# Physicochemical Characteristics of Groundwater obtained from Bodo Community in Gokana Local Government Area of Rivers State

Chinedu Azubuike Uzor and Fubara Alex

Department of Science Laboratory Technology, School of Science and Technology, Port Harcourt Polytechnic, Rumuola, P.M.B. 5936, Port Harcourt, Rivers State
Corresponding author's e-mail: uzorchinedu@yahoo.com

**Abstract:** Bodo community is situated in Ogoniland where oil exploration and exploitation has had its positive and negative impact on the environment. In recent times, water pollution is a top priority in environmental health concerns. The quality of water for domestic activities is affected by conditions of water supply system which are prone to contamination sources. Some physical and chemical characteristics of groundwater from wells in Bodo community were studied for three months (March to April) to assess the potability of the waters obtained by the people. A total of 30 water samples collected from 10 randomly selected private wells in the area were analysed using standard analytical techniques and instruments. Most of the physicochemical parameters (pH, Conductivity, Turbidity, Total hardness, Calcium hardness, Magnesium hardness, Chemical Oxygen Demand, Total Dissolved Solids, Copper, Zinc, Iron, Lead, Cadmium, Nickel, Potassium and Chromium) analyzed were within the Permissible levels of physicochemical parameters in drinking water set by the Nigerian Industrial Standards for Drinking Water Quality and the World Health Organization Guidelines for Drinking Water.
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**Key words:** Oil exploration and exploitation, water pollution, groundwater, Bodo community.

## 1. Introduction

Fresh water is a source of life to man and other organisms in the environment. The contamination of fresh waters with a wide range of pollutants has become a matter of concern over the last few decades (Dirilgen, 2001; Vutukuru, 2005). Ground water is the water beneath the surface where all the voids in the rocks and soil are filled.

It is a source of water for wells, boreholes and springs. In developing countries including Nigeria, where the majority of people live in rural areas, rivers, streams, wells and more recently boreholes, serve as the main sources of water for drinking and domestic use (Ibe and Okpienye, 2005). The underground water supplies are usually considered safe provided they are properly located, constructed and operated according to the World Health Organisation Guidelines for Drinking Water (WHO, 2008). Owing to the increasing demand for water by the community members, the numbers of dug wells and boreholes in the community have been on the increase on a yearly basis such that well water and borehole water are becoming the primary and sometimes the only source of drinking water in Bodo community in Gokana Local Government Area, as opposed to the previous practice of relying on streams and rivers for water for domestic activities.

The reliance of these water sources is on the belief that these groundwaters are relatively far from oil polluted streams and rivers and are thus less susceptible to pollution. This is true to some extent only. However, groundwaters are sometimes known to be vulnerable to quality problems that may have serious impact on human health. The problem with some of these water sources is that they are rarely if ever subjected to periodic testing of key water parameters to ascertain their portability before being consumed.

Main origins of pollution of wells and boreholes are industrial, domestic and agricultural effluents and pollution can be continuous or accidental (Ibe and Okpienye, 2005). Industrial pollution may involve seepage of used water containing chemicals such as metals and radioactive compounds, or contaminated water from damaged pipelines infiltrating into the borehole.

Domestic pollution may involve seepage from broken septic tanks, pit latrines, cesspools and privies. Agricultural pollution is from irrigation water and runoff water after rains, carrying fertilizers, pesticides, herbicides and faecal matter. Environmental pollution is mainly from sea water intrusion into coastal aquifer.

The World Health Organization (WHO) had earlier recommended that boreholes should be located at least 30m away from latrines and 17m from septic tanks (Chukwurah, 2001; Wagner and Lanoix, 1969). The discovery of oil can be described as a blessing to any nation, but the uncontrolled exploration and exploitation of the same commodity can be and has always resulted in negative consequences (Akpahwe and Solomon, 2012).

These negative consequences arise from spillage from broken pipes, leaky or broken tankers and barges, gas flaring, careless loading, uncontrolled attitudes of seismic activities and vandalization of oil installations (UNEP, 2011). The negative effects arising from mismanagement or negligence on the part of the oil (petroleum) company's operators and the regulatory authorities generally result to oil pollution (Akpahwe and Solomon, 2012).

A large number of literatures have been recorded over the past few decades, describing oil pollution and its effects on the temperate regions, the Middle East and in some tropical areas of South America. Apart from the limited reports from South America, available information may not have much useful carry-over value to tropical African ecosystem (Ekweozor, 1989).

## 2. Materials And Methods

### 2.1 The Sampling Area

The water samples were collected from 10 functional wells sited in different parts of Bodo community. The inhabitants of the place use the water for domestic activities such as bathing, washing and cooking amongst others. Table 1 shows the sample area identification.

