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ANALYSIS OF GROUNDWATER QUALITY WITHIN AGBARHO COMMUNITY IN UGHELLI NORTH LOCAL GOVERNMENT AREA OF DELTA STATE, NIGERIA

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Abstract:

A total of five (5) water samples were collected for physio-chemical and bacteriological assessment in Agbarho. The water samples were all groundwater. The water samples were collected in a clean litre plastic rubber that had been sterilized to avoid contamination at each location. The water samples were all preserved in coolers then taken to the laboratory and stored in the refrigerators for analysis. The water samples were analyzed for nineteen (19) parameters (pH, Temperature, TDS, Conductivity, DO, BOD, Chloride, Phosphate, Sulphate, Nitrate, Nitrite, Ammonium, Turbidity, TSS, Potassium, Zinc, Iron, Mercury and TCC). Most of the value are within the allowable limit of WHO but some of the samples are not in conformity with WHO limit which make the water to be unsafe for drinking. In conclusion, further treatment is recommended for the water.

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INTRODUCTION:

Water is the most common liquid on our planet earth, vital to life forms. Water can be said to be pure by some people but water is never 100% pure. It inevitably carries trace of other substance various organic compound particles gases minerals and ions which impart to its physical chemical and bacteriological characteristics (Ibitoye, 2012). Groundwater pollution (also called groundwater contamination) occurs when pollutions are released to the ground and make their way down into the groundwater. Groundwater pollution can also be coursed by the disposal of solid or liquid wastes in pit, abandoned boreholes or even stream channels and landfills (Onunkwo and Uzioje, 2011)

Those most susceptible to water borne illness are children, pregnant women and immune compromised individuals, making water borne illness one for the five (5) leading to course of death among children under the age of five(5) (Gerba *et al.*, 2007) The major proportion of groundwater quality degradation (reducing) is due to anthropogenic influence such as domestic or municipal waste, agricultural waste etc.

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. Global groundwater storage is roughly equal to the total amount of freshwater stored in the snow and ice pack, including the north and south poles Oyem, (2014). This makes it an important resource which can act as a natural storage that can buffer against shortages of surface water, as in during times of drought. Generally, groundwater is clean and colourless. When water seeps down into ground, it dissolves inorganic salts. This water is therefore, harmful then surface water of the area in which it occurs. R. Parker et al (2008). Groundwater is also generally free from bacteria and other living organisms as they get filtered out while percolating through the sub-soil.

According to Mc Donnell, (2003) stated that all water utilities should deliver to the consumer and adequate supply of high-quality drinking water at a cost commensurate with the needs of each individual water system. Garg (2008) outlined that there are various methods employed for bore-hole construction. This depends on the geology of the area and they include: Percussion drilling, Hydraulic rotary drilling,Core drill method and Jetting.

The planet contains about 70% water I form of oceans, sea, rivers, lake and groundwater. Water provided for human consumption should receive minimum possible treatment, though the best supply is one which does not need treatment at all. Public health is vulnerable to the danger of incident of diseases mainly through water borne, water related and water washed diseases. These diseases include cholera, typhoid and Para-typhoid fever malaria, yellow fever, schistosomosois and guinea worm for an acceptable quality of water supply the international standard for drinking water established by world health organization (WHO, 2007) state that the intended to human consumption must be free from organisms and from concentration of chemical substance that may be hazardous to health. supplies of drinking water should be pleasant to drinking as circumstance permit the quality of water must be wholesome and portable. Wholesome water must be free from organisms poisonous and excessive amount of mineral, turbidity taste, odour and must be well.

The quality of giving water is continuously changing as a result of the reaction of water with contact media and human activities. The water quality refers to as physical, chemical and biological characteristics, which can be determined by comparing results of test and characteristics of the water with acceptable standards (such as WHO) for drinking water. This study will help people living in the study area be aware of the presence of contaminant in the water and bring the knowledge of human activities that can contaminate the groundwater

MATERIALS AND METHODS:

STUDY AREA

The sample were collected from Agbarho community in Ughelli North Local Government Area of Delta State, Nigeria and its located near the city of Warri the Urhobo are main tribes living with the area Agbarho is one of the populated town in Ughelli North has GPR coordinate of 5.35 16.39"n 5 51 26.219" e and area of 818km2, pollution of 178,000 as at the 2006 census. Agbarho made of 15 communities and the people are mainly farmer and business man, and woman.

