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RESEARCH ARTICLE

DELINEATION OF GROUNDWATER POTENTIAL ZONE BY USING GEOPHYSICAL ELECTRICAL RESISTIVITY INVERSE SLOPE METHOD IN THE KADAYAMPATTY PANCHAYAT UNION, SALEM DISTRICT, TAMIL NADU

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ABSTRACT

Kadayampatty Panchayat Union situated in the northern part of Salem district and adjoining the Dharmapuri district of Tamilnadu. It lies between the latitudes 11^{o} 45^{l}–12^{o} and longitudes 78^{o}–78^{o} 15^{l} in the Toposheet No 58 I/1. The study area mainly consists of late Precambrian age characterized by migmatitic gneisses, Ultramafic and Pyroxenite. In this study an attempt has been made for demarcating groundwater potential zone by using geophysical techniques. Resistivity of rock formation varies over a wide range, depending on the material, density, porosity, pore size and shape, water content, quality and temperature. In relatively porous, highly jointed and fractured formation the resistivity is controlled more by water content and quality with in the formation then by the rock resistivity. For demarcating groundwater potential zones in the Kadayampatty Panchayat Union water table analysis and ten Vertical Electrical Sounding (VES) followed by Schlumberger electrode configuration were carried out. The maximum depth of investigation was 150mts. The electrodes spread were generally in steps of five meters interval up to 50mts and 10mts interval up to 150mts. VES locations were selected within the study area with respect to their topographic features. Has been used to evaluate the geoelectrical parameters in order to demarcate the potential groundwater zones for new dugwell and borewell locations. The Lithological interpretation reveals that the presence of a maximum of five geoelectrical formations in the study area viz. Topsoil, weathered zone, fissure and fractured zone, fracture basement, and fresh basement. However all five formation do not occur throughout the study area as the maximum and minimum of geoelectric layers are four and three respectively. Similarly a thin geoelectric layer was observed in some places also. The comparatively high resistivity value with corresponding high values of thickness is indicative of a wide stretch of unweathered and unfractured fresh rock layers. A highly weathered (saturated) basement is indicated by the extremely low resistivity value. The depth to the fresh basement varies.

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INTRODUCTION

The Kadayampatty Panchayat Union situated in the northern part of Salem district adjoining the Dharmapuri district of Tamilnadu (Fig.-1). It covers an area of 188 km^2 and lies between North latitudes 11^{o} 45^{l}–12^{o} and East longitudes 78^{o}–78^{o} 15^{l}. The total population is nearly about 1.5 Lakhs who living in 200 hamlets. The average rainfall in the area is 1147 mm for the period of 10 years (1995-2004). Integrated studies involving geological, hydrological and geophysical (Electrical Resistivity) surveys led to the identification of groundwater potential zones in Kadayampatty Panchayat Union (David Keith Todd., 2003) & (Fetter, C.W., 1988),. Inverse slope method proposed by (Sankaranarayan 1974) et.al. Horizontal geoelectrical layer at different selected depth levels are made to understand aerial distribution of different zones that may help to infer the possible locations of exploitable groundwater (Seshagiri Rao, K.V., 2000).

Geological Setting

The geological succession in the study area is given below:

Recent	Alluvium and dyke
Closepet granite	Pink granite, Pegmatite
Peninsular gneisses	Charnockite, Amphibolites, gneisses.
Dharwars	Magnetite, Quartzite.

The study area consists of unclassified gnesses, Charnockite, Granite, Pegmatite, Quartzite and resent alluvium and dyke (**fig-2**). In hard rocks which are recrystalline and massive having little intragranite porosity in the form of fissures fractures and joints in hard rock provide higher permeability number of fractures, if they connect to form networks can be expected to form principal path way for groundwater movement and Individual storages fractures in hard rock may vary over several order of magnitude, and the geometry of inter

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connection of fractures is generally irregular in nature (Krishnan, M.S., 1954).

