AN ASSEESSMENT OF GROUNDWATER POTENTIAL OF PARTS OF IKONO L.G.A. (AKWA-IBOM STATE) S.E. NIGERIA

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ABSTRACT

The groundwater potential of an area of 1406 Km^2 within the Benin formation-southeastern Nigeria has been assessed based on data from six boreholes sunk at various locations within the Ikono Local Government Area of Akwa-Ibom State, Nigeria. The Benin formation is composed of loosely consolidated sands and gravels with minor intercalations of shales. The sands are poorly sorted, sub-rounded to rounded, medium to coarse grained and often pebbly. The characteristics of the borehole determined include: lithologic log, yield, drawdown, hydraulic conductivity and transmissivity. The yield ranges between 472.32–1918.4 m^3/day while the transmissivity ranges between 106.08-700.84 m^2/day. The findings indicate the area to have moderate to high groundwater potentials. The borehole production could have been better if the borehole drilling had been preceeded by thorough geophysical studies to pick more favourable locations.

Introduction

The study area is the Ikono L.G.A.(Akwa Ibom State) southeastern Nigeria. It lies between Latitudes 5° 00 and 5°25'N and Longitudes 7° 35′ and 8'00'E (figure 1) The area is underlain by sedimentary rocks and constitutes a part of the Niger Delta of Nigeria.

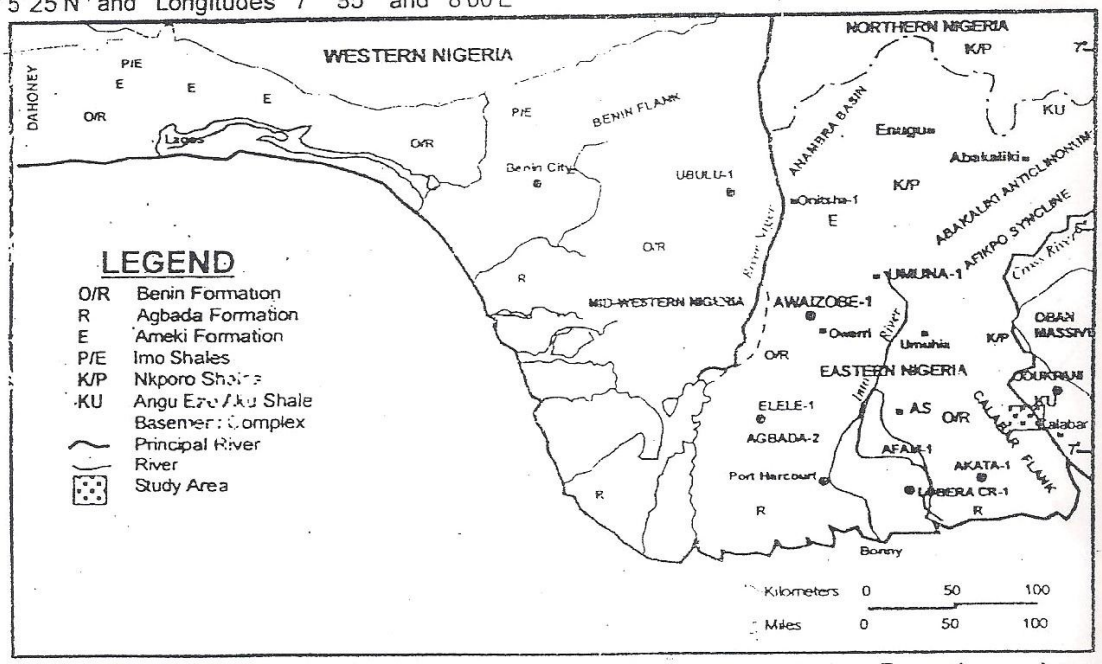


Fig. 1: Map of Southern Nigeria showing outcrops of Cretaceous and Tertiary Formations and type localities of subsurface stratigraphic units. (After Short and Stauble, 1967)

Geological setting

According to Reyment (1964) the surficial sediments in the Nigeria Niger Delta was referred to as "Coastal Plain Sands" by Tattam (1944). Short and Stauble (1967) described the deltaic sequence as consisting mainly of marine clays overlain by continental gravels and sands. The authors recognized three subsurface stratigraphic units namely Akata, Agbada and Benin formations (Table 1) with type localities as shown in fig.1

The lowermost units (Akata formation) is composed of uniform shale grading upward to grey sandy, silty shale. It often contains

sandstone lenses near the contact with the overlying Agbada formation and attains a minimum thickness of 1,200m. Agbada formation consists of an upper predominantly sandy unit minor shale intercalations and a lower units which is thicker than the upper sandy unit (Assez, 1976) (Fig.2). The thickness of the formation may be over 3000m in places. The uppermost stratigraphic unit is the Benin formation which is made up of over 90% sand and gravelly sandstone with shale intercalations. The sands and sandstone are coarse grained, gravelly and locally fine grained. They range in colour from white to yellowish brown. Generally the sediments in the Niger Delta range in age from Paleocene to recent.

