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Assessment of Water Quality Index of Borehole and Well Water in Wukari Town, Taraba State, Nigeria

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Abstract

Water samples collected from boreholes and hand dug wells located in two wards in Wukari town were assessed for some physico-chemical parameters on collection and after one week of storage using standard analytical methods. Furthermore the quality indices were determined for the water samples on collection and after one week of storage. The parameters determined include temperature, turbidity, suspended solids, total dissolved solids, conductivity, pH, nitrate –nitrogen, phosphates, chlorides, alkalinity, COD and DO. The result showed that some parameters like turbidity, conductivity and suspended solids exhibited a marked drop in value following their storage for one week in both borehole and hand dug well water samples. Mean values of parameters like nitrate-nitrogen, phosphates and chlorides did not exhibit marked drop in concentration values in both water sources. Turbidity and suspended solid values in the well water samples was more than that of borehole waters however the mean conductivity values in borehole water is more than in well water. Water from both sources was found to exhibit hardness on collection and after one week of storage. The quality indices in borehole and well water on collection were found to be 26 and 136 respectively. After one week of storage the quality indices were determined and the values were found to be 15 and 89 respectively indicating improvement in the water quality after storage for one week. Borehole water in Wukari was found to possess better quality for drinking than well water. The study provides baseline information on the quality of borehole and hand dug well waters in Wukari Town. In addition, the hardness of the water sources may be an indication of the presence of underlying minerals in the ground.

Keywords: Borehole, hand dug well, storage,water quality index

1. Introduction

Water indeed is an essential component of life (Osunkiyesi, 2012). The need for water in the day to day activities of man include for cooking, washing, drinking and for industrial activities (Akpoborie *et al*, 2008). For the chemist therefore the quality of water is very important to ensure that it is potable for drinking (Agbazue, 2008). Two major sources of water whose quality are assessed by chemists are the surface (streams, rivers, ponds, lakes) and ground waters (wells, boreholes). The reason is that surface waters are prone to contamination because it was reported that surface waters are generally poor in quality (Okeola *et. al*, 2010). Ground waters on the other hand are more reliable for domestic and agricultural irrigation needs (Okeola *et al*, 2010; Haruna *et al*, 2008 and Shymala *et al*, 2008). In fact a study revealed that well waters are the main source of water in Akure, Ondo state (Ogundele, 2010), an indication of how people generally desire this kind of water source for use in their daily activities especially as surface water is not accessible to some communities. Due to run offs into groundwater, they also tend to experience some level of contamination owing to leaching from waste dumps and industries (Mahananda *et al* , 2010).

Owing to lack of potable water in most rural areas in Nigeria, the people tend to depend on streams and river water for domestic use and other activities (Shittu *et al*, 2008). The contamination of these water sources comes from different sources in the environment. They include effluents from industries, abattoir activities and pesticides (Iornumbe and Onah , 2008) and from animal faecal discharges into surface and ground waters due to washing by rain falls (Oko, 2008). One sure way by which information on the quality of water could be conveyed to those concerned is by using suitable indices (Dwivedi and Pathak, 2007).The water quality index is a single value obtained from large number of variables in a sample (Shultz, 2001). It summarizes data into terms that can be described as excellent, good, bad and so on for the purpose of reporting to recognized bodies or organizations and to the public on the state of water in a place (Barti and Kartyal, 2011). Various methods have been employed to determine the water quality index but the most commonly employed is the Weighted Arithmetic Index (WAI) method.

It has been reported that the various sources of water supply in Wukari town include boreholes (14.6%), hand-dug wells (46.6%), streams (1.80%) and water vending (37%) (Ishaku *et al*, 2010).The level of adequacy of the water was rated 28.38% as against 71.64% inadequacy. Inhabitants rely mostly on boreholes, vended water and hand-dug wells as sources for drinking water and for other domestic activities and because of this inadequacy, households are necessitated to collect waters in plastic containers or metal tanks for storage so they can use when the need arises. Against this background this study is aimed at determining some physico-chemical parameters and water quality indices of bore hole and well water in Wukari town at collection and after storage in plastic containers over a period of time.

2. Materials and methods

2.1 Study site

Wukari local government lies on the co-ordinates 7°51'N 9°47'E or 7.850°N 9.783°E covering an area of 4,308Km^2 and having a population of 241,546 based on the 2006 census (www.en.wikipedia.org/wiki/wukari). The local government headquarter is Wukari town which lies on the trunk A highway. The town is divided into three wards namely Avyi, Puje and Hospital (Ishaku *et al*, 2010). A lot of agricultural products such as yams and fishes can be found in Wukari town because the people of Taraba are predominantly farmers (Ishaku *et al* , 2009).

