# ASSESSMENT OF GROUNDWATER QUALITY IN YENOGOA, BAYELSA STATE NIGERIA

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## ABSTRACT

This research was focused on the investigation of groundwater quality in the metropolis of Yenogoa which is often considered as a significant part of the Niger Delta region. Water samples were collected from designated areas and these samples were subjected to laboratory tests. The tests were targeted at ascertaining the bacteriological, physical and chemical characteristics of the sample water from the boreholes. With the results obtained from the tests, it was revealed that the groundwater characteristics in the metropolis conformed to the acceptable limits of the World Health Organization and Nigerian Industrial Standards except for its iron concentrations which did not conform to the accepted standards.

**Keywords:** Groundwater Quality, Laboratory Tests, Bacteriological, Physical and Chemical Characteristics, World Health Organization and Nigerian Industries.

## INTRODUCTION

Groundwater makes up about twenty percent of the world's fresh water supply, which is about 0.61% of the entire world's water including oceans and permanent ice. Groundwater is naturally recharged with surface water from rainfall, streams and rivers as they reach the water table. It has been observed that the volume of groundwater comprises 30.1% of all freshwater on earth as compared with 0.3% of surface fresh water. Groundwater is a significant part of the water cycle. Water gets down to the ground through pores that are contained on the earth strata. Groundwater is contained inside the ground and it is assessed through digging into the ground, thereby penetrating into the water table. Water assessed through this method is extended vertically and later horizontally for proper reticulation and usage. The vertical digging to reach the groundwater makes the drilled well or borehole.

Generally, groundwater exploitation is by the use of well. Holes are dug and they extend vertically into the aquifer and are brought out through pumping. Wells or boreholes can be shallow or deep. Wells with dept of more than 6m are called deep wells while the ones less than 6m are regarded as shallow. Groundwater has become a veritable source of community water which can be used for domestic and industrial uses. Urbanization and industrialization have contributed immensely to the contamination of groundwater through refuse dumping, wastewater and septic tank location. The focus of this research is to investigate the degree of pollution of groundwater in Yenogoa, Bayelsa State. Water should be free from disease vectors and mineral and organic materials that are harmful to human health.

## Aquifer

Aquifer is defined as a permeable stratum or a geological formation of permeable material which is capable of yielding appreciable quantities of groundwater under gravity. Aquifers can be classified into unconfined or non-artesian and confined or artesian aquifers. The unconfined aquifers is an aquifer which is not hidden or confined by any top-most water bearing stratum or having any impermeable overburden lying over it. These are mostly ordinary gravity wells of 2m to 5m dept, which are constructed to tap water from the top most bearing strata. On the other hand, when an aquifer is concealed or confined on the upper and under surface, by impervious rock formation and it is also broadly inclined so as to expose the aquifer some where at a catchment area at a higher level to create a hydraulic head. A well excavated through such aquifer yields water that often flows out automatically under hydrostatic pressure. This is called flowing well. With high ground profile, the water may remain in the ground well. This means that the pressure surface is below the ground surface, the well will be artesian but non-flowing and it will require a pump to bring the water to the surface.

## Water Quality

Groundwater is ordinarily pure and safe because of the natural filtration process which underwent before being accumulated at the aquifer. Inspite of this, groundwater is often subjected to contamination due to human activities such as location of septic and soak away tanks near the source of groundwater and disposal of wastes at the point of groundwater source or the chemical composition of its rock formation. Foreign substances can also pollute groundwater and these pollutants adversely affect the physical, chemical and biological characteristics of groundwater.

## Physical Pollutants

Most physical contaminants occur in ground water due to sediments arising from soil erosion. Turbidity may occur as a result of the suspended materials such as clay and silt. High concentration of detergents may cause formability in ground water. The foam arising thereby may not pose any serious health challenge but may be a clue that other dangerous substances are present.

## Bacteriological Pollutants

Bacteriological pollution occurs in groundwater when human or animal waste enters into an aquifer. The safety of groundwater in this respect can be determined through the identification of the presence of bacteria belonging to Escherichia coliform group. E-colis are harmless or non-pathogenic but since the whole e-coli form group is foreign to water, a positive e-coli test indicates the presence of bacterial contamination.

## Chemical Pollutants

Groundwater is susceptible to chemical pollutants because as the water moves through the soil profile to the aquifer, it dissolves materials contained in the rocks and soils. The domestic sewage composed of faeces from pit latrines, kitchen laundry etc are sources of contamination of household wells.

## BOREHOLE DRILLING OPERATION

The presence of groundwater can be found by drilling into the ground to search for the availability of water. Modern technology had provided tools which increases and facilitates the success of drilling operations. The tools are of three types namely cable tool or percussion method, hydraulic rotary method, and reverse rotary method.

