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THE EFFECT OF WELL DEPTH ON WATER QUALITY IN 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 up to 2.8 m depth and 300 m distance from the River were selected. These parameters were measured according to the standard method. A total of 120 samples of well water from these villages (Shintaku, Ganaja village, Gbobe and Lokoja metropolis) were taken and analyzed. Results showed that Total Suspended Solid, (TSS), Total Dissolved Solid (TDS), Turbidity and Total Hardness(TH), shows a range of 13-450 mgL $^{-1}$, 57-905 mgl^{-1}, 11.5-18 mgl^{-1} and 202-818 mgl^{-1}, respectively. Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) shows a range of 0.1-0.45mgl^{-1}, 108-3and 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. Nitrate and Phosphate also show a range of 3.9-43 mgL $^{-1}$ and 1.5-14.95 mgL^{-1} in the dry season respectively. Total Suspended Solid,(TSS), Total Dissolved Solid (TDS), Turbidity and Total Hardness(TH), shows a range of 13-450 mgL^{-1}, 57-905 mgL^{-1}, 0.611-140 NTU and 130-404 mgL^{-1} . Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) shows a range of 0.2-31 mgL^{-1} and 60-818 mgL^{-1} Electrical Conductivity (EC) and pH shows a range of 0.611-140 NTU, Nitrate and phosphate shows a range of 7.5 - 65mgL^{-1} and 3.1-13.5 mgL^{-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. Nitrate, turbidity and pH values of the well water were found to increase with depth in the dry season while Zn content increased with proximity of the well to the rivers. Therefore, good water management and geological survey must be employed for constructed wells in flood plains to have acceptable water quality.

Keywords: Physico-chemical properties, depth of the well, proximity to the River

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). 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 these rivers are the main different contamination of groundwater and lake (Karbassi *et al.,* 2007).. 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 (Kinzelbach, 2002) 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 floodplains 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 are within Lokoja Metropolis a short distance (500 m) away from the Rivers.

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 4^0C to 10^0C and the water samples were taken for analysis within twenty four hours of collecting the samples at Nigerian institute of leather and science technology Zaria.

Determination of physico-chemical parameters

The temperature, pH and conductivity of the well water collected were determined *in situ* following the methods of APHA (2000). Determination of all other parameters were measured in the laboratory; these include turbidity (using a nephelometric or turbidity meter), total hardness (using Titrimetry (EBT/EDTA), dissolved oxygen (using Winkler Azide), biochemical oxygen demand (BOD) (using Winkler Azide), nitrate (UV spectrophotometry) and phosphate (UV spectrophotometry), using standard methods adopted by APHA (2000), APHA-AWWA (2000), US-EPA (1983) and FWPCA (2000).

A portion of each of the samples of water for heavy metal determination was preserved by treatment with drops of analytical grade concentrated HNO_3 to a pH of 2. Acid digestion of the water was carried out by using a 2:1 of concentrated HNO_3 and concentrated HCl (APHA, 2000). The concentrations of Cd, Cu, Ni, Mn, Pb, Zn in the water was then determined by using an atomic absorption spectrophotometer (model TAS990, Intec Co. Ltd., Rome). Absorbance measurements of both the standards and sample solutions were read at appropriate wavelengths using a single element hollow cathode lamp on the spectrometer, equipped with automatic background correction ((Ekwumemgbo *et al*., 2011). The results of each sample were the average of triplicate sequential readings. The quality assurance for the analyses was conducted through the spiking method, to evaluate the sample digestion process and effectiveness of the atomic absorption spectrophotometer (Uwumarongie and Okieimen, 2008; Lori *et al*., 2009; Amit *et al*., 2010).

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.

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
15	*B1*	Gbobe	700	2.7

Results in Table 2 showed that 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).The results showed 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 of 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 limits in 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 are due to high level of pollutants present in water samples (Yadav and Kumar, 2011), as a result of anthropogenic activities.

Table 2. Mean values of physicochemical parameters for wells water sampled during the season and the 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
BOD	0.0731	0.4088	0.4088	0.1707	0.0228	0.3457	0.0001	0.0003
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
Phosphate	0.8114	0.0072	-0.2681	0.0279	0.4601	0.0003	0.0122	0.0003
Nitrate	0.8019	0.0074	0.8724	-0.1510	0.0290	0.0169	-0.0047	-0.0033

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/L and 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). 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 (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). 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 illustrated which 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.

CONCLUSSION

In Conclusion the nitrate, turbidity and pH value of the wells water were found to increase with depth in dry season, since their R2 value were fall between 0.7 - 0.8. Zn content was found to increase with the well proximity to the rivers. However, all the samples have metal contents far below the permissible limits in the wet season, except for the Cd content which was found to be above the permissible limit in some of the water samples. Cu, Zn and Mn were found to be below the permissible limits in drinking water. Since the physico-chemical qualities of the well water close to the rivers Niger and Benue in Lokoja, Nigeria fall below the standard for potable water; the sustainable development goal should be step up to meet the provision of adequately safe drinking water for the increasing urban and rural populace.

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