

**GIS ANALYSIS OF GROUND TRUTH, GPS AND GEOPHYSICAL DATA FOR  
IDENTIFICATION OF SUITABLE LOCALES OF RAINWATER HARVESTING:  
A CASE OF PERIYAR UNIVERSITY CAMPUS, SALEM DISTRICT, SOUTH INDIA**

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**ABSTRACT**

An attempt was made to identify suitable locations for establishment of rainwater harvesting (RWH) structures within the Periyar University Campus, by GIS analysis through use of data on lithology, physiography and spatial variation of soil zone, weathered zone and fracture zone. Accordingly, the area had been classified into three major categories viz., most suitable, moderately suitable and least suitable for establishment of RWH structures. In addition, the study had also demonstrated the efficacy of GIS analysis over conventional modes of interpretation for natural resource management and establishment of decision support systems.

**INTRODUCTION**

Water, though a renewable resource, due to its unequal distribution and improper management practices poses constraints in the form of inadequateness and poor quality. To overcome these problems, establishment of boreholes, dugwells and construction of percolation ponds and tanks are in practice. The yield of these structures may not be satisfactory since many of them lack scientific base in most of the regions in India (Yaduathiputty et al. 2000). Increasing the availability of water is possible only through application of techniques such as water harvesting and better water management. Rainwater harvesting is an important, useful and simplest cost effective method for water resource management (Ramkumar et al. 1993; Yaduathiputty and Raje Urs, 2005).

The Periyar University is located in an area of groundwater deficiency (Fig.1). During recent years, owing to rapid growth of number of research and academic departments and resultant higher influx of students, staff and visitors, Periyar University requires enormous quantity of water to meet the demand for domestic and laboratory and gardening usage. The demand neither can be met from Municipal water supply nor be met through borewells alone. Hence, augmentation of water resources through rainwater harvesting was mooted and formed the basis of this paper study. The rationale for such idea stemmed from the following fact.

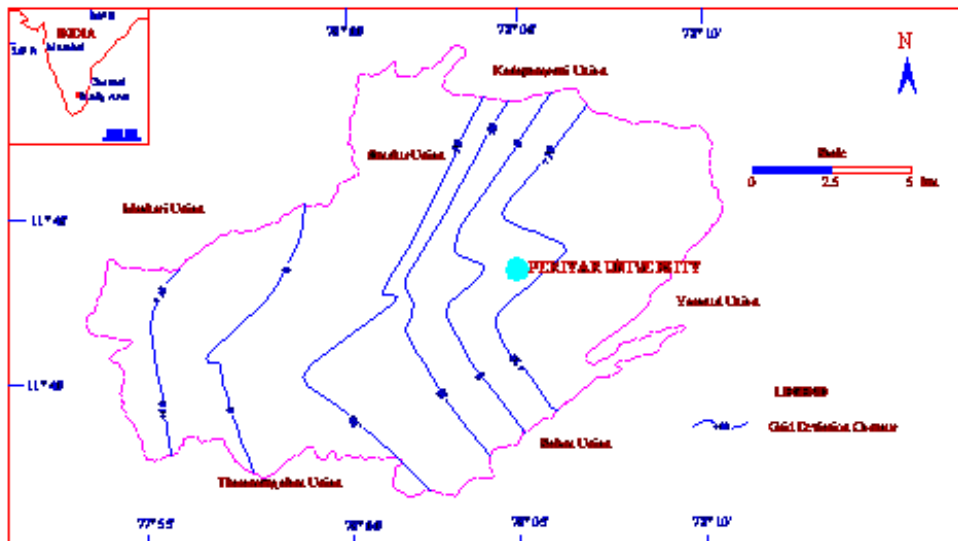
Multiplication of total area of the university campus (8000 sq.m.) with the average rainfall of this region (1146.8 mm/year/sq.m; *an average of rainfall occurred at Omalur Rain gauge station collected for the years 1994 to 2004*) gives an average estimate that a total of

