



IDENTIFICATION OF GROUNDWATER FEASIBLE SITES IN ERRAVAGU SUB-BASIN OF GUNTUR DISTRICT, ANDHRA PRADESH USING GEOPHYSICAL AND GEOSPATIAL METHODS

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Abstract

Groundwater exploration using geophysical method particularly Vertical Electrical Sounding (VES) method is used in the Erravagu-sub basin to identify the vertical successions of subsurface geo-materials in terms of their individual thicknesses and corresponding resistivity values. It indirectly helps to locate well site locations for water supply purposes. The results indicate that Eastern part is feasible for dug wells and the western part is feasible for bore wells and tube wells for higher yields. The fracture lineament map suggests that North eastern part is a good water potential zone, western part is a moderate groundwater potential zone and Northern part indicates poor water potential zones of the study area.

1 INTRODUCTION

The usage of water for drinking and other activities is strongly increasing in recent decades due to population growth, urbanization and industrialization. The construction activity is related either directly or indirectly with water utilization which indeed depends on the both surface and groundwater sources. The utilization both sources may vary depending on their quality and quantity. In areas where the surface water flow is limited the dependency on the groundwater has increased. Therefore, pre-construction evaluation such as exploration performed primarily for an effective and sustainable utilization of groundwater resources. The dependency on groundwater has increased in developed and developing countries for the different water supply purposes in urban and rural areas [1]. The exploration of groundwater in hard rock terrain is challenging task, if the promising groundwater zones are associated with fractured and fissured media [2]. In such conditions, the groundwater potentiality depends mainly on the thickness of the weathered/ fractured layer overlying the basement. The different layers of the sub-surface can be identified by geophysical survey which has gained more importance for groundwater exploration over the last few years due to the rapid advances in computer packages and associated numerical modeling solutions [1, 2]. These methods are very important for both groundwater resource mapping and water quality evaluations [1]. Geophysical survey generally consists of the Vertical Electrical Sounding (VES) and Horizontal Profiling (HP) methods. Of the both Vertical Electrical Sounding (VES) is currently being used for groundwater investigations due to its simplicity [3, 4]. Geophysical survey detects the sub-surface heterogeneities by flow of electric current inside the earth [2, 5]. It provides depth and thickness of various subsurface layers and their relative water yielding capacities [5]. Therefore, the objective of this study was aimed to identify groundwater potential zones using satellite imagery data and surface geophysical investigations.

2 STUDY AREA

The Erravagu Sub-basin is located in the central part of the Guntur District of Andhra Pradesh. It is geographically located in between North latitudes of 16°02'10" N - 16°27'14" N and East longitudes of 79°05'21" E - 80°04'13" E and falls in survey of India Toposheet No. 65D/3 and 56 P/15 (Fig.1). The climate of the area is semi-arid and hot throughout the year. The maximum, minimum and mean temperatures are 43.0 °C, 18.50 °C and 29.20 °C respectively. The average annual normal rainfall is 782 mm. The study area is characterized by undulating topography. High altitude hills are located in northwestern and Southern Parts of the study area. The area is sloping towards northeast. The highest peak, having 349 m. in the south-west elevation above mean sea level, and the lowest 95 m. in northeast part are observed in the study area. The study area is drained mainly by Erravagu originating from hill ranges located in the south-west side of the Krishna and flows towards north-east and finally merges into the Edduvagu. The drainage pattern can be classified as dendritic to sub-dendritic. The geological succession of the study area shows varied rock types ranging in age from Archean to Proterozoic. Rock types include granite gneisses, schist, quartzites, shales, phyllites, dolomites and lime stones. The predominant soil type of the study area is black soils, red soils and clayey loams with moderate permeabilities. The areal extent of the study area is about 78.41 Sq.km. of which 17.10 Sq. Km area is covered by forest and hills, and 57.81 Sq. Km of area falls under the command of Nagarjuna Sagar Right Canal (NSRC) and 3.5 Sq.km falls under non-command area. The existence and movement of groundwater depends on the geological setting, climate, rainfall, drainage, topography and extent of surface water bodies. The occurrence of groundwater is confined to weathered and fractured zones in the study area. The data obtained from the inventory of existing wells indicate that the groundwater occurs in highly weathered and fractured portions of country rocks. In the study area, depth to water levels ranges in between 1.10 and 6.95 m except in the Beeravallipaya site. The depth to water level in Beeravallipaya varies in between 80 and 130m.

