AN ASSESMENT OF G*R*OUNDWATER POTENTIAL OF NANKA GULLY EROSION SITES IN SOUTH EASTHERN NIGERIA USING AQUIFER PARAMETER, TRASMISSIVITY.

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Abstract
The study area lies in the humid tropical rainforest belt of Nigeria. The landscape is a cuesta within the Awka-Orlu uplands formed by the Nanka formation (early Eocene) and the Imo Shale formation (Palaeocene). The geological, hydro geological, geotechnical and hydro geochemical characteristics of the area and human activity have contributed to gully development and growth. It was observed that there are numerous springs, streams and lakes draining the gully floodplains. The research indicated that increase in hydraulic head produces rapid flow rates that enhance the gullying process during rainy seasons. It was discovered that those exposed lithology, houses lens of water, perched aquifers, and fully saturated aquifer when the erosion, landslides, flooding encounter and exposes highly saturated Nanka formation. The paper therefore examines the potential of groundwater resources of the various gully sites within Nanka gully region in Anambra state.
Keywords*:* Anambra River Basin, Nanka Sands, Groundwater, *Gully* and Aquifer Parameters

Introduction
The Nanka gully erosion is located with the Anambra basin. The basin *covers an area of about 30,000*km^2. It stretches from the area just south of the confluence of the river Niger and Benue. Groundwater potential within the Anambra basin -southeastern Nigeria has been assessed by many authors based on data from boreholes sunk at various locations within the State and surface waters, and ground water potential of the state(Kogbe,1976):.
The gullying at Nanka started around 1850 and the rate of gully growth is estimated at 20-50 m year. (Reyment, 1964).In NankaMajor Aquifers, aquclude, aqufuge and Aquitards form highly dynamic multiaquifer systems and heavy rainfall causes a rise in the water table, through capillary action, adhesion and advection. The stratigraphy, hydrology and hydrogeology and geologic formation are composed of loosely consolidated sands and gravels with minor intercalations of clay at the surface but mainly of thick beds of *Imo shale*. These shales acts as a confining layers for the aquifer of the study area which is well exposed on the flood plain of Eziokor beach, where sand miners excavate mineral sands indiscriminately.

Location of the Study Area
Nanka is located in the Orumba North Local Government Area of Anambra State. Its geographic coordinates are 6" 03' 00 North, 7" 05' 00 East.[1] Its neighboring towns are Oko, Agulu, Ekwulobia, Aguluzigbo, Isuọfia, Umuọna, and Awgbu