9173.6 cubic meter volume of rainwater could be collected if proper rainwater storage systems are established by collection of rainwater within the University campus alone. Even if evaporation and transportation loss of 20% is considered, about 7338.8 cubic meter of rainwater can be collected annually. Even if 20 liters of usage per member (including students, staff, visitors) is considered an average population of 2000 that use water within University campus per day (including domestic and laboratory usage) of water per year would be about 14600 cubic meters (20 liter X 2000 people X 365 days) against the 7338.8 cubic meter collectible water through rainwater harvesting. From this statistics, it is understood that if proper RWH structures are established and stored, nearly half of the demand for water can be met from rainwater alone.

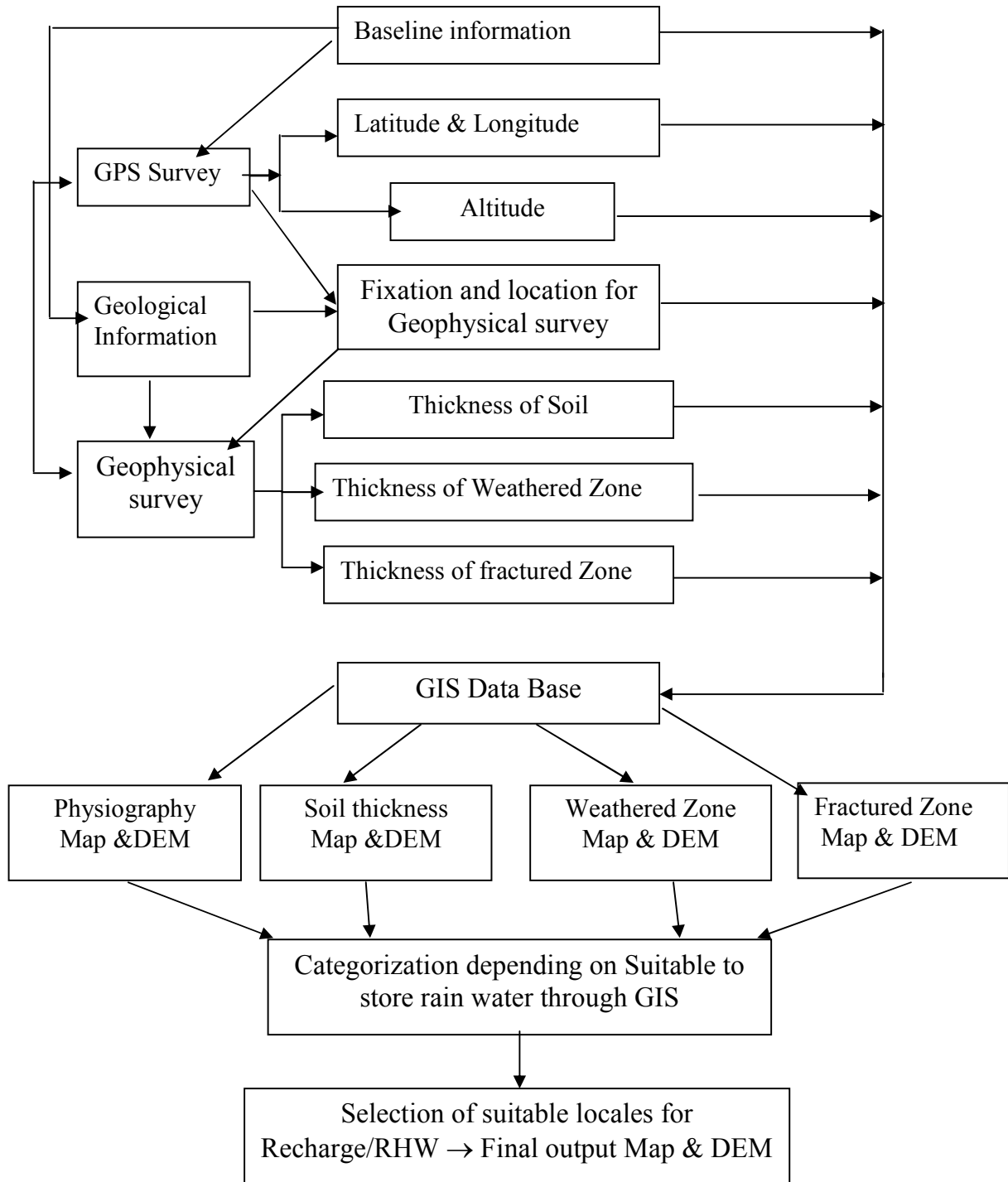
**STUDY AREA**

The study area lies between longitudes E 78° 04' 21.5'' and E 78° 05' 12'' and latitudes N 11° 43' 1.5'' and N 11° 43' 36.2'' and is part of toposheet 58 I/2, published by the Government of India in the year 1972. The Periyar University