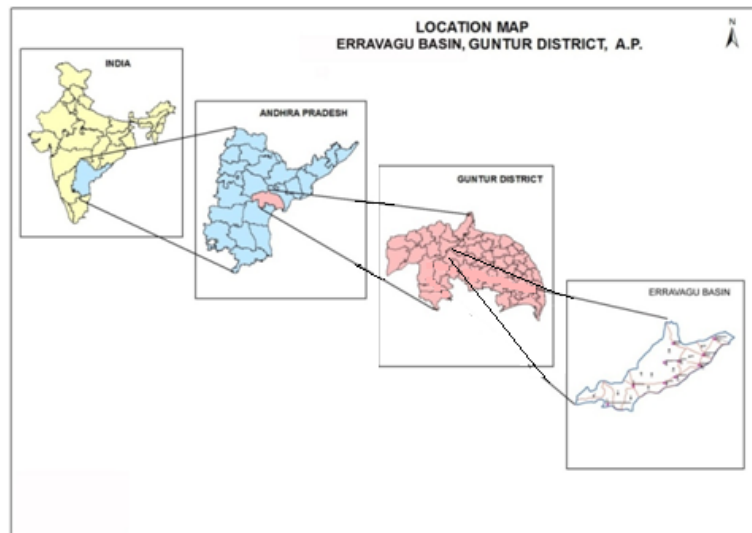


Figure 1: Location of the Erravagu sub-basin, Guntur District, Andhra Pradesh, India

3 METHODOLOGY

Geophysical surveys, employing vertical electrical sounding (VES) method were conducted at pre-determined locations based on the hydrogeological surveys. The VES were conducted, adopting Schlumberger configuration. The maximum current electrode separation employed (AB) is 160 m and maximum potential electrode (MN) separation employed is 20 m. A total of 19 VES was conducted in the study area. VES 1 to 16 was conducted in granite formation and the soil cover is Black cotton soil with alkaline nature. VES 17 to 19 conducted in shales formation with red soil coverage. The obtained VES have been interpreted through curve matching techniques, using Orellana-Mooney master curves and also using the RESIST software. Fracture-lineament map was prepared with the help of IRS P6 LISS III, satellite with pixel resolution of 23.5 mts.

4 RESULTS AND DISCUSSION

Out of total nineteen soundings 13 were conducted in Rajupalem mandal and rest of the soundings were done in Nekarikallu mandal. The VES 1 was conducted in Reddypalem village whereas VES 2 and 3 were conducted in Ganapavaram village, VES 4 to 6 were done in Balijepalli. VES 7 to 10 were conducted in Uppalapadu village. VES 11 to 13 were conducted in Inumetla. Rest of the soundings 14 to 19 was conducted in Nekarikallu village of Nekarikallu mandal. The VES data has been interpreted in terms of resistivity (Ohm-m) and thickness (m) individual layers using axillary curves. The interpreted data of VES indicates that the thickness of surface soil cover in the area varies from 0.9 to 1.7 m represented by resistivity values ranging between 2 ohm.m to 62 ohm. m, the second layer is weathered rock and the layer thickness varies from 0.9 to 7.1 m and the resistivity values ranging between 1 ohm.m to 77 ohm.m. The weathered rock followed by semi weathered fractured rock, thickness varies from 2.7 m to 29.4 m and the resistivity values ranging between 7.0 ohm.m to 68 ohm.m and the semi-weathered fractured rock followed by massive rock, which can be treated as geo-electric basement (Table.1)

5 GEOELECTRICAL CROSS SECTION

Geoelectrical cross section was drawn along the profile AB (Fig. 2). The depth to basement varies from 5.5m to 31.9 m from bgl and the geoelectrical basement is deeper towards west of the basin.

