The Hydrogeological investigation for Groundwater Potential in Markandi basin by using Electrical Resistivity Surveys, Kalwan Valley Nashik District, Maharashtra

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Abstract

The objective of this Electrical resistivity survey is to assess the hydrogeological characteristics of the study area. This includes the depth of aquifer, availability of groundwater, determining of weathered zone of underlying geological formation which is competent basement and the delineation of the subsurface into various geo-electric layers. The availability of the groundwater is controlled by various factor such as Hydrogeology of the area, Geological set of the area and structural arrangement of the area.

The method used for the survey is direct current method by using schlumberger array arrangement of the electrode. The artificial current introduced into ground by using current electrode and the potential difference measured on ground at potential electrode. Deviations from the expected pattern of potential differences from homogeneous and heterogenous ground provide information which reflect the anomalies lithological units and electrical properties of subsurface formation. A total of 10 vertical electric sounding was carried out in the study area. The data plotted and computer software IP2iwin used to iterate the result. This removes the noise and field errors incorporated in the data. The result of the VES curve shows that there are three major geoelectric layer.

Keywords: Aquifer, Electrical resistivity survey, Groundwater.

INTRODUCTION

The monitoring of the groundwater level a decreasing trend of water level. The main reason for this decline in the groundwater table is that overexploitation wells from groundwater resource than the exceeded natural recharge in the recent years. It is important to get an overview of the ground conditions in early stages of planning and design of water related projects. The use of resistivity survey makes the groundwater exploration to estimate quantity and quality of groundwater. The geophysical survey is non-distractive method which is used effectively for the groundwater prospecting. The available groundwater resources can be estimated after preparing lithological logs and utilized usefully to supplement the canal water supplies for domestic and agricultural productions to remove the shortage of water. The availability of groundwater in unconfined aquifers underlain by impermeable basalt igneous rock often controlled by the secondary porosity and permeability of the rock unit formation.

Hydrogeological and geophysical investigations are often conducted to assess the groundwater potential of an area. Geophysical investigations, although sometimes plagued with ambiguities and uncertainties in interpretation, provide a rapid and cost-effective means of deriving distributed information on subsurface hydrogeology. (Keary, 1991)

STUDY AREA

The Markandi River basin is located with Northern part of the Deccan volcanic province (DVP) of the India. The basin (figure no-1) is highly irrigated part of the Nashik district Maharashtra state, which cover area about 257sq km.

