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Determination of Groundwater Availability in Parts of Ilesha, Osun State - An Effort to alleviate the Challenges of Food Insecurity

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Abstract

This paper is aimed at studying the hydrogeological and geophysical characteristics of some parts of Ilesha using the electrical resistivity method, with the intention of identifying locations where water can be abstracted for irrigation purposes and to ameliorate water supply, and thereby improve food security in the areas.

The available surface water resources are inadequate to meet the entire water requirement for various purposes. Therefore, the demand for groundwater has increased over the years. Generally, groundwater is less prone to pollution in comparison to surface water. Hence, groundwater serves as an important source of water for various purposes in rural and urban areas.

Groundwater is suspected to be available in the weathered, fractured, joints and cracks of the crystalline basement. This study clearly shows that most of the areas within the sixteen sampled locations have geological rock types that contain water or has good groundwater potential.

Key words: Groundwater availability, food security, irrigation, vertical electrical sounding, Ilesha

Introduction

It is not often realized, except in times of shortages and drought, that water is a unique resource that has no substitute. It is high time we stopped regarding water as an inexhaustible gift of nature. Water has to be transformed from its natural raw state and then transported to our homes and factories to satisfy man's needs because the hydrologic cycle does not adapt itself to our space, time and quality requirements (Kavannagh, 1967).

The accelerating growth of human population, the rapid advances made in industries and agriculture have resulted in a rapidly increasing use of water by man, to the extent that the availability of water, as well as the control of excessive water, has become a critical factor in the development of the world (Williams, 2010). Over the decades, water supply management have proved to be insufficient to deal with strong competition for water with growing per capital water use, increasing population, urbanization pollution and storages (Xiao- Jun et al, 2009). Also the need for domestic, industrial and agricultural water supply is growing, but the absence of demand policy means that the increase in demand will likely outstrip the available supply, causing water scarcity (UNESCO, 2006). Throughout the world, groundwater development has increased tremendously over the last decade and many governmental and non-governmental organizations seek to improve the critically limited access to potable water, especially in the rural areas, through the construction of water wells. However, in prospecting for groundwater, especially in hard areas, it is often necessary to employ geophysical methods to locate zones of weakness (i.e. diastrophic features) and areas of deep weathering in the rocks, which can act as good water bearing zones. Consequently, it may be necessary to

- Determine the lateral and vertical limits of the diastrophic features like faults, fractures, joints and shears,
- Delimit the extent and thickness of the weathered mantle, and
- Estimate quantitatively the porosity and permeability of rock samples.

Fig.1. Map showing the Study Area

The study area lies between latitudes 7^0 30'N and 7^0 36'N and between longitude 4^0 38'E and 4^0 50'E. Ilesha urban area is made up of two Local Government Areas (LGAs), namely Ilesha West and Ilesa East. Both LGAs areas are bounded in the North, West and South by Obokun, Atakunmosa and Oriade Local Government areas respectively. The town covers a total area of about 73.6 km^2. It is about 32 km northeast of Ile-Ife and about 30 km southwest of Osogbo, the Osun State Capital. The population of Ilesha has been put at 210,141 in 2006 (NPC, 2006). Due to the passage of the sun on its way to and from the Tropic of Cancer, two periods of high temperatures as recorded annually in the study area. The first period occurs in March - April and the second in November - December. The average daily temperature varies between about 20°C (for a very cold day) and about 35°C (for a very hot day). The coolest period is in the middle of the raining season (July - August) (Kayode, 2006).

Previous study has shown that this area is underlain by Precambrian rocks typical of the basement complex of Nigeria (Rahaman, 1976). Some of the main rock types found in this area are granite-gneiss, which occupies most part of the eastern flank, as well as amphibolites complex, quartzite and schist, which occupies other parts of the study area (Kayode, 2006; Ajayi *et al*, 2003; Folami, 1992; Ajayi, 1981; Elueze, 1986). The topography is gentle with few local rock outcrops in the northeastern and northwestern parts.