### Cable Tool or Percussion Method

The cable tool method is suited to well drilling in any formation from soft clay to the consolidated hardest rock materials. The hole is drilled by striking force of the drilling bit attached to the lower end cable. The drilling bit is automatically lifted and dropped in the descending borehole to break the formation. The pulverized material or cuttings loosened by the bit are removed out of the bore by means of sand pump or a bailer.

### Hydraulic Rotary Method

This is also called direct rotary method and it is the fastest method of drilling and it is especially useful in unconsolidated formations. The method involves the continuous rotating of the hollow bit, through which a mixture of clay and water or mud is forced. The bit cuttings are carried up in the hole by the rising mud. No casing is required during drilling because the mud itself makes a lining on the walls of the holes, preventing it from caving. After the drilling is completed the casing is lowered into the hole. The clay deposited on the well-walls during mud pump is removed by washing it with water. Water containing some chemicals such as sodium hexametaphosphate is forced through the drill rod and washings come out through perforations of the casing.

### Reverse Rotary Method

This is a modification of the hydraulic rotary method. It is useful for making large wells of 1.2m diameter in unconsolidated formations. The tool consists of a hollow drill, drill pipe and water swivel. In the method, the cuttings are removed by water through a suction pipe called drill pipe. The equipment consists of a mast or a derrick, a centrifugal pump, water and power equipment and the needed casing pipe. The hole is driven by pumping water under pressure through the drill bit while it is churned up and down.

## GEOLOGY OF BAYELSA

Bayelsa State is a part of the Niger Delta area and its origin dates back to the opening of the Atlantic Ocean as South America separates from Africa during the cretaceous geological period. The Niger Delta sediments have been accumulating for over seventy five thousand years. The Niger Delta is part of the formation resulting from the subsidence of the Benin Dahomey. The underlying sediments estimated at different rates have given rise to different formations namely the Akata formation, Agbada and Benin formations upon which clay and sand of massive thickness are found in most parts of Niger Delta as we observe the Quaternary deposits of different colours. Yenogoa is located in the central Niger Delta and it belongs to the Benin formation noted for sand ranging from coarse to fine soil grain sizes. But in the locality, the stratas (rock layers are made up of sand and clay, pure sand, sandy clay etc). So that when drilling from the surface, clay is encountered first. The aquifers in

the area are mostly unconfined. The presence of sand stone and clay in the area reveals that the environment in Yenogoa City is sedimentary.

## METHODOLOGY

### Study Area

The study area is Yenogoa which is located between latitude 4.55'N and $4^0$57'N and longitudes $6^0$15'E and $6^0$18'E in the coastal area of Nigeria. The map of the study area is shown in Fig. 1.