Since people living in Agbarho are mainly farmer and some of them are using fertilizer for the crops which pollute the groundwater though leading also using pit latrines soak away pit and dumping site which can pollute the groundwater. The research work will help to know the quality of ground water in Agbarho.

SAMPLE COLLECTION

The water samples were collected using a litre plastic that has been sterilized to avoid contamination by any physical chemical or microbial means. After collection, the sample was immediately place in ice cooler for transportation to the laboratory and stored in refrigerator. The water quality deals with physical, chemical and biological characteristics of water. Water quality parameter analyzed in accordance to standard method was PH, temperature total suspended solid (fds). Dissolve oxygen (DO), chloride Nitrate, Zinc, total iron, Califon count, phosphate, nitrite, ammonium, turbidity total suspended solid (tss) potassium biochemical oxygen demand (BOB) and mercury

METHOD OF ANALYSIS

PH METYER/TEMPERATURE METER ORION MODEL, 290A ASDTM D1293B

CALIBRATION AND MEASUREMENT

1. With power on, select the CALIBRATE mode
2. Place electrode(s) into PH 7 buffer and stir moderately
3. Press yes to select the two-buffer calibration which brackets your sample
4. When "READY" is displatye4d beside the reading, indicating stability press NO to change buffer value or press yes to accept buffer value
5. Remove the electrode(s) from the first buffer. Rinse with deionized water
6. Place the electrode into the second buffer and stir moderately
7. When "READY" is displayed beside the reading, indicating electrode stability, press **no** to change buffer value or [press yes to accept buffer value
8. After the second buffer has been entered press yes, the electrode slope will be displayed, press yes to accept
9. Remove the electrode4s from buffer. Rinse with deionized water. Place electrodes into sample. When "READ" is displayed, record the sample result.

ELECTRICAL CONDUCTIVITY/TDS METER: OAKTON MODEL 35607, ALPHA 2520B/ASTM D1125

CALIBRATION AND MEASUREMENT

1. Switch on the power
2. Clear any previous calibration data (press clear for five seconds)
3. Place the conductivity cell in the calibration solution
4. Select the required working unit for conductivity
5. Select conductivity mode and wait for the reading to stabilize
6. Using keys, adjust the reading so that the correct value for the standard is displayed then press the "ENTER" key
7. Transfer cell to sample and record reading when stable
8. The "mode" key can now be used to select the required measurement mode (Ωs; MΩ; TDS; ^{O}C).

TURBIDITY METER MOPDEL 800

1. Switch on the power and allow the instrument to warm up for 30 minutes
2. Insert a 0 NTU polymer standard into the chamber45 and cover
3. Set the rang switch to 20 NTU
4. Use "zero control" potentiometer, set the meter to read "0"
5. If the meter cannot be made to read zero (0). Then set the "zero control" knob at mid-range so that the arrow on the knob points at the letter "0" on the word "control"
6. With a small screwdriver, set the coarse zero pot so that the meter reads as close to zero as possible. An exact zero cannot be set with the "zero control" knob
7. Insert a 10 NTU standard solution into the chamber and cover
8. Set the rang switch to 20
9. If the meter does not read 10.00, adjust the potentiometer marked "20" with a screwdriver until the meter reads 10.00
10. With the 10 NTU standard solution in a chamber and covered, set the range switch to "200"
11. If the meter does not read 10.00, with a screwdriver, adjust the potentiometer marked "200" until the meter reads 10.00
12. Replace the standard solution with sample and set the meter to appropriate range
13. Allow the value to stabilize, record the sample result

TOTAL SUSPENDED SOLIDS (TSS)

FILTRATION TECHNIQUES (ALPHA 208D/ASTM D1868)

- Weight the Millipore filter paper (Xmg)
- Put the TSS filtration assembly in place
- Place the Millipore filter paper properly
- Hold tight the filter paper with the aid of the clamp
- Shake the water sample vigorously
- Measure an aliquot of 250ml of the water sample
- Transfer the water sample into the filtration flask
- Carefully remove the filter paper and put in the oven for drying for about 30mins
- Weight the filter paper plus the recovered solid (mg)

