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YIELD ASSESSMENT AND QUALITY ANALYSIS OF GROUNDWATER IN LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY CAMPUS OGBOMOSO .NIGERIA

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ABSTRACT

The problem of shortage of water supply is athreat to inhabitants that do not have access to potable water supply. The research is aimed at determining the quality and quantity of groundwater in LAUTECH community, Ogbomoso with the mind of ascertaining the hydraulic properties of boreholes and the suitability of the water resources for domestic and agricultural purposes. Pump testing was conducted in LAUTECH to determine the actual discharge. Water samples were collected and analysed for physicochemical parameters and bacteria using Standard method.Quality Indexes such as Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP) and Residual Sodium Carbonate (RSC) were used to assess the suitability of water for agricultural purposes.The range of hydraulic properties of aquifers (Transmissivity (0.095 m^2/day to 7.591 m^2/day), Hydraulic conductivity (0.003 m/day to 0.278m/day), Specific capacity (0.250 m^3/ day/m to 16.506 m^3/day/m) and Yield (0.341l/s -1.66l/s), shows that four (4) out of the seven (7) borehole have moderate yield which are quiet prolific. All the water samples within the study area falls below the WHO,2004 indicating that there is no contamination and that LAUTECH groundwaters are suitable but the biochemical result showed that LAUTECH stream are highly polluted .The prolific boreholes which include engineering workshop, work's workshop, new ICT, and health center have moderate yield and rapid recharge rate and this contribute to minimum quantity of water supply on campus while the less prolific ones which are those at FAG (Faculty of Agriculture), mathematics department, and senate building have low yield and with very slow recharge rate .Hence it is recommended Recconnaissance survey through the use of Very Low Electromagnetic (VLF-EM) Method should be duly incorporated alongside Geophysical survey to avoid the problem of dry boreholes or seasonal well in Borehole drilling.

Introduction

Borehole water is groundwater available in an aquifer that is capable of holding, transmitting and yielding sufficient water in underground to well SharmaandSharma **(**2007**)**. Thus, borehole yield is often associated with certain aquifer hydraulic parameters like specific capacity, drawdown, regolith thickness, bedrock type, saturated thickness and screen length among others. Groundwater is accessed and abstracted, generally through borehole drilling, and the yield of the borehole will determine the rate at which groundwater can be abstracted. Groundwater occurrence depends primarily on geology, geomorphology/weathering and effective rainfall.

The major problem of boreholes is chemical contents of the groundwater, which must be analyzed to ascertain if these dissolved products are within the permissible limits for consumption proposed by the authorities, in this case the World Health Organization (WHO).One of the difficulties in tackling this problem is that contamination is likely to come from various possible point and nonpoint sources (Mahler*et al*., 2000), thus obscuring its origins. It is important to detect fecal contamination in groundwater, especially if there are no pre-consumption water treatment systems Autherholt *et al*., 2003. Improving the quality of groundwater resources offers an important economic opportunity for the gradual improvement of the quality of life (Valenzuela *et al*., 2009).

The study area, Ladoke Akintola University of Technology (LAUTECH) is located within Ogbomoso North, Oyo State, Southwestern Nigeria. It is located Latitudes $8^0$9'859'' and $8^0$10'363'' and Longitudes $4^0$15'808'' and $4^0$16'217''(Figure 1) Elevation varies between 338m and 390m, averaging about 364m above sea level. The rivers and streams are topographically controlled and flow in the direction of rock strike. The trends of foliation and joints in rocks largely control the directions of the rivers, thereby imposing a dentritic pattern on the drainage with regular branching of tributary streams. The study area lies within the Southwestern Nigeria which is underlain by basement complex. Field observations reveal that the migmatite gneiss is the most widespread rock type within the area. It is observed to cover about half the area extent under this study. The outcrop islowlying flat terrains. This study seeks to assess the quality analysis and productivity of ground water at the LAUTECH community with the objectives to obtain the aquifer properties; determine the hydraulic properties of boreholes and the suitability of the groundwater resources for domestic and irrigation purposes.