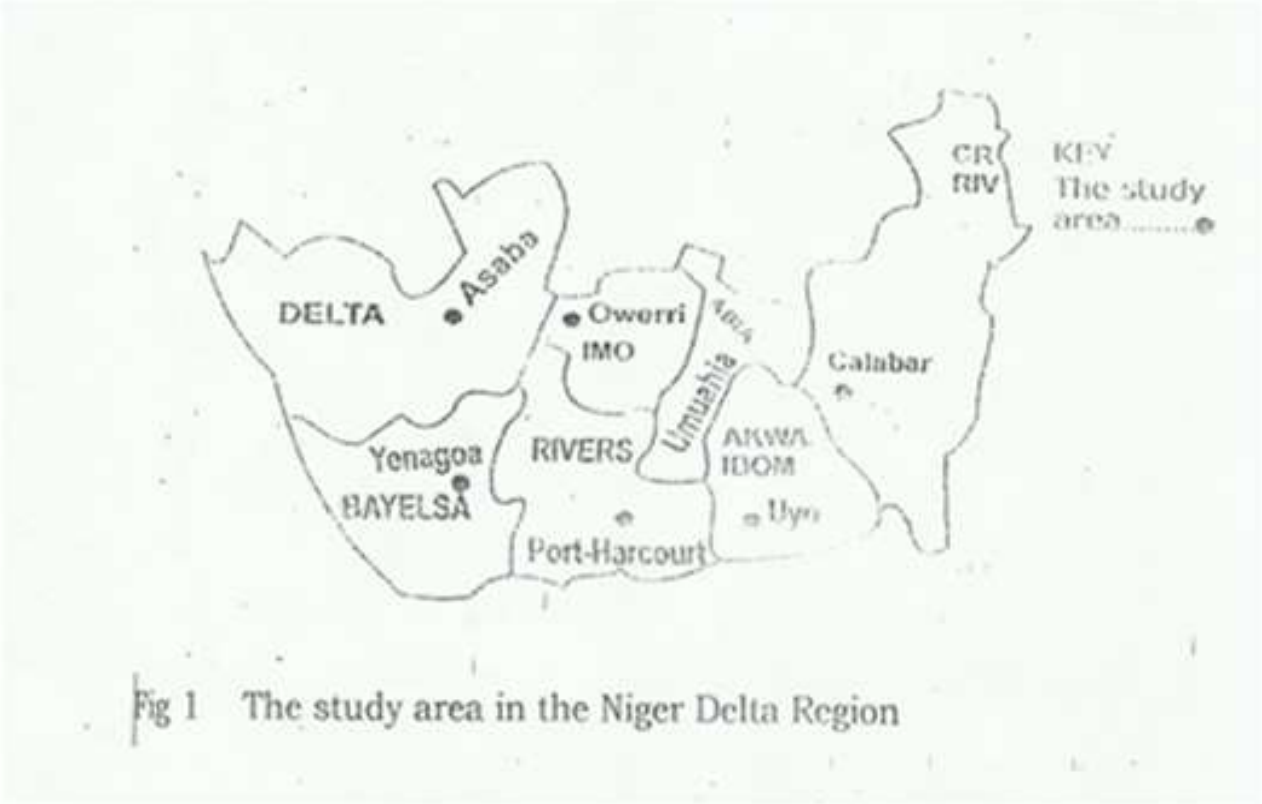


Fig 1 The study area in the Niger Delta Region

### Sample collection and Analysis

Samples were collected from representative areas of Bayelsa and the samples were tested and analysed.

## RESULTS AND ANALYSIS

### Presentation of Results

The results obtained from the tests conducted on the samples are presented in Table 1.

Table 1: Results of Physio-Chemical Analysis

| Parameters | Units | Borehole No | | | | WHO (2007) | NIS (2007) Permitted Maxi Level |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | | |
| Colour | TCU | 5 | 5 | 5 | 5 | 5 | - |
| Turbidity | N.T.U | 25 | 30 | 20 | 5 | 5 | 5 |
| Conductivity | µ5/cm | 75.7 | 30.6 | 20 | 90 | 10 – 1000 | 10-1000 |
| Ph | - | 8.3 | 7.5 | 8.0 | 7.2 | 6.5-8.5 | 6.5 – 8.5 |
| Chlorides as NaCl | Mg/L | 100 | 150 | 170 | 110 | 250 | 250 |
| Alkalinity | Mg/L | 25 | 20 | 30 | 18 | 200 | - |
| Total Hardness | Mg/L | 1.0 | 12 | 15 | 12 | 100 | 150 |
| Total Iron | Mg/L | 4.5 | 13 | 7.0 | 2.5 | 0.3 | 0.3 |
| Appearance | - | Turbid | Turbid | Turbid | Clear | Clear | - |
| $C0_2$ | Mg/L | 20 | 18.5 | 30 | 25 | - | - |
| Chromium | Mg/L | - | - | - | - | 0.05 | 0.05 |
| E-coli | Cfu/ml | - | - | - | - | 0 | 0 |
| Temperature | $^0C$ | 20 | 25 | 24 | 25 | 25 | Ambient |
| Dissolved Oxygen | Mg/L | 7.0 | 7.5 | 7.0 | 7.5 | 7.5 | - |

*Source*: Laboratory Test Results.

## ANALYSIS OF RESULTS

The result in table 1 shows that some parameters tested satisfied the World Health Organization Standards and that of the Nigerian Industrial of standards while others were outside the acceptable limits. In the physical characteristics of the water tested, it was observed that colour, conductivity, Ph, temperature and dissolved oxygen were within the limits of the specified standards. It was also discovered that the turbidity value was very much higher than the given standards except in borehole 4 which was exactly the same with the stated value of the standards. The chemical characteristics such as chlorides, total hardness and dissolved oxygen, were within the limits acceptable while the iron contents of the samples were very high and not acceptable. The bacteriological characteristics show that the e-coli concentrations in boreholes are within the limits. It can be observed that there is a correlation between turbidity and appearance. Samples from boreholes with high turbidity were not clear.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

It has been established that groundwater from Yenagoa are safe except for the relatively high concentrations of iron. This research is of the opinion that the groundwater should be treated to reduce its iron content to the acceptable limits.

## RECOMMENDATIONS

(i) Area within 15 metres of boreholes should not be used as a dump site, and soak away/septic tanks to reduce pollution and contamination of the groundwater.

(ii) Analytical tests of the bacteriological, chemical and physical characteristics of every new borehole should be carried out before usage.

(iii) All boreholes in the city should be inspected and samples from them tested at a regular interval of time to ensure its safety for public usage.

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