CALCULATION: TSS (mg/L) = (Y-X) ×1000/ml of sample

ANALYSIS OF HEAVY METALS AND EXCHANGEABLECATIONS IN WATER:

WET OXIDATION METHOD

1. Measure about 100ml of a well-mixed water sample into a 150ml beaker
2. Add 5.0 of conc. HNO_3
3. Evaporate the solution to near dryness on a hot plate, making sure that the sample does not boil (use low to medium heat)
4. Allow the beaker4 and the content to cool
5. Add another 5.0ml of conc. HNO_3 to the beaker
6. Cover the beaker immediately with a watch glass
7. Return the beaker to the hot plate and set a gentle reflux action on the solution by increasing the temperature of the hot plate (medium heat)
8. Continue heating with the addition of HNO_3 as necessary until light color residue is obtaine4d (digestion is completed)
9. Add 1-2ml of conc. Hno_3 to the residue
10. Wash with distilled water
11. Filter into 100 ml; volumetric flask to remove silicate and other insoluble materials
12. Store the solution in 125ml polypropylene bottle
13. Then use atomic absorption spectrophotometer (model: Varian 220 fast Sequential)

DETERMINATION OF DISSOLVED OXYGEN: WINKLERS METHOD

1. Fill a 250-ml brown bottle with the sample, making sure that bubbles are notb trapped in
2. Add 2ml of $MnSO_4$. $5H_2O$ well below the surface of the sample
3. Add 2ml of alkaline-iodide solution at the surface of sample
4. Stop carefully so as to avoid inclusion of air bubbles and mix thoroughly
5. Allow the precipitate to settle completely
6. Add by pipette 1ml of diluted sulphric acid or 85-90% orthophosphoruic acid
7. Replace the stopper and thoroughly mix the content by rotating
8. Mix 100ml of the solution into conical flask
9. Titrate immediately with 0.0125N $NaS_2O_25H_2O$ using as indicator 2ml of starch solution added towards the end of the titration. The color changes from straw yellow to colourless at end point
10. Calculate the DO with the following equation

$$DO=\underline{V_1\ N(8)\ 1000}$$

Where: V_1 = volume of 0. 0125N $NaS_2O_25H_2O$

V_2 = volume of sample taken

N= normality of NaS_2O_25H

SALINITY AS CHLORIDE (CL-)

1. Measure 100ml of sample into a 250-ml of conical flask
2. Add 1ml of K_2CrO_4
3. Titrate with 0.014N $AGNO_3$
4. The colour changes from yellow to reddish brown at the end point

CALCULATION:

$$Mg/lc(CL-) = 35.5 \times \frac{C_b \times V_b}{Ml\ of\ sample} \times \frac{1000}{1}$$

Where: C_b= concentration of $AgNO_3$ (Normality)

V_b = volume of $AgNO_3$ (Consumed)

DETERMINATION OF BOD_5 BY DILUTED METHOD

1. Dilute the sample in ratio 1: 5 with diluted water in brown bottles
2. Fill another two-brown bottle with diluted water
3. Determine the initial DO in one of the mixtures of sample and dilution
4. Also determine the initial DO in one of the bottles containing only diluted water
5. Place the other bottle in incubator (the one that contains mixture of sample and dilute water and that with dilution water only –blank)
6. After 5 days determine the DO in the dilutes sample and the blank by titrating 200ml against 0.0125N thiosulphate
7. Calculate the BOD_5 using the following equation

$$BOD_5 = \frac{(x-y-a-z)}{A+1} \quad \frac{(a+z)}{2}\ mg/l$$

Where: x = vol. of 0.0125N triosulphate required for 200ml of original dilution (ml)

Y = vol. of 0.0125N triosulphate required for 200ml of incubated dilution (ml)

A = vol. of diluted water to 1 volume of sample (ml)

Z = diff. between volume of 0.0125N triosulphate 200ml of dilution water before and after incubation (ml)

INTERNAL CALIBRATION PROCEDURE FOR SULPHATE ION USING COLORIMETRIC METHOD (TEST METHOD 427 C)

APPARATUS/ MATERIALS

I. Volumetric flasks (100ml capacity)
II. Pipettes (10ml capacity)
III. Cuvette (25ml capacity)

REAGENTS/ CHEMICALS

I. Barium chloride salt
II. NaCL-HCL solution
III. Alcohol-Glycerol mixture

EQUIPMENT
HACH DR2000 (Absorbance mode)
Preparation of 1000mg/l sulphate stock standard solution

- Dissolve 1.479g of anhydrous Na_2SO_4IN 500ml of distilled water in 1000ml size volumetric flask; make to volume with distilled water.