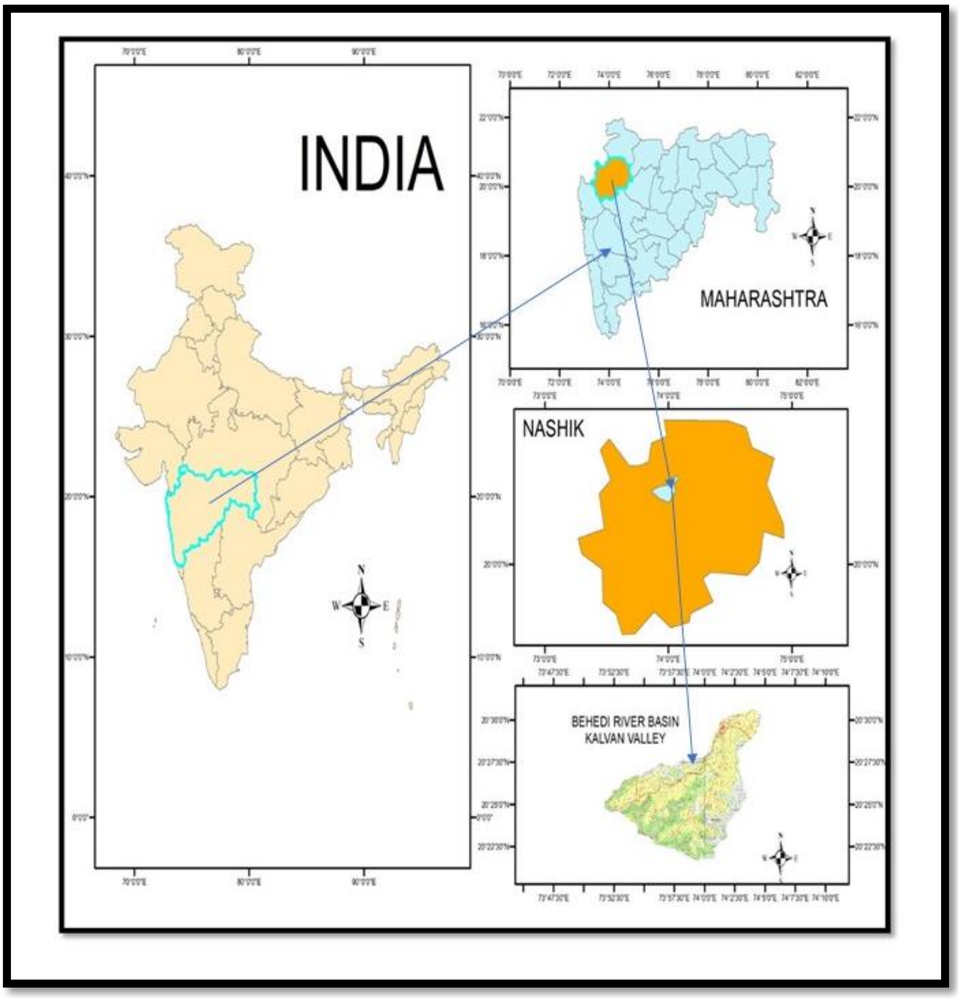


Figure no1 Location map of the Study area.

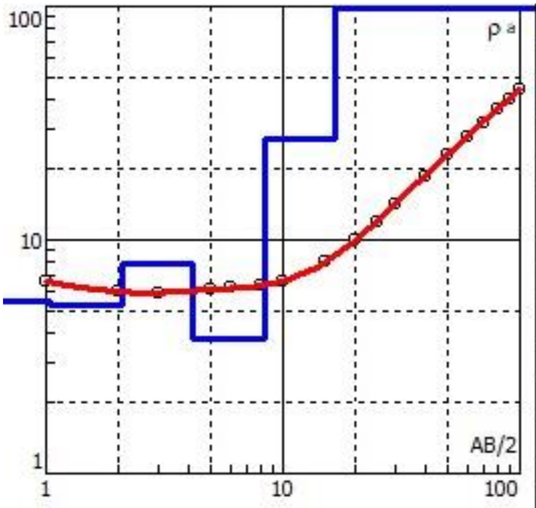
MATERIAL AND METHOD

The Electrical resistivity survey method is traditional method for characterizing the objective being to thickness and/or lateral extent of the protective layer. This implies that as well resistivity and induced potential measurements as voltage measurements. The electrically isolated transmitter sends out well defined and regulated signal currents, with strength up to 1000 mA and a voltage up to 400 V. The receiver discriminates noise and measures voltages correlated with transmitted signal current and measures un-correlated DC potentials with the same discrimination and noise rejection. This makes it suitable for all sorts of resistivity surveys. It comprises a battery powered, deep penetration resistivity meter with an output enough for a current electrode separation of 200 m under favourable conditions.