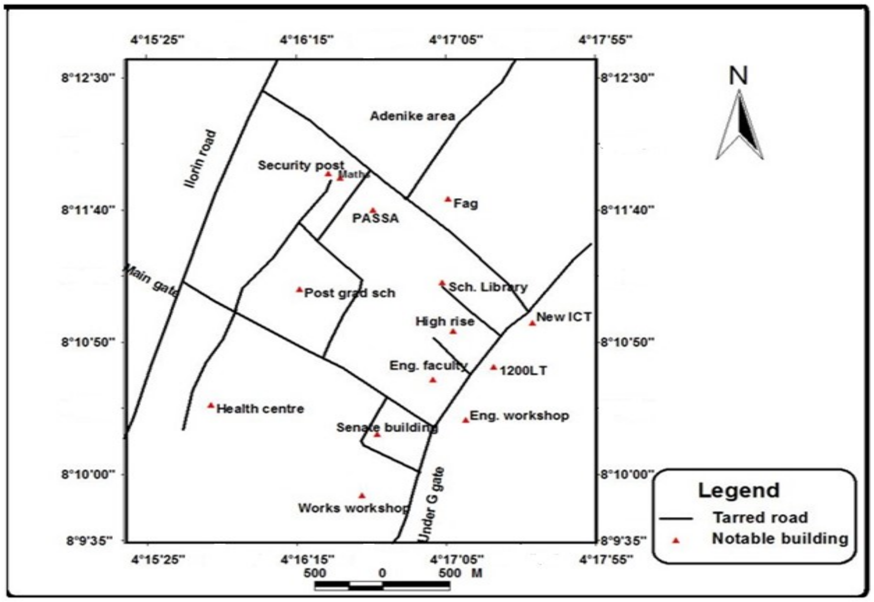

Figure 1: Base Map of the LAUTECH,Ogbomoso (This work)

Methodology

Pumping test for each borehole was carried out. Pumping test was conducted to determine the actual discharge of each borehole. Data provided include static water level, time for pumping test, pumping rate, pumping level and subsequent draw down was determined. A constant rate pumping test involves pumping of a well until it reaches a constant pumping draw dawn. It depends on the aquifer and the pumping rates with time. Water level was stabilized" at a constant water pumping level when the aquifer is supplying water to the well at the same rate the pump is extracting water from the well. Procedures for pumping test was conducted according toGross, 2008,Jacob's method and Thesis method.Water samples used for study were collected from seven different boreholes located in LAUTECH. These groundwater samples were collected using pre-cleaned polyethylene bottle. Physical and chemical parameters were taken and analyzed on the borehole water samples according to AOAC,2005. Bacteriological test was carried out in the Laboratory to determine E – Coli bacteria.Quality Indexes such as Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP) and Residual Sodium Carbonate (RSC) were used to assess the suitability of water for irrigation purposes.It has been calculated as follow

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

where: Na^+, Ca^{2+} and Mg^{2+} are in meq/L.

It is also used to evaluate sodium hazard. The Soluble Sodium Percentage (SSP) was calculated as in

$$SSP = \frac{(Na^+) \times 100}{Ca^{2+} + Mg^{2+} + Na^+ + K^+}$$

Where all ions are expressed in meq/l.

RSC was used. It can be calculated as follows:

$$RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

Result and Discussion

The water quality result and interpretation was compared with standard of World Health Organization (WHO,2004).The bacteriological test is done by comparing the total coliform also be compared with the standard of WHO so as to detect if water is contaminated by any pathogen causing disease. The results of the pumping test data, used in estimating the quantity of water supply from the boreholes, through aquifer parameters which are transmissivity, specific capacity, specific yield and hydraulic conductivity.

