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The Effect of Well Depth on Physicochemical Variationin Neibouring Villages of River Niger and Benue in Lokoja Kogi State

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Abstract
The effects of well depth on the physicochemical properties of well water of neighboring villages in close proximity to Rivers Niger and Benue were investigated. Wells of to 2.8m depth and 300m distance from the River were selected. These parameters were measured according to the standard method. A total of 120 samples of well waterfrom these villages (Shintaku, Ganaja village, Gbobe and Lokoja metropolis) were taken and analyzed. Results showed that Total Suspended Solid, (TSS), Total Dissolved Solid (TDS),Total Solid (TS),turbidity, alkalinity andTotal Hardness(TH), shows a range of 13-450mgL $^{-1}$, 57-905mgl^{-1}, 10-170mgL^{-1},0.611-140NTU 11.5-18mgl^{-1} and 202-818mgl^{-1} .Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO), shows a range of0.1-0.45mgl^{-1}, 108-346mgL^{-1}and 0.08-0.75 mgl^{-1} while Electrical Conductivity (EC) and pH shows a range of 53.5-98.5µscm^{-1} and 5.9-7.5. Ammonia, nitrate and phosphate alsoshow a range of 0.01-0.3mgl $^{-1}$, 3.9-43mgl $^{-1}$ and 1.5-14.95mgl^{-1} in the dry seasonrespectively. Total Suspended Solid,(TSS), Total Dissolved Solid (TDS), Total Solid (TS), turbidity, alkalinity and Total Hardness(TH), shows a range of 13-450mgl^{-1}, 57-905mgl^{-1}, 10-170mgl^{-1}, 0.611-140 NTU, 59-131 mgl^{-1} and 130-404 mgl^{-1} . Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) shows a range of 0.2-31 mgl^{-1}, 60-818 mgl^{-1} and 0.9 - 1.2 mgl^{-1},Electrical Conductivity (EC) and pH shows a range of 0.611-140 NTU and. Ammonia, nitrate and phosphate show a range of3.1-14.5mgl^{-1}, 7.5 - 65mgl^{-1}and 3.1-13.5mgl^{-1} respectively. During the wet season, it was found that the nitrate, turbidity and pH increased with depth of the well and the values of TS and TDS also increases positively with the wells proximity to the river in wet season, which was evident in their R^2 Values (correlation coefficient) as they range from 0.7-0.8. Careful consideration and planning is needed in construction of the wells. This suggests that wells must be up to 15m deep and 300m distance away from the river so as to be free from pollution.

INTRODUCTION

Water is a finite resource that is very essential for the human existence, agriculture, industry etc.,without any doubt, inadequate quantity and poor quality of water have serious impact on sustainable development. The scarcity of clean water and pollution of fresh water has therefore led to a situation in which one-fifth of the urban dwellers in developing countries and three quarters of their rural dwelling population do not have access to reasonably safe water supplies (Lloyd and Helmer, 1992). [1]

It has been reported by WHO (2003) that 80% of sicknesses and deaths among children in the world are caused by unsafe drinking water and on the average, one in every eight person in the world dies because of contaminated water.

Hand dugged wells have been the sources of water for people in Nigeria for ages(sina *et al.,*2002*),*a record indicates that some of these wells are dug within close proximity to rivers, and theserivers are the main different contamination of groundwater and lake (Karbassi *et al.,*2007). For a long time it has been found that the quality of groundwater supersedes that of most known surface water bodies or source,its quality maybe dependent on changes related to human or nature phenomena. Although, shallow groundwater is affected more by contamination compared with deep groundwater (Kinzelbach, 2002). The ultimate distance to which the pollution will be carried is dependent upon a number of complex and interlocking factors, namely wet and dry weather. In cases where agricultural land is located near a well, pesticides and nutrients (such as nitrate) are contaminants potentially found at land surface which could be transported to the subsurface along a deficient well seal.(Kinzelbach, 2002)

Efe (2008) stated that the longer the polluted water travels through the soil formation the better (cleaner) it becomes. Iserman (1977) and Essien (1996) stated that shallow wells close to sites that are contaminated will invariably be contaminated with the contaminating substances if they are less than 15m deep. Agbede and Akpen (2008) in their study on the bacteriological and physico-chemical qualities of ground water in Makurdi metropolis floodplains (depth between 1.82 and 7.43m) found that all the ten wells studied were polluted with faecal bacteria; while the wells outside the floodplain were polluted with non-faecal bacteria.