The potentiometer window and dial reading multiply by range selected gives resistance in ohms. The "Schlumberger" and "Wenner" array configurations are two electrode layouts those are widely employed in the resistivity surveys. (Furman & Ferré, 2003) A high resistivity value indicates low GWP and vice versa. (Innocent Muchingami, 2012)

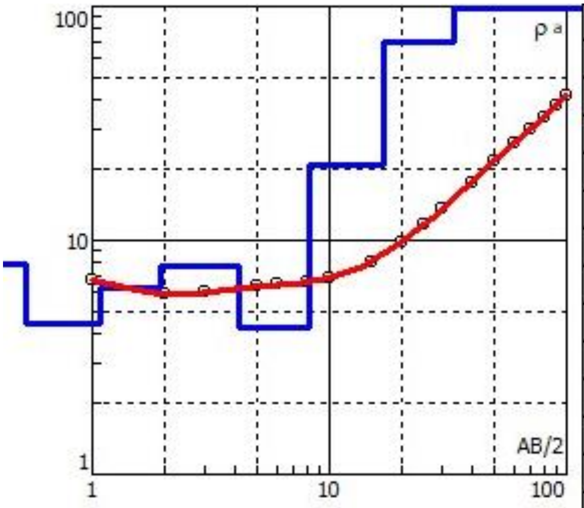
RESULT ANALYSIS

The results were discussed under geoelectric sections, assessment of groundwater prospect in terms of weathered overburden thickness and assessment of aquifer vulnerability. The Schlumberger array depth soundings produced a short range of sounding curves: three-layer type A (40%), H type (50%), and four-layer curves of type KH (10%) were recorded. Typical curves are shown in Figure 5 (a-j). Summary of the formation of layer parameters and classification of the resistivity sounding curves are presented in Table 1 and 2 respectively. The nature of the successive lithologic sequence in a place can be used in qualitative sense to assess the groundwater prospect of an area. Type H and KH curves are often associated with groundwater possibilities while type A may typify a rapid resistivity progression, indicative of shallow, resistive bedrock. Geoelectric Sections The aquifers in Markandi river basin were delineated through geoelectric sections. From figure 6, the 8 VES stations were grouped into 1 profile can be located on a straight line to see an image representation of the subsurface. The results of the interpreted VES curves were used to draw 2D geoelectric sections (figures 6a–c) along profiles A, B and C to show the vertical distribution of resistivities within the volume of the earth in the investigated area. The sections consist of sequence of uniform horizontal (or slightly inclined) layers (horizons). Each layer (horizon) in a geo-electrical section may completely be characterized by its thickness and true resistivity. The geoelectric sections show both vertical and lateral variations in layer resistivity. One of the importance of 2D geoelectric sections is that it helps someone to see clearly where there is thin overburden as well as thick overburden within the sounding locations. The presence of groundwater in any rock presupposes the satisfaction of two factors: adequate porosity and adequate permeability. Because of their crystalline nature, the basalt igneous rocks are thus considered to be poor aquifers because of their low primary porosity and permeability necessary for groundwater storage. However, secondary porosity and permeability imposed on them by fracturing, fissuring, jointing, and weathering through which water percolates make them favourable for groundwater deposited. Electrical resistivity contrasts exist across interfaces of lithologic units in the subsurface. These contrasts are often adequate to delineate discrete geoelectric layers and identify aquifers or non-aquifers layers. The geoelectric parameters of the aquifer units were determined from the interpretation of the sounding curves. Resistivity of earth materials is strongly affected by water saturation and water quality. The resistivity parameter of a geoelectric layer is an important factor to adjudge an aquifer. The electrical resistivity of the saprolite layer overlying the basement is controlled by the parent rock type, climatic factors, as well as the clay deposits content. A low resistivity of the order of less than 20 ohm-m is indicative of a clayey regolith layers. This reduces the permeability and thus causes to lower the aquifer yield. Weights are assigned to the weathered layer resistivity values according to Wright, (1992). However, study shows that the resistivity value of fresh bedrock often exceeds 1000Ω m, besides, where it is fractured/sheared and saturated with fresh water, the resistivity often reduces below 1000Ω m. Profile A maximum of three-to-four subsurface geoelectric units were delineated beneath this profile (figure 6a). These include the topsoil which lies above the water table, the clay/partially weathered rock with resistivities ranging from 9.4 to 105.9Ω m, and the fresh bedrock under VES 6 and VES 10 while VES 9 showed fractured bedrock.



