ELECTRICAL RESISTIVITY STUDIES FOR GROUNDWATER EXPLORATION

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Abstract: - Land and water are two broad components on which the entire biotic community thrives. The groundwater level is decreasing day by day as the exploitation is increasing manifolds every day. Occurrence of groundwater in hard rock terrain is mainly controlled by structures, landforms, litho logy and recharge conditions. Remote Sensing technology is today widely used in survey and management of natural resources. The technology has been found to be very effective in identification of potential zones for ground water exploration. Hence the method adopted to find groundwater should be reliable, inexpensive, convenient, and easy. The property and thickness of various litho units obtained from geophysical survey at different locations if integrated can yield a groundwater potential model of higher reliability and precision (Shamsudin Shahid and Shankuar Kumar Nath 2002). The electrical resistivity method, of all the subsurface geophysical methods, has been applied most widely in groundwater exploration studies (Todd 1995).

Keywords: Groundwater, Potential zones, Electrical Resistivity, Geophysical, Subsurface strata

1. Introduction

Land and water are two broad components on which the entire biotic community thrives. The available surface water resources are inadequate to the entire water requirements for all purposes. So, the demand for ground water has increased over the years. In most states in India withdrawal of groundwater both for agricultural and industry needs has been more than what can be recharged. And almost everywhere callously handled waste management has ended in polluting not just rivers but aquifers as well. The assessment of quality and quantity of groundwater is essential for the optimal utilization. The interpretation of satellite data in conjunction with sufficient ground truth information makes it possible to identify and outline various ground features such as geology, structure, geomorphic features and their hydraulic characters (Das.et.al. 1997), that may serve as direct or indirect indicators of the presence of groundwater (Ravindran and Jayaram 1997). Electrical Resistivity method is widely used in groundwater potential exploration studies (Sree Devi 2001). The resistivity value of rocks varies depending upon the presence of secondary porosity such as weathered, fractured joints. An electrical resistivity survey was carried out to determine the lithology, weathered fractured pattern, depth to basement and resistivity variations in the study area (Janardana Raju and Reddy 1998). The resistivity value of rock formations varies significantly with the presence / absence of water content.

2. Methodology

In Electrical Resistivity method, the electrical resistance is measured by applying an electric current between a pair of outer electrodes and measuring the apparent potential difference between a pair of inner electrodes. Depth of current penetration is proportional to the spacing between the electrodes in homogeneous ground and varying the electrode separation provides information about the stratification of the ground (Koefoed 1979).There are mainly two methods of electrode arrangement. They are Wenner method and Schlumberger method. In Wenner method all the four electrodes are spaced at equal distance and in a straight line. For each measurement, all the four electrodes are shifted simultaneously keeping the electrode spacing at equal distance(a). The current is sent through the outer electrodes and the potential difference is measured between the inner electrodes. In Schlumberger method, all the four electrodes were kept in a straight line and the distance between the inner electrodes is kept constant but the distance between the outer electrodes is varied for each measurement. Vertical Electrical Sounding (VES) measurements were taken at 25 locations in the study area using Wenner method. The datas derived from VES measurements were processed using IPI2 WIN software. The top soil, weathered zone, semi weathered zone, fractured zone and the bed rock constitute the five layer configuration. The four layer configuration consists of the top soil, weathered zone, semi weathered or fractured zone and the bed rock. In a four layered case, the 2nd and 3rd layers are interpreted as potential groundwater formations from which a good amount of groundwater can be extracted. The processed resistivity values are shown in Table 1 which shows the layer thickness (h1, h2, h3 and h4) in meters and its corresponding resistivity values (ρ1, ρ2, ρ3, ρ4 and ρ5) in Ω meters.

