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Assessment of shallow Aquifer Potential zone using Electrical Resistivity Scanning Techniques Compare with Borehole Lithology in Western part of Lower Vellar basin, Chidambaram Taluk, Cuddalore, Tamilnadu, India

Dushiyanthan C.[1], Jeyavel Raja Kumar T.[1], Karthikeyan K.[2], Davidraju D.[3], Thiruneelakandan B.[1] and Suresh R.[1]
[1]Department of Earth Sciences, Annamalai University, Annamalai Nagar, INDIA
[2]Department of Civil Engineering, Annamalai University, Annamalai Nagar, INDIA
[3]Govt Engineering College, Tirunelveli, Tamil Nadu, INDIA

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Abstract

Six multi-electrode resistivity scanning techniques has been conducted shallow aquifer potential zone in western part of lower vellar basin. Geologically it comprises of alluvium and tertiary formations. Multi electrode resistivity scanning was carried out 250m using 50 electrodes by interspacing 5m using SSR-MP-AT-ME model resistivity meter and data were interpreted in surfer software. the interpreted scanning image represented maximum resistivity of 1000Ωm at nallanthethu and low resistivity of 60Ωm noticed at muthukrishnapuram, in other location the resistivity noticed 750Ωm .in order to identify moderate resistivity of >10Ωm to 60Ωm has been noticed sandy aquifer for the favourable aquifer potential zone at shallow depth to the interpreted resistivity scanning. The interpretation result compared with bore hole lithology to validate the results.

Keywords: Resistivity scanning images, SSR-MP-AT-ME, Groundwater, lower vellar basin.

Introduction

Groundwater forms one of the vital sources of potable water and the rate of withdrawal of groundwater is increasing due to faster growth of population. The recent changes in climate patterns highlight the need to secure reliable water supplies especially in areas where water is scarce. Consequently, there is an urgent need to monitor the changes taking place within the aquifer, and assess the threat to the drinking water supply. For that causes two complementary geophysical methods has been applied, Transient Electromagnetic method (TEM) and Vertical Electrical method[1]. The application of geophysical methods to study the groundwater for approaching and successfully solving the hydrogeological and environmental problems. Especially the geoelectric techniques have been successfully used to detect the fresh and salt-water interface in coastal aquifers[2]. Resistivity surveys are often used to search for ground water in both porous and fissured media. Resistivity methods are very sensitive to variations in earth resistivity, and are therefore useful for identifying lithological units. Such features and changes are usually highly significant with respect to groundwater occurrence[3]. Among geophysical exploration techniques, one of the most important developments in the geophysical exploration wide spread used for 2D and 3D resistivity survey[4].The electrical resistivity imaging method has been increasingly applied in geo-environmental investigations. This method provides information about resistivity distribution within the subsurface structures. It is commonly used by researchers for groundwater exploration and seawater intrusion, and proved to be successful in detecting the fresh and salt-water interface in coastal aquifers[5-8]. Electrical resistivity tomography techniques increasingly used to map groundwater formations[9] solving environmental problems. In this case study the multi-electrode resistivity scanning method has been used to assess the shallow fresh groundwater potential in a western part of the lower vellar basin.

Study Area: The study area western part of the lower vellar basin, Chidambaram taluk, Cuddalore district, Tamilnadu. It lies in the Survey of India (SOI) topo sheet no 58 m/11 the latitude is 11^0 25 to 11^0 30’ and the longitude is 79^0 30’ to 79^0 40’ as shown in figure-1. The study area is a flat plain, slopping very gently towards the sea on the east. Geologically the study area comprises of alluvium and Tertiary formations. The alluvium covers almost the entire area where as Tertiary formation occupied the northern side of the study area as shown in the figure-2, Geomorphologically, the area is covered by flood plain along the river course and remaining area by alluvial plain and coastal plain. Hydrogeologically, the district can be classified as hard crystalline rocks and porous sedimentary rocks. The study area comes under porous sedimentary formation of tertiary cuddalore sand stone, quaternary alluvium. Groundwater occurs in phreatic and semi confined aquifer down to 150m b.g.l yield 30 to 40 lps. Fresh ground water has been observed in tertiary semi consolidated sand stone of cuddalore series. The normal rain fall of the district receives southwest monsoon 373.6 mm and north east monsoon 716.5mm.

