International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 07 | July 2018 www.irjet.net p-ISSN: 2395-0072

An Experimental approach for the investigation of Fresh water at Srinivas University Campus, Mukka, Mangaluru, Karnataka, India

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Abstract - *This research is focused on the geophysical survey using Resistivity meter to determine the underground layers, and availability of fresh water and saline water. The study was conducted at Srinivas Integrated Campus at Mukka in Mangaluru, Karnataka. The values obtained from the Resistivity meter were tabulated and analyzed by drawing bi-log graph, with Apparent Resistivity Rap (ρa) on Y-axis and current electrode separation (AB/2) on X-axis. Various properties of water sample were determined and compared with standard values. Availability of fresh water and saline water at different depth were also determined.*

Key Words: **Geophysical Survey, Vertical Electrical Sounding, Fresh water, Saline water, Resistivity.**

1. INTRODUCTION

Dakshina Kannada is a maritime district located in the south-western part of Karnataka state (india)adjoining the Arabian Sea. The geographical area is 4,770 sq. km extending between 12˚ 30' 00'' & 13˚ 11' 00'' North Latitude and 74˚ 35' 00'' & 75˚ 33' 30'' East Longitude. The district is drained by Netravathi, Gurupur, Mulki, Kumaradhara, Payasvini and Shambhavi River which originate in the Western Ghats and flow westwards to join the Arabian Sea. Agriculture is the main activity of the people in the district. The net sown area comprises 28% of the total geographical area. Major crops are paddy, areca nut, coconut, cashew nut, rubber and vegetables. About 57% of the net sown area is irrigated by different sources. Groundwater irrigates about 75% of the irrigated area and the remaining is by surface water sources. Near the coastal belt people are often facing the sea water intrusion in to the drinking water wells and making it difficult to the population to get the good drinking water at an accessible distance.

1.1 Problem Definition

Seawater intrusion is the movement of saline water into freshwater aquifers, which can lead to contamination of drinking water sources and other consequences. Saltwater intrusion occurs naturally to some degree in most coastal aquifers. Because saltwater has a higher content of dissolved salts and minerals, it is denser than freshwater, causing higher hydraulic head than freshwater. As a result, saltwater can push inland beneath the freshwater. Certain human activities, especially groundwater pumping from coastal freshwater wells have increased saltwater intrusion in many coastal areas. Water extraction drops the level of fresh groundwater, reducing its water pressure and allowing saltwater to flow further inland. Sea water intrusion may also become more critical by extreme events like hurricane storm surges. Since Mangaluru is along the coastal region, fresh groundwater flowing from inland areas meets with saline groundwater from the ocean. The fresh groundwater flows from inland areas towards the coast where elevation and groundwater levels are lower. In this investigation, an effort is made to harness the fresh water in the Srinivas Integrated Campus at Mukka in Mangaluru by conducting the Geophysical Survey of the area and the water quality tests for the water samples obtained.

1.2 Scope and Objectives of the project and literature review

Srinivas Integrated Campus at Mukka is a very fast developing campus housing four colleges and a super speciality hospital. It is having a very high requirement of drinking water for the colleges, hostels, hospital and canteen. Presently the requirement is fulfilled partly by the Corporation and commercial supply tankers. If a good source of water is available in the campus, it will help more than 5,000 people in the campus. Hence, this will solve the problem to a large extent in order to meet the demand effectively and economically. In this investigation, the study was conducted by using electrical geophysical survey method (Vertical Electrical Sounding) with the detection of surface effects produced by the flow of electric current inside the earth.

[1]Groundwater is a very important component of water resources in nature. Since the demand of groundwater increases with population growth, it is necessary to explore groundwater more intensively. In order to determine the existence of usable groundwater for irrigation and drinking purposes, he carried out 2D resistivity imaging technique by using Wenner-Schlumberger electrode array configuration as this array is moderately sensitive to both horizontal and vertical structures. The survey was employed with resistivity meter, multicore cable, multi electrodes with Wenner and Schlumberger array configuration respectively. The

existence of groundwater was indicated by the resistivity values about 10-100 ohm-m. The results showed that the subsurface is made up of alluvium and clay with high resistivity values of more than 1000 ohm-m near the surface due to the presence of laterite and at the end interpreted as mixture of weathered material or bedrock. The collected data was processed using the Res2Dinv original software. The topographical corrections were carried out in the survey. This is the most effective technique to get reliable information in the field and gathered resistivity pseudo section. The combination of Vertical Electrical Sounding (VES) data and borehole data provided useful information on subsurface hydro-geological conditions. The results indicate that VES survey has the potential to identify the layer containing water and quality of groundwater depth and thickness for its development[1].