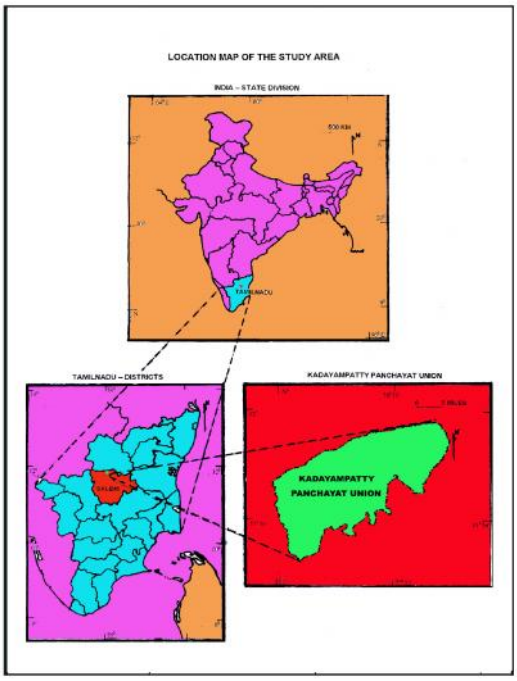

Figure 1 Location map of the study area

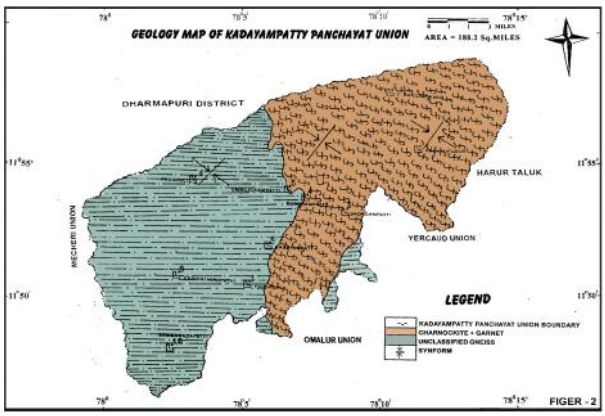

Figure 2 Geology map of the study area

Grid Deviation Water Table Map

Grid deviation method of representing the geological data seems to be more convenient, object and informative and brings out more sharply, the regional trend by eliminating the local interferences. Hence, this method has been adopted in the present study and analysis.

The water level data collected from 10 dug wells in December 2004 are listed in Table 1 (Venkateswaran, S. 1995). The following steps in preparing the grid deviation water table map have used.

- Water levels measured below the measuring point on the dug well have been recalculated to water levels above mean sea level (AMSL).
- Average elevation of water table (A_1) for each dug well have been computed.
- An average value (A_2) of all the average elevation of water table computed in step 2 has been determined for the union. This is called the union average.
- The deviation D= A_1 - A_2 for the union average water level attitude and the average elevation of water levels of individual observation wells have been determined.
- The desired deviation map results from an objective contouring of the deviation result of step 4 of each location of the unions given in Table.1

Table1 Grid deviation of average water levels of Kadayapatty panchayat union december – 2004

Well No	Location name	Water level in meter			
		Below ground level (bgl)	Mean sea Level (msl)	Above mean sea level (amsl)	Grid deviation (d)
1.	Kanavaipudur	8.7	480	471.3	+ 108.0
2.	V. Manganikadu	8.9	410	401.1	+ 37.8
3.	Vadagampatty	7.5	380	372.5	+ 9.2
4.	Bommiampatty	12.8	380	367.2	+ 3.9
5.	Umbilickampatty	5.6	380	374.4	+ 11.1
6.	Kadayampatty	11.4	340	328.6	- 34.7
7.	Pannapatty	8.1	320	311.9	- 51.4
8.	Jodukuli	7.0	380	373.0	+ 9.7
9.	Chinnathirupathi	10.3	330	319.7	- 43.6
10.	Semmandapatty	6.7	320	313.3	- 50.3

It could be seen that the entire Kadayampatty panchayat union is characterized by positive and negative horizon separated by zero contour lines and it is illustrated in (**Fig.3.)** The positive zone lies in the Northern side of the upstream area denoting the high elevations and recharge horizon and the negative zone lies in the lower reaches of the Kadayampatty panchayat union indicating the discharge horizon.

The wide spacing of the contours and their disposition are suggestive of flat gentle gradient of water table and high permeability of the formation material.

Table 2 Electrical Resistivity Prospecting Schlumberger Array

AB/2 Depth Mts	MN/2 Mts	Geometrical Factor G	Resistance Ohm mts R	Apparent Resistance Ohm Mts °a = GR	Depth/°a
5	2	19.64	14.5	284.78	0.018
10	2	78.55	4.0	314.20	0.032
15	2	176.74	1.9	335.81	0.045
20	2	314.2	1.2	377.04	0.053
25	2	490.94	0.8	392.75	0.064
30	2	706.95	1.0	706.95	0.042
35	2	962.24	0.9	866.02	0.040
40	2	1256.8	0.8	1005.44	0.040
45	2	1590.64	0.7	1113.45	0.040
50	2	1963.75	0.5	981.88	0.051
60	10	549.85	1.4	769.79	0.078
70	10	754.08	1.9	1432.75	0.049
80	10	989.73	1.5	1484.60	0.054
90	10	1256.8	1.4	1759.52	0.051
100	10	1555.29	1.3	2177.41	0.046
110	20	919.04	1.7	1194.75	0.092
120	20	1099.7	1.3	1869.49	0.064
130	20	1296.08	0.9	1684.90	0.077
140	20	1508.16	1.4	1357.34	0.103
150	20	1735.96	1.0	2430.34	0.062