Hydraulic Properties Transmissivity

Transmissivity value from pumping test analysis ranged from 0.095 m^2/day to 7.591 m^2/day (Table 1). These values could be considered good for crystalline aquifers. Chilton and Smith (1984) working in a similar geological environment in Malawi, computed transmissivity values of 2-35 m^2/ day for high yielding borehole in Lilongwe areas. Transmissivity results obtained from pumping test in aquifers consisting of fracture zones and weathered basement have to be treated with some cautions, since transmissivity is highly variable depending on the number and size of fracture and thickness of weathered basement penetrated by the boreholes casing strong phenomenon, a condition caused by the water in the annular space between the well casing and the pump riser pipes (Adanu, 1989) could affect transmissivity value (Schafler, 1978).

Transmissivity values are less dependent on borehole yield, and therefore represent a more reliable gauge of aquifer productivity, where they are available. According to Kransny's standard 1978 Table 2 five out of the boreholes are intermediate because their transmissivity values falls within 10 m^2/day except for Fag with transmissivity value of 0.500m^2/ day(5.787 x 10^{-6} m^2/sec) which haslow value for transmissivity and Mathematics which its transmissivity value is 0.095 m^2/day (1.099 x 10^{-6} m^2/ sec) which is imperceptible. Kransny's standard 1978 Table 2 shows that borehole at Engineering workshop, works workshop, New ICT, Health center, and senate building has ground water supply potential of withdrawals for local water supply (small communities, plants etc). Fag has smaller withdrawals for local water supply (private consumption etc) while for Mathematics department sources for water supply are difficult

Table 1: Transmissivity Values for Well Points at Lautech Campus

Locations	M^2/ day	M^2/sec	kransny
Fag	0.500	5.787 X 10^{-6}	Low
Engineering workshop	2.671	3.091 X 10^{-5}	Intermediate
Works workshop	2.467	8.634 X 10^{-6}	Intermediate
New Ict	7.591	8.785 X 10^{-5}	Intermediate
Health center	6.585	7.622 X 10^{-5}	Intermediate
Mathematics	0.095	1.099 X 10^{-6}	Imperceptible
Senate Building	1.225	1.418 X 10^{-5}	Low

Table 2: Kransny's Standard 1978 for Transmisivity

T(m^2/day)	Designation of transmissivity magnitude	Ground water supply potential
1000	Very high	Withdrawals of great regional importance.
100	High	Withdrawals of lesser regional importance.
10	Intermediate	Withdrawals for local water supply (small communities, plants etc.).
1	Low	Smaller withdrawals for local water supply private consumption etc).
0.1	Very low	Withdrawals for local water supply with limited consumption.
	Imperceptible	Sources for local water supply are difficult (if possible unsure)., obviously the storage contribution from the fractured zones and weathered basement.

Hydraulic Conductivity

Hydraulic conductivity from the pumping test analysis in the study area ranges from 0.003 m/day(3.472 x 10^{-8}) to 0.278m/day(3.218 x 10^{-6}) (Table 3), New ICT has the highest value for hydraulic conductivity which is 0.278m/day(3.218 x 10^{-6}) and Mathematics department has the lowest value which is 0.003 m/day(3.472 x 10^{-8}). By comparison with the Todd (1980) (Table 4) below the hydraulic conductivity values of the fractured basement corresponds tomoderate to low for all boreholes because their values falls within 10^{-5} to 10^{-7} on the Todds standard(1980) (Table 4) below, the only exemption is borehole of the Mathematics department which values is > 10^{-7} which corresponds with very low on the Todds standard(1980). According to Dominico and Schwartz(1990) standards (Table 5) on crystalline rocks, all the boreholes falls within fractured igneous and metamorphic rocks because their values falls within 8 x 10^{-9} – 3 x 10^{-4} and 3x 10^{-14}-2x10^{-6}

Hydraulic conductivity is related with transmissivity of an aquifer. Hydraulic conductivity of crystalline rock aquifers depends on fracture characteristics: aperture distribution, surface roughness, contact asperities area, shape, infilling, and length of fractures and on the degree of interconnection between them (Brown & Bruhn 1998, Muldoon et al. 2001). Few fractures are not always an indication of low hydraulic conductivity, or vice versa, high fracture frequency does not always mean high hydraulic conductivity (Johnson 1999). Rock gouge filling or cementation of fractures reduces the K-value even in the case of dense fracturing (Huntley et al. 1991).

