Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2018, 5(4):47-52

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Determining the Portability of Groundwater in Uromi, Edo State, Nigeria

Biose O.*, Ezomo F.O., Imhontu M.U.

National Centre for Energy and Environment, Energy Commission of Nigeria, University of Benin, Benin City, Nigeria

Abstract This study has assessed the probable contamination of ground water resources in Eguare and Ubierumum-oke area of Uromi, Edo State, Nigeria. The ground water samples were collected in 2013 and 2014 for Eguare and Ubierumum-oke, Uromi. The water samples were analyzed for Physico-Chemical parameters using standard procedures. The results revealed that both Eguare and Ubierumum-oke ground water contained high amounts of nitrite with values ranging between 3.20mg/l and 4.96mg/l above the benchmark recommended by World Health Organisation (WHO) of 3.00mg/l. It was also observed from the analysis that there were traces of heavy metals (Fe, Zn, Mg, Ca, Mn and PO_4) in the hand dug well water samples collected from the study areas. However, they were all within the desirable drinking water limits of World Health Organisation (WHO). The high level of nitrite concentration was due to the clusters of septic tanks, pit latrines, indiscriminate dumping of wastes (dump sites), graves and the use of fertilizer in the study areas and this could lead to adverse health implication on the people of the study area. It is therefore recommended that there should be periodic analysis of Wells /boreholes water in the study area to provide early warning of consuming polluted water, Public enlightenment on adoption of clean technology and provision of water treatment plants should also be deployed to address water pollution problem in the study area.

Keywords Groundwater, Hand dug well, Pollutants, WHO

Introduction

Groundwater pollution is mainly due to the process of industrialization and urbanization that has progressively developed over time without any regard for environmental consequences [1]. Water is regarded as being polluted when it is unfit for its intended use. Protection of groundwater is a major environmental issue since the importance of water quality on human health has attracted a great deal of interest lately. Assessing groundwater quality and developing strategies to protect aquifers from contamination are necessary for proper planning and designing of water resources [2].

About 40% of the drinking water comes from groundwater, about 97% of the rural population drinks groundwater, and about 30–40% of the water used for agriculture comes from groundwater [3]. Potable water is an essential ingredient for good health and the socio-economic development of man [4], but it is lacking in many communities. Therefore, groundwater is a valuable resource and it must be protected from any pollution. The quality of water is of vital importance whether for industrial or domestic purposes. For water to be of consumable quality, it must attain a certain degree of purity. Often, the raw water used for domestic purposes is vulnerable to contamination due to anthropogenic activities resulting in pollution. Water can also be a source of serious environmental and health problems if the design and development of such water supply system is not coupled and tied with appropriate sanitation measures.

It is of high necessity that inhabitants should be provided with potable drinking water within its environment [5]. According to Davis and Royer, [6], drinking water standard are based on two main criteria namely; the presence of objectionable taste, odour and colour; and the presence of substances with adverse physiological effects.

Good well design is an important factor in the prevention of underground water pollution. An open hole during the construction stage can be a direct route for contaminants from the surface to the aquifer thereby providing an ideal opportunity for chemical and bacteriological pollution to occur. Lasting damage can be avoided if the well is completed, disinfected and piped within a short space of time. Boreholes and hand dug wells are extracted for drinking without a detailed chemical investigation therefore monitoring the quality of water is very essential for environmental safety.

Plate 1: Hand dug well under construction in Uromi. The wells are locally dug to depths of 135meters to 150meters, shallow aquifers which are susceptible to pollutants.

Plate 2: Hand dug well near completion in Uromi.

Plate 3: Poor aesthetic of the hand dug well in Uromi. The people of the area depend on the water for drinking and domestic purposes

Plate 4: Poor aesthetic of the hand dug well in Uromi. Flood water carrying pollutants can flow into the well to pollute groundwater

It is worthy of note that the regional supply wells in the study area are constructed at a depth of about 144 meters – 165 meters and inhabitants of the area depend on the well water for consumption [7]. It is imperative to establish that the quality of groundwater being exploited for rural water supply demands consideration because the people of the study area have no means of judging the safety and quality of the water themselves.

Materials and Method

Location of Study Area

The study was carried out at Eguare and Ubierumum-oke community of Uromi which is located in the north eastern esan, a sub ethnic group of the Binis in Edo State. The Esanland is divided into two groups: first is the waterless plateau [8] and the second is the low lands rich in water [9]. Among the Esan plateau dwellers, Uromi stands topmost on the plateau sitting at about 300 meters above sea level [10]. Underlying the plateau is the lignite group of rocks consisting of clay, fine grained sands, lignite and carbonaceous clay.