**Table 1: Sample Area Identification**

| Sample code | Sample source |
|---|---|
| WW 1 | Barabor well |
| WW 2 | Nubari well |
| WW 3 | Baridule well |
| WW 4 | Patrick bade well |
| WW 5 | Well water |
| WW 6 | Micheal Gbaranem well |
| WW 7 | Agbara well |
| WW 8 | Nobari well |
| WW 9 | Barisi well |
| WW 10 | Kpananon well |

***WW**= Well water

### 2.2 Collection of Samples

The well water samples were fetched with the bucket and rope and turned into the jerry can directly and capped. The cans were also labelled according to the name (Table 1) of the owner of the well. The samples were preserved in coolers with ice block, to preserve their state and minimise any biochemical changes which may affect the pH of the samples. They were then transported to the laboratory for analysis.

### 2.3 Physicochemical Analysis

The temperature of the water samples was measured with a $100^0$C mercury-in-glass thermometer by dipping it directly into the water and reading off the value when the mercury remained steady at a point. The pH was determined using the electronic Fisher Accumet pH meter. Water conductivity and total dissolved solids (TDS) were measured at the laboratory with Hannah Instrument Portugal No. HA9812.

Conductivity and TDS were expressed in µmcm-1 and ppm respectively. The HACH 2100P turbidometer was employed in the determination of the turbidity of the water samples. The test was conducted in accordance with AOAC (1985) standards. Hardness is a measure of the calcium and magnesium concentration of a sample. It is expressed as mg $CaCO_3$/liter. The detection limit is 5 ppm. Estimation of magnesium concentrations in water were obtained from the EDTA calcium hardness and total hardness titration in accordance with the APHA (1998) method.

The metals were determined by atomic absorption spectrophotometer (AAS) method. This was carried out at Eleme Petrochemicals Company Limited, Quality Assurance/Quality Control Laboratory (QAQC Lab), Eleme, Rivers State, Nigeria.

## 3. Results And Discusion

Determination of both heavy and trace metals of water and some other physicochemical parameters were done using standard laboratory procedures and equipments (such as FAAS, pH and Conductivity meters, turbidometer, colorimeter, UV spectrophotometers and classical Titrimetry methods.

The results obtained were compared with the Nigerian Standards for Drinking Water Quality (Nigerian Industrial Standards (NIS 554: 2007)). These standards were guided by the World Health Organisation (WHO) International Standards for Drinking Water. These values are based on WHO guideline value for which no adverse health effect is noticed.

Table 2 shows the Permissible levels of physicochemical parameters in drinking water as recommended by the Nigerian Industrial Standards (NIS 554: 2007). Furthermore, Table 3 indicated the average results obtained from the analysis of the different groundwater (well) samples from Bodo community in Gokana Local Government Area of Rivers State, Nigeria.

**Table 2: Permissible Levels of some Physicochemical Parameters in Drinking Water**

| S/No. | Parameter | Unit | Maximum Permissible level |
|---|---|---|---|
| 1 | pH | - | 6.5-8.5 |
| 2 | Conductivity | µS/cm | 1000 |
| 3 | Turbidity | NTU | 5 |
| 4 | Total Suspended Solids | mg/L | 500 |
| 5 | Hardness (as CaCO3) | mg/L | 150 |
| 6 | Calcium | mg/L | 75 |
| 7 | Magnesium (Mg+2) | mg/L | 50 |
| 8 | Chemical Oxygen Demand | mg/L | <10 |
| 9 | Total Dissolved Solids | mg/L | 500 |
| 10 | Copper (Cu+2) | mg/L | 1 |
| 11 | Zinc (Zn) | mg/L | 3 |
| 12 | Iron (Fe+2) | mg/L | 0.3 |
| 13 | Lead (Pb) | mg/L | 0.01 |
| 14 | Cadmium (Cd) | mg/L | 0.003 |
| 15 | Nickel (Ni) | mg/L | 0.02 |
| 16 | Potassium | | None listed |
| 17 | Chromium (Cr6+) | mg/L | 0.05 |

*Permissible levels of physicochemical parameters in drinking water. (NIS 554: 2007).