Preparation of working standards

- From the stock solution, prepare lower concentrations of 2.0, 4.00, 6.00, 8.00 and 10.00mg/l, in 100ml volumetric flask employing serial dilution method ($C1\ V_1 = C_2\ V_2$). Also prepare reagent blank.

PROCEDURE

I. Measure, quantitatively 70ml of each standard solution into the volumetric flask.
II. Add 10ml of NaCL-HCL and shake again.
III. Then add 10ml of alcohol- glycerol mixture, shake well
IV. Add 5.0g of finely divided $BaCl_2$ crystal and make the volume to mark
V. Read the absorbance values, at 380nm on HACH DR2000 UV- visible Spectrometer, for standards, and reagent blank

SAFETY PRECAUTRIONS
The following safety materials should be worn when carrying out this experiment

I. Hand gloves
II. Eye goggles
III. Laboratory coat/ covered

INTERNAL CALIBTRATION PROCEDURE FOR AMMONIUM ION USING COLORIMETRIC METHOD

APPARATUS

I. Pipette (25ml)
II. Volumetric flask (50ml)
III. pH meter
IV. HACH DR 2000 spectrophotometer

REAGENTS/ CHEMICALS

I. TRI-sodium phosphate solution (5%)
II. Phenol salt
III. Phenate reagent.
IV. Alkaline bleach (commercial bleach, 3.5%)
V. Sodium hydroxide solution
VI. Ammonium stock standards solution

Preparation of 1000mg/l ammonium ion stock solution

- Dissolve 2.965g of NH_4CL salt in 500ml of distilled water in 1000ml capacity volumetric flask, after the dissolution, make the volume to mark with distilled water.

Preparation of working standard solution

Prepare from the 1000mg/l standard stock solution 0.50, 1.00, 1.50, 2.00 and 2.50mg/l into 100ml capacity volumetric flasks. Also prepare a reagent blank

PROCEDURE

- Place 20.0ml of each standard solution in 50ml volumetric flask
- Add 4.0ml tri-sodium phosphate solution
- Add 10ml of phenate reagent 1, shake gently
- Make the volume to mark
- Allow colour development for about 25minutes
- Carry out the same for the reagent blank
- Read the absorbance of the standard and reagent blank on DR 2000 at 635nm
- Plot the calibration graph of absorbance vs. concentration in mg/l

SAFETY PRECAUTION
The following safety materials should be worn when carrying out this experiment:

- Hand gloves
- Eyes goggles
- Laboratory coat/ coverall

DETERMINATION OF TOTAL COLIFORM BACTERIA (Multiple Tube- APHA 9222A)

METHOD: most probable number (MNP) technique
PROCEDURE:

- Firstly, sterilize all the apparatus, material and growth medium using autoclave
- Prepare three sets of five test tube/ Maccartney bottles containing 9ml of macConkey broth
- Inoculate 1ml of the water sample to dilute 9ml of sterilized distilled water for serial dilution, pour 1ml each in a first five set of maccartney bottles/test tube. Pour 0.1ml to second set, and 0.01ml to the third set
- Mix the inoculums with growth medium (broth) in the bottles by agitating gently
- Invert the durham tube in each bottle and cover
- Incubate the bottle at 37°C for 48 hours
- Observe each tube for acid production which signify microorganism growth through colour change, and gas production in the durham tube.
- Combine the number combination from the standard MPN table to obtain the estimated number of coliform cells present in 100ml of the original water sample (using McCrady's Statistic table)

BRUCINE METHOD FOR NITRATE/NITRITE DETERMINATION IN WATER (ASTM D3867)