Based on the interpreted results of VES, it is concluded that, the western part of surveyed area has the basement at shallow depth with the fracture zones of smaller magnitude whereas the eastern part has relatively deeper basement with more number of fractures with larger magnitude. The aquifer is pro-basement layer and consists of weathered and semi-weathered fractured rock. It is observed from the interpreted data that the aquifer thickness is substantial at eastern part and it is feasible for dug wells. Due to less thickness of aquifer in western part, it is feasible

for bore wells and tube wells for higher yield.

Table.1 Interpreted geophysical results of Erravagu Sub-basin

VES.No	ρ_1	h_1	ρ_2	h_2	ρ_3	h_3	ρ_4	h_4	ρ_5	h_5	H
1	7	1.1	3.0	0.9	47	12.7	∞	∞	-	-	14.7
2	27	1.1	77	1.0	37	14.2	∞	∞	-	-	16.3
3	2	1.1	21	2.9	52	12	∞	∞	-	-	16
4	5	0.9	3.0	1.1	25	6.6	∞	∞	-	-	8.6
5	3	1.7	6	4.5	42	12.9	∞	∞	-	-	19.1
6	2	1.5	7	1.4	26	6.7	∞	∞	-	-	11
7	2	1.4	7	1.4	38	2.7	∞	∞	-	-	5.5
8	2	1.4	5	2	21	3.2	∞	∞	-	-	6.6
9	2	1.4	1	2.5	22	3.4	∞	∞	-	-	7.3
10	2	1.3	1	1	23	8	∞	∞	-	-	10.3
11	3	1.4	6	1	27	13.0	∞	∞	-	-	15.4
12	3	1.4	5	1	27	13.4	∞	∞	-	-	15.8
13	3	1.4	1	1.1	7	12.6	∞	∞	-	-	15.1
14	11	1.3	4	1.2	14	8.8	∞	∞	-	-	11.3
15	5	1.4	9	1.3	26	22.7	∞	∞	-	-	25.4
16	21	1.6	33	7.1	68	18.9	∞	∞	-	-	27.6
17	48	1	23	1.8	44	26	∞	∞	-	-	28.8
18	55	1	12	1.8	31	20.6	∞	∞	-	-	23.4
19	62	1	10	1.5	35	29.4	∞	∞	-	-	31.9

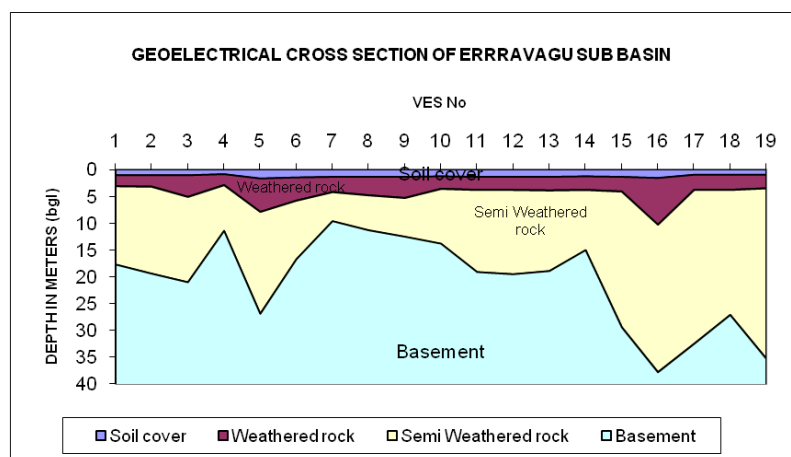


Figure 2: Geoelectrical cross section

6 TRENDS OF WATER LEVELS

The short period and long term changes in groundwater regime are monitored through the network of wells spread in the study area. The water levels and fluctuations noticed seasonally and annually are analyzed in relation to the causative factors, such as rainfall, recharge, drought and extraction of groundwater in the area.