campus is situated along the National Highway No.7 about 10 km from the Salem city. It is located in Omalur Taluk of the Salem District (Fig.1). The University campus extends for about 100 acres, accommodating the administrative building, science and arts blocks, Periyar Institute of Management Studies, Hostel buildings etc. In addition, various developmental activities such as construction of auditorium, additional buildings for science departments are going on.

Fig.1. Map Showing Location of the Periyar University Campus and Depth to Water Table



**Fig.2 Systems approach depicting methods employed in the study**

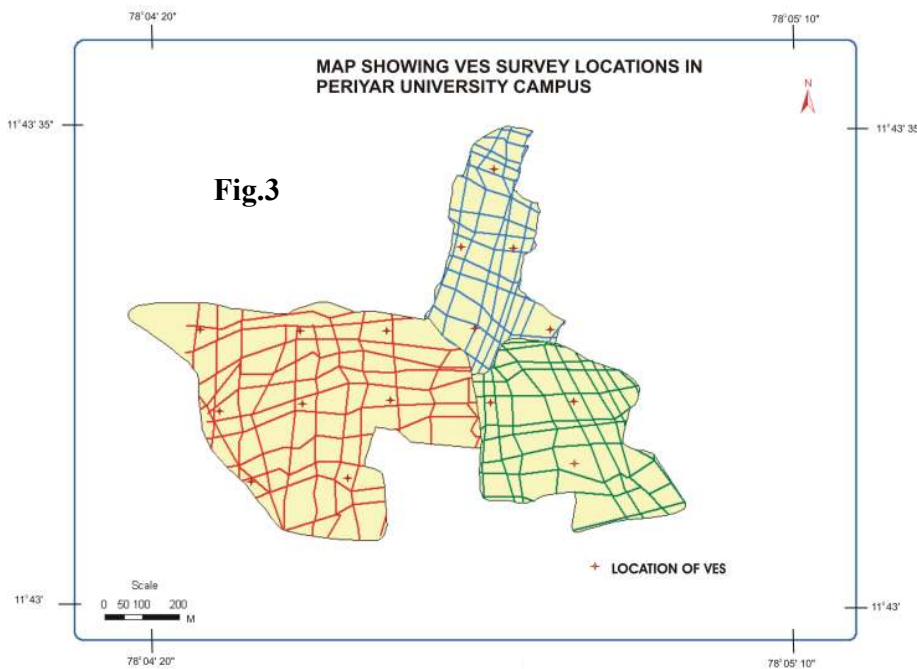


**METHODS AND MATERIALS**

Aim of the present study was to identify suitable locales for rainwater harvesting and storage within the Periyar University Campus area. It was achieved through three major

objectives namely, to document lithological distribution and physiographic setting of the Periyar University Campus, to recognize subsurface features and to integrate geologic, geophysical and other data through GIS. These objectives were met through the following.

