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Quality Assessment of Traditional Hand Dug Wells in Awka, Anambra State, Nigeria

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Abstract
The physical and chemical quality of traditional hand dug wells in Awka city, Anambra State, that are utilized for numerous purposes were analysed. A total of five (5) samples were collected randomly from (hand-dug wells) located in the city. Collected samples were subjected to standard analysis, viz, physical, chemical and microbial analysis which revealed results and variations of temperature, turbidity, taste and odour, PH, total hardness, sodium (Na^+), Calcium (Ca^+), Iron (Fe^+), Copper (Cu^{2+}), Lead (Pb^+), Chloride (Cl^-) nitrate (NO_3^-), Sulphate (SO_4^{2-}), Carbonate (CO_3^-), Bi-Carbonate (HCO_3^-) with WHO and NSDWQ standards. Results revealed that hand dug wells in the study area contain high coliform counts with respect to the WHO (2011) and NSDWQ (2007) drinking water guidelines. This indicates bacteriological pollution of water sources. Also, concentration of Iron (Fe) in all samples exceeds maximum permissible limits (0.3 mg L-1) which has health implications on consumers of this water.

Keywords: Hand dug well, Standard analysis, Water Quality, Pollution.

1. Introduction
Some households in Awka are heavily dependent on the traditional hand dug well for their water supply, and are unperturbed with water qualities accessed in these hand-dug wells. The quality of this water for direct consumption and other uses should be a concern to all and sundry as the quality of this water source can impart greatly on the life of the inhabitants depending on it. Water "suitability" depends on the use for which it is intended. Hand dug well serves several purposes in Awka metropolitan city ranging from Brick making, livestock watering, fisheries, car wash, laundry services, domestic or even small scale irrigation. Some of these activities e.g. washing/ laundry are usually carried out within the vicinity of well, this in turn, can affect water quality since majority of wells in metropolis uses the traditional non-pulley system (i.e. bucket) in extraction of water. Drinking untreated surface water is potentially hazardous, and risks increases as reservoir use intensifies. Lack of pipe borne water further complicates the water quality situation in Awka. Access to adequate urban water supply from the state water corporation is a serious prob1em facing the inhabitants since 1999. Several factors imparts on the quality of hand-dug wells such as surface run-off, dumping of solid waste, citing of pit latrines close to wells, automobile repair shops layout, unfettered disposal of industrial effluents in water bodies, disposal of untreated sewage are common sites and practices in the Awka metropolis which may indirectly influenced the groundwater quality. Researches has shown that underground water is highly susceptible to contamination that has led to outbreaks of water borne diseases (Eneh, 2011; Obiefuna and Sheriff, 2011; Shittu et al., 2008; Al-sabahi et al., 2009; Badmus, 2001). Akungbo (1990), Gideon (1999), Folorunsho (2010), Adediji and Ajibade, (2005) among others showed the relationship between well water quality and refuse dumpsites. Bacteriological qualities of groundwater (wells) in Nigeria have been reported to have high faecal coliform count exceeding recommended standards by WHO and NSDWQ (Ariziki, 1991; Gideon, 1999; Taylor et al., 2002). Human senses is limited to analyzing aesthetic quality of water, also is the chemical quality of drinking water , which cannot be analyzed merely by physical contact with water either.
The Objectives of the study are:
1. To determine some physical, chemical and microbial parameters obtained from these hand-dug wells.
2. To compare the identified said parameters with the national and international standard.

2. Description of Study Area
Awka capital city is in Awka South local government area of Anambra State. It lies between latitude 6°06 and 6°15'N and longitudes 7°05'E and 7°15'E (Nwanna and Ezenagu, 1995). Awka as an administrative, commercial and educational town is a rapidly growing urban center with a large percentage of migrant settlers. There is also an increase in the number of industries, commercial and recreational centers in the town. The qualities of water resources in the study area were tested for physicochemical and microbiological pollution. The samples were drawn from underground water resources. Sampling points includes Unizik Temp Sites Area, Amikwo-Akwata Area, Umudioka-Ezioka, Nkwelle-Agu-Awka Area, Amenyi-Ifite Are (fig. 1).