**Table 3: Average Result for Analysis of Groundwater (well) Samples in Bodo Community of Ogoniland**

| S/no. | Parameter/ sample | pH at 25 $^0$C | Cond (us/cm) | Turb. (NTU) | TSS (ppm) | To-HD (ppm) | Ca-HD (ppm) | Mg-HD (ppm) | COD (ppm) | TDS (ppm) | Cu (ppm) | Zn (ppm) | Fe (ppm) | Pb (ppm) | Cd (ppm) | Ni (ppm) | K (ppm) | Cr (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Barabor well | 4.6 | 167 | 0.01 | 2 | 9 | 5 | 4 | 18 | 6 | <0.02 | 0.6 | 0.5 | <0.01 | 0.06 | <0.02 | 1.23 | <0.02 |
| 2 | Nubari well | 4.5 | 62.2 | 0.01 | 2 | 9 | 7 | 2 | <5 | 5 | <0.02 | 0.04 | 0.5 | <0.01 | 0.07 | <0.02 | 1.24 | <0.02 |
| 3 | Baridule Well | 5.0 | 51.2 | 0.01 | 11 | 7 | 6 | 4 | 26 | 8 | <0.02 | 0.04 | 0.5 | <0.01 | 0.06 | <0.02 | 0.40 | <0.02 |
| 4 | Patrick Bade well | 4.5 | 75.0 | 0.01 | 5 | 12 | 9 | 3 | 23 | 4 | <0.02 | 0.3 | 0.4 | <0.01 | 0.07 | <0.02 | 0.48 | <0.02 |
| 5 | Well water | 4.4 | 435 | 3 | 6 | 14 | 7 | 7 | 4 | 10 | <0.02 | 0.16 | 0.5 | <0.01 | 0.08 | <0.02 | 7.76 | <0.02 |
| 6 | Micheal Gbaranem well | 4.5 | 115.1 | 0.1 | 2 | 15 | 10 | 5 | <5 | 8 | <0.02 | 0.06 | 0.6 | <0.01 | 0.09 | <0.02 | 0.45 | <0.02 |
| 7 | Agbara well | 4.5 | 203 | 0.2 | 8 | 13 | 7 | 6 | 14 | 5 | <0.02 | 0.4 | 0.3 | <0.01 | 0.05 | <0.02 | 1.54 | <0.02 |
| 8 | Nobari well | 4.6 | 171 | 0.01 | 2 | 10 | 6 | 5 | <5 | 9 | <0.02 | 0.4 | 0.4 | <0.01 | 0.08 | <0.02 | 2.02 | <0.02 |
| 9 | Barisi well | 4.4 | 432 | 5 | 8 | 12 | 7 | 5 | 14 | 3 | <0.02 | 0.8 | 0.2 | <0.01 | 0.09 | <0.02 | 1.23 | <0.02 |
| 10 | Kpananon well | 6.1 | 271 | 0.2 | 6 | 10 | 6 | 4 | 11 | 5 | <0.02 | 0.3 | 0.5 | <0.01 | 0.09 | <0.02 | 2.56 | <0.02 |

In 2005, the National Council on Water Resources (NCWR) recognized the need to urgently establish acceptable Nigerian Standard for Drinking Water Quality because it was observed that the "Nigerian Industrial Standard for Potable Water" developed by Standards Organisation of Nigeria and the "National Guidelines and Standards for Water Quality in Nigeria" developed by Federal Ministry of Environment did not receive a wide acceptance by all stakeholders in Nigeria.

Since water quality issues are health related issues (Alex, F. and L. Solomon, 2016), the Federal Ministry of Health, collaborating with the Standards Organisation of Nigeria (the only body responsible for developing National Standards in Nigeria) and working through a technical committee of key stakeholders developed this Standard.

From the results obtained for the different physicochemical tests conducted, it was observed that most of the water sources tested had parameters which conformed to the Nigerian Standard for Drinking Water Quality. The pH was very acidic in all the borehole and well water samples tested. The chemical oxygen demand for a good number of the wells also fell short of the recommended level. The iron content of all the water samples tested was higher than the permissible levels. Cadmium was also significantly high in majority of the well waters tested.

## 4. Conclusion

The results obtained from the chemical analysis indicate that the groundwater system of wells in Bodo Community could be said to be chemically and physically fit for drinking and other domestic activities. From the analysis of the well waters, it was seen that parameters such as pH, Chemical Oxygen Demand (COD), Iron and Cadmium were mostly above the permissible levels for drinking water as prescribed by the Nigerian Standard for Drinking Water (Nigerian Industrial Standards).

Since the level of parameters such as Lead is very low as compared to the standards prescribed, it is assumed that the waters are wholesome. However, a comprehensive bacteriological examination of the waters is essential for the above assumptions to be true. This is because the physicochemical analysis to which the waters were subjected cannot detect any bacteriological contaminants in the water.

**4.1 Recommendations**

- Due to the acidic nature of the waters, the well waters should be subjected to lime or sodium carbonate treatment in order to lower the acidity of the waters and thereby eliminate health hazards associated with corrosive waters.
- Periodic testing of the water should also be done to assess the potability of the waters to avoid consequent health issues associated with contaminated water.
- From the results obtained and the relationship of the presence of a contaminant such as cadmium in the water bodies tested, it may be that there is bioaccumulation along the food chains/webs in the aquatic habitat.
- And there is also the possibility of leaching of pollutants from water into the soil which was now present in the well waters tested. So it will be advised that remediation activities should be intensified to reduce the level of pollution of the river to reduce the risk of continued pollution of the groundwater sources.

**Corresponding Author:**
Chinedu Azubuike Uzor
Department of Science Laboratory Technology, School of Science and Technology, Port Harcourt Polytechnic Rumuola, P.M.B. 5936, Port Harcourt, Rivers State. Tel.: +2348030728972
E-mail: uzorchinedu@yahoo.com

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