Sampling

Determination of groundwater quality from test on samples from hand dug wells were carried out at Eguare and Ubierumum-oke communities in Uromi, Edo State between 2013 and 2014. Washed polythene bottle containers were used for the collection of water samples at each location. The bottle containers were rinsed with the water from which samples were to be taken. The groundwater samples were collected directly from the tap not from the storage tank. This was done for each location where samples were collected. The samples were tightly corked and well labelled according to their location and were placed at a temperature of 4 ºC.

The laboratory analysis of sampled water revealed the chemical composition of the groundwater. The data obtained were compared with World Health Organisation [11] benchmark of drinking water. The samples for heavy metals were pre concentrated with H_2SO_4 and nitric acid respectively on the field and was immediately transferred to the laboratory to ensure quality assurance, 18 parameters were analysed for each samples collected from hand dug well in the study area. The water samples obtained were analyzed using standard procedure [12].

pH: The pH of the hand dug well samples were determined insitu with a digital handheld pH meter of the model Exstick EC500. The pH meter was calibrated by placing the electrode into buffer solutions of pH 4, 7 and 9.2 before taking readings. While doing the three point calibration, the pH 7 buffer was used first for the calibration, followed by pH 4 and then pH 9.2 buffers.

Conductivity: A Conductivity meter of model: HACH C0150 was used to measure the conductivity of the hand dug well water sample in µScm-^{1}.

Determination of heavy metals: Atomic Absorption spectrophotometer of the model PerkinElmer A Analyst 200, was used for the determination of the heavy metals Fe, Zn, Mg, Cu, Mn, Ca, Pb.

Nitrate/Nitrite/Phosphates (Nutrients): This was determined with the UV/Visible Spectrophotometer of the model LABTECH 722.

Total Dissolved Solids/Total Solids: This was done by evaporating the water samples to dryness.

Total Suspended Solids: Indirect method was used, this involved finding the difference between the total solids and dissolved solids.

Hardness: This is calculated via titration with Ethylene diamine tetraacetic Acid, EDTA as the titrant.

Colour: This was determined with the use of Aminco Micro Colorimeter of the model 4-7450.

Results

Table 1: Result of Physicochemical properties of hand dug well water samples in Uromi for 2013.

Parameters	Units	EG, HDW 2013	UO, HDW 2013	WHO limits
pH		6.80	6.57	6.5-8.5
EC	µS/cm	80.50	18.80	1000
TDS	Mg/l	57.10	14.40	1000
TSS	Mg/l	Nil	Nil	N/A
Total Hardness	Mg/l	2.69	2.53	100-500
Turbidity	FAU	2.00	3.00	5.00
Colour	Mg/l Pt/Co	2.00	1.00	5.00
Alkalinity	Mg/l	73.00	120.00	500
Fe	Mg/l	BDL	BDL	0.3
Zn	Mg/l	**0.21**	**0.21**	5.00
Mg	Mg/l	Nil	Nil	50.00
Mn	Mg/l	**0.02**	BDL	0.10
Cu	Mg/l	BDL	BDL	1.00
Ca	Mg/l	Nil	Nil	75.00
NO_2	Mg/l	**4.44**	**3.86**	3.00
NO_3	Mg/l	Nil	Nil	10.00
Pb	Mg/l	Nil	Nil	0.05
PO_4	Mg/l	Nil	Nil	N/A

Table 2: Result of Physicochemical properties of hand dug well water samples in Uromi for 2014.

Parameters	Units	EG, HDW 2014	UO, HDW 2014	WHO limits
pH		6.93	6.55	6.5-8.5
EC	µS/cm	85.60	18.60	1000
TDS	Mg/l	56.30	14.10	1000
TSS	Mg/l	Nil	Nil	N/A
Total Hardness	Mg/l	4.80	3.60	100-500
Turbidity	FAU	1.00	2.00	5.00
Colour	Mg/l Pt/Co	2.00	1.00	5.00
Alkalinity	Mg/l	68.00	118.00	500
Fe	Mg/l	**0.03**	BDL	0.3