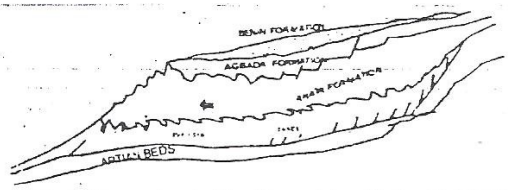


FIG 2: Important Stratigraphic Unit of Niger Delta (After Burke, 1976)

Study objective

The main objective of this study was to analyse available data from six drilled boreholes in the project area and to use it in assessing the occurrence of groundwater as well as evaluating the ground water potentials of the area.

The study also provided information that can be used for optimum development and proper management of groundwater resources of this area and the Niger Delta in general. The need for data for environmental studies will be partly met by this study as well.

Methodology

To determine the groundwater potential of an area the potential aquifers have to be identified and their hydrogeological features (e.g. the geologic character aquifer characteristics, thickness and boundary conditions of the aquifers) have to be considered. These hydrogeological data were obtained from borehole drilling records and pumping test results. There were no us pre-drilling geological/geophysical data in the area, probably due to the general assumption of good groundwater potential of the area. The borehole locations are shown in figure 3.

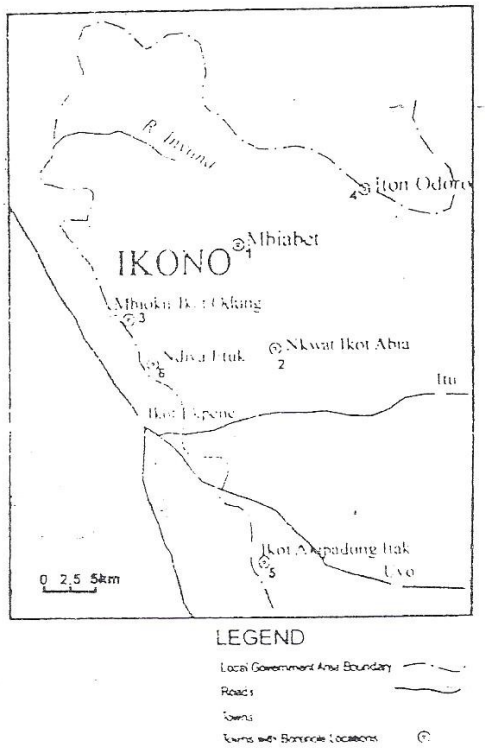


Fig. 3: Map of Ikono Iga showing borehole locations

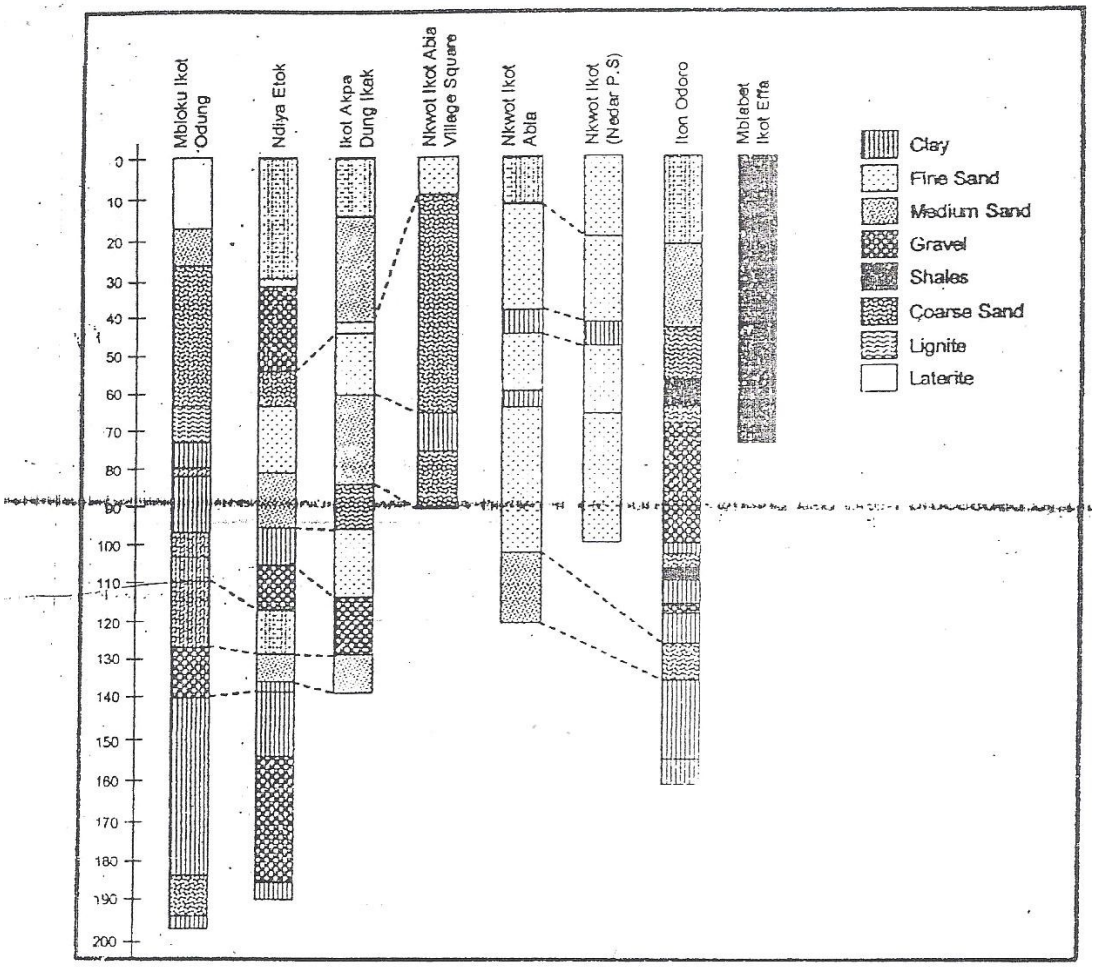


Fig. 4: Lithologic Composition of formations in Ikono LGA and their Correlation

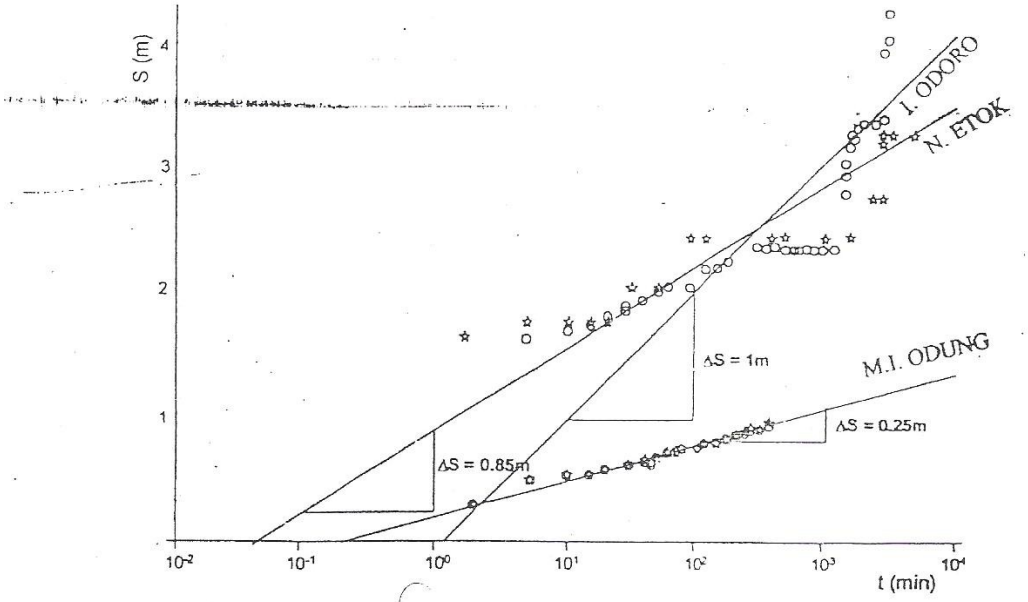


Fig. 5: Analysis of Data from Pumping Test 'IKONO LGA'

Lithologic logs

Rock samples obtained from the borehole drilled in six locations in the study area were collected and processed to provide accurate well logs(Fig.4) The data analysis of these samples were then used to obtain an initial impression of thee Lithologic character and thickness of the aquifer and the boundaries.