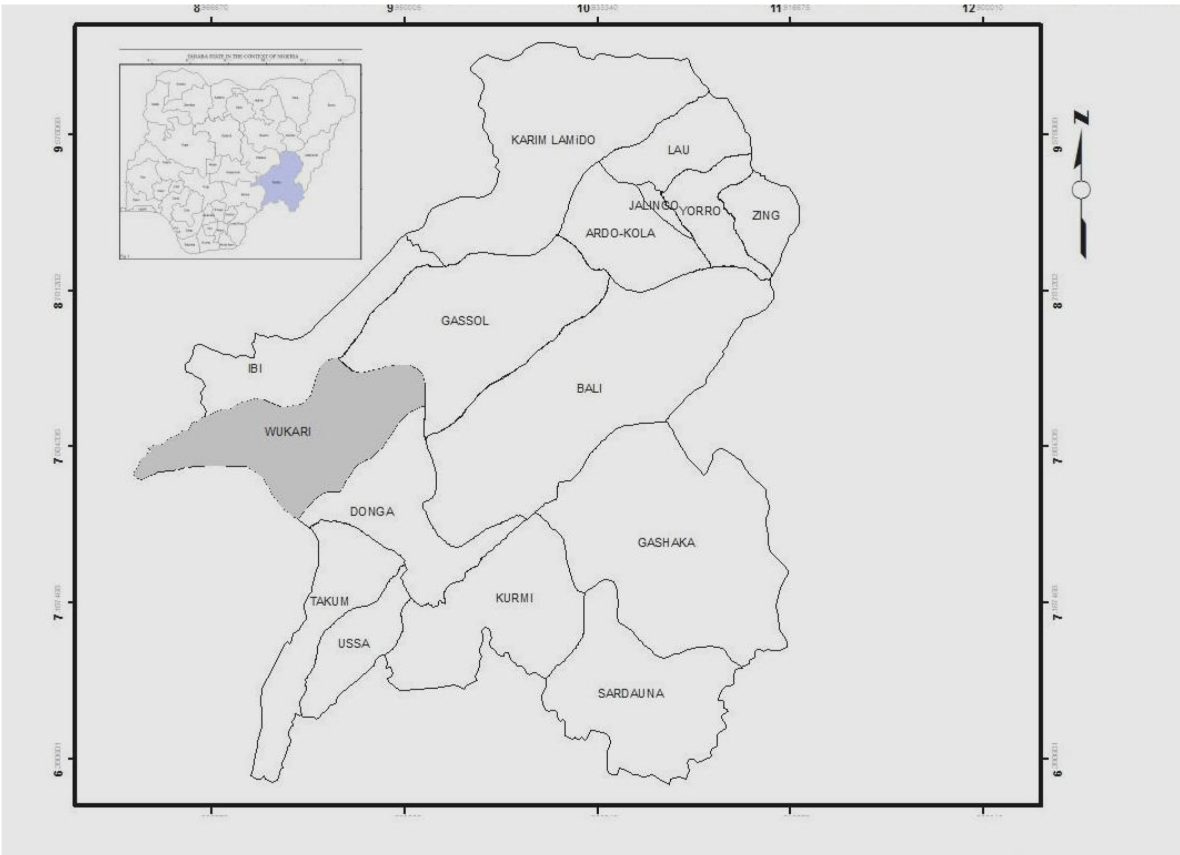

Fig. 1: Map of Taraba State showing Wukari Local Government (inset: map of Nigeria showing Taraba State)

2.2 Sample collection, treatment and preservation

The water samples were collected from boreholes and hand- dug wells sited in two of the three wards of Wukari town. The samples were collected in August 2013 from Avyi and Puje wards of the town. The samples were collected in pre-cleaned 4 L plastic containers then acidified with Analar grade of concentrated nitric acid(pH=1.5) (Aremu *et al* , 2011). The choice of plastic containers for sample collection is for the fact that the level of contamination from it to the water especially from heavy metals is low (Odoh *et al* , 2013).They were then kept in coolers containing ice blocks and transported to the laboratory for preservation in a refrigerator before analysis was carried out on them.

2.3 Physicochemical analysis of borehole and hand-dug well samples

Thirteen parameters were analyzed in the samples collected. The parameters analyzed for include temperature which was taken at the site of collection using a calibrated thermometer, pH using a pH meter, conductivity using conductivity meter ; nitrate nitrogen and phosphate were determined by colorimetry using DR 2000 spectrophotometer (Model 50150), chloride by gravimetry, alkalinity by titrimetry; dissolved oxygen , chemical oxygen demand and hardness by standard methods.

2.4 Determination of water quality index

The method employed for this study is as described by Dhakad *et al*(2008) on groundwater samples which involves first calculating the quality of parameters, Qp as presented in the equation below;

$$Q_p = \sum_{p=1}^{n} \left(\frac{A_p - I_p}{S - I_p} \right) x\, 100$$

Ap is the average values of the parameters determined under laboratory conditions, S is the standard permissible values obtained from recognized organizations/bodies and Ip is the ideal values for the parameters. All ideal values (Ip) are taken to be zero except that of pH =7, DO=14.6 and fluorides=1(Dhakad et al ,2008). The unit weight is calculated by taking the reciprocal value for the standard permissible value S for the parameter considered. The water quality index therefore is determined by aggregating the products of the parameter qualities and the unit weights and dividing by the aggregate of the unit weights.

$$WQI = \frac{\sum_{p=1}^{n} Q_p W_p}{\sum_{p=1}^{n} W_p}$$

The water quality ratings assigned to water quality index values are given below;