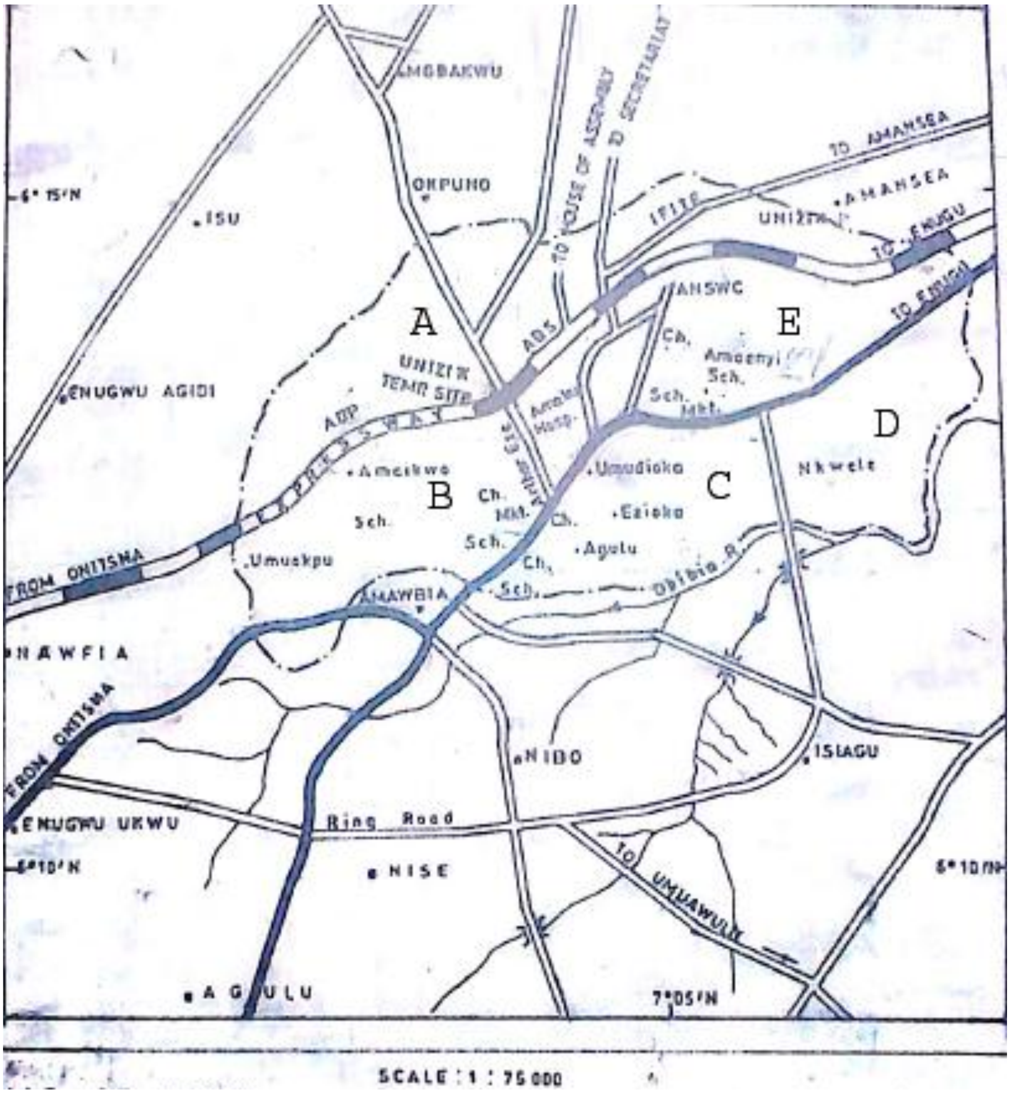

Figure 1: Map of Awka, Anambra State showing sampling points

3. Research Methodology

Well Water samples were collected from five (5) hand-dug wells within the Awka metropolis. A small plastic bottle of one (1) liter capacity rinsed with distilled water was used to collect water samples. Water samples were collected in a properly washed and sterilized 500m1 screw-capped glass bottles transported in ice pack and analyzed immediately. Samples were analyzed for the studied parameters, viz, temperature, turbidity, taste and odour, pH, total hardness, sodium (Na^+), Calcium (Ca^+), Iron (Fe^{2+}), Copper (Cu^{2+}), Lead (Pb^{2+}), Chloride (Cl^-) nitrate (NO_3^-), Sulphate (SO_4^{2-}), Carbonate (CO_3^-), Bi-Carbonate (HCO_3^-) among other, using standard methods as described in APHA (1992).