Pump testing data

Pump test was carried out to obtain information about the yield and draw down of the wells. It is these data that were used to determine the specific capacity or the discharge-draw down ratio of the well. It is the discharge value that was finally used to determine the transmissivity which gives a pictures of the groundwater potentials of Ikono.

The specific capacity gives a measure of the effectiveness or productive capacity of the borehole. The pump testing data (Draw down versus time) were complied and drawn for the area.

Fig 5 shows the graph of Drawdown versus Time and recovery for three borehole locations (locations 3,4 and 6 respectively) in the area.

From the Drawdown versus Time graph, it took a long time to reach a steady flow condition where the hydraulic gradient has became constant.

Result and discussion

Hydrostratigraphic Unit

Rocks having similar hydrogeologic properties such as specific yield, transmissivity, storativity etc. are called hydrostratigraphic

Based on the constituent materials, a formation (units of rock) can be named or classified as either a sandstone aquifer(i.e. sand being the constituent material) Limestone aquifer (i.e. limestone being constituent material) or Aquitard (i.e. shale being constituent material).

a. From the panel diagram (fig.4) an hydrostratigraphic unit can be established at depth 184-195 in Mbioku Ikot Odung and 153-186m in Ndiya Etok. This is clear from their constituent rock materials i.e. med to coarse grained sand. Other hydrostratigraphic units can be established by studying the different lithological materials.
b. Likely hydrostratigraphic units are shown with the dash lines in Fig.4

Aquifer characteristics

By test pumping the aquifer characteristic such as storage coefficients and transmissivities were determined.

However, it is important to note the following points:-

i) Steady-state flow implies no change occurs with time and it took a long time to be reached during pumping.
(i) The non steady-state flow implies that changes occur with time during pumping.
(ii) Well flow equations have been developed for steady and non-steady flows for various typesf aquifer and for several special conditions.

In this study, the Cooper-Jacob method of non-steady flow in a confined aquifer has been used for the calculation of transmissivity.

i) Discharge (Borehole)

The discharge was measured by the use of a submersible pump. The units is Litres/S or m^3/day in the study area the discharge from boreholes are stated below:-

1 Mbioku 1kot Odung

Discharge =6 Litres/S
=6/1000m^3/S
= 6 x 60x 6024m^3/day
1000
=918400m^3/day
1000
=918.4m^3/day

2 Iton Odoro

Discharge = 31.8m^3/h
= 31.8x24m^3/day
= 763.2m^3/day

3 Ndiya Etok

Discharge =19.68m^3/hr
=472.32m^3/day

ii) Transmissivity

Transmissivity may be defined as the rate at which water of prevailing Kinematic viscosity is transmitted through a unit with of aquifer under a unit hydraulic gradient.(Kinematic Viscosity equals dynamic viscosity divided by fluid density).

T=kb= (m/day) (m)=m^2/day

Where T= transmissivity m2/day
K= Hydraulic conductivity
B= Saturated thickness m

Calculations:

Using the discharge values recorded in Table 2 and applying cooper-Jacob's method of non-equilibrium equation:

1. For location 'X'$_1$ at Mbioku 1kot Odung:

$$T = \frac{2.3Q}{4\pi\Delta S}$$

Where T= transmissivity(M3/day)
Q= discharge = 918.4m3/day
ΔS=slope=Drawdown difference per log cycle of time = 0.25m

$$T = \frac{2.3 \times 918.4 m^3/day}{4 \times 3.014 \times 0.25m} = 700.84 m2/day$$

2. For location 'X'$_2$ at Iton Odoro:

$$T = \frac{2.3Q}{4\pi\Delta S} = \frac{2.3 \times 7632 m^3/d}{4 \times 3.014 \times 1.0m} = 145.600 m^2/day$$

3. For the location 'X'$_3$ at Ndiya Etok

$$T = \frac{2.3Q}{4\pi\Delta S} = \frac{2.3 \times 472.32 m^3/d}{4 \times 3.014 \times 0.85m} = 106.08 m/day$$

iii) Storativity: It should be noted that for storativity Cooper-Jacob has advised that the straight-line approximation method be restricted to small values of U(U<0.01 where U is the lower limit of Theis integral) to avoid large errors and that a close by well with small radius of separation. R be used. Therefore the storativity was not calculated here with this method.