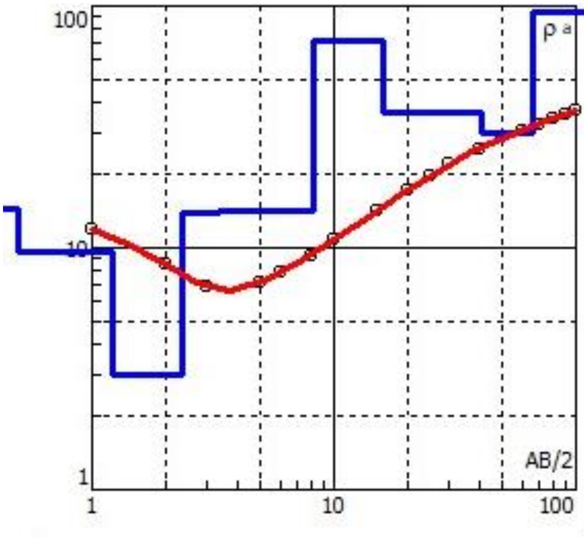
N	ρ	h	d	Alt
1	7.28	0.5	0.5	-0.5
2	5.48	0.5481	1.048	-1.0481
3	5.234	1.051	2.099	-2.0991
4	7.894	2.087	4.186	-4.1861
5	3.778	4.129	8.315	-8.3151
6	26.87	8.418	16.73	-16.733
7	209.8	16.74	33.47	-33.473
8	973	34.53	68	-68.003
9	369.4			

Figure: 5a The modelled curve for VES 1



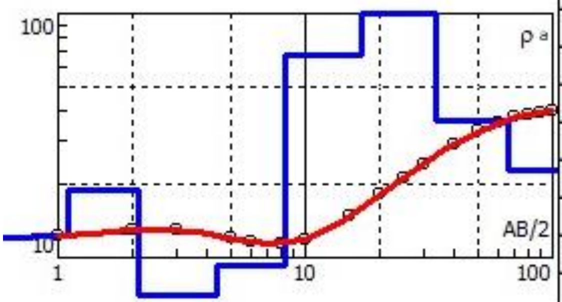
N	ρ	h	d	Alt
1	7.98	0.525	0.525	-0.525
2	4.42	0.565	1.09	-1.09
3	6.21	0.836	1.93	-1.926
4	7.8	2.2	4.12	-4.121
5	4.23	4.16	8.29	-8.286
6	21.1	8.52	16.8	-16.81
7	70.1	16.6	33.4	-33.41
8	352	34.6	68	-68
9	745			

Figure: 5b, The modelled curve for VES 2



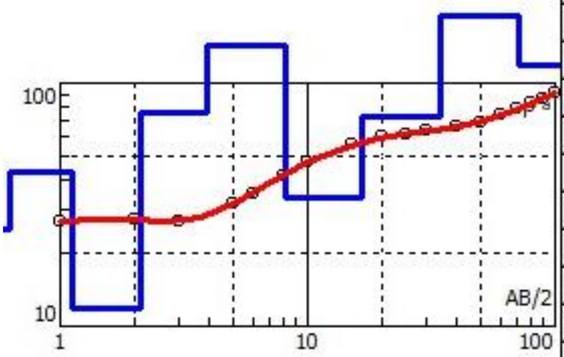
N	ρ	h	d	Alt
1	14.5	0.5	0.5	-0.5
2	9.61	0.712	1.21	-1.212
3	2.99	1.14	2.35	-2.348
4	13.9	0.977	3.32	-3.325
5	14.3	4.93	8.25	-8.255
6	71.4	7.7	16	-15.95
7	36	24.9	40.8	-40.81
8	30	25.8	66.6	-66.57
9	94.4			