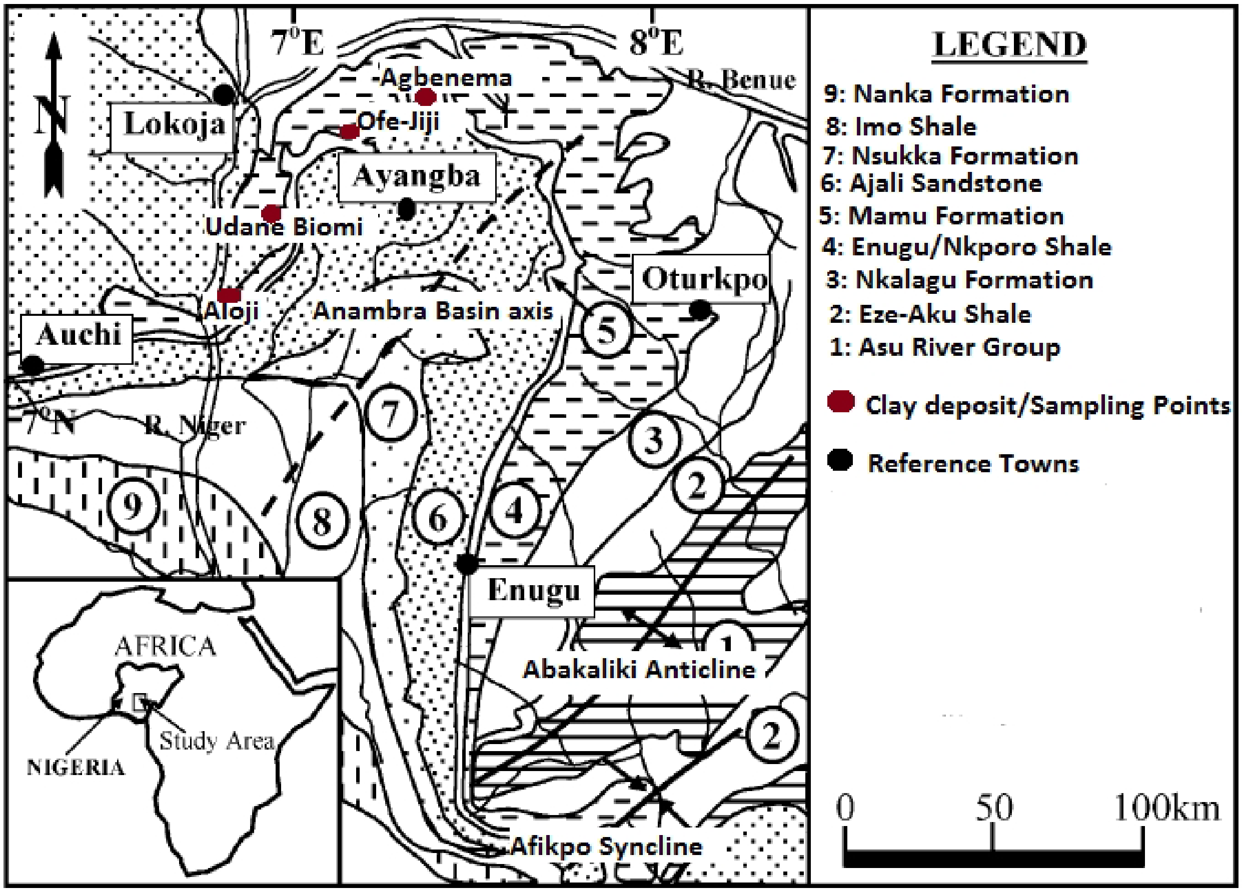

Figure 1, showing Anambra Basin, adopted from (Egboka1984).

Geological Sitting of the Study Area

The dominant geological formation is the Nanka sands, which lies conformably on the Imo Shale of Paleocene age and overlain by the Ogwashi-Asaba formation. The Basin delineates the southern border of the Benue Trough which was formed along with the Afikpo syncline and Abakaliki Ridge during the santonian tectonics (Short K.C. and Stauble, A.J. (1967). The stratigraphic sequence of the Anambra Basin in the study area is given in figure2.The study area lies within the humid tropical rainforest belt of Nigeria with an average annual rainfall of 1,800mm.

The sands are poorly sorted, sub-rounded to rounded, medium to coarse grained and often pebbly