A groupof Researchers[2] carried out geo-electrical resistivity survey using VES in order to assess the subsurface geology and groundwater potential zones. Interpretations revealed the number of subsurface layers, thickness and water bearing capacity within the study area. The main objective of the present study was to apply VES to identify the groundwater condition and the nature of subsurface layers within the study area. The best layer having lower resistivity values was considered as good aquifer.

The study was carried out with a view to determine the subsurface layer parameters (resistivity's and thicknesses) and use the same to categorize the ground-water potential of the study area[3].

A group of researchers[4] carried out geo-electrical resistivity profiling by collecting VES data in order to study the aquifer characteristics and recommended hydro-geologically suitable sites to construct water supply boreholes. The Schlumberger electrode configuration was first used in the line profiling. Qualitative interpretation of the geo-electrical resistivity profiling data resulted in the identification of weathered regions. Interpretation of one-dimensional inversion of VES resistivity data has provided the overburden and aquifer layering resistivity along with thicknesses. The geo-electric sequence revealed predominantly a three subsurface layer which was largely congruous to the weathering profile above the fresh bedrock, namely, thick top soil, weathered and the variably weathered and fractured bedrock respectively. The geo-electric sections provided no evidence of a descent into the fresh bedrock. The geophysical target was reasonably thick and extensive zone of saturated weathered rock beneath the overburden. On the basis of the perceived aquifer properties, sites were recommended for drilling water supply boreholes for the communities.

The Geo-electrical resistivity survey technique was used to assess the potentiality of fresh water layer lying over the saline groundwater. For this purpose the Schlumberger electrode configuration was followed with half current electrode spacing and potential electrode (MN). The collected data were interpreted in terms of resistivity and corresponding thickness of various sub-surface layers using "Interpex IX1D" computer software and the outputs were verified using borehole data. The results indicated that VES survey has the potential to identify the layer containing water and quality of groundwater, depth and thickness for further development.

Based on the research investigations, VES has proved very popular for the groundwater studies and engineering investigations due to its simple technique. Groundwater has become very important source to survive in urban and rural areas. Exploration of groundwater in hard rock terrain is very challenging and difficult task when the promising groundwater zones are associated with fractured and fissured media. In this environment, groundwater potentiality depends mainly on the thickness of the weathered / fractured layer overlying the basement. The use of geophysics for engineering studies and water groundwater exploration has increased over the last few years due to the rapid advances in computer software's and associated numerical modeling solutions[5,6,7].

2 .Result and Discussions

A total numbers of four layers were depicted from each VES curve. An overview of the VES results obtained during the investigation is shown in Table 1. The test results obtained from VES method were plotted to get a curve on a bi-log graph, with Apparent Resistivity Rap (ρa) on Y-axis and current electrode separation (AB/2) on X-axis. The depth sounding curves were interpreted quantitatively to determine depth of fresh basement bedrock.

The collected water sample was taken to the laboratory to carry out tests to ensure the quality of water such as pH, alkalinity, turbidity, hardness, magnesium and calcium content. Alkalinity is primarily a way of measuring the acid neutralizing capacity of water, its ability to maintain a relatively constant pH. Water hardness is an expression for the sum of the calcium and magnesium cation concentration in a water sample. Conductivity of a substance is defined as the ability or power to conduct or transmit heat, electricity or sound. When an electrical potential difference is placed across a conductor, its movable charges flow, giving rise to an electric current. Chemical composition of water determines its conductivity.

Table -1: Sample Table format

MN/2 meters	AB/2 meters	Aqua meter reading	Geometric Factor, K	Calculated Resistivity	Log AB/2	Log R_{ap} (ρ_a)	Log (AB/2) / Log R_{ap}
0.5	1.5	251	6.28	1576.28	0.17609126	3.19763337	0.000951608
	2	75.5	11.7	883.35	0.30103	2.94613281	0.002264108
	3	8.4	27.5	231	0.47712125	2.36361198	0.012987013
	4	2.6	49.45	128.57	0.60205999	2.10913964	0.031111457
	5	0.63	77.7	48.951	0.69897	1.68976157	0.102142959
	7	0.123	153.2	18.8436	0.84509804	1.27516388	0.371478911
	9	0.078	253.3	19.7574	0.95424251	1.29572979	0.455525525
	10	0.063	313.2	19.7316	1.00	1.2951623	0.506801273
2	10	0.28	75.3	21.084	1.00	1.32395901	0.474293303
	12	0.21	109.9	23.079	1.07918125	1.36321699	0.519958204
	15	0.13	173.5	22.555	1.17609126	1.35324283	0.665041011
	20	0.08	310.8	24.864	1.30103	1.395571	0.804375804
	25	0.04	487.5	19.5	1.39794001	1.29003461	1.282051282
	30	0.02	703.36	14.0672	1.47712125	1.14820766	2.132620564