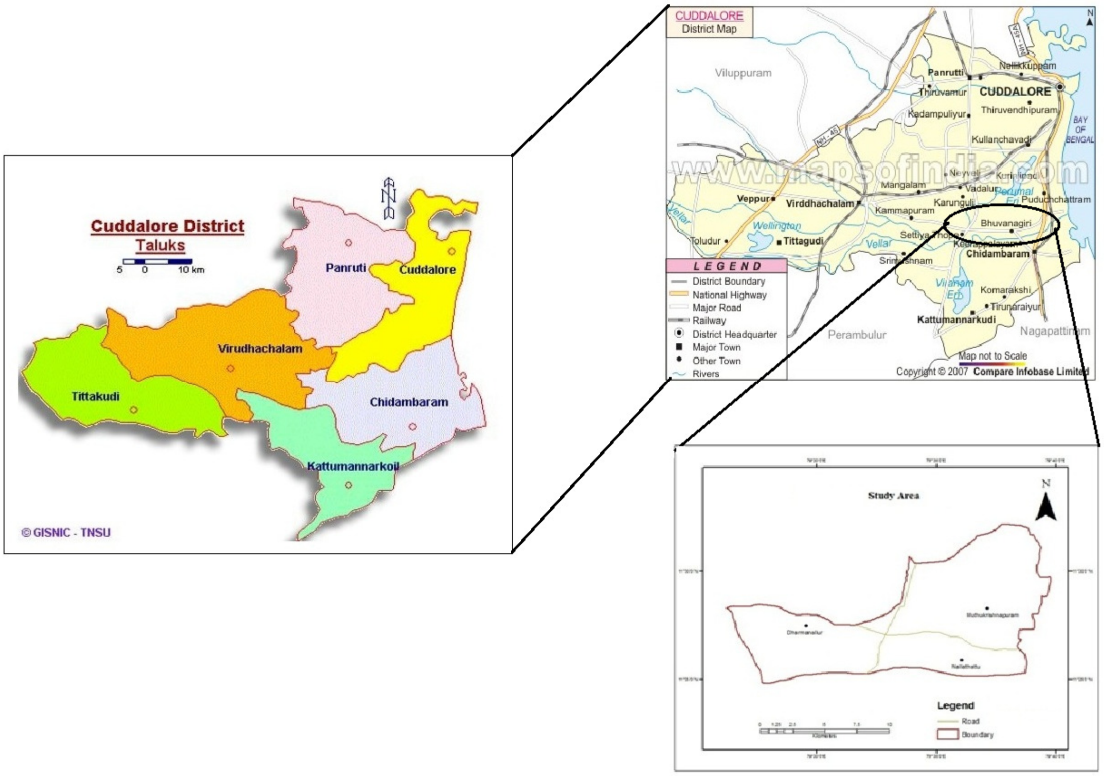
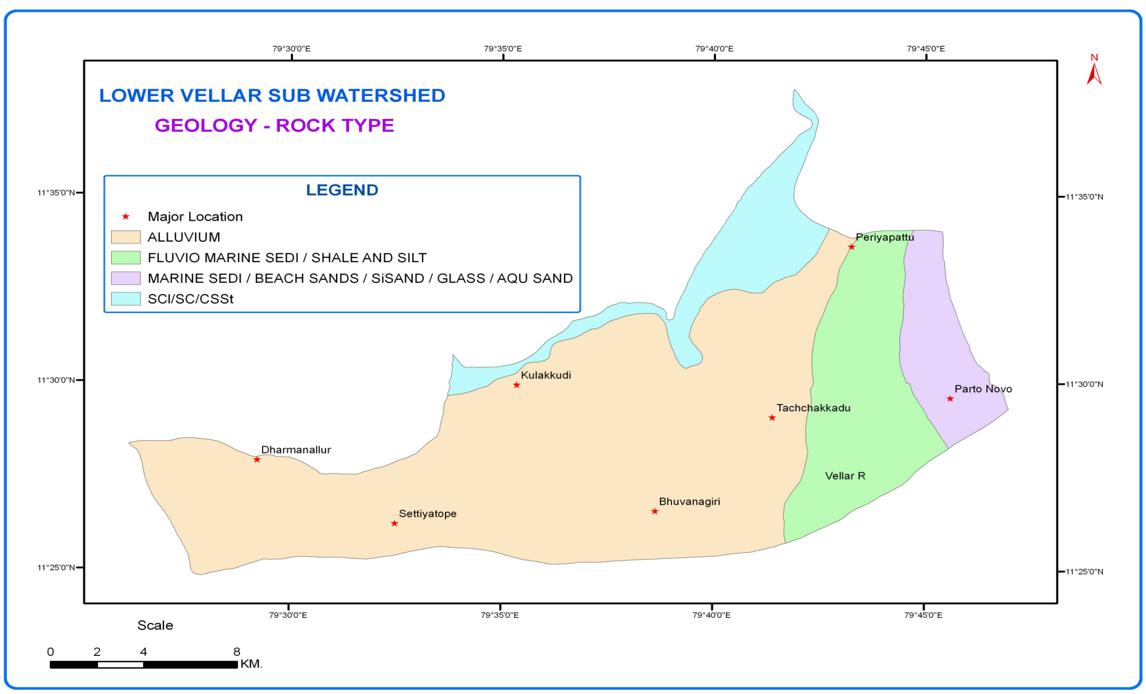