Proximity of the source of pollutants plays a prominent role in groundwater pollution a study in India showed that the percentage of polluted wells significantly increases with distance to the sources of pollution. (Mahedeven and Krishamswamy, 1998).

In a similar study Asimi (1998) in Ilorin concluded that effluents from slaughtering slab increases groundwater COD, total water hardness, total solids, turbidity and other water quality variables in the immediate vicinity of these slabs. These conditions decrease in importance with depth of water table and depth of well.The purpose of this works is to ascertain the quality of water from these sources and verified the adverse effect on the influence of proximity and depth of wells located around the river Niger and river Benue on the water quality.

MATERIALS AND METHODS

Study Area

The study area Include the three villages (Gbobe, Shintaku and Ganaja) near the Rivers Niger and Benue floodplain located in Lokoja, Kogi State. The south bank has two flood plains and one at the east floodplain. These areas are flooded in the rainy season and the study area has two seasons, wet season (May - October) and dry season (November - April). Nwajide (1982). Other sites located within Lokoja metropolis a distances away from the Rivers. Kogi state is found in the north central region of Nigeria, it occupies 29,833 square kilometer, it lies on 7^{o}30'N and 6^{o}42'E,

Sample collection

The samples were collected in two different occasions, one for the wet and the other for dry season, i.e. in the month of May and October of 2014 respectively. A total of 120 samples were collected and analyzed. Samples for heavy metals determination was preserved by treating to a pH of 2 with analytical grade concentrated nitric acid. Those for bacteriological analysis were preserved in well sterilized sample bottles and stored in ice box at 4^{o}C to 10^{o}C and the water samples were taken for analysis within twenty four hours of collecting the samples at Nigerian institute of leatherand science technology Zaria.

Physico chemical analysis: The parameters like pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness (TH), nitrate, phosphate and ammonia were analyzed using standard procedures (APHA 1992).

RESULTS AND DISCUSSION

The properties of the well water from which the water samples were sourced are defined in Table 1. The distances of the wells from the main river basin and the corresponding well depths are presented in the table. Better water quality was found in dry season than in the wet season,

The pH values fluctuated between 5.9 and 7.5. The maximum permissible limit of pH value for drinking water as specified by the Nigerian drinking water standards is 6.5 to 8.5. The pH from the results shows a slightly neutral trend. Generally pH of water is influenced by geology of catchments area and buffering capacity of the water . pH affects the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms and the sensitivity of these organisms to pollution, parasites and disease (FWPCA 1968).

Table 1: Table of the properties of well water samples sourced

S/n	Sample ID	Source	Proximity to the river (m)	Depth of well (m)
1	*K1*	Lokoja	<1000	9.2
2	*K2*	Lokoja	<1000	8.8
3	*K3*	Lokoja	<1000	6.8
4	*K4*	Lokoja	<1000	9.6
5	*K5*	Lokoja	<1000	4.9
6	*K6*	Lokoja	<1000	5.3
7	*K7*	Lokoja	<1000	6
8	*S1*	Shintaku	350	2.4
9	*S2*	Shintaku	850	5.2
10	*S3*	Shintaku	1000	5.4
11	*S4*	Shintaku	800	3.6
12	*G1*	Ganaja	650	1.85
13	*G2*	Ganaja	520	4.2
14	*G3*	Ganaja	300	8.4
14	*B1*	Gbobe	700	2.7