Table 3: Hydraulic Conductivity Values for Well Points

Locations	m/day	m/sec	Todd Standard	Dominico and Schwartz Standard (1990)
Fag	0.010	1.157 x 10-7	Moderate-low	Fractured igneous and metamorphic rocks
Engineering workshop	0.100	1.157 x 10-6	Moderate-low	Fractured igneous and metamorphic rocks
Works workshop	0.221	2.56 x 10-5	Moderate-low	Fractured igneous and metamorphic rocks
New Ict	0.278	3.218 x 10-6	Moderate-low	Fractured igneous and metamorphic rocks
Health center	0.120	1.389 x 10-6	Moderate-low	Fractured igneous and metamorphic rocks
Mathematics	0.003	3.472 x 10-8	Very low	Fractured igneous and metamorphic rocks
Senate building	0.068	7.870 x 10-7	Moderate-low	Fractured igneous and metamorphic rocks

Table 4: Todd Standard (1980) for Hydraulic Conductivity

Hydraulic conductivity	Designation of magnitude
>10-3	Very high
10-3- 10-4	High
10-5- 10-7	Moderate - Low
< 10-7	Very low

Table 5:Dominico and Schwartz (1990) in Crystalline rocks

Materials	Hydraulic conductivity
Permeable Basalt	4 x 10-7- 2 x 10-2
Fractured igneous and metamorphic rocks	8 x 10-9- 3 x 10-4
Weathered granite	3.3 x 10-6- 5.2 x 10-5
Weathered grabbro	5.5 x 10-7- 3.8 x 10-6
Basalt	2 x 10-11- 4.2 x 10-7
Fractured igneous and metamorphic rocks	3 x 10-14 – 2 x 10-10

Yield

It is observed from the pumping test, that engineering workshop, works workshop, new ICT and health center has the highest discharge (yield) with yield of 1.25 l/s, 1.25 l/s, 1.66l/s, 1.66 l/s respectively, while mathematics department and senate building has the lowest discharge as shown in the (Table 6) below with yields of 0.625 l/s and 0.341 l/s. The productivity of the boreholes that has the highest yield is enough to supply the campus. The borehole with the lowest yield might be due to the quantity of water available in the aquifer that is supplying water to the borehole. Secondly, the actual depth of the aquifer might not be reached during the construction of boreholes. In addition, some contractors like to maximize profit by using poor quality constructional items (materials) and reducing the quantity of the materials required for the boreholes. Yield of the water producing capacity of the basement aquifer is generally moderate to mediocre in Table 7 below according to Dupreez and Barber (1965). Borehole yields greater than 143.94 m^3/ day (6.0 m^3/ h)) in Table 7 are relatively uncommon. Consequently, the use of high capacity submersible pump or monitorised pumping for domestic usage is therefore limited.

Table 6: Yield Values for Well Points at Lautech Campus

Locations	Yield (l/s)	Yield(m^3/day)	Specific yield(m^3/day)	Du preez and Barber (1965)
Fag	0.625	2.25	54.00	Mediocre
Engineering workshop	1.250	4.50	108.00	Mediocre
Works workshop	1.250	4.50	108.00	Mediocre
New ICT	1.660	6.00	143.00	Moderate
Health center	1.660	6.00	143.00	Moderate
Mathematics	0.004	0.25	6.11	Mediocre
Senate building	0.341	1.23	29.46	Mediocre

Table 7: Dupreez and Barber (1965) Standard for Yield

Yield	Designation of magnitude
Excellent	24.0 m^3/ h
Good	24.0-15.0 m^3/h
Moderate	15.0-6.0 m^3/h
Mediocre	< 6.0 m^3/day