- Set up number of reaction tube in a wire rack containing 10ml of sample, blank and standard solution prepared from sodium nitrate for nitrate and sodium nitrite for nitrite, spacing them so that empty space surrounds each tube.
- Set the rack in a cool water bath, ad 2ml Nacl solution prepared from (300g of Naclcrystals in distilled water) to the sample, standard and blank solution.
- Mix thoroughly by swirling and then add 10ml H_2SO_4 prepared from (500ml of conc. H_2SO_4 to 125ml distilled water) to each of the solution.
- Again, swirl to mix thoroughly and add cool (if any turbidity or colour is observed, dry the tubes using clean tissue paper or soft cloth.
- Replace the rack of tubes mix thoroughly and now place the rack of tubes in well stirred boiling water bath that maintain a temperature of not less than 95°C. let them remain there for 20minutes.
- Remove the sample and immerse them in a cold-water bath, when thermal equilibrium is attained i.e when the temperature of the tube and the cold is about room temperature, remove the tube and dry them with tissue paper or soft cloth. Read the standard and sample against the reagent blank at 410nm in the spectrophotometer.

RESULTS AND DISCUSSION:

The table below shows the result obtained from the analyzed sample.

Parameters	1	2	3	4	5
pH	3.81	3.73	3.68	5.71	3.93
Temp (°C)	29.9	30.2	30.8	31.3	31.9
Tds (mg/l)	58.00	40.03	50.20	56.52	36.70
Conductivity (µs/cm)	115.48	76.92	99.64	112.47	72.96
DO (mg/l)	2.70	3.00	2.80	3.20	4.50
BOD (mg/l)	0.90	1.04	1.00	1.10	1.40
Chloride (mg/l)	22.65	9.38	14.21	19.42	7.85
Phosphate(mg/l)	0.13	0.03	0.06	0.09	0.01
Sulphate (mg/l)	0.82	0.51	0.64	0.76	0.37
Nitrate (mg/l)	0.49	0.20	0.27	0.31	0.14
Nitrite (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium (mg/l)	0.22	0.06	0.09	0.13	0.03
Turbidity (N.T.U)	0.57	0.69	0.35	0.51	0.49
TSS (mg/l)	1.00	1.00	1.00	1.00	1.00
Potassium (mg/l)	0.20	0.08	0.11	0.14	0.02
Zinc (mg/l)	2.18	1.76	1.92	2.07	1.41
Total Iron (mg/l)	1.87	1.09	1.34	1.61	0.96
Mercury (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Coliform count (MPN/100ml)	0	0	0	0	0

2011 W.H.O STANDARD FOR DRINKING WATER

PARAMETER	WHO LIMITS
pH	6.5 8.5
Temperature (° c)	24 – 29
Tds (mg/l)	600.00
Conductivity (Nskm	Not available
Hardness (mg/l)	200
Do(mg/l)	Not available
Bod (mg/l)	Not available
Chloride(mg/l)	250.00
Phosphate (mg/l)	Not available
Sulphate (mg/l)	500.00
Nitrite(mg/l)	50.00
Nitrite (mg/l)	3.00
Ammonium(mg/l)	Not available
Turbidity (n.t.u)	1.00
Tss (mg/l)	Not available
Potassium(mg/l)	Occur in drinking water at concentrations well below those of health concerns
Zinc (mg/l)	3.00
Total iron(mg/l)	0.300
Mercury (mg/l)	0.006
Aluminium (mg/l)	0.90
Ammonia (mg/l)	0.20
Copper(mg/l)	2.00
Cadmium(mg/l)	0.003
Chlorite(mg/l)	0.70
Chromium(mg/l)	0,05
Fluoride(mg/l)	1.50
Lead (mg/l)	0.01
Sodium(mgll)	<200
Coliform count	O
(mpn /100ml)	

DISCUSSION:

The result is being compared with the WHO 2011 standard for potable drinking water.

The concentration of PH in the water samples range from 3.68-5.71 and the WHO standard for PH concentration in portable drinking water range from 6.5-8.5, making all the water sample not meeting the WHO standard for PH thereby making all the water samples acidic.