Effect of Depth and distance on water quality

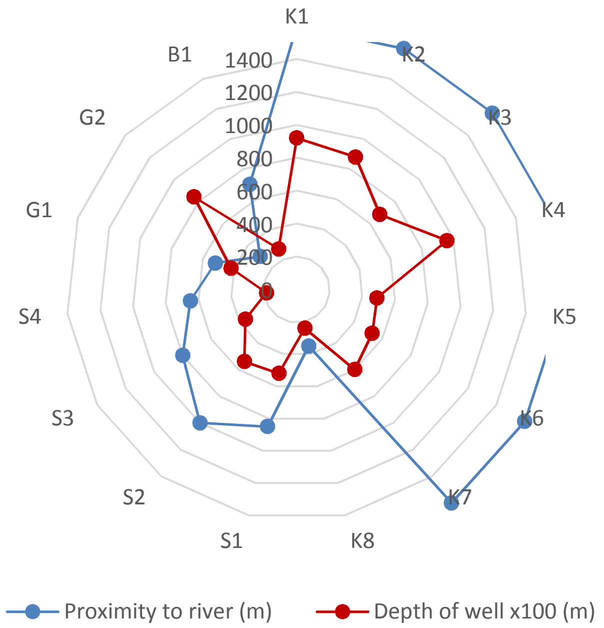

Figure 2: Mean values of physicochemical parameters for wells water samples during dry season

Table 3: correlation coefficients of the effect of depth and distance on water quality

Parameter	Depth				Distance			
	R2		**Slope**		**R2**		**Slope**	
	Dry	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**
TSS	0.2133	0.0468	-6.4370	2.0741	0.1179	0.0033	0.0371	0.0157
TDS	0.0037	0.5414	2.8616	133.4600	0.3714	0.7631	-0.1490	0.7476
TS	0.0875	0.5187	-33.1280	144.8900	0.3714	0.7361	-0.1490	0.7479
BOD	0.0731	0.4088	0.4088	0.1707	0.0228	0.3457	0.0001	0.0003
DO	0.3110	0.0484	0.0218	0.0265	0.2060	0.0460	4.0000	0.0001
COD	0.0544	0.4786	-34.9440	37.3800	0.0100	0.1935	0.1526	0.0238
Total Hardness	0.3102	0.0959	24.0580	22.4200	0.0006	0.2687	-0.2748	-0.0239
Turbidity	0.8868	0.1314	-0.0196	-0.0150	0.4173	0.1802	-0.0039	-0.1047
EC	0.1183	0.4283	-59.3950	131.5700	0.1905	0.0027	-0.6747	0.0907
Ph	0.8114	0.0072	-0.2681	0.0279	0.4601	0.0003	0.0122	0.0003
Nitr	0.8019	0.0074	0.8724	-0.1510	0.0290	0.0169	-0.0047	-0.0033
Amm	0.0668	0.0072	-0.0137	0.0279	0.3371	0.0003	-0.0002	0.0003
Cu	0.2735	0.9058	0.0003	0.0012	0.0848	0.0307	0.0000	0.0000
Ni	0.1714	0.1975	-0.0010	0.0014	0.6371	0.3358	0.0000	0.0000
Zn	0.0000	0.0000	-0.3907	-0.0004	0.0760	0.9454	0.0000	0.0000
Pb	0.2850	0.0987	-0.0002	-0.0003	0.0056	0.0019	0.0000	0.0000
Cd	0.0000	0.0000	0.1705	0.0001	0.0000	0.0000	0.0046	0.0000
Mn	0.6292	0.0017	-0.6292	-0.0017	0.5469	0.0000	-0.5469	-0.0000
Mb	0.7751	0.6556	-1.6061	-2.9076	0.7369	0.4563	-0.0326	-0.0296

Where R^2 = is the coefficient of correlation

The EC values of all 15 samples for the wet and dry seasons is presented in tables x and y. EC ranged between 53.5 and 98.5 µs/cm in the dry season and 47.4 to 1398 µs/cm in the wet season. A comparison of the seasonal changes of EC in the wet and dry seasons is presented in table 3 above.