Figure-1
Study Area



Figure–2
Geology map of lower vellar basin

Methodology

Electrical imaging is a surveying technique for an area of complex geology where the use of resistivity sounding and other techniques are unsuitable for providing detailed subsurface information in a limited area[10]. In the present study, the shallow fresh groundwater potential level has been evaluated by electrical resistivity scanning technique. To understand the subsurface lithology and layer thickness, six electrical resistivity scanning were carried out on different locations shown in figure-3. The improvement of resistivity methods, using multieletrode array has an important development of electrical imaging system has been used in this experimental study. Electrical resistivity scanning were performed 250m along the traverse, using 50 electrodes connected to a multi core cable, each electrodes spacing 5 meters interval. The resistivity scanning measurements were collected by using SSR-MP-AT-ME model resistivity meter. The resistivity scanning image of pseudo section prepared on the basis of the apparent resistivity data. It is not representing the true distribution of intrinsic resistivity, rather gives a very approximate picture of the true subsurface resistivity[11]. The measured field data were transferred through IGIS scan software and interpreted by Surfer 9.0 software.

Results and Discussion

Multi-electrode resistivity scanning imaging surveys have been carried out at 6 locations to determine the shallow aquifer potential zone in the study area.

In Dharmanallur the resistivity varied from 1Ωm to 600Ωm figure-4a, from the surface to a depth level of 27m very low resistivity of <5Ωm was noticed due to presence of clay formation. There is a moderate resistivity formation of 20Ωm to 100Ωm was observed between the 27m to 50m presence of sand. Below the 50m depth from surface low resistivity formation extended up to the depth level of 60m.

In X road the resistivity varied from less than1Ωm to 750Ωm figure-4b, from the surface to a depth level of 10m the resistivity observed <10Ωm presence of clay formation. Below 20m the resistivity is gradually increased up to a depth level of 50m. The resistivity increased to a maximum of 60Ωm the low resistivity small patches are noticed below 50m. The low resistivity observed could be presence of sandy clay formation. Where the moderate resistivity followed by could be sand or semi consolidated sand stone formation. High resistivity >100Ωm due to presence of shale or calcareous rich.

In location Nallanthethu, resistivity varied from <5Ωm to 180Ωm (figure 4c), from surface to 20m depth a moderate resistivity of 20Ωm to 60Ωm, the low resistivity <10Ωm observed small patches were noticed below 20m depth. A resistivity zone of >160Ωm observed either side high resistivity zone. Where as a above 20Ωm indicate fresh water zone.

In Uluthur, resistivity varies from 1Ωm to 160Ωm figure-4d, from surface to 70m depth very low resistivity <10Ωm is observed. A moderate resistivity range 10Ωm to 60Ωm is noticed as a small pocket. The low resistivity highly thickness of clay or sandy clay formation.