Specific Capacity

Specific capacity is a measure of the productivity of a well. It is defined as the volume of water pumped per unit time per unit drawdown (Freeze & Cherry 1979) or as the sustainable pumping rate divided by the drawdown in the well at a quasisteady state (Singh et al. 2001).Specific capacity data gives better indication of borehole and aquifer performance than records of yield alone, as that reflect aquifer permeability and thickness (Chiton and Carrigton, 1984) specific capacity values are still dependent on the chosen borehole yield to some extent and may also lead to inaccurate estimates of aquifer productivity.The values of specific capacity computed in the study area range from 0.250 m^3/ day/m to 16.506 m^3/day/m in Table 8 .The specific capacity of the boreholes shows that the specific capacity for all the borehole locations are good to moderate except for Mathematics department which has a poor performance Table 9 . Specific capacity in fractured aquifers is approximately log-normally distributed (Jetel et al.1968). Specific capacity is preferred to yield as a measure of well productivity because it ac-counts for the loss in head that is associated with pumping of water. Specific capacity thus normalizes the effects of pumping rate on drawdown (Knopman et al .2001). Specific capacity is a function of aquifer setting, well setting and pumping set-ting. That is, specific capacity depends not only on aquifer transmissivity and storativity and boundary conditions within the aquifer but also on well diameter, well condition, open well section, partial penetration ratio of the well, well loss correction and pumping rate and time (Lattman & Parizek 1964).

Table 8: Specific Capacity Values for Well Points at Lautech Campus

Locations	Specific capacity (m3/day/m)	Science and Nature
Fag	2.405	Moderate
Engineering workshop	8.730	Moderate
Works workshop	3.348	Moderate
New ICT	16.506	Good
Health center	14.32	Good
Mathematics	0.250	poor
Senate building	2.865	Moderate

Table 9: Specific Capacity Classification (Nature and Science, 2009)

Specific Capacity	Borehole Performance
>31.30	Excellent Performance
11.95-31.30	Good
1.16-11.95	Moderate
0.60-1.16	Poor Performance

Physico-Chemical Parameters

The standard value for pH according to WHO (World health organization) is 6.5-8.5mg/l in

Table 10, senate building has the highest level of PH which is 8.37 mg/l while Lautech downstream has the lowest level of pH Which is 6.26 mg/l, the water samples in the study area falls below within the permissible limit required for pH according to its standard. The standard value for temperature according to WHO is 40^0 c which is the maximum permissible limit, it ranges from 36.80^0c to 45^0c, all the samples in the study area falls below this range except for Engineering and new ICT which has 45.70^0c and 43.5^0c respectively in Table 10 . According to WHO ,2004 which is 1500 µs for conductivity , all samples within the study area falls below the permissible limit of these standards ,it ranges from 78µs to 470.79µs, Lautech well has the highest level of conductivity, and Fag has the lowest conductivity .

Chloride ranges from 6mg/l to 187.2 mg/l, all the samples within the study area falls within the standard Health centre has the highest level of chloride while Lautech upstream has the lowest value of chloride. Calcium has a standard of 50mg/l -75mg/l in Table 10. It ranges from 0.1 mg/l to 58.7 mg/l. Lautech upstream has the highest level of calcium new ict hats the lowest level of calcium, all the samples within the study area falls below the permissible for calcium. Magnesium has standards of 0.20mg/l-75mg/l according to (WHO,2004). It ranges from 0.68 mg/l to 7.63 mg/l. All samples within the study area are below the permissible limit according to the standard. Lautech upstream has the highest level of magnesium while Fag has the lowest level of magnesium. Potassium according to WHO has standards 50mg/l, it ranges from 1.8 mg/l to 13.00 mg/l, all the samples within the study area falls within the permissible limit, Lautech well has the highest level of potassium , while Fag has the lowest . The standard for No_3^- according to WHO is 50mg/l ,it ranges from 0.067 mg/l to 0.719 mg/l, Health centre has the highest level of No_3^- which is 0.719mg/l and the new ICT has the lowest value, all samples falls within the WHO standard.