Zn	Mg/l	**0.02**	**0.19**	5.00
Mg	Mg/l	**0.39**	**0.28**	50.00
Mn	Mg/l	BDL	BDL	0.10
Cu	Mg/l	BDL	BDL	1.00
Ca	Mg/l	1.28	1.32	75.00
NO_2	Mg/l	**4.96**	**3.20**	3.00
NO_3	Mg/l	**0.05**	BDL	10.00
Pb	Mg/l	BDL	BDL	0.05
PO_4	Mg/l	**0.18**	BDL	N/A

pH, Electrical Conductivity (EC), Total Dissolved solid (TDS), Total suspended solid (TSS), Total Hardness, Turbidity, Colour, Alkalinity, Iron (Fe), Zinc (Zn), Manganese (Mn), Magnesium (Mg), Copper (Cu), Calcium (Ca), Nitrate (NO_3), Nitrite (NO_2), Lead (Pb), Phosphate (PO_4), **FAU** = Formazin Attenuation units, **µS/cm** = Micro Siemens per centimetre, **Mg/l** = Milligram per litre, **ptCo** = Platinum cobalt scale, **BDL** = Below Detectable limit, **N/A**= Not Available, **EG** = Eguare, **UO** = Ubierumum-oke, **WHO** = World Health Organisation.

Interpretation of Result of Hand Dug Well Water Sample for 2013 and 2014 Respectively

Tables 1 and 2 shows results obtained from hand dug well water samples at Uromi and compared with World Health Organisation drinking water limit [11].

pH: The analysis of the result for 2013 and 2014 shows that pH values ranges between 6.55 and 6.93 respectively which are in agreement with the World Health Organisation standard of drinking water.

Electrical Conductivity (EC): A Conductivity meter of model: HACH C0150 was used to measure the conductivity of the hand dug well water sample in μScm^{-1}. The analysis of the results for 2013 and 2014 showed that the electrical conductivity values obtained during the study ranged between 18.6$\mu s/cm$ and 85.6$\mu s/cm$, this showed that the values are within the desirable limits set by WHO drinking water standard. However, it was observed that Eguare for 2014 had the highest value of EC.

Total Dissolved Solids (TDS): The analysis of the result for 2013 and 2014 showed that the total dissolved solids obtained from hand dug well water sample during the study ranges between 14.1mg/l and 57.1mg/l, which is in concordance with the desirable limits set by WHO standard.

Total Suspended Solid (TSS): The analysis of the result for 2013 and 2014 obtained indicated that there was no trace of total suspended solid in the samples.

Total Hardness: The analysis of the result for 2013 and 2014 obtained indicates that the total hardness of the sample is within the desirable limits set by the WHO standards with ranges of values between 2.53 and 4.80 mg/l.

Turbidity: The analysis of the result for 2013 and 2014 obtained showed that the turbidity values ranges between 1FAU and 3FAU, this indicated that the values were within the limit of drinking water of WHO in the areas.

Colour: The analysis of the result for 2013 and 2014 shows that the colour of the hand dug well water samples are within the desirable limits set by the WHO benchmark with range of values between 1ptCo and 2ptCo.

Alkalinity: The alkalinity values for 2013 and 2014 respectively ranged between 68 mg/l and 120 mg/l and were all within the desirable limits set by WHO benchmark.

Iron (Fe): The analysis of the result for 2013 and 2014 indicated that Iron was not detected in the hand dug well water sample collected. However, a trace of Iron (Fe) was observed at Eguare in 2014 with value of 0.03mg/l which is within the WHO benchmark (0.3mg/l) of drinking water in the area.

Zinc (Zn): The result obtained from the analysis for 2013 and 2014 indicated that Zinc is within the desirable limits set by WHO benchmark with range of values between 0.02mg/l and 0.21mg/l.

Magnesium (Mg): The value for Magnesium for 2014 ranged between 0.28 mg/l and 0.39 mg/l and was all within the desirable limits set by WHO benchmark. However, there was no trace of Magnesium at Eguare and Ubierumum-oke in 2013.

Manganese (Mn): The result obtained from the analysis for 2013 and 2014 indicated that Manganese was not detected in the hand dug well water sample. However, a minute trace of Manganese with value of 0.02mg/l was observed at Eguare in 2013.

Copper (Cu): The analysis of the result obtained for 2013 and 2014 indicated that Copper was not detected in the hand dug well samples.

Calcium (Ca): The Calcium value for 2014 range between 1.28mg/l and 1.32mg/l and were all within the desirable limits set by WHO drinking water benchmark. However, in 2013 there was no trace of Calcium in the area.

Nitrite (NO_2): The analysis of the result for 2013 and 2014 obtained revealed that nitrite recorded high values above the desirable limits set by the World Health Organisation (WHO) drinking water benchmark in all the locations with values ranging between 3.20mg/l and 4.96mg/l. it was observed that the highest nitrite value (4.96mg/l) was recorded at Eguare in 2014.