- a. Delimitation of physical boundary of the Periyar University campus with the help of GPS and collection of latitude, longitude and altitude data through campus perimeter survey followed by systematic traverses along and across the campus.
- b. GPS survey was followed by selection of 16 locations spread all over the campus for vertical electrical sounding and its conductance.
- c. The primary data and calculated results of GPS and VES surveys were fed into GIS system for generation of thematic maps and interpretation of suitable locales of recharge/rainwater harvesting.



A systems approach involving these methods is presented in Fig.2. The GPS traverselines and the locations of geoelectrical sounding are shown in Fig.3.

## RESULTS AND INTERPRETATIONS

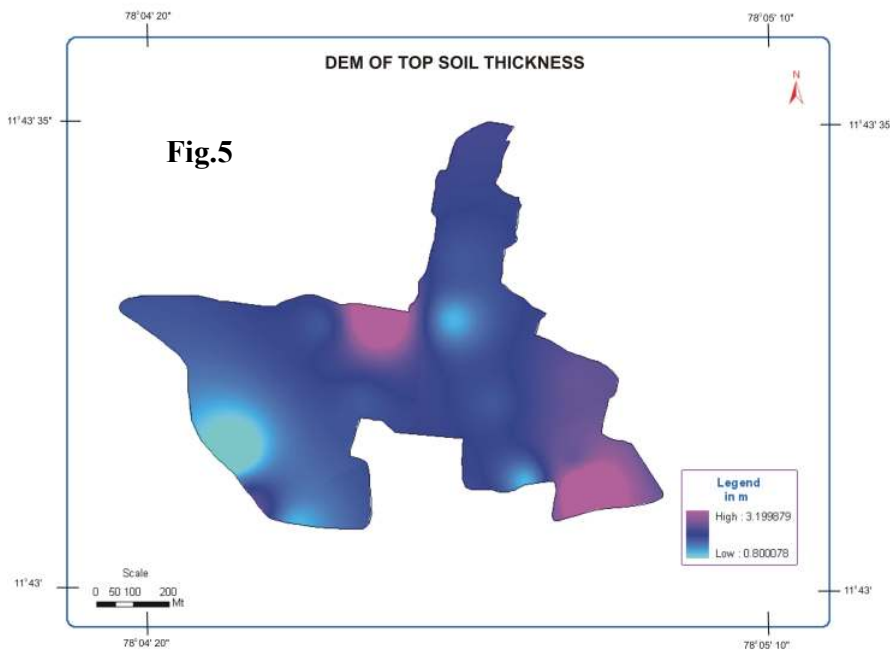
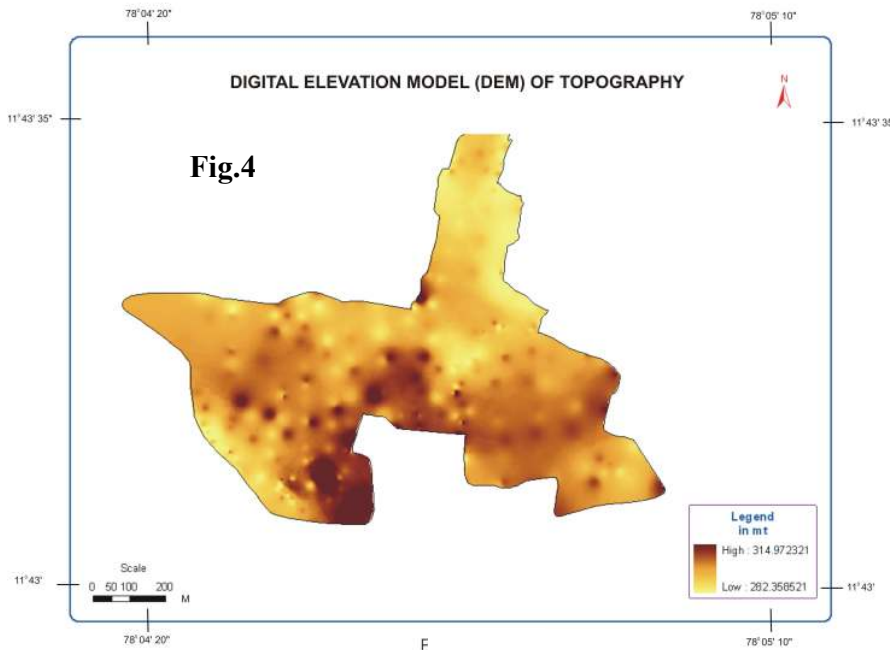
### Lithology