According to WHO,2004 which is 6.0227.40 mg/l, it ranges from 0.00 mg/l to 0.924 mg/l,all samples in the study area falls within the permissible limit, health centre has the highest value while Lautech well has the lowest level w in Table 10 . $HC0_3$ has the standard value of 500mg/l according to WHO, it ranges from 0.1 mg/l to36.6 mg/l, all samples falls below the permissible limit, senate and works has the highest level of bi-carbonate while Lautech well has the lowest level . TDS according to which 500mg/l and WHO which is 42.300mg/l-622.500, it ranges from 0.02 mg/l to 633 mg/l,all the samples falls within the maximum permissible limit except Lautech midstream which has value above the permissible limit. Health center, Senate building, Fag, Works workshop has the lowest value while Lautech midstream has the highest value of TDS.

Table 10: Statistical Analysis for the Water Samples in Lauctech Campus

Parameters	Min	Max	Mean	Standard	WHO,2004
PH	6.26	8.37	7.56	0.7570	8.50
Calcium	0.10	58.70	18.07	24.7478	75.00
Magnesium	0.68	7.63	3.10	2.7168	75.00
Potassium	1.80	13.00	5.07	3.7405	< 50
Sodium	22.58	72.00	39.17	15.7998	NA
Nitrate	0.067	0.719	0.24	0.1897	50
Sulphate	0.00	0.924	0.35	0.2499	27.40
Chloride	6.00	187.20	60.41	60.2956	250
Bicarbonate	0.10	36.60	17.26	14.559	500
TDS	0.02	633	197.56	278.9447	622.5
Electrical conductivity	78.80	470.79	255.62	155.3378	1500
Temperature	36.80	45.70	39.89	155.3378	40

Water quality analysis for irrigation purpose

SAR is an important index for the determination of suitability of agricultural purpose; it causes cation-exchange reactions in soil cation-exchange reactions in soil where sodium replacing adsorbed calcium and magnesium causing damage to the soil structure becoming compact and impervious. Excess sodium in water results in the undesirable effects of changing soil properties and reducing soil permeability (Biswas et al., 2002). High sodium concentration leads to development of alkaline soil. Alkaline soils are difficult to take into agricultural production. Due to the low infiltration capacity, rain water stagnates on the soil easily and, in dry periods, cultivation is hardly possible without copious irrigated water and good drainage. The sodium adsorption ratio ranges from 3.76 meq/l to 13.13 meq/ l (Table 11). In the study area all the groundwater samples have SAR values within the excellent class and acceptable for irrigation except groundwater samples in senate building,faculty of Agriculture (FAG),New ICT AND Works department. The classification for SAR as is given (Richards, 1954) in Table 12.

Table 11: Sodium Adsorption Ratio Values for Lautech Campus

Location	SAR	Richard (1954)
Health center	8.05	Excellent
Senate building	10.18	Good
Fag	16.22	Good
Engineering workshop	8.20	Excellent
New Ict	10.14	Good
Mathematics	8.34	Excellent
Works workshop	13.13	Good
Lautech upstream	4.69	Excellent
Lautech midstream	3.76	Excellent
Lautech downstream	3.97	Excellent
Lautech well	3.78	Excellent

Table 12: Irrigation Water Quality Classification (Richard 1954)

Water class	Sodium adsorption ratio(meq/l)	No of samples
Excellent	Up to 10	7
Good	10-18	4
Fair/ medium	18-26	-
Poor/Bad	>26	-

A positive RSBC value indicates that the amount of dissolved calcium and magnesium ions in water is less than the carbonate and bicarbonate contents.Likewise, positive value indicates that the bicarbonate and carbonate will rescue free calcium and magnesium in the soil, thereby creating room for sodium to accumulate. Higher RSBC values indicate a lower quality of irrigation water. A negative value indicates little risk of sodium accumulation due to offsetting levels of calcium and magnesium. The classification for RSC is given (Richards, 1954). The RSC values < 1.25 mg/l are considered as safe for irrigation, while those from 1.25 mg/l to 2.5 mg/l are marginally suitable for irrigation. If RSB values are > 2.5 the ground water is unsuitable for irrigation (Richards, 1954). The RSB values for ground water samples of the study area range from -1.78 meq/l to 0.53 meq/l with an average of 14.81 meq/l. The classification of ground water for irrigation purpose according to the RSBC values in (Table 13a and 13b) indicates that all water samples in the study area are in safe category and are suitable for irrigation purpose.