The concentration of the total dissolve (tds) in the water sample range from 36.70-58.00mgll and the WHO standard for total dissolve solid concentration in portable drinking water is 600.00mgll in limit making all the water sample to meet the WHO standard for concentration of total dissolve solid in portable drinking water. In regard to this parameter all the water analyzed are suitable for drinking

The concentration of the dissolve oxygen (DO) in the water sample ranging from 2,70-4.50mgll but the WHO standard for dissolve oxygen concentration is for available.

The concentration of chloride in the water sample range from 7.85-22.6mgll and the WHO standard for chloride concentration in portable drinking water sample to meet WHO standard for concentration of chloride in portable drinking water. in regard to this parameter all the water sample are suitable for drinking.

The concentration if phosphate in the water sample range from 0.01-0.13mg/l but the WHO standard for phosphate concentration in portable drinking water is not available.

The concentration of sulphate in the water samples range from 0.01-0.13 mgll and the WHO standard for sulphate concentration in portable drinking water is 500 mg/l in limit, making all the water samples to meet the WHO standard for concentration of sulphate on portable drinking water .in regard to this parable all the water ,sample are suitable for drinking.
The concentration of nitrate in the water sample range from 0.49mgll and the WHO standard for nitrate concentration in portable drinking water is 50.00mgll in limit, making all the water sample to meet the WHO standard for concentration of nitrate in portable drinking water. in regard to this parameter all the water sample are suitable for drinking.

The concentration of nitrate in the water sample are all <0.01mgll which mean they are all below detection limit of equipment used and the WHO standard for nitrite concentration I portable drinking water is 3.00mgll making all the water sample to meet the WHO standard for concentration of nitrite in portable drinking water.

The concentration of turbidity in the water sample ranges from 0.35-0.69NTU and the WHO standard for turbidity concentration in drinking water is INTU making all the water sample to meet the WHO standard for turbidity .in regard to this parameter all the water samples are suitable for drinking.

The concentration of zinc in the water sample ranges from 1.41-2.18mgll and the WHO standard for zinc concentration in portable drinking water is 3mgll in limit, making all the water sample to meet the WHO standard for the amount of concentration of zinc in drinking water.

The concentration of potassium in the water sample ranges from 0.02-0.20mgll but the WHO standard for potassium concentration in portable drinking water is not available because potassium occurs in drinking water at concentration, well below those of health concern.

The concentration of total iron in the water sample ranges from 0.96-1.87mgll and the WHO standard for iron concentration in portable drinking water is 0.30 in limit making all the water sample collected to exceed the WHO standard for total iron concentration in potable drinking water. Therefore, the entire water sample analyzed are definitely not good for drinking in regard to this parameter.

The concentration of all the mercury in the water sample are all 0 and the WHO standard for total coli form count in portable drinking water is 0 making all water sample collected to meet the WHO standard for the total amount of Califon count in portable drinking water. These means that all the water is free from bacteria thereby making them all suitable for drinking.
The concentration of coli form count in the water sample are all 0 and the WHO standard for total coli form count in portable drinking water is 0 making all the water sample collected to meet the WHO standard for the total amount of coli form count in portable drinking water. These means that all the water is free from bacteria thereby making them all suitable for drinking.

CONCLUSION AND RECOMMENDATIONS:

CONCLUSION

The quality or portability of water is determined by comparing the result with the WHO 2011, it was observed that not all the parameter analyzed meet the WHO 2011 standard apart from the total coli form count which shows that all the sample are free from bacteria zinc nitrate sulphate nitrate chloride and total dissolve solid. The PH of these sample area probably might have been reduced due to dead of organic matter (plant animals).

According to this analysis we can see that the entire samples are not adequate for human consumption in regard to some parameter. All the borehole needs to be treated and ensure that they all reach the WHO standard to avoid health problem and then ready for human consumption

RECOMMENDATIONS:

According to analysis, not all the samples are adequate for human consumption. It is hereby recommended that all the boreholes where the sample were collected must be treated in order to meet up the WHO standard so that it can be adequate for drinking, domestic uses, industrial uses medical uses and agricultural uses.

Dumping of refuse should be located for away from the borehole and that the government should provide good treatment for plant and also ensure that there is a need for quality functional water board for human use.

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