Table 1. VES Results

Sl. No.	Location Name	ρ1	h1	ρ2	h2	ρ3	h3	ρ4	h4	ρ5	Total depth
1	Mulanur	95.1	1.72	131	4.2	1693	14.5	41.2			20.4
2	Kundadam	135	2.12	522	0.58	71	1.86	214	41.5	20753	46.1
3	Puduppai	16.4	1	2177	1.62	32.5	5.54	5172	25.8	24757	34
4	Pungandurai	103	1.62	643	3.6	2482	11.6	1362	37.6	52099	54.4
5	Kattangani	561	1.47	243	3.8	523	6.71	109	12.6	23976	24.6
6	Mudalipalayam	45.5	1.03	11.1	1.4	59.4	12.6	318	1	2933	16
7	Kottanur	99	0.97	239	1.41	110	3.61	19046	8.95	349	14.9
8	Kurukkapalayam	11.9	4.21	39.2	23	57.6	19.2	1752	27.5	180	73.91
9	Puvanallur	389	1.08	68	2.28	166	3.36	315	43.3	3102	50
10	Sedampudur	154	1.13	667	1.32	58	5.75	5657	2.86	666	11.1
11	Chinnakavundan valasu	173	1.45	436	1.85	83.3	6.13	24093	10.8	282	20.2
12	Malaiyattapalayam	163	1.41	327	2.2	43.2	5.31	830	131	2933	140
13	Alambadi	176	1.96	55.5	5.66	376	13.06	4226	55.2	22762	75.9
14	Anjur	113	1	3321	1.73	252	6.56	3535	18.3	131	27.6
15	Paranjervali	315	0.99	108	1.61	7487	4.04	180	12.7	5725	19.4
16	Kodumudi	116	0.59	35.4	1.15	3949	3.39	122	7.68	2983	12.8
17	Reddipalayam	46.7	1.22	252	1.32	23.6	6.2	1056	12.3	7883	21.1
18	Ramalingapuram	942	1	298	2.24	173	7.26	666	23.5	2012	34
19	Marudurai	11.9	1.38	39.2	2.45	57.6	6.79	1752	18.8	180	29.5
20	Sivagiri	36.2	1.24	1116	2.32	56.6	7.74	219	5.86	73426	17.2
21	Nanjundapuram	202	0.81	133	1.6	345	5.42	133	16.4	27361	24.2
22	Chennimalai	3.26	1.15	5596	11.8	9257	41.5	1808			54.4
23	Puthurpallapalyam	126	1.72	282	4.2	468	14.5	409			20.4
24	Avalpoonthurai	101	2.62	62.6	3.69	543	21.8	23			28.1
25	Kunnathur	83.2	1.07	42	2.7	1082	4.05	82.2			7.83

The pseudo cross sections and resistivity cross sections were also developed using IPI2 WIN software for all 25 locations. Based on the processed VES results, the weathered layer thickness map and depth to basement maps were developed using Arc GIS 9.1 software. They are shown in Figures 1and 2 respectively. The weathered and fractured zones constitute the potential location for groundwater occurrence (Pramod Chandra sahu and Hrushikesh Sahoo 2006). Information on the depth to bedrock for an area is a necessity in order to estimate the thickness of the zone of saturation (Srinivasa Gowd 2004).The spatial distribution of weathered layer shows that (Figure 1) most part of the study area lies in the low thickness range of 2.5 to 4.0m. The thickness is very high at few parts of Southeast, Northeast, central and Northwest sides and it ranges from 7 to 36m. The thickness is predominantly very low at Southeast, few parts of central and southwest directions and it varies from 0.1 to 2.5m. The spatial distribution of depth to basement shows that (Figure 2) the study area mostly lies in the low to moderate category. The depth to basement is low towards Northern, central and at few parts in Southwest and southeast directions and is in the range of 15 to 30m. The depth to basement is moderate at South, central and at few parts in northwest and northeast directions and it varies from 30 to 40m. The depth is very high at very few parts of central and southeast sides. The depth is very low at very few parts in central portion of the study area.