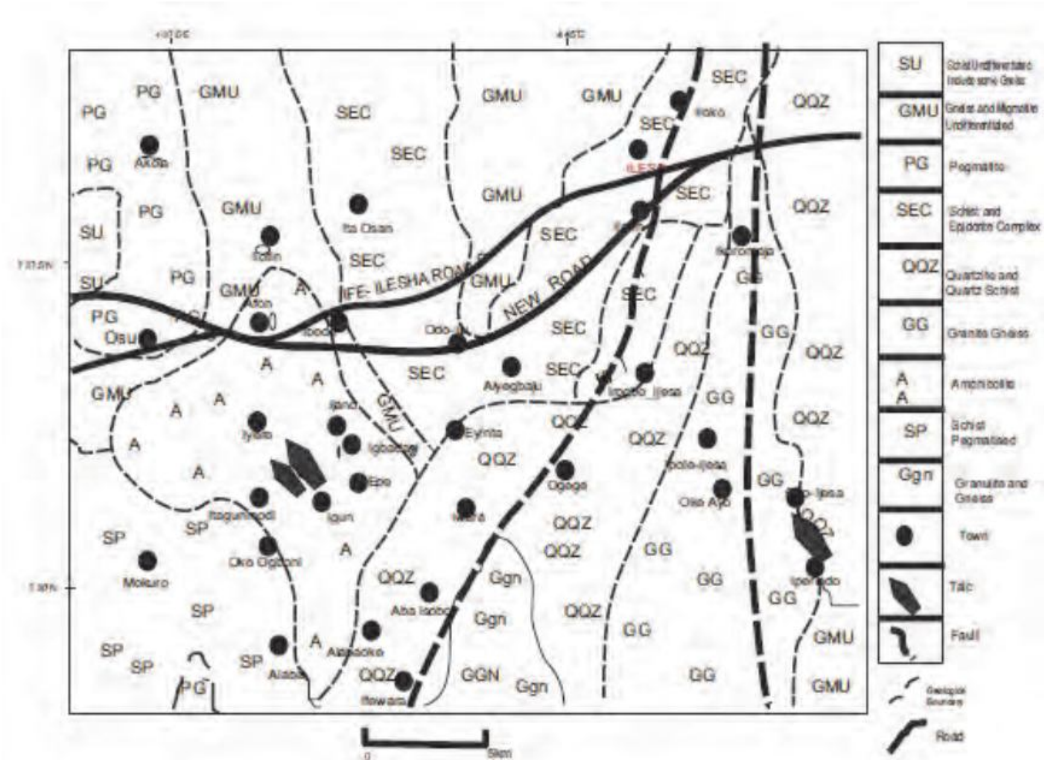

Fig.2: Geological map of the study area (after Adebayo, 2008; Adelusi, 2005)

Research Methodology

The Vertical Electrical Sounding (VES) was carried out and Schlumberger configuration was used in collecting the data.

The raw data were interpreted quantitatively by partial curve matching and computer iteration. The Winresist software was used for the computer iteration. From the results obtained geo-electric section was generated. From the geo-electric sections, locations that are good for groundwater development in the study area were determined.

Result and Discussion

The interpretation of field resistivity data are in terms of resistivity and depth of geo-electric layers, as well as depth to the bedrock. The analysis and interpretation of the data acquired in the field show that there are three to six geo-electric layers in the study area.

Geo-electric Sections

The summary of the thicknesses and resistivities of the geo-electric layers are presented in Table 1. Table 2 shows the resistivities and thicknesses of the water bearing layers at various locations f the study area.

The top layer (i.e. the top soil) consists of clayey, sand and sandy clay and has a maximum layer thickness of 35.0 m, while the resistivity ranges from 72.5 ohm-m – 868.4 ohm-m. The top soil contributes to the development of groundwater because infiltration takes place there and the infiltrating water evaporated from the soil, absorbed by plant root or used for transpiration by plants. The resistivity of the second layer ranges from 36.1 ohm-m - 2514.0

ohm-m, while the thickness varies between 0.9 m - 17.0 m. The resistivity of the third layer ranges from 84.4 ohm-m - 2886.9 ohm-m, while the thickness varies between 2.5 m and 55.1 m. The resistivity of the fourth layer ranges from 87.2 ohm-m - 3748.5 ohm-m, while the thickness varies between 5.8 m and 31.8 m. The resistivity of the fifth layer ranges from 39.0 ohm-m - 4358.4 ohm-m, while the thickness varies between 11.8 m and 29.2 m. The fresh basement, which is the sixth layer, comprises of resistivity values which range from 440.2 ohm-m to 4536.9 ohm-m. The fresh basement is made up of infinite resistive rocks in most stations which form the bedrock. The rock in this zone is hard, with little permeability and water bearing qualities. In fresh, non-fractured rock, the porosity is often less than 2%, as a result, run off is high and infiltration rate is very low in areas where the rock is occurring o the surface. The geo-electric section shows that the depth to the bedrock varies across the sounding station.

Overburden Layer

The thickness of the overburden is of an important hydrogeologic consideration in groundwater development in the basement terrain (Ajayi and Hassan, 1990; Olorunfemi and Idornigie, 1992) because water gets into the saturated zone through the overburden. The thickness of the overburden ranges from 4.1 m to 71.5 m in the study area. The variation in the overburden is due to variation in the degrees of weathering.

Weathered/Fractured Layer

The weathered and fractured zone thickness shows that Location 4 have the highest of thickness of about 55.1 m and Location 5 have the lowest, with about 0.6 m. Deriving from this, the thickness of the weathered/fractured layer here is sufficient for groundwater accumulation and therefore recommended for location of a borehole.