The University campus consists of unclassified peninsular gneiss and can be considered as a heterogeneous mixture of different types of granitic intrusions. Lithologically, whole of the university campus is uniform except in places wherein unaltered gneissic outcrops are situated. Being covered by gneissic terrain is itself a favorable situation as these rocks tend to have very high proportion of fractures developed during weathering. True to this inference, the dagwell sections located within the campus show highly fractured and jointed exposures in addition to highly interconnected porosity i.e., high permeability. As these pores are dry, location of recharge/RWH structure anywhere within the campus is suitable as per the lithological criteria of the study area.

## Physiography

First, accuracy of the GPS (Garmin make; e-trex model) was tested by taking readings

near known landmarks available within and near the University campus and checking the latitudinal and longitudinal and altitudinal values of GPS with Topographic map, University Campus plan and benchmarks. It was observed that, when the GPS shows good satellite coverage, (>5 satellites in contact) and displays a message “ready to navigate” and margin of error <8 m, the latitude, longitude and altitude values shown by GPS are falling within  $\pm 1\text{m}$  of topographic/ Campus map/benchmark values and thus, the survey was conducted only during display of these conditions.



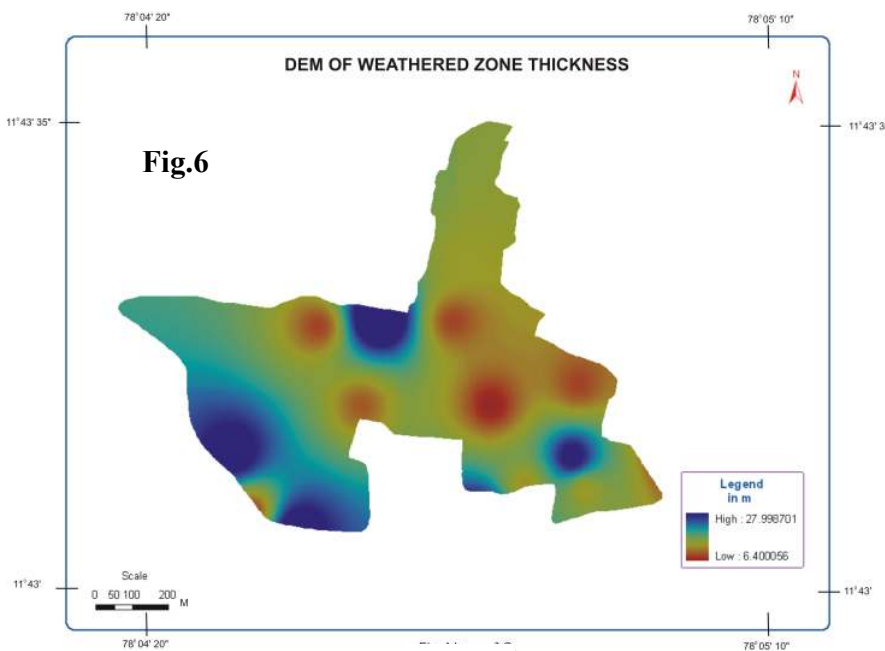
A perimeter survey was conducted encircling the campus area to delimit traverses. It was followed by traverses along and across the campus as depicted in Fig. 3. A total of 375 locations were fixed along, across and encircling the university campus. Altitudinal data suggests that maximum height of 315 m above msl and a minimum altitude of 282 above msl