Figure: 5c, The modelled curve for VES 3



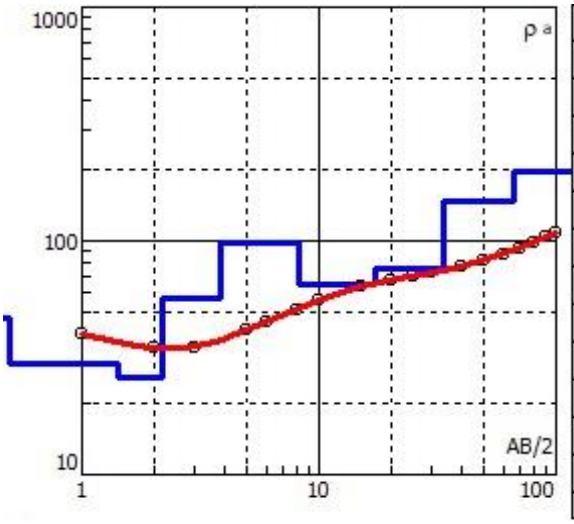
N	ρ	h	d	Alt
1	12	0.781	0.781	-0.7815
2	12.2	0.323	1.1	-1.105
3	18.9	1.01	2.11	-2.112
4	7.06	2.24	4.35	-4.353
5	9.23	3.9	8.26	-8.256
6	67.9	8.66	16.9	-16.91
7	101	16.8	33.7	-33.73
8	36.1	32.1	65.9	-65.88
9	22.9			

Figure: 5d, The modelled curve for VES 4



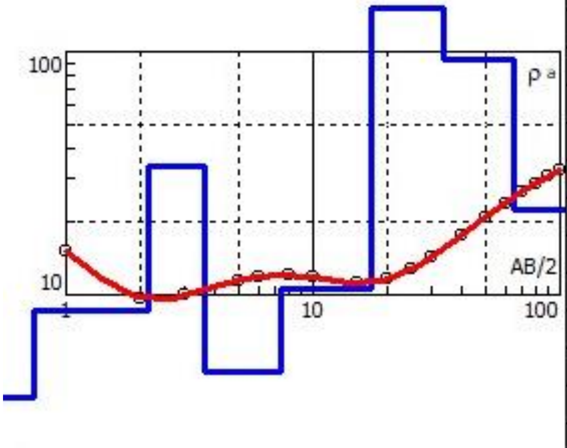
N	ρ	h	d	Alt
1	25	0.627	0.627	-0.627
2	43.3	0.484	1.11	-1.111
3	11.8	0.999	2.11	-2.11
4	76.1	1.81	3.92	-3.919
5	143	4.3	8.22	-8.215
6	34.1	8.34	16.6	-16.55
7	72.3	17.6	34.1	-34.13
8	188	36.8	70.9	-70.93
9	119			

Figure: 5e, The modelled curve for VES 5



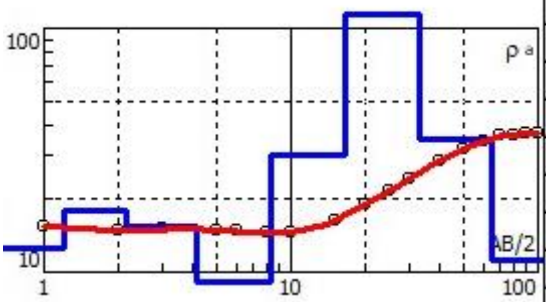
N	ρ	h	d	Alt
1	46.5	0.5	0.5	-0.5
2	29.7	0.908	1.41	-1.408
3	26.1	0.787	2.2	-2.196
4	57.3	1.68	3.88	-3.879
5	97.1	4.35	8.22	-8.225
6	65.4	9.02	17.2	-17.25
7	76.4	16.2	33.5	-33.49
8	149	33.5	67	-66.98
9	197			

Figure: 5f, The modelled curve for VES 6



N	ρ	h	d	Alt
1	24.7	0.5	0.5	-0.5
2	3.76	0.239	0.739	-0.739
3	8.57	1.42	2.16	-2.158
4	33.8	1.5	3.66	-3.662
5	4.82	3.75	7.41	-7.413
6	10.7	9.86	17.3	-17.27
7	150	16.6	33.9	-33.86
8	93.5	30.7	64.5	-64.53
9	22.3			