The standard desirable limit of alkalinity in potable water is 120 mg/L. The maximum permissible level is 600 mg/L (Escher *et al*, 2011). The mean value of alkalinity in the well water samples were in the range of 11.5 to 18 mg/L in the dry season and 59 to 131mg/L in the wet season. The results show that the alkalinity values in the dry season were within normal and in permissible limits. The value of alkalinity in water provides an idea of natural salts present in water (Escher *et al*, 2011). The cause of alkalinity is the minerals which dissolve in water from soil (Shyamala *et al*., 2008). (Parashar *et al.,* 2006). Anthropogenic activities from small scale dyeing units, mechanic workshops, fertilized farm, restaurants etc. present in Lokoja are constantly increasing in the absence of proper drainage systems. The waste waters are discharged into the soil and this may lead to increase in alkalinity of ground water in these areas (Shyamala *et al*., 2008). Samples K5, G1, K2, S4 and G2 showed a decrease in alkalinity in the wet season).

The results show that the turbidity of the 15 well samples in the range of 0.063 to 130.45 NTU in the dry season and in the range of 0.611 to 140 NTU in the wet season. World Health Organization prescribed the highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU (Yadav and Kumar, 2011).

In few well locations, the value of turbidity present is higher than permissible limitsin the present study, fluctuating trends in the values of TH of water samples from the different locations were observed in the range of 202 to 818mg/L of $CaCO_3$ in the dry season and 130 to 404 mg/L $CaCO_3$ in the wet season. NIS has specified the maximum permissible limits of TH to be within 150 mg/L of $CaCO_3$ while the USEPA guidelines are within 500 mg/L of $CaCO_3$. In the dry season, S1 has the highest TH values at 818 mg/L while K8 has the highest value in the wet season at 404 mg/L. Regarding the Nigerian standards all samples were above the recommended limit but were within the USEPA limits in the wet season. Samples S1 (818 mg/L), S4 (815 mg/L), K7 (621 mg/L) and K1 (515 mg/L) were well above the recommended limits in the dry season.The values of the dry season have comparatively higher TH values than the wet seasons. Though the hardness of water is not a pollution parameter and has no adverse effect on human health, it indicates water quality and water with hardness above 200 mg/L may cause scale deposition in the water distribution system and more soap consumption (Kumar *et al*., 2010; Yadav and Kumar, 2011).).

The observed COD values in all the 15 wells in dry seasons are varied from 108 to 346 mg/L and 60 to 818 mg/L in the wet season.The permissible limit of COD for drinking water is 255 mg/L (Escher *et al*, 2011). The maximum mean COD values was recorded as 818 mg/L at B1 and 345 mg/L in the wet and dry season respectively, while the minimum values was recorded as 60 mg/L at K8 and 105 mg/L at K4 for wet and dry season respectively. The high value of COD in the study areas, as shown in table 3, are due to high level of pollutants present in water samples (Yadav and Kumar, 2011), as a result of anthropogenic activities.Most applications of COD determine the amount of organic pollutants found in surface water, making COD a useful measure of water quality and is helpful in indicating toxic conditions and the presence of biologically resistant organic substances (Kumar *et al*., 2010; Yadav and Kumar, 2011).

BOD were found in the range of 0.1 to 0.45 mg/L with the exception of sample G2 which was 0.035 mg/L at the dry season and at the wet season, 0.2 to 0.6 mg/L, with the exception of sample B1 which was 31g mg/L. Desirable limit for BOD is 4.0 mg/Land permissible limit is 6.0 mg/L. BOD demand below 3 mg/L or less is required for the best use (Kumar *et al*., 2010).

Dissolved oxygen DO of ground water samples is an indication of the capacity of the water to hold oxygen (Pushpendra *et al*., 2012) and were found in the range of 0.08 to 0.75 in the dry season and 0.9 to 1.2 in the wet season, with the exception of sample B1 with DO value of 0.03. The effect of seasonal changes on dissolved oxygen is illustrated in Figure 4.5. Generally, there was an increase in DO values from dry to wet season. Except for the values of sample B1 which indicated a decrease from 0.12 to 0.03.