are recorded for the Periyar University Campus with the present study. It is also observed from Fig. 4 that the University campus shows an undulating landscape scattered with minor-major high points of outcrops. In addition, a general slope of North and Southeast are also observed. In general, the campus area is of higher attitude along southern extremities and a gradual slope is observed towards northern, NE and SE directions. Hence, it is advisable to locate RWH structures along Northern, NE and SE boundary. Combination of inferences on lithology and physiography suggest the importance of targeting northern, NE and SE regions of the campus for RWH/recharge.

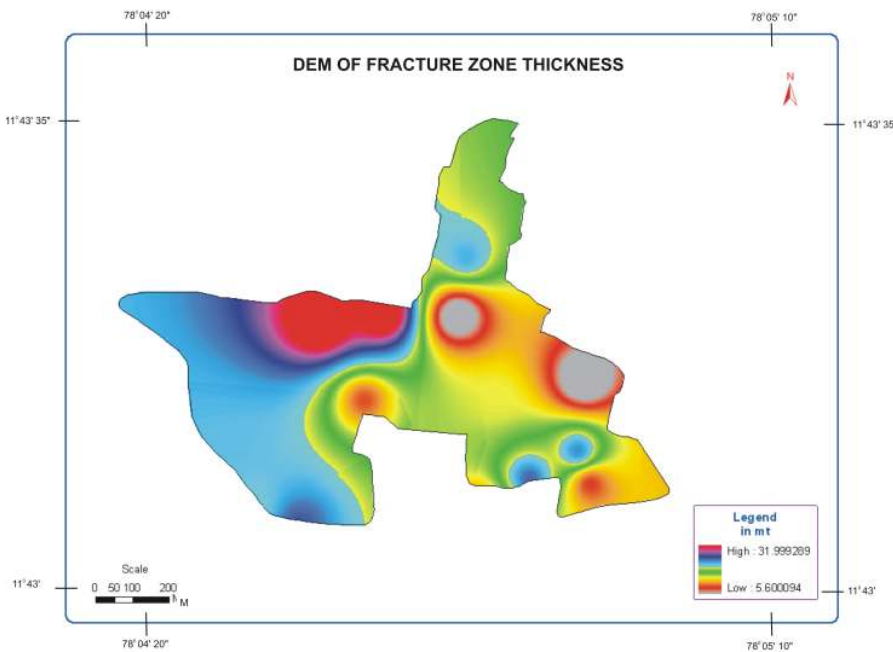
**Sub-surface characteristics**

From the GPS survey and field geological observations, sixteen locations spread all over the campus were selected for electrical resistivity survey (Fig.3) with a view to estimate depth to massive rocks, depth to fractured zone, depth to weathered zone and depth of soil

from below ground level (bgl). Purpose of conducting VES with this view is to locate highly fractured, weathered and very thick soil horizon, that may be suitable for recharge/RWH. VES was conducted for a maximum of 150 meters depth. The numeric data on thicknesses of



different layers as explicit in break/change in apparent resistivities are fed into GIS database together with latitude and longitude data to draw DEM of soil thickness (Fig. 5), DEM of weathered zone thickness (Fig. 6) and DEM of fractured zone thickness (Fig.7) to provide geographic extensions of these zones within the university campus.