Village : Semmandapatty Direction of Spread : $N5^0E$

Table 3 Kadayampatty Panchayat Union Geophysical Result November – 2004

Ves no	Ves location name	Layers thick ness in meter	Resistivity in ohm meter	Layer inverse slope (1/s)	Spring layers from ground level in meter	Spring layers thickness in meter	Spring layer resistivity in ohm-meter
1.	Kanavaipudur	H1 = G.L-4.5	125	0.0080			
		h2 = 4.5-24.5	1000	0.0010			
		h3 = 24.5- 91	1727	0.0006	24.5	20	1000
		h4 = 91-121.5	7500	0.0001	91	66.5	1727
		h5 = 121.5-α	2000	0.0005			
2.	V. Manganikadu	H1 = G.L- 5	400	0.0025			
		h2 = 5-52	1500	0.0025			
		h3 =52-64.5	208	0.0048			
		h4 =64.5-109	1000	0.0010	64.5	12.5	208
		h5 =109-α	1000	0.0010			
3.	Vadagampatty	H1 = G.L- 5	214	0.0047			
		h2 = 5-51	1777	0.0006			
		h3 = 51-60	1250	0.0008			
		h4 = 60-79	733	0.0014	79	19	733
		h5 = 79-α	1000	0.0010			
4.	Bommiampatty	H1 = G.L-5	52	0.0192			
		h2 = 5-60	1727	0.0006			
		h3 = 60-117	4000	0.0003	60	55	1727
		h4 = 117-α	783	0.0013			
5.	Umbilickampatty	H1 = GL - 5	286	0.0035			
		h2 = 5 -34.5	1714	0.0006			
		h3 = 34.5 -49	3500	0.0003	34.5	29.5	1714
		h4 = 49 - 70	2600	0.0004			
		h5 = 70 –α					
6.	Kadayampatty	H1 = GL -2.5	400	0.0025			
		h2 = 2.5 -36	813	0.0012			
		h3 = 36 -65	3200	0.0003			
		h4 = 65 -113	281	0.0036	113	48	281
		h5 = 113 -α	250	0.0040			
7.	Pannapatty	H1 = GL-5	73	0.0137			
		h2 = 5-16	296	0.0033			
		h3 = 16-85	1154	0.0009	16	11	296
		h4 = 85-110	3500	0.0003			
		h5 = 110-α	600	0.0017			
8.	Jodukuli	H1 = GL-3.5	400	0.0025			
		h2 = 3.5-32	1833	0.0005			
		h3 = 32-49.5	4500	0.0002			
		h4 = 49.5-72	1364	.0007.	72	22.5	1364
		h5 = 72-α	1000	0.0001			
9.	Chinnathirupathi	H1 = GL-3	167	0.0060			
		h2 = 3-46	692	0.0014			
		h3 = 46-80	769	0.0013	46	43	692
		h4 = 80-97	909	0.0011	80	34	769
		h5 = 97-α	2285	0.0004			
	Semmandapatty	h1 = GL-4	263	0.0038			
		h2 = 4-16.5	400	0.0025			
		h3 = 16.5-45	4750	0.0002	16.5	12.5	400
		h4 = 45-55.5	400	0.0025			
		h5 = 55.5-105	2222	0.0005	55.5	10.5	400
		h6 = 105- α	750	0.0013			

GL – Ground Level

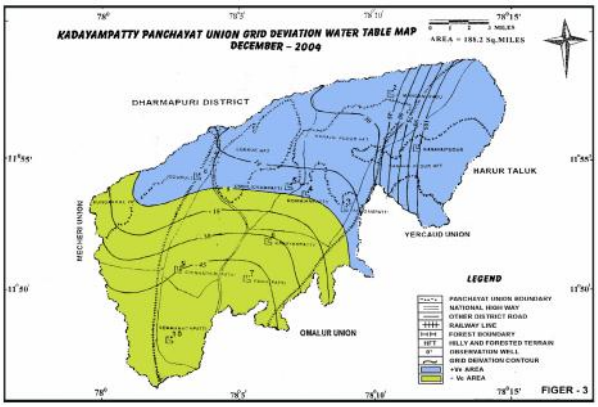

Figure 3 Grid Deviation map of the study area

The 'U' shaped and closely spaced negative contours indicate steep gradient of water table. The positive and negative areas hint at the recharge and discharge zones respectively. Artificial recharge projects through infiltration ponds can be planned in the recharge zone demarcated in the union.

Electrical Resistivity Surveys

Ten vertical electrical soundings were conducted in the study area. Schlumberger Electrode Configuration was employed with a maximum current electrode (AB/2) separation of 150mts Karnath, K.R., (1987) & Janardhana Raju, N., Reddy, T.V.K., and Naidu, P.T., (1966). The electrodes spread were generally

in steps of five meters interval up to 50mts and 10mts interval up to 150mts

Inverse Slope Method

Inverse slope proposed by Sankaranarayan (1974) *et.al*. has been used to evaluate the geoelectrical parameters in order to demarcate the potential groundwater zones.