Discussion :

The need for borehole to augment water supply from surface water makes it imperative to have a good knowledge of the aquifer potentials from which groundwater is being sourced.

The study of groundwater potentials in different parts of Nigeria has revealed that most boreholes are wrongly located due to inadequate predrilling geophysical and hydrogeological studies.

Although most of the boreholes in the area here have good aquifer potentials this might have been because of the sedimentary environmental condition rather than thorough study.

The study area reveals moderate to a high groundwater potential based on the aquifer characteristics especially the calculated transmisivity values as shown in table 3 (After Gheorghe. 1978).

TABLE 3 Aquifer potential estimate

T(m^2/day)	Aquifer Potential	Location and Value
Over 500	High	Mbioku Ikot Odung T=700.84m^2/day
50-500	moderate	Ndiya Etok-T=106.08m^2/day Iton Odoro T=145.60m^2/day
5-50	Low	-
0.5 –5	Very low	-
Less than 0.5	Negligible	-
(After Gheorghe 1978		

Summary and conclusion

1. Ikono L.G.A sits on top of the continental Benin formation deposits. The sediments are loosely consolidated and unconsolidated and gravels with shale intercalations. The sands are medium to coarse grained sub angular to rounded and they are poorly sorted.
2. The aquifer characteristic values ranges from medium to very high making groundwater a viable option for water supply (Discharge:472.32m3/day or 472.320 Litres/day-918.4m3/day or 918.400 Litres/day Transmissivity 106.08m2/d-700/day)
3. The moderate to high values of Transmisivity which is a good indicator of aquifer potential shows that the study area has a high groundwater potential, however, proper geophysical and hydrogeological study would have enhanced greater productivity and provide more information that can be used for optimum development and proper management of groundwater resources of this Niger Delta area of Nigeria

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TABLE 1
Stratigraphy of the Niger Delta area

SUBSURFACE			SURFACE OUT CROPS		
YOUNGEST KNOWN AGE		OLDEST KNOWN AGE	YOUNGEST KNOWN AGE		OLDEST KNOWN AGE
RECENT	BENIN FM	OLIGOCENE	PLIO/PLESITOCENE	BENIN FM	MIOCENE
RECENT	AGBADA FM	EOCENE	MIOCENE	OGWASHI-ASABA FM	OLIGOCENE
			EOCENE	AMEKI FM	EOCENE
RECENT	AKATA FM	EOCENE	L.EOCENE	IMO SHALE FM	PALEOCENE
EQUIVALENTS NOT KNOWN			PALEOCENE	NSUKKA FM	MAESTRICHTIAN
			MAESTRICHTIAN	AJALI FM	MAESTRICHTIAN
			CAMPANIAN	MAMU FM	CAMPANIAN
			CAMP. / MAEST.	NKPORO SHALE	SANTONIAN
			CONIACIAN-SANTONIAN	AWGU SHALE	TURONIAN
			TURONIAN	EZE AKU SHALE ASU RIVER GROUP	TURONIAN
			ALBIAN		ALBIAN

(After Short and Stauble, 1967)

TABLE 2
Values obtained by cooper-jacob's method for nonequilibrium equation

SERIAL NO	DESCRIPTION	LOCATION	LOCATION	LOCATION
1.		Mbioku Ikot Odung	Iton Odoro	Ndiya Etok
2.	Symbol of Location	X'_1	X'_2	X'_3
3.	Drawdown difference per log cycle of t (m)	0.25m	1.0m	0.85m
4.	Depth at which screen was installed (m)	(127-136) and (183-193)	(62.2-[illegible]8)	(164.65-179.87)
5.	Total length of screen (m)	16	38.45	15.22
6.	Aquifer material	Coarse Sand	Coarse Sand	Medium to Coarse Sand
7.	Discharge (m^3/day)	910.4m^3/day(910,400 Litres/day)	783.[illegible]m^3/day (783,200 Litres/day)	472.32m^3/day (472,320 Litres/day)
8.	Transmissivity(m2/day)	700.84m^2/day	145.9[illegible]	406.08m^2/day
9.	Types of rock overlying the aquifer	Clay	Shale	Clay