The analysis was carried out at the Chemistry Laboratory Department of Project Development Institute (PRODA), Enugu, Nigeria. The results obtained were compared with Standard values provided by the NSDWQ (2007) and WHO (2011).

4. Results and Discussion

Descriptive statistics was basically employed to ascertain minimum, maximum, mean, standard deviation and variance of these identified properties.

Table 1: Sampling location with their coding

Sample codes	*Names*
S1	Unizik Temp Sites Area
S2	Amikwo-Akwata Area
S3	Umudioka-Ezioka
S4	Nkwelle-Agu-Awka Area
S5	Amenyi-Ifite Area

Table 2: Water quality analysis results from selected hand-dug well water in Awka, Anambra State, Nigeria.

Parameters	hand-dug well water					WHO standard	NSDWQ
	1	2	3	4	5		
Specific Gravity	2.13	2.15	2.1	2.1	2.1	NG*	NG*
Temperature ^{O}C	19	26	27	26	24	NG*	NG*
pH	5.9	6	6	6	6	6.5-8.5	6.5-8.5
Colour (HAZEN Unit)	480	10.5	6.5	5	5.6	NG*	15
Turbidity (NTU)	20	4	0.5	0.5	0.5	5	5
Conductivity (µhr/cm)	17	12	12	11.5	12.5	20	NG*
TSS (mg/L)	120	980	220	540	380	NG**	NG**
TDS (mg/L)	140	140	630	360	6.8	NG**	500
TS (mg/L)	260	1120	860	900	840	NG**	NG**
Chloride, Cl^- (mg/L)	71	149.1	67.45	142	84	250	250
Sulphate, SO_4^{2-} (mg/L)	0	0	0	0	0	200	100
Nitrate, NO_3^- (mg/L))	0	0	0	0	0	45	50
Bicarbonate, HCO^- (mg/L)	292.8	508.44	491.05	396.5	250.8	500	NG**
Carbonate, CO_3^{2-} (mg/L)	0	0	0	0	0	NG**	NG**
Total Hardness	292.8	508.44	491.05	396.5	250.8	200	150
Calcium (mg/L)	48.1	84.17	51.1	362.92	45.82	75	NG**
Iron (mg/L)	2.46	3.69	4.93	2.46	2.34	0.3	0.3
Manganese (mg/L)	0	0	0	0	0	0.1	0.2
Magnesium (mg/L)	18.24	25.54	12.16	80.26	17.64	0.2	0.2
Lead (mg/L)	0	0	0	0	0	0.01	0.01
Silica , SiO_2 (mg/L)	14	15	16	14	16	NG**	NG**
Copper (mg/L)	0	0	0	0	0	2	1
Total Coliform (cfu/ml)	40	49	48	52	55		10

NG* = No Guideline, because it occurs in drinking water at concentrations well below those at which toxic effects may occur.
NG** = No value obtained

Table 3: Descriptive Statistics of quality parameters of drinking water samples from selected hand-dug wells in Awka, Anambra State, Nigeria.