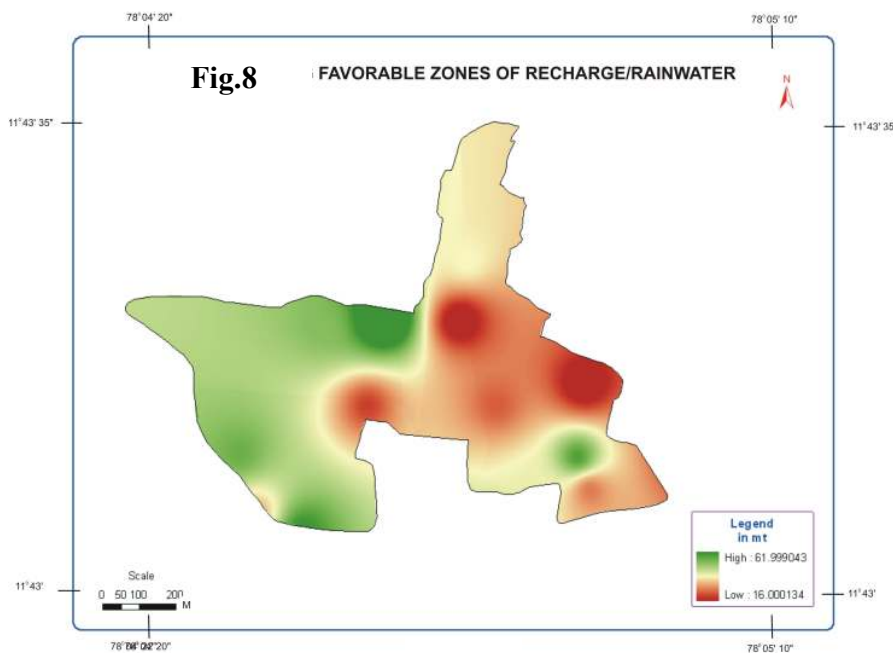
As depicted in Fig.5, the University campus has an uniform soil thickness of about 2 - 2.5 m with deeper soil sections scattered at southwest and north center regions. Least thickness of soil horizon occurs at southwest boundary. Weathered zone thickness varies from <10 m to >25

m (Fig.6). While the highest soil thickness zone located at north central region coincides with highest weathered zone, absence of such coincidence at southeast and occurrence of anomalously highly weathered zone at E - SE region indicates high variability of sub-surface features. Fractured zone thickness varies from <10 m to >30 m (Fig.7) while western part has an uniform fracture zone depth of 20 – 30m and the eastern half shows 10 – 20 m thick

fracture zone. In addition, there are few isolated deeper fracture zones located in eastern region.

### GIS Analysis

The objective of the present study being identification of suitable locales for groundwater recharge/rainwater harvesting, efforts were made to integrate the thematic maps into a



single map depicting areas wherein highly fractured, weathered and thick soil cover is

present. For this, all the thematic maps were superposed into a single map and a map showing high soil cover, fracture and weathered zone thickness was drawn (Fig. 8) These areas are also classified according to their relative capability defined in terms of the geophysical, topographic and subsurface features studied and the same are depicted in Fig.8.

It is interesting to note that the lake located along northern region of the University campus would have been the natural choice of RWH/Groundwater recharge, the studied parameters and GIS analysis portray an altogether different choice, expressing importance of studying surface and subsurface features before attempting any developmental activity, particularly the tasks such as identification of suitable locales of RWH/artificial recharge. In addition, the capability of GIS analysis to handle large voluminous and widely differing data types for micromanaging natural resource is also demonstrated with this study.

## **CONCLUSIONS**

- a.** The present study had identified most suitable regions wherein RWH structures can be established. The RWH systems if established within the University Campus can meet the demands of the growing needs of the University and also replenish groundwater resources. However, suitable modes of collections transport mechanism and means of channeling the rainwater to these priority areas have to be worked with before implementing RWH in the University campus.
- b.** While remotely sensed data together with survey data or other types of secondary sources of data are analyzed for many tasks including natural resource management and development of decision support systems through GIS, the scales of which are to an extent restricted within the resolutions satellite data, had shown that the GIS analysis can provide better and accurate results for natural resource management and decision support systems than interpretations largely based on visual or other modes of analysis.

## **ACKNOWLEDGEMENTS**

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