Kelly's ratio is used to find whether the ground water is suitable for irrigation or not. It is the ratio of sodium ion to calcium and magnesium ion in meq/l. Based on Kelly's ratios (Kelly, 1963) groundwater was classified for irrigation, Kelly's ratio water more than 1 was unsuitable for irrigation indicating an excess level of sodium in water; therefore the water Kelly's ratio of less than 1 was suitable for irrigation. In the study , Kelly's ratio (KR) obtained for the water samples ranges from 1.58-42.49 meq/l.All KR values for studied water weremore than 1and this fall within the unsuitable category , hence, the groundwater quality were unsuitable for irrigation . The values obtained are higher than the permissible limit of 1.0 recommended by Ayers and Wescot,1985 water quality for irrigation (Table 14).

Table 13a: RSB Values in LAUTECH Campus

Location	RSBC Values	Richard (1954)
Health center	0.32	Safe for irrigation
Senate building	0.53	Safe for irrigation
Fag	0.36	Safe for irrigation
Engineering workshop	0.34	Safe for irrigation
New ICT	0.26	Safe for irrigation
Mathematics	0.30	Safe for irrigation
Works workshop	0.54	Safe for irrigation
Lautech upstream	-1.78	Safe for irrigation
Lautech midstream	1.23	Safe for irrigation
Lautech downstream	-1.50	Safe for irrigation

Table 13b: Irrigation water Quality Classification (Richard 1954)

RSBC	CLASSES
< 1.25	Safe for irrigation
1.25-2.5	Marginally suitable for irrigation
>1.25	Unsuitable for irrigation

Table 14: Kelly's Ratio Values in Lautech Campus

Location	Kelly's Rato Values	Ayers and Wescot
Health center	14.53	Unsuitable
Senate building	19.77	Unsuitable
Fag	42.69	Unsuitable
Engineering workshop	16.29	Unsuitable
New Ict	26.18	Unsuitable
Mathematics	13.57	Unsuitable
Works workshop	27.82	Unsuitable
Lautech upstream	1.75	Unsuitable
Lautech midstream	1.69	Unsuitable
Lautech downstream	1.62	Unsuitable
Lautech well	1.58	Unsuitable

Soluble sodium percentage (SSP) is frequently used in determination of the suitability of water for irrigation purpose. When concentration of sodium ion is high in irrigated water, it tends to be absorbed by clay particles, dispersing magnesium and calcium ions. This exchange process of sodium in water for $Ca^{2+}$and Mg^{2+} in soil reduces the permeability and eventually results in soil with poor internal draining.In this study ,the SSP values range from 64.12 – 97.78 in Table 15a and 15b . Wilcox is used for classification of irrigation waters,most are in "poor category" except LAUTECH stream that is in "poor" category.

Table 15a: Soluble Sodium Percentage Values in Lautech Campus

Location	Soluble sodium ratio (SSP)	Wilcox
Health center	93.38	Poor
Senate building	95.40	Poor
Fag	97.78	Poor
Engineering workshop	94.58	Poor
New ICT	96.51	Poor
Mathematics	93.63	Poor
Works workshop	96.68	Poor
LAUTECH upstream	64.78	Fair
LAUTECH midstream	64.98	Fair
LAUTECH downstream	64.12	Fair

Table 15b: Wilcox Standard of Quality of Water for Irrigation

SSP Values	Grade
<20	Excellent
20-40	Good
40-80	Fair
>80	Poor

Biochemical Test

The results on biochemical test, total viable and total caliform of bacteria isolates is presented in Table 16 in which total viable count range between 1.8 X 10^5 -6.0 x10^5 and total caliform range between 1.6 x10^4-8.5x 10^3 respectively. A total of 6 bacteria were isolated from Lautech upstream, mid-stream, down-stream Table 17.The isolates were selected on the basis of their cultural and morphological characteristics after which they were sent for biochemical test. The isolates were identified to be Bacillus Sp., Pseudomonas Sp., Flarobacteria Sp., Enterobacteria Sp., Aeromonas Sp. From the result of total viable count and total caliform count it was clearly apparent that the water samples were highly polluted this is because the bacteria contamination level is determined high in all the water samples.From the results obtained in this study, it was evidence that the microbial load and the status of the microorganisms isolated from Lautech upstream, midstream, downstream showed the level of contamination which indicate that the presence of domestic and fecal wastes in any water body would make it highly polluted with different species of microorganisms.