Parameters	N	Range	Minimum	Maximum	Mean	Deviation	
						WHO	NSDWQ
Specific Gravity	5	.05	2.10	2.15	2.1160	-	-
Temperature ^{o}C	5	8.00	19.00	27.00	24.4000	-	-
PH	5	.10	5.90	6.00	5.9800	-	-
Colour (HAZEN)	5	0.20	5.00	4.80	1.9600	-	-10.2
Turbidity (NTU)	5	19.50	.50	20.00	5.1000	15	15
Conductivity (µhr/cm)	5	5.50	11.50	17.00	13.0000	-3	-
TSS (mg/L)	5	860.00	120.00	980.00	448.0000	-	-
TDS (mg/L)	5	623.20	6.80	630.00	255.3600	-	130
TS (mg/L)	5	860.00	260.00	1120.00	796.0000	-	-
Cl (mg/L)	5	81.65	67.45	149.10	102.7100	-100.9	-100.9
SO_4^{2-} (mg/L)	5	.00	.00	.00	.0000	-200	-100
NO_3^{2-} (mg/L)	5	.00	.00	.00	.0000	-45	-50
HCO^- (mg/L)	5	257.64	250.80	508.44	387.9180	8.44	-
CO_3^{2-} (mg/L)	5	.00	.00	.00	.0000	-	-
Ca^{2+} (mg/L)	5	317.10	45.82	362.92	118.4220	-70.07	-
Fe^{2+} (mg/L)	5	2.59	2.34	4.93	3.1760	-0.3	-0.3
Mn^{2+} (mg/L)	5	.00	.00	.00	.0000	80.16	80.06
Mg^+ (mg/L)	5	68.10	12.16	80.26	30.7680	-0.2	-0.2
Pb^{2+} (mg/L)	5	.00	.00	.00	.0000	15.99	15.99
SiO_2 (mg/L)	5	2.00	14.00	16.00	15.0000	-	-
Cu^{2+} (mg/L)	5	.00	.00	.00	.0000	53	54
Total Col. (cfu/ml)	5	15.00	40.00	55.00	48.8000	0	-10

Temperature, turbidity, taste and odour, pH, total hardness, sodium (Na^{2+}), Calcium (Ca^{2+}), Iron (Fe^{2+}), Copper (Cu^{2+}), Lead (Pb^{2+}), Chloride (Cl^-) nitrate (NO_3^-), Sulphate (SO_4^{2-}), Carbonate (CO_3-), Bi-Carbonate (HCO_3^-) results for the five (5) hand-dug well samples are summarized in Table 2. Table 1 also shows the various sampled points with respective coding for the study. The values in Table 2 and Figure 5 further shows that 100% of the observed 5 hand-dug wells have total hardness beyond the standard limits; total coliform and Iron identified in these water samples exceeds the WHO (2011) and NSDWQ (2007) standard guideline limit of cfu/10 and 0.3 mg/L respectively. This implies that water from all the observed points were hard. All the zones had similar results as far as total coliform are concerned. The level of total contamination exceeds the WHO (2007) guidelines of no counts per 10 ml of sample which means that the water is not fit for consumption because of high bacterial contamination.

Iron (Fe^{2+}) concentrations in the ground water samples ranged from 2.34-4.93 mg/L. This exceeds the maximum allowable limits (0.3 mg/L) for potable ground water according to WHO (2011) recommendation. On exposure to the atmosphere, ferrous iron oxidizes to ferric iron, giving an objectionable reddish-brown color to the water. The concentrations of manganese in the samples were below the maximum allowable limits (0.1 mg/L). The concentration of manganese in the study area is acceptable for health purposes as toxicity is not a factor with manganese.