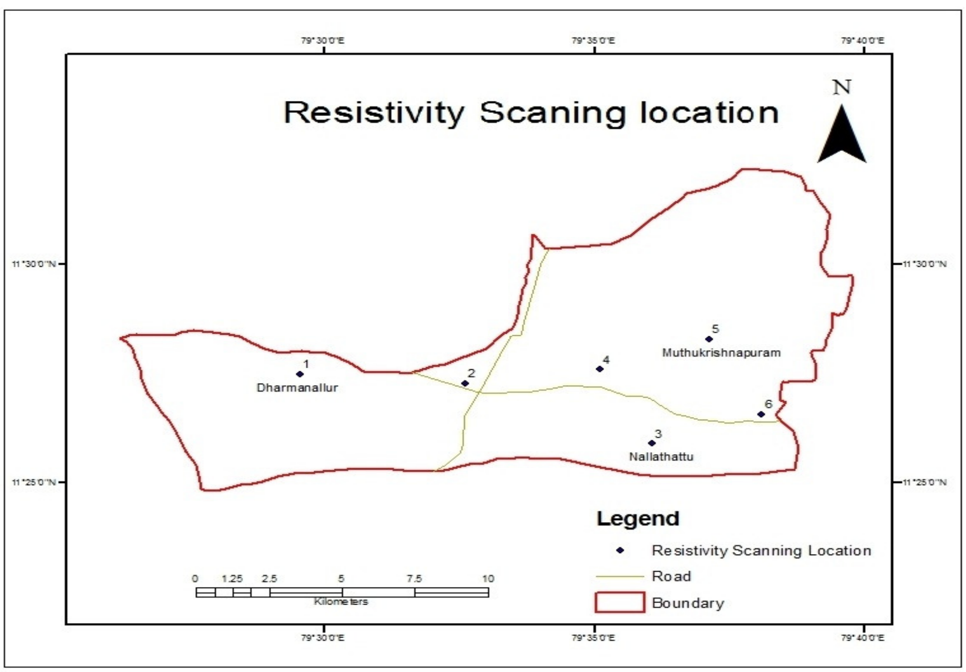
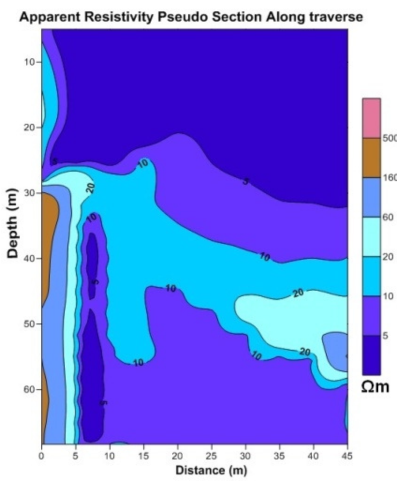


Figure-3
Scanning location

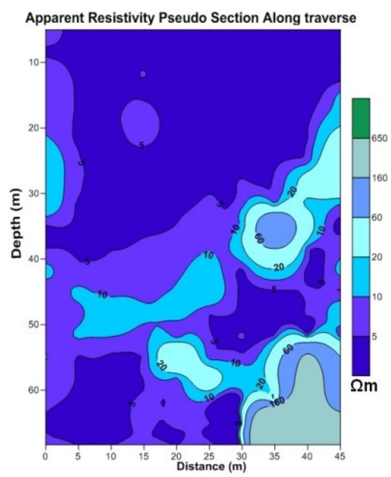
In Muthukrishnapuram, resistivity varies from1Ωm to 60Ωm figure-4e, a very low resistivity <10Ωm observed from surface to 70m depth, a small patches of >10Ωm to 60Ωm noticed at the depth of 30m, the low resistivity could b a sandy clay formation. The isolated patch may be fresh water zone.

In Suttukuzhi, resistivity varies from 1Ωm to 300Ωm figure-4f, from surface to 20m, a moderate resistivity 10Ωm to 20Ωm, and the same resistivity trend extended up to 60m depth .in between 20 to 50m depth low resistivity <10Ωm observed, the low resistivity indicate sandy clay formation. The moderate resistivity zone >10Ωm to 60Ωm favourable for fresh groundwater potential zone.

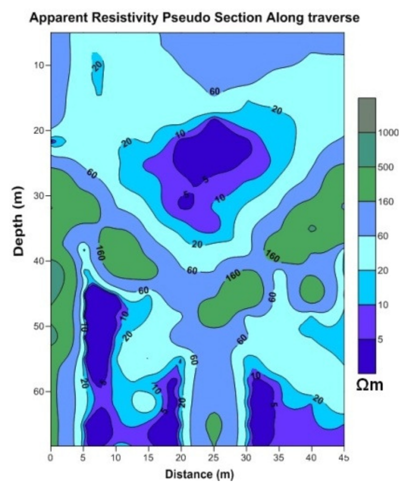
To establish that the validity of resistivity scanning to determined layer thickness, it is correlated with existing bore-hole lithology of marudhur village, which is northern boundary of the study area, the drilled bore-hole depth of 500m.the existing bore-hole lithology data collected from cuddalore district profile. In this correlation maximum depth of resistivity scanning interpretation has been taken for validation. The maximum depth of 70m is taken for resistivity scanning interpretation for correlation. This is noted in muthukrishnapuram figure-4e, in the borehole lithology top layer from surface to 31.6m sandy clay formation, followed by 6.3m thickness of sand stone, subsequently below 37.9m clay sandy clay formation. From this interpretation it is able to differentiate the sandy clay, sandstone and formation, however the interpretation data of thickness is relatively matched with existing bore hole lithology in the resistivity scanning image of muthukrishnapuram figure-5.