Nitrate (NO_3): The value (0.05mg/l) for Nitrate for 2014 was within the desirable limit set by WHO benchmark. However, Nitrate was not detected in the hand dug well water sample in 2013.

Lead (Pb): The results of the analysis for 2013 and 2014 revealed that Lead (Pb) was not detected in the hand dug well water sample in the area.

Phosphate (PO_4): The analysis of the result for 2013 and 2014 indicated that the hand dug well was not polluted with high concentration of phosphate. However, it was observed that there was a trace of phosphate with value 0.18mg/l at Eguare in 2014.

Discussions/ Conclusion

It was observed that the hand dug well water sample analysed for Eguare in 2013 and 2014, revealed that nitrite (NO_2) of values 4.44mg/l and 4.96mg/l was above the World Health Organisation drinking water benchmark of 3.0mg/l as shown in Tables 1 and 2 respectively. It was also observed that there were traces of some heavy metals present in groundwater however they were all within the benchmark of World Health Organisation drinking water. The major occupation of the people in the study area is farming. These farmers apply nitrogen based fertilizer to their crops to improve productivity. It was observed that the hand dug wells were sited close to farmlands were NPK fertilizers are used. When there is excessive rainfall nitrite will be leached below the plants roots zone and may eventually contaminate the groundwater. It was also observed that the hand dug well water was sited around a cluster of septic tanks (sewage system), pit latrines and graves. Information gathered from residence in the area through a questionnaire revealed that the depth of the hand dug well was 96 meters suspected to be medium sand and the diameter of the hand dug well to be 1.5 meters. It was learnt from the residence that the water has an offensive odour. It was stated that these toilet units are designed to discharge waste into the ground. Therefore the presence of these sanitation units could be said to have direct impact on the groundwater of the study area. It is therefore suggested that hand dug wells should be discouraged in this region because of the poor aesthetic design and boreholes should be drilled to depths of 280 metres for accessibility of potable drinking water. However, if economic condition dictates the siting of hand dug well it should not be sited along the flow path of potential pollution sources.

Reference

[1]. Longe, E. O and Balogun, M. R. 2010. Groundwater Quality Assessment near a Municipal landfill, Lagos, Nigeria; *Research of Applied Science, Engineering and Technology. Volume 2(1): page 39-44.*

[2]. Ezomo, F. O. and Biose, O. 2015. Mapping of Groundwater Contamination Using Electrical Resistivity Tomography in Eguare, Uromi, Esan North East Local Government Area, Edo State. *Journal of the Nigerian Association of Mathematical Physics (J of NAMP). Volume 32: page 425-430.*

[3]. Sharma, H. D., and Reddy, K. R. 2004. Geoenvironmental Engineering site Remediation waste contamination and Emerging waste Management Technologies. John Wiley and Sons, Hoboken, New Jersey.

[4]. Udom, G. J., Ushie, F. A. and Esu, E. O. 2002. A Geochemical Survey of Groundwater in Khana and Gokana Local Government Area of Rivers State, Nigeria. *Journal of Applied Science and Environmental Management. Volume 6: page 53-59.*

[5]. Ezomo, F. O. and Biose, O. 2015. Geoelectric Imaging of the Subsurface using Non-invasive Techniques in Uwalor-oke, Uromi, Esan North East Local Government Area, Edo State. *Journal of the Nigerian Association of Mathematical Physics (J of NAMPS). Volume 32: page 431-436.*

[6]. Davis, S. N. and Royer, J. M. De-wiest. 1966. Hydrogeology, New York, John Wiley and Sons. Page 459-463.

[7]. Biose, O. 2015. Application of Electrical Resistivity Tomography in mapping Sub-surface Contaminant Plume in Uromi, Esan North East Local government Area, Edo State, Nigeria. Unpublished PhD thesis, University of Benin.

[8]. Okojie, C.G. 1994. Esan Native Laws and Customs with Ethnographic Studies of the Esan People. Benin Ilupeju Press, 2.

[9]. Ojiefoh, A.P. 2002. Uromi Chronicles 1025-2002 History Culture Customary Law. Nigeria Aregbeyeguale Pub. 1.

[10]. Butcher, H.L.M. 1982. Intelligence Reports in Ishan Division of Benin Province. Nigeria National Archives Ibadan. Page 240.

[11]. World Health Organisation 2010. Guidelines for drinking water quality, 4^{th} Edition. World Health Organisation, Geneva.

[12]. American Public Health Association Method 9221. 1992. Standard methods for the Examination of Water and Waste Water. 40 CFR 136. 3(a), APHA.