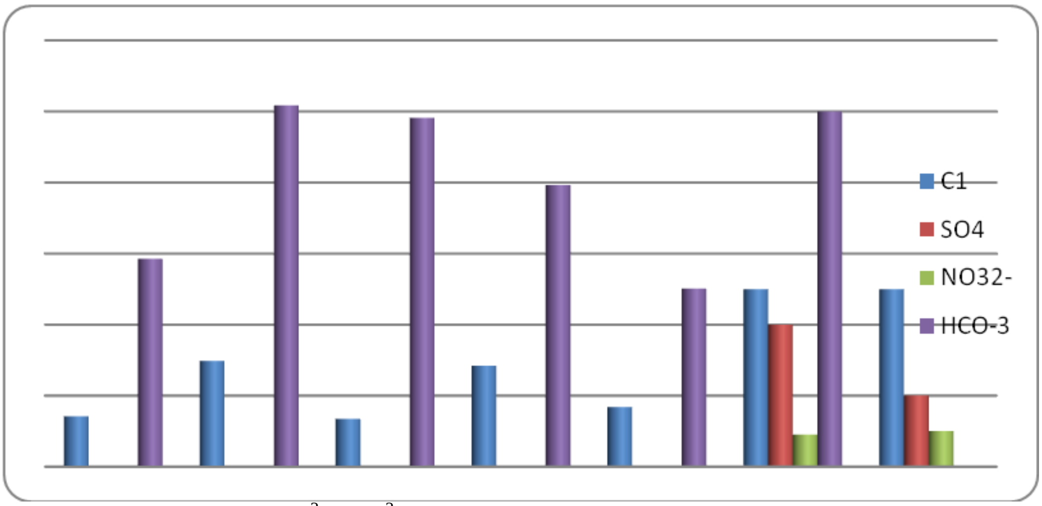

Figure 2: Cl^-, SO_4^{2-}, NO_3^{2-}, HCO_3^- concentration at various sampling points

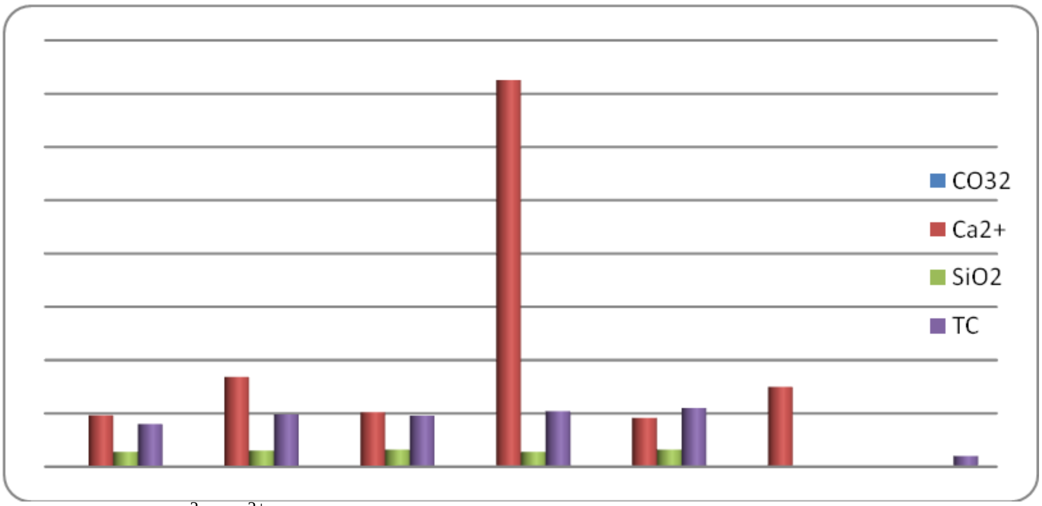

Figure 3: CO_3^{2-}, Ca^{2+}, SiO_2, Total Coliform (TC) concentration at various sampling points