In the inverse slope method the plotting of the results can be either of the following.

1. Plotting a/ρa against a
2. Plotting I/R against a

It should be noted that a/ρa = ½ x 3.14 R.

Hence by plotting I/R the results need to be multiplied by 2 x 3.14 for getting resistivity, since I/R = a/ρa x 2 x 3.14. The origin is also a point to be reckoned with. The points are jointly "best fitting straight line segments" similar to that being has done in statistical analysis. While joining the points, the depth-sounding curve should be studied by comparison. The joining should not be done in the geometrical. It should be done to have the number of layers finalized from the depth sounding (DS) curve.

After completing the drawing of the segments, the inverse slopes of each segment should be calculated. This gives the resistivities in ohm-meters of the various layers in the case of plotting by the method a/ρa against a. In the case of plotting by the method I/R, the result should be multiplied by 2 x 3.14 to give the result in ohm – meters.

The points of intercepts give the depth to the various interfaces in both the methods of plotting. In some cases, in which the field curve shows a slope of more than 45 ^{o}, the interpretation by this method will generally give a negative slope. Under such cases, it should be inferred that these results are due to non homogeneity ie., lateral variations in the resistivities of the layers and also the non-validity of the assumption that current penetration in equal to the electrode spacing. In the case of such features, the DS curves should not be interpreted by this method. In such cases the data should be obtained again, correctly changing the spread direction. Sample data sheet is given table 2.

Field Data Interpretation

The apparent resistivities and thickness of the different layers in the Kadayampatty panchayat union is given in **table-3.** A perusal of this table show that the most of the locations, the aquifer consists of five layers and the third and fourth layers normally weathered and highly fractured layers. Weathered and highly fractured layers have attained a thickness range from10 mts to 60 mts at Semmandapatty, Pannapatty, Kanavaipudur, Chinnathirupathi and Bommiampatty. The electrical resistivity sounding data and graphs for Kanavaipudur, Manganikadu, Vadagampatti, Bommiampatti, Umbilickampatty, Kadayampatty, Pannapatty, Jodukuli, Chinnathirupathi and Semmandapatty respectively. Based on the geophysical parameters obtained from Table 3 a fence diagram has been prepared (**fig 4**)

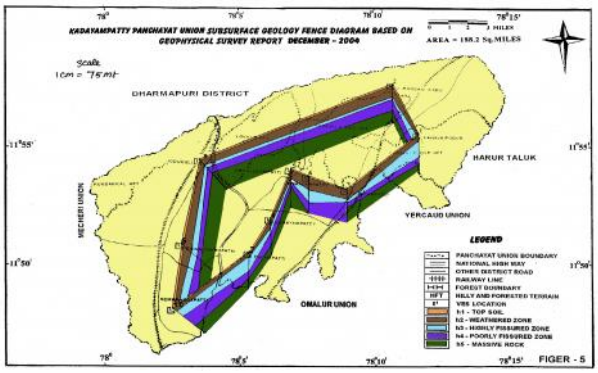

Figure 4 Fence Diagram of the study area

CONCLUSION

Areas of recharge and discharge have been delineated with the grid deviation water table map. It could be seen that the entire union is characterized by positive and negative horizon separated by zero contour line and it is illustrated in (**fig 3**) the positive and negative zones hint at the recharge and discharge area respectively, Artificial recharge project and rain water harvesting structures may be more effective in Kanavaipudur, Manganikadu, Vadagampatti, Bommiampatti, Kanavaipudur hilly forested terrain and Lokur hilly forested terrain the groundwater potential zones demarcated by grid deviation water table map synchronize with fence diagram prepared by geoelectrical parameter. The Lithological interpretation reveals that the presence of a maximum of five geoelectrical formations in the study area viz. Topsoil, weathered zone, fissure and fractured zone, fracture basement, and fresh basement. However all five formation do not occur throughout the study area as the maximum and minimum of geoelectric layers are four and three respectively. Similarly a thin geoelectric layer was observed in some places also. The comparatively high resistivity value with corresponding high values of thickness is indicative of a wide stretch of unweathered and unfractured fresh rock layers. A highly weathered (saturated) basement is indicated by the extremely low resistivity value. The depth to the fresh basement varies. It is clearly reveals that the weathered and highly fracture zones are fall in the discharge zone more number of large diameter, circular dug wells and shallow depth bore wells could be sunk in the discharge area for higher groundwater yield In the Kadayampatty Panchayat Union Kundakkal hilly forested terrain, Kadayampatty, Chinnathirupathi, Semmandapatty and Pannapatty villages have been demarcated as groundwater potential zone.

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