Table 1: Summary of layer thickness of resistivities

VES Locations	Thickness (m)						Resistivities (ohm-m)						Overburden Thickness (m)
	A1	A2	A3	A4	A5	A6	A1	A2	A3	A4	A5	A6	
1	0.8	6.9	17.1	–			72.5	100.1	84.4	388.3			24.8
2	0.9	7.3	11	27	–		128.7	561.6	2328.2	199.1	2562.4		46.2
3	0.7	9.4	22.5	–			393.2	2514	250.5	1427.7			32.3
4	0.7	3	55.1	–			868.4	1257.7	493.2	911.1			58.7
5	0.6	0.9	2.5	5.8	27.1	–	116.4	226.1	85.9	468.5	39	440.2	36.9
6	1.8	2.7	10.1	7.7	11.8	–	813.5	2256.3	742.4	555.6	611.3	3585.6	34.2
7	1.2	7.9	–				1762.4	66.6	844				9.1
8	0.9	4.9	3.6	27.7	29.2	–	347.4	1903.7	910.9	3098.8	222.6	4536.9	66.3
9	1	2.3	35	31.8	–		111.9	48.5	329.4	87.2	710.8		70.1
10	1	5	22.2	30.5	–		446.3	1021.3	2886.9	259.9	4358.4		58.7
11	0.8	3.2	–				76.4	36.1	1022				4.1
12	0.7	10.2	29.1	–			361.4	2358.4	512.8	3748.5			40
13	1	17	45.6	–			210.9	750.1	253.3	2408.4			63.7
14	1.1	4.7	8	15.7	–		209.9	111.2	87.5	67	697.2		29.6
15	1.3	7.5	–				113.8	50.7	759.1				8.8
16	1.2	6	16.5	47.7	–		553.8	155.5	494.4	104.8	683.3		71.5

Table 2: Resistivities and thicknesses of water bearing layers

VES Stations	Latitude	Longitude	Thickness (m) A1	Thickness (m) A2	Thickness (m) A3	Thickness (m) A4	Thickness (m) A5	Thickness (m) A6	Overburden Thickness (m)	Water bearing Layer Thickness (m)	Resistivity of Water Bearing Layer (ohm-m)
1	07°37'08	004°42'46	0.8	6.9	17.1	-			24.8	17.1	388.3
2	07°37'13	004°44'19	0.9	7.3	11.0	27.0	_		46.2	27	199.1
3	07°37'09	004°44'03	0.7	9.4	22.5	_			32.3	22.5	250.5
4	07°37'14	004°44'10	0.7	3.0	55.1	_			58.7	55.1	493.2
5	07°36'20	004°44'26	0.6	0.9	2.5	5.8	27.1	_	36.9	27.1	39.0
6	07°36'03	004°44'15	1.8	2.7	10.1	7.7	11.8	_	34.2	11.8	611.3
7	07°37'59	004°44'58	1.2	7.9	_				9.1	7.9	66.6
8	07°38'18	004°45'17	0.9	4.9	3.6	27.7	29.2	_	66.3	29.2	222.6
9	07°35'57	004°42'44	1.0	2.3	35.0	31.8	_		70.1	31.8	710.8
10	07°35'59	004°43'59	1.0	5.0	22.2	30.5	_		58.7	30.5	259.9
11	07°36'57	004°44'56	0.8	3.2	_				4.1	3.2	36.1
12	07°36'54	004°44'38	0.7	10.2	29.1	_			40.0	29.1	512.8
13	07°37'17	004°47'08	1.0	17.0	45.6	_			63.7	45.6	253.3
14	07°38'23	004°44'58	1.1	4.7	8.0	15.7	_		29.6	15.7	697.2
15	07°38'41	004°44'31	1.3	7.5	_				8.8	7.5	759.1
16	07°38'18	004°44'24	1.2	6.0	16.5	47.7	_		71.5	47.7	683.3

VES Stations 1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 14 and 16 are the locations good for groundwater development, because they have the highest thickness of both weathered and fractured zones, which are good for groundwater accumulation. If the fractured zones are interconnected and hence permeable, the thickness of the weathered zone in this section confers advantage on this over others. The locations will be good for optimum groundwater development, and may be the only safe sources of potable water in those parts of Ilesha. The available groundwater may also be cheapest source of good quality water supply for irrigation purposes, since its development can be gradual in small increments rather than with relatively large scale investment as in the case with dams.

Conclusion

The study area is characterized by undulating topography and experiences seasonal rainfall pattern; it lies within the rainforest belt of the northern part of the south-western region of Nigeria. To alleviate the challenges of food insecurity in Ilesha and environ, promotion of irrigated agriculture must be given priority. Thus, construction of boreholes or hand dug wells has become one of the activities both by the individuals as well as the government on a sustainable basis.

In this research work, a total number of sixteen locations were sampled, some of which gave rise to a good platform for further hydrogeological activities (drilling of boreholes) around the area of study while some, from the analysis of the results that were generalized, cannot support large-scale water production. Hence, if these few ones are to be embarked upon, they are to be given critical considerations.

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