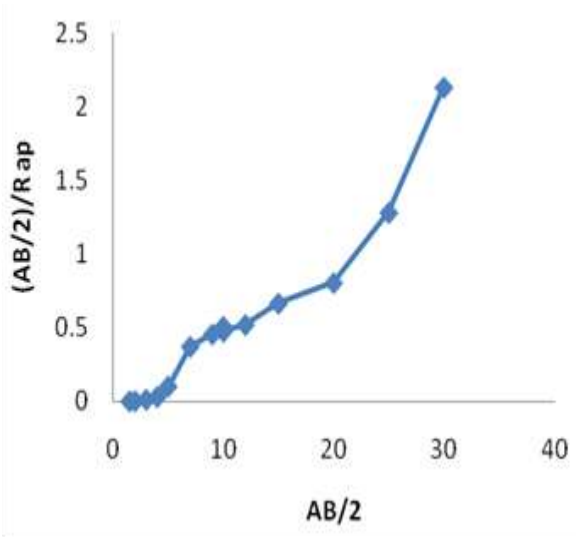

Fig 1 (a) :VES curve 1

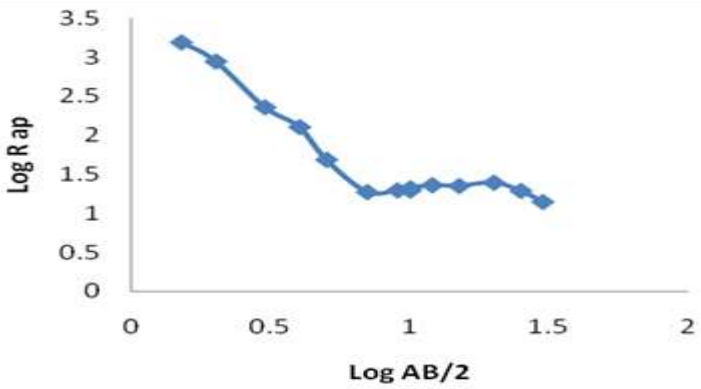

Fig 1(b): VES Curve 2

The collected water sample was taken to the laboratory to carry out tests to ensure the quality of water such as pH, alkalinity, turbidity, hardness, magnesium and calcium content. Alkalinity is primarily a way of measuring the acid neutralizing capacity of water, its ability to maintain a relatively constant pH. Water hardness is an expression for the sum of the calcium and magnesium cation concentration in a water sample. Conductivity of a substance is defined as the ability or power to conduct or transmit heat, electricity or sound. When an electrical potential difference is placed across a conductor, its movable charges flow, giving rise to an electric current. Chemical composition of water determines its conductivity. Water that has high mineral content is known as hard water which contains bicarbonate, chlorides and sulphates of calcium and magnesium. When hard water reacts with soap, it gets precipitated in the form of insoluble salts of calcium and magnesium. Hardness of water is a measure of the total concentration of calcium and magnesium ions expressed as calcium carbonate.

Table 2: standard values and the values obtained for the water sample collected from the newly excavated open well.

Test	Standard values	Values obtained
p^H	6.5 - 8.5	6.8
Total Alkalinity (mg/L)	120	121
Total Hardness (mg/L)	300	74
T.D.S (S/cm)	500	0.06
Calcium (mg/L)	75	41.06
Magnesium (mg/L)	30	59.6
Chloride (mg/L)	250	194
Turbidity (NTU)	---	29.1

Table 3: fresh water is available only upto a depth of 4m. The Resistivity values observed at various depths at the proposed site are as below:

Depth (m)	Resistivity (ohm-m)	Remarks
4	128.57	Fresh water
7	18.8436	Saline water
20	24.864	Saline water
30	14.0672	Saline water

3. CONCLUSIONS

From the above values and results, we can conclude that from at a depth of 4m the resistivity was found to be 128.57 ohm-m and the water quality was suitable for consumption. Below 4m depth the resistivity is abnormally low indicating the presence of saline water. Layers of lower resistivity were observed between 7 and 30m depth indicating sandy layer with saline water. Hence, it was proposed to excavate an open well to a maximum depth of 4 m with diameter 8 to 10m at the site where the investigation was carried out. It was also observed that at upto a depth of 4m the resistivity values were reasonable and soil is Laterite in nature. Hence good infiltration is possible.

After the proposal was forwarded, the Management of Srinivas Group of Colleges invested 4.5 Lakh Rupees for the construction of open well at the proposed site with depth of 4 m and diameter of 10m. The internal side walls are constructed by using Laterite bricks. The construction of open well was completed in 22 days.

Approximately 2 lakh liters of water can be pumped out every day from this open well to cater the needs of the campus.

The break-even point of the construction of open well was calculated as three months which has proved the importance of geophysical survey with the help of Resistivity meter in selecting the right location for the excavation of open well and bore-wells.

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