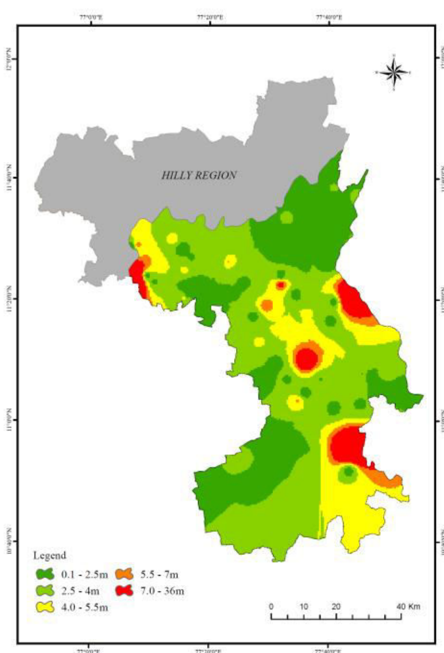

Figure 1. Spatial Distribution of Weathered Layer Thickness Map

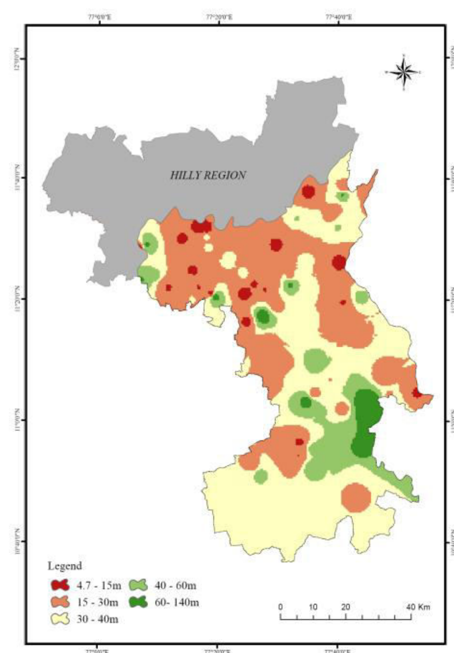

Figure 2 . Spatial Distribution of Depth to Basement Map

3. Results and Discussion

3.1 Delineation of Groundwater Prospective Zones

The groundwater potential zone in the study area is identified by three methods. The methods are Weighted Overlay of Weathered Layer and Depth to Basement Maps, Weighted Overlay of Lineament Density and Depth to Basement Maps and Weighted Overlay of Weathered Layer, Depth to Basement and Lineament Density Maps. In the first method, the groundwater potential zone is identified by weighted over lay of weathered layer and depth to basement maps which is shown in Figure 3. In the second method, the Lineament density and depth to basement maps were overlaid and is shown in Figure 4. In the third method the weathered layer, depth to basement and Lineament density maps were overlaid and is shown in Figure 5.

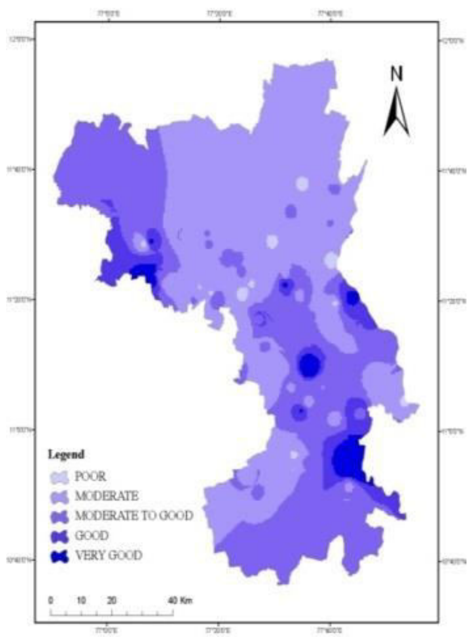

Figure 3. Weighted Overlay of Weathered Layer and Depth to Basement Maps

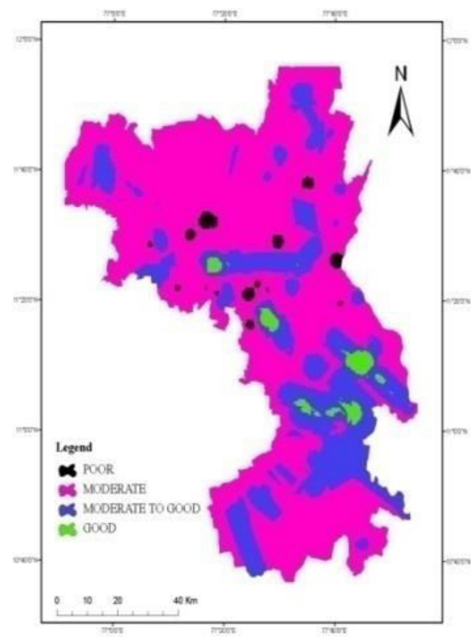

Figure 4. Weighted Overlay of Lineament Density and Depth to Basement Maps

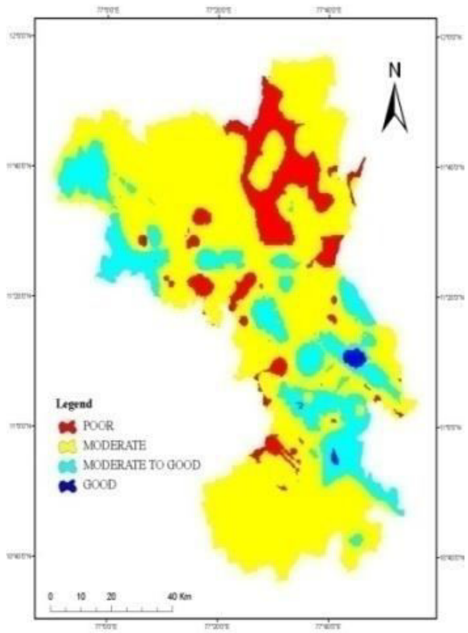

Figure 5. Weighted Overlay of Lineament Density, Depth to Basement and Weathered Layer Maps

4. Conclusions

The groundwater potential zones have been identified in Erode district by making use weighted over lay analysis. The first method shows that the groundwater potential in the study area mostly lies under moderate category (47%) followed by moderate to good (37%), Good (13%), Very good (2%) and poor (1%) categories. In the second method, the groundwater potential is moderate (84%) in many parts of the study area followed by moderate to good (14%), Good (1%) and Poor (1%) categories. In the third method groundwater potential is predominantly in moderate category (69%) followed by moderate to good (20 %), Poor (10%) and Very good (1%) categories. The study has shown that the modern tools of GIS and remote sensing can provide an efficient method for delineating groundwater prospects zones in an area and there was a good inter relationship found among the geography units, geological characteristics and yield data in the study area.

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