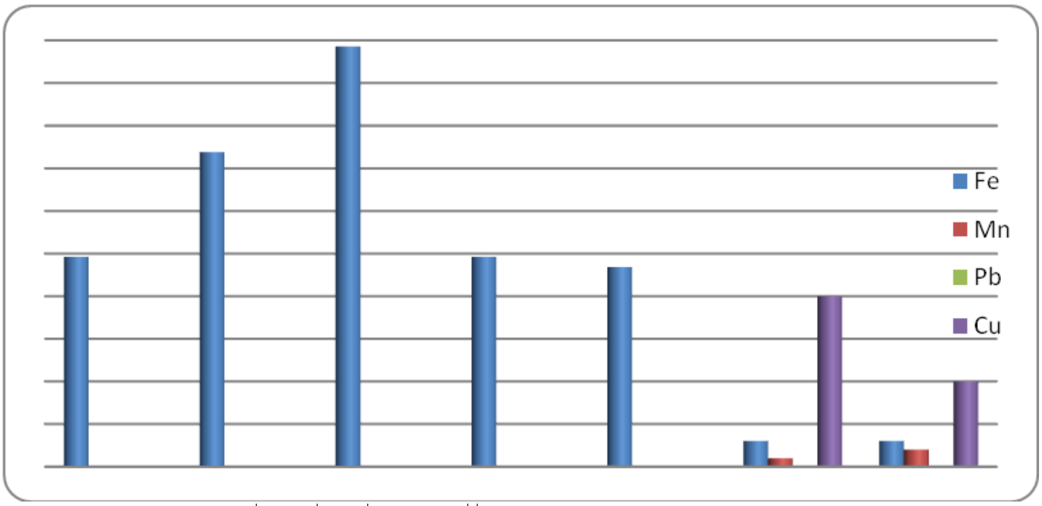

Figure 4: Fe^+, Mn^+, Pb^+, and Cu^{++} concentration at various sampling points

Ca^{2+} concentration of sample S4 is 362.92mg/L, which is above the maximum allowable concentration according to WHO (2011) and NSDWQ (2007) standard for drinking water quality. When calcium (Ca^{2+}) and magnesium (Mg^{2+}) occurred in high concentration, they result in the hardness and alkalinity of the water (Tab. 2 and Fig. 5). Chloride in drinking-water originates from natural sources, sewage and industrial effluents (Canter and Knox, 1985). From our study, the concentration of chloride is found to be below the maximum allowable concentration of 250 mg/l which is acceptable for health purposes. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), but groundwater concentrations generally show relatively slow changes. Some ground waters may also have nitrate contamination as a consequence of leaching from natural vegetation. The concentration of Nitrate falls below the maximum allowable concentration of 45 and 50mg/l for WHO (2011) and NSDWQ (2007) respectively. This is acceptable for health purposes.

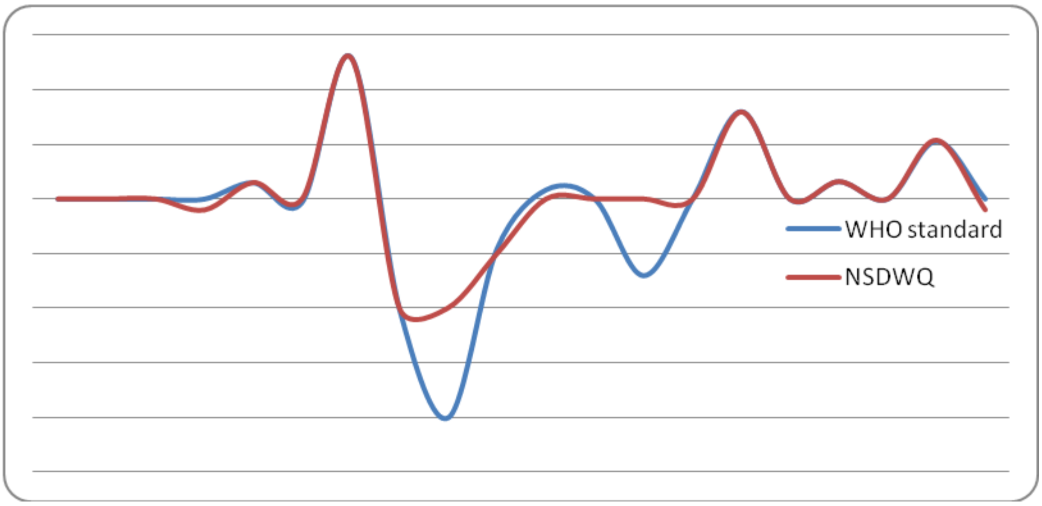

Figure 5: Deviation of water samples parameters from the WHO and NSDWQ standards

5. Conclusion and Recommendations

Hand-dug well water sources in the study area contain high coliform counts with respect to the WHO (2011) and NSDWQ (2007) drinking water qualities. This indicates that these water sources are bacteriological polluted. This can be attributed to poor and unhygienic handling of wastes, careless utilization of wells and fetchers. The consumers from these water sources are unaware of this situation and hence do not take precautionary measures to abate it or its consequences.
The pit latrine system of toilets still used by some households in the study area most assuredly has an influence in the water pollution as seen in table 2 and fig. 5.
Furthermore, parameters with values above the MPL are Iron, Calcium and Magnesium. Observed values of Iron in all sampled points are above the MPL, same holds for calcium and magnesium presence which results to high hardness value of sampled water. Aggressive public awareness by way of organizing seminars and the inclusion of environmental education in school curricula should be ensured as enlightening populace on unsafe water causes, effects and treatment reduces the incidence of water related.

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