Data generated from periodic monitoring of depth to water levels in the network of villages indicate deep water levels during the pre -monsoon (November) followed by progressive decline in water levels up to the onset of next monsoon. The exploitation of ground water in the non-command area, particularly in Beeravallipaya of Ganapavaram village is mainly by bore wells because of limited depth of weathering. The depth of dug wells in the command area varies between 6.9 to 9.6 m and the yield varies between 80 to 90 m³/day. The depth of bore wells in the adjacent command area varies between 60 to 85 m with a yield range of 96 to 144 m³/day. The depth of bore wells in non-command area varies between 80 to 135 m with a yield range of 72 to 96 m³/day. Exploitation of groundwater through bore wells is intensive in Beervallipaya village of Rajupalem Mandal. Most of the bore wells are getting dried up by the end of January.

7 FRACTURE LINEMENT MAP

The structures are expressed in terms of lineaments, which are the surface manifestations (fractures and joints) developed due to compressional tectonics [6]. A total of 59 lineaments were observed from the study area (Fig. 3), which show mostly NE-SW trend, following the general strike (NE-SW) of the Eastern Ghats. The lineaments which are the linear fractures are suitable sites for groundwater recharge zones, which also control the movement and storage of groundwater [7], as they play as good surface indicators of conduit avenues for infiltrating recharge water from surface directly into sub-surface as groundwater [8]. From this map, it is observed that Ganapavaram Village and North eastern part is a good water potential zone. Moderate groundwater potentiality is observed from western part of the study area. Northern part of the study area indicates poor water potential zones. This was

supported by the field observations in the non-command area of the Beeravallipaya Village.

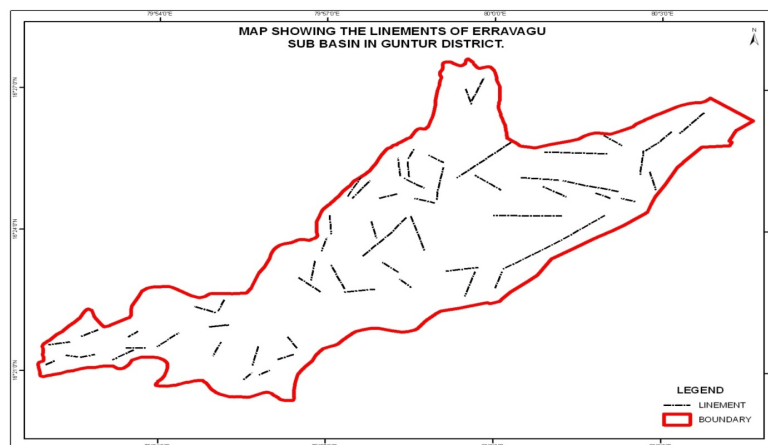


Figure 3: Fracture Lineament map of the Erravagu sub-basin

8 CONCLUSIONS

Based on the geophysical investigations the study area is categorized into four layers namely soil cover, weathered rock layer, semi-weathered rock layer and bed rock. The thickness of surface soil cover varies from 0.9 to 1.7 m, the second layer (weathered rock) thickness varies from 0.9 to 7.1 m and the third layer (semi weathered fractured rock) thickness varies from 2.7 m to 29.4 m respectively. The third layer will be followed by fourth layer (bed rock). The Eastern part is feasible for dug wells and the western part is feasible for bore wells and tube wells for higher yields. The fracture lineament map suggests that North eastern part is a good water potential zone, western part is a moderate groundwater potential zone and Northern part indicates poor water potential zones of the study area.

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