The average values of TDS in the well water samples were in the range of 57 to 310 mg/L, except for sample K8 which was 905 mg/L, in the dry season. The TDS values observed in the 14 sites were well within the desirable limit. The average values of TDS in the well water samples were in the range of 100 to 1560 mg/L in the wet season. The TDS concentrations were found to be below the permissible limit though some of the values were above the desired limit of 500 mg/L. The high values of TDS in the well water may be due to ground water pollution by the leaching of various pollutants when waste waters from both residential and industrial units are discharged into pits, ponds and lagoons enabling the waste migrate down to the water table (Rani *et al*., 2003; Pushpendra *et al*., 2012). This decreases the portability and may cause gastrointestinal irritation in human and may also have laxative effect particularly upon transits (WHO, 1997). Table 3 reflects on the effect of seasonal changes on the TDS values of the well water samples. The TDS levels in the well samples, K1, B1 and G1, increased from the dry season to the wet season. This may be due to the increased migration of ground water in the water Table which promotes the transport of pollutants.

The minimum TSS value in the well water samples was recorded as 13 mg/L at site S1 and maximum value as 450 mg/L from site B1 in the dry season. The results also show a minimum value of 70 mg/L and 370 mg/L for the wet season. The total suspended solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of Ca, Mg, Na, K, Mn organic matter, salts and may also include mud, algae, detritus, and fecal material (Kumar *et al.,* 2010; Pushpendra *et al*., 2012). The effect of presence of total suspended solids is the turbidity due to silt and organic matter. When the concentration of suspended solids is high it may be aesthetically unsatisfactory for bathing (Pushpendra *et al.,* 2012). The effect of seasonal changes in the TSS is illustrated. All values increased from dry to wet samples except sample K7.The values of TS in the dry season were recorded at a minimum of 105mg/L in site S4 and a maximum of 925 mg/L in site G3. The values in the wet season were higher with a minimum of 170 at site G1 mg/L and a maximum of 1820 mg/L at site B1.The effect of seasonal changes, as illustratedwhich shows that there is an increase in TS values from the dry to the wet season. The exception of K7 is attributed to the relatively smaller value of the TSS value.The mean nitrate content of the well water samples were found in the range of 3.9 to 43.4 mg/L in the dry season and in the range of 7.5 to 65 mg/L during the wet season. The highest mean nitrate value of 43.4 mg/L in sample B1 and 65 mg/L in sample K2 were recorded for the dry and wet season respectively while minimum at station 3.9 mg/L, K8 and 7.5 mg/L, K9 were also recorded for the dry and wet seasons respectively.

The nitrate content values fall within the WHO and NIS accepted limits of drinking water standards, except for sample K2 at 65 mg/L which exceeded the permissible limit,The phosphate content of the well water samples were found in the range of 1.5 to 14.95 mg/L in the dry season and 3.1 to 13.5 mg/L was recorded at the wet season for all 15 samples. The recommended limit for phosphates in drinking water is 0.1 mg/L. Therefore none of the samples were within the acceptable limits.The ammonia (NH_4^+) concentration in the samples ranged from 0.01 to 0.3 mg/L in the dry season and from 3.1 to 13.5 mg/L in the wet season. Ammonia nitrogen is well known as toxic to aquatic organisms (Dyer *et al*., 2003). A comparison of the wet and dry season ammonia content suggests that seasonal changes from dry to wet has a direct influence on the ammonia concentration in the well water samples. There was an increase in the ammonia content in the wet season for all samples.

CONCLUSSION

In Conclusion the result showedthat The nitrate, turbidity and pH value of the wellswater were found to increase with depth in dry season, since their R^2 value were between 0.7-0.8., TS and TDS were also affected by well proximity to the river in the wet season. These shows that the farther the well is from the river the deeper the well would be and therefore wells.

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