel Bar: It is an elevated region of sediment that has been deposited by the flow in a river.

Debudational Hill: It is moving water by ice, by wind and by waves, leading to a reduction in elevation and in relief of landforms and of landscapes by wearing away of the Earth's surface.

Flood Plain: It is an area of land which stretches from the banks of its channel adjacent to a stream or river.

Inselberg: It is an isolated hill or mountain which rises abruptly from a plain.

Paleochannel: It is a residue of an inactive river that has been filled by younger sediment.

Pediment: It is a broad, gently sloping inclined bed rock surface.

Pediplain: It is an extensive plain formed by the joiing or merging of pediments.

Structural Hill: It is a landform which extends above the neighbouring terrain.

Hydrogeomorphology map of the study area is shown in Fig. 11.

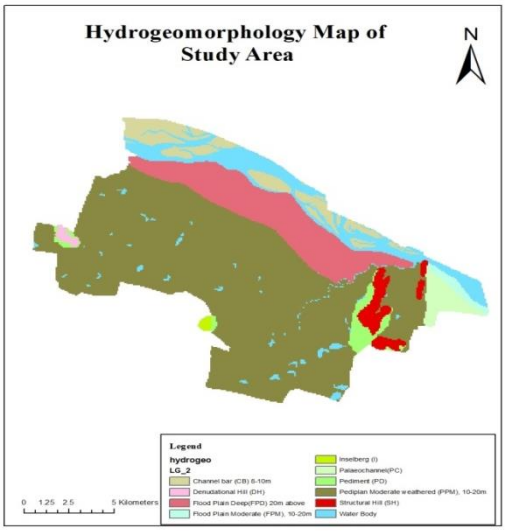

Fig. 11: Hydrogeomorphology map

Ground Water Potential Map

The final output ground water potential map is obtained by overlaying all the above thematic maps i.e, slope map, LU/LC, hydrogeomorphology, drainage density map...etc., by using weighted overlay analysis tool in ArcGIS 10.2 by assigning weights to each parameter by using Analytical Hierarchy Process (AHP) based on their influence on ground water. The ground water potential map is divided i to three zones based on water availability i.e, good, moderate, poor. Ground Water Potential map of the study area is shown in Fig. 12 and Table II shows areas of potential zones.

Table II: Areas of potential zones

S. No	Potential Zones	Area(sq.km)
1.	Good	26.4
2.	Moderate	187.3
3.	Poor	8.0

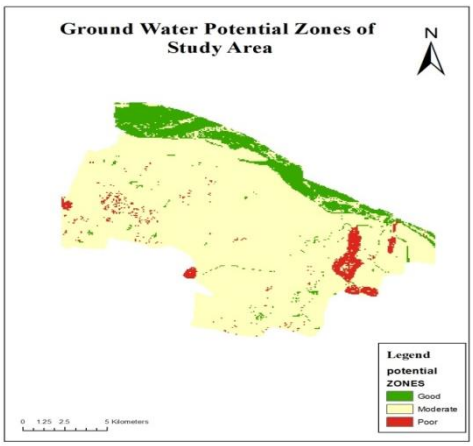

Fig. 12: Ground Water Potential Map of Amaravati Capital City

VI. CONCLUSION

In the present study, ground water potential zones in capital city are found to be good to poor. 26.4 sq.km of area comes under good zone, 187.3 sq.km of area comes under moderate zone and 8.0 sq.km of area comes under poor zone. Mostly, the study area has moderate zones. Present condition of ground water in Amaravati capital city is good. But in coming years due to development of capital city there used to be reduction in ground water levels. So, water management is necessary and more vegetation should be planned in the capital city so that there will be penetration of rain water in to the ground.

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