Accumulation 0f microbes inside water meant for human consumption could cause diseases such as cholera, typhoid fever, dysentery, skin diseases, pneumonia, and cutaneous infections etc. Fecal contamination in water is usually demonstrated by the detection of specific bacteria that are present in very large numbers in the intestines Egboka et al. (1989). Also from the results it can be deduced based on the report of WHO ,2004 that the water from the upstream, mid-stream , downstream indicated are not potable since they are higher than the safe limits of WHO,2004 (i.e portable water must have zero or less the one coliform count). The water is heavily contaminated because it has coliform count higher indicating human fecal materials and other contaminants. Hence it can be deduced that the water is not safe for human consumption and domestic purpose unless given primary, secondary and tertiary treatment.

Table 16: Results of Total Viable and Coliform Count.

Sample code	Total viable count	Total caliform count
LAU UP	4.4×10^4	1.6×10^4
LAU MID	1.8×10^5	7.5×10^4
LAU DOWN	6.0×10^5	4.8×10^4
LAU WELL	3.3×10^4	8.5×10^3

Table 17: Results for Biochemical Test

Probable identity	Place of occurrence
Bacillus Sp	LAU midstream, upstream, downstream and well
Pseudomonas Sp	LAU midstream, upstream, downstream and well
Flarobacteria Sp	LAU upstream and downstream
Protecus Sp	LAU midstream, upstream, and well
Enterobacteria Sp	LAU midstream, upstream, and well
Aeromonas Sp	LAU midstream and upstream

Conclusion

The assessment of yield and quality analysis of groundwater in Ladoke Akintola University of Technology Campus Ogbomoso .Nigeria has been undertaken.The prolific boreholes which include engineering workshop, work's department, new ICT, and health center has moderate yield, rapid recharge rate andthey are adequate enough to alleviate water problem on the campus. The less prolific boreholes are those at FAG (Faculty of Agriculture), mathematics department, and senate building contribute in minimum quantity to the water supply due to the low yield and very slow recharge rate of these less prolific boreholes, pumping is regulated by almost closing the valve of the pipes from the pump.

All the parameters analyze in the water samples within the study area falls below the maximum permissible limit, according to the standard given by WHO.This means that there is no contamination of the water and it also implies that the water is very suitable for consumption, domestic activities, but the biochemical results showed that Lautech upstream, midstream, downstream are highly polluted because the water were exposed both point source and non-point pollution. Quality Indexes showed that SAR values within the excellent class and acceptable for Agricultural usages except groundwater samples in senate building,faculty of Agriculture (FAG),New ICT AND Works department. RSBC values indicated that all water samples in the study area are in safe category and are suitable for Agricultural usages. KR values for studied water were more than 1 and this fall within the unsuitable category, hence were unsuitable for Agricultural usage .SSP most are in "poor category" except LAUTECH stream that is in "poor" category. Biochemical Results evidenced that the microbial load and the status of the microorganisms isolated from Lautech upstream, midstream, downstream showed the level of contamination which indicate that the presence of domestic and fecal wastes in any water body would make it highly polluted with different species of microorganisms.

Hence it is recommended Recconnaissance survey through the use of Very Low Electromagnetic (VLF-EM) Method should be duly incorporated alongside Geophysical survey to avoid the problem of dry boreholes or seasonal well in Borehole drilling. Also, continuous, effective treatment combined with constant monitoring is essential to ensure that it meets the standard of Drinking water.

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