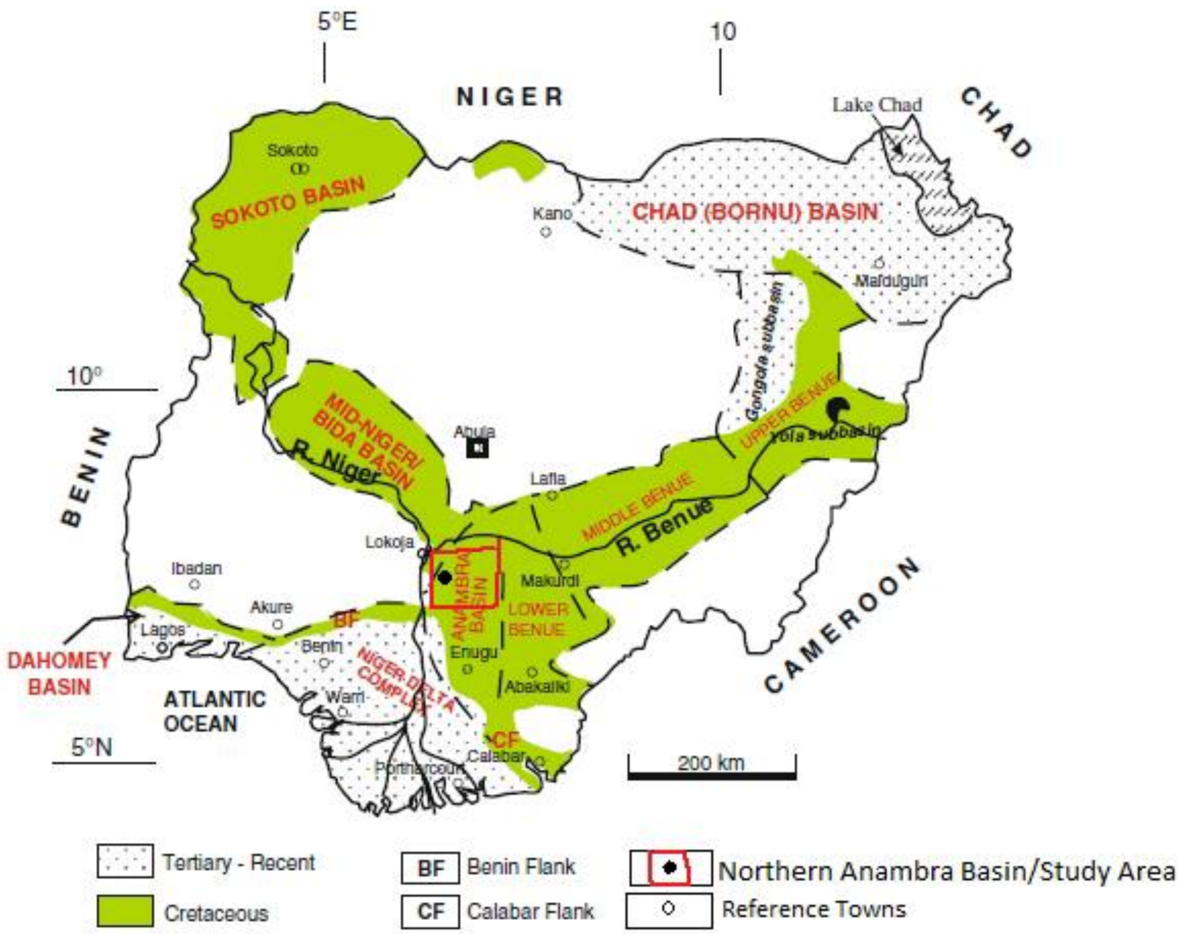

Figure2 ; showing all the sedimentary basins in Nigeria

Methodology

Field trips were embarked on to gully sites and corridors within the study areas, where the deep seated gullies exposes spring waters oozing from exposed Nanka multi aquifer formations, and also places where the flood waters from drains forms artificial lakes, ponds and other numerous surface water that is associated with gullies. Questions were asked to the inhabitants and villagers on the ages and behavioral patterns of the numerous surface waters that are associated with the various massive gullies in almost all the communities in Nanka. Information on whether they are seasonal or perennial were asked.

In order to determine the groundwater potential of the gully area the potential aquifers have to be identified and their hydro geological features (e.g. the hydrologic character, exposed seepages, aquifer characteristics, thickness and boundary conditions of the aquifers) have to be delineated and considered.

Rock and sand samples were obtained from various gully site locations in the study area. They were collected and subjected to mathematical analysis of to provide accurate hydro geological parameters and log of numerous exposed groundwater systems at the base of the gullies. . The data analyses of these samples were then used to obtain an initial impression of the lithologic character and thickness of the aquifer and the boundaries within the geological formation of the gullies.

Result and discussion

The local geology of Eocene Nanka sands indicates that sands are loose, friable, unconsolidated and poorly cemented with thin shaley layers. The sands are very permeable with high porosity, well sorted while the shales are the aquitards, acting as a confining layer. Below the water table, these sands and shales are saturated with water which affects their strength. The area receives torrential downpours of rain during the rainy season when the water table rises and high groundwater flow rates occur. During the dry season, the water table falls as a result of hydraulic head decay. This produces decreased flow rates, and an increase in the depth of the unsaturated zone. During the dry season, erosion and gullying activities are therefore at a minimum. The depth to the water table varies spatially (Egboka, 1984). In areas where the overlying lateritized soils have been eroded, the water table is shallower and may outcrop as effluent seepages, springs, ponds or streams. (Egboka,1985)

A considerable rise in the water table occurs during the rainy season, despite the thick unsaturated zone. This is due to the high vertical hydraulic conductivity of the freely draining medium- to coarse-grained soil overlying the multiaquifer system.

Table 1 Aquifer potential estimate of Nanka gully sites (After Todd, D.K. (1980)

T(m^2/day)	Aquifer Potential	Location and Value
Over 500	High	Nanka main town: T = 700.84m^2/day
50-500	**Moderate**	Nanka Erosion site: T = 106.08m^2/day :
5-50	Low	
0.5-5	Very low	-
Less than 0.5	Negligible	

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 m^2/day

K = Hydraulic conductivity

B = Saturated thickness m

Calculations:

Using the discharge values recorded in Table 2 and applying cooper Jacob's

1. For location 'X'$_1$ at
Odudunkananka:

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

Where T = transmissivity (m^2/day)

12

Q = discharge= 918.4m3/day

ΔS = slope= Drawdown difference per log cycle of time = 0.25m

T = 2.3 x 918.4m3/day

=700.84m2/day

2. For location 'X'$_2$ at

Erosion site Nanka

T = 2.3 X = $2.x472.32m^3/g$= 106.08m/day

4πΔS 4 x 3.014 x 1.0m

3. For the location 'X'a at Nanka main town

T = 2.3Q= $2.3 \times 472.32m^3/d$= 106.08m/day

4πΔS 4 x 3.014 x 0.8

The study area reveals moderate to high groundwater potential based on the aquifer characteristics especially the calculated transmisivity values as shown in table 1

Summary and conclusion

1. Nanka sand stone are loosely consolidated and unconsolidated sand and gravels with shale intercalations. The sands are medium to coarse grained sub angular to round 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 472,32m^3/day or 472.320 Liters/day-918.4m^3/day or 918.400 Liters/day Transmissivity ranges from 106 0.8m^2/d-700/day)
3. The moderate to high values of Transmissivity which is a good indicator of aquifer potential shows that the study area has a high groundwater potential, however, further geographical and hydro geological study using other aquifer parameters, would have enhanced greater productivity and provide more information that can be used for optimum development and proper management of groundwater resources of the study area

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