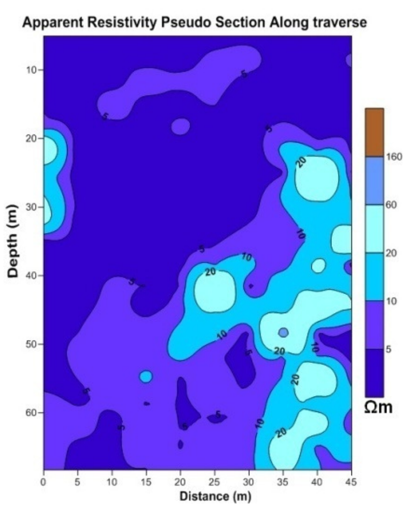
4.a.Dharmanallur



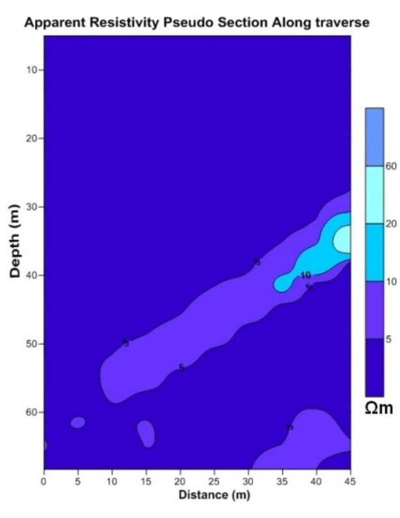
4.b.X road



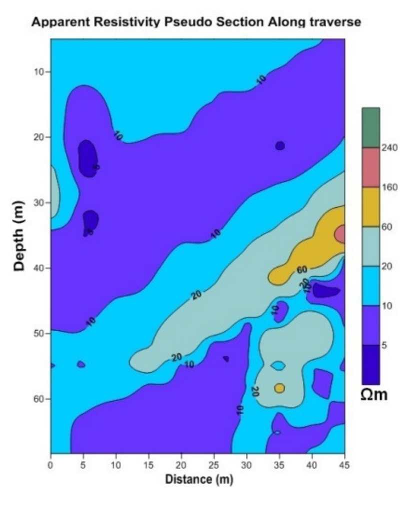
4.c.Nallanthathu



4.d.Uluthur



4.e.Muthukrishnapuram



4.f.Suttukuzhi

Figure-4 (a,b,c,d,e,f)
Resistivity scanning image

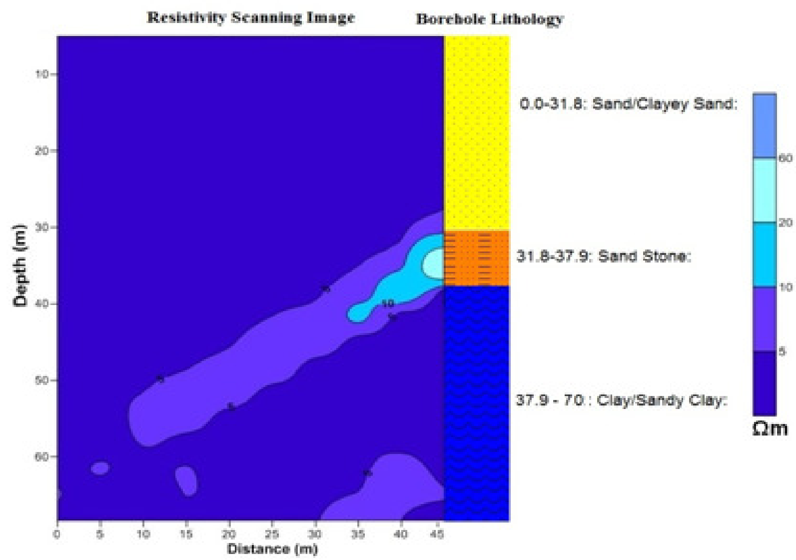


Figure-5
Correlation of resistivity scanning and borehole lithology

Conclusion

The study area subsurface lithology and layer thickness can identify fresh groundwater potential zone. The electrical resistivity scanning imaging is effective for delineating the groundwater aquifer potential zone. Hence, the low resistivity value claysandyclay formation and the high resistivity value could be possible due to presence of sand or sand stone formation, the resistivity value possible for compare with existing borehole lithology. The resistivity scanning image clearly shows shallow fresh water zone Nallanthethu and Suttukuzhi below the depth 10m.

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