Figure: 5g the modelled curve for VES 7



N	ρ	h	d	Alt
1	16.3	0.578	0.578	-0.5783
2	12.6	0.621	1.2	-1.199
3	18	0.952	2.15	-2.151
4	15.4	2	4.15	-4.149
5	9.11	4.15	8.3	-8.303
6	30.4	8.34	16.6	-16.65
7	113	16.7	33.3	-33.31
8	34.8	32	65.4	-65.36
9	11.3			

Figure: 5h, The modelled curve for VES 8

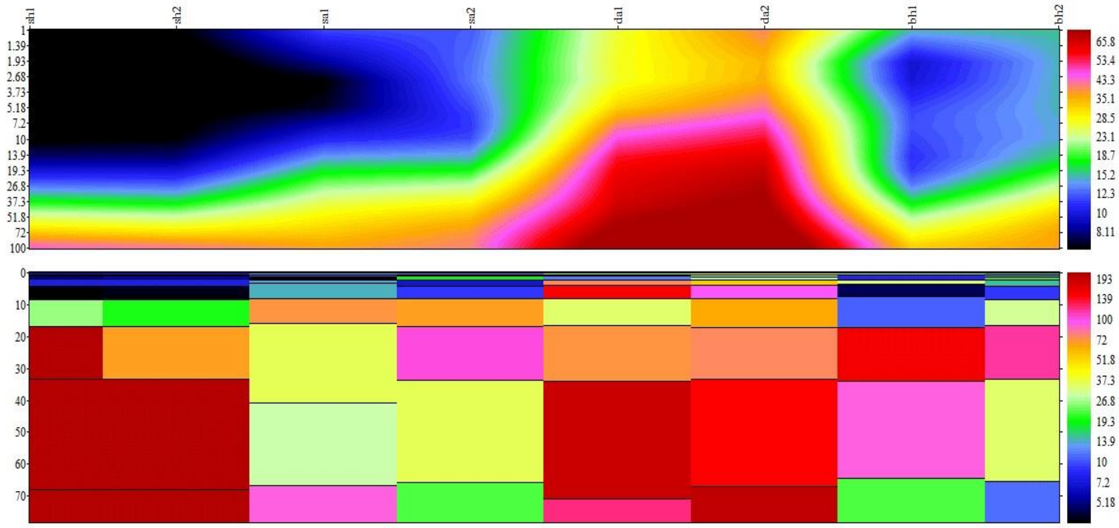


Figure -6. vertical cross section for resistivity survey.

CONCLUSIONS

The objective of this study is to assess the water potential and investigate the shallow subsurface moisture distribution of the study area by using a vertical electrical sounding (VES). The extent of fracturing proposed by these geophysical surveys can be used to indicate a high ground water potential at the study area. Twelve sites were used to evaluate the sub-surface hydrogeological conditions to a depth of about 30 m. Based on the interpretation of geoelectrical analysis data, the following conclusions has been drowned: The geoelectrical soundings provides data for characterizing the groundwater conditions of the region. Interpretation of the VES tests indicates that the presence of aquifer that mainly consists red tuffaceous basalt and fractured basalt. The resistivity values of the aquifer ranges between 30 to 64 m. The resistivity values increasing indicated that the presence of fresh groundwater. The Vertical Electrical Sounding (VES) result analysis revealed three sub-surface geo-electric layers consisting of surface layer (top soil), black cotton soil layer and saturated (bottom soil) layer, depth, and thickness and type of all the layers were identified.

RECOMMENDATION

Based on the results of Electrical Resistivity Surveys, it was concluded that the zone of sub-soil between 30 - 140 m contains adequate volume of fresh groundwater, which may be exploited by installing Borewells for its utilization.

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