Table 1: Water quality index and water quality status

Water quality index	water quality status
0-25	Excellent
26-50	Good
51-75	Bad
76-100	Very bad
>100	Unfit for drinking

Source: Chatterji and Razuiddin(2002)

3. Discussion

The result shows that the mean temperature for borehole water is 21.35°C. The temperatures of the water on collection at Avyi and Puje wards were 21.4°C and 21.3°C respectively which fall within acceptable standard limits. Turbidity value was found to be 1.25 NTU well below the limit set by SON standard (2007). The turbidity affects clarity of water and presents an unpleasant look of the water. Suspended solids and total dissolved solids had mean values of 2 mg/l and 246 mg/L respectively. The TDS was found to be lower than that determined for boreholes in Kubwa , FCT (Aremu *et al*, 2011).

The mean conductivity was found to be 436 µs/cm. Avyi ward had the least value of 301 µs/cm while Puje was 571 µs/cm. These values were higher than that determined for boreholes in Kubwa (Aremu *et al*,2011) which had conductivities values of 0.44 µs/cm though lower than determinations made for bore holes in Gusau (Adejo *et al*, 2013) where conductivity levels were found in the range of 248-3,764 µs/cm in borehole samples. This expresses the level of dissolved ions in the Wukari borehole water.

The pH expresses the extent of acidity or alkalinity of a sample. It was found to have a mean value of 6.68. This is an indication of weak acidity. The soil type may be such that it permits dissolution of materials which bring about slight acidity in the sample. The pH was found to be lower than that for Kubwa though slightly higher than that for Gusau borehole waters. It however falls within the accepted range of 6.5-8.5.

Nitrate nitrogen was determined to be 2.26 mg/L. The presence of nitrates in a water sample could be due to inorganic fertilizers, plants and animal decomposition and wastes which may have percolated the soils over time (Ademoroti, 1995). The average mean for borehole water in Gusau (3.09 mg/L) was higher than that for the nitrate level for Wukari and even much lower for boreholes in Akure which range between 30-61 mg/L (Akinbile and Yusoff, 2011).

Phosphate and chloride levels were found to be 1.14 mg/L and 63.86 mg/L, respectively. The presence of phosphate in a water source could be attributed to discharges from detergents, animal wastes and related contaminants. The presence of chlorides on the other hand in natural water could be attributed to pollutions from sewage, minerals and industrial effluents (Mandal *et al* ,2011) .Furthermore geochemical conditions could make chlorides to present in varying conditions (Aremu, Gav,Opaluwa,Atolaiye, Madu and Sangari, 2011).The mean value for alkalinity was found to be 8.00 mg/L. This expresses the component of the water sample.

Water hardness values for the borehole sample is 140 mg/L though the values for Puje ward indicated above the permissible levels and Avyi had values that were lower than the accepted limit of 150 mg/L. The reason for this variation is not clear but may be due to variations in the geochemical features of the soil in moving from one part of the town to the other. It may also be an indication of the presence of limestone, gypsum, dolomite or other calcium or magnesium containing minerals in the soil of Wukari town.

Calcium hardness has been classified as 0-20 mg/L (soft); 20-40 mg/L (moderately soft); 40-80 mg/L (moderately hard), 80-120 mg/L (hard), >120 mg/L (Very hard) (www.watrresearch.net/watrqualindex/index.htm) The borehole water samples may therefore be described as hard thus creating difficulty for washing generally because it would not form lather with soap easily. It would however be good for drinking because hard water maybe preferable to soft water for the purpose of drinking.

COD and DO recorded mean values of 89.00 mg/L and 4.85 mg/L respectively. These parameters are important for the sustenance of aquatic lives.COD test has been indicated to indirectly measure the organic compounds in water (www. en.wikipedia.chem.oxygen demand). The process requires the quantity of oxygen which would convert all chemicals in the water into forms such as carbon (IV) oxide and ammonia.

The results of parameters in borehole water after one week of collection are presented in table 3. For the parameters discussed, the mean results show a drop in temperature (20.15^{o}C). Turbidity (0.54 NTU), suspended solids (0.53mg/L), total dissolved solids (109 mg/L) and conductivity (268.5 μS/cm). This may be attributed to the fact that the particles in the water settled at the bottom of the container after one week of storage thus causing most of the physical parameters determined to be less in the body of the water. Owing to gravitational force most of the dissolved ions may have also settled which could have accounted for the drop in their conductivities and hence their values.

The mean values for nitrate nitrogen (2.14 mg/L), Phosphate(1.12 mg/L) and Chloride(63.34 mg/L) which expressed little lower concentrations were within range as the values determined for the parameters on collection of samples. The reason for this is also not clear but it could be that soluble particles that are chemical in nature could be well distributed in the body of water and possibly interact with the water molecules in a form that storage for one week may not have significantly affected the concentration in the body of water. Furthermore, the analysis was only repeated after one week. It is possible that the concentration may further drop significantly if the water was allowed to stay for a longer period of time before analysis is done on it. The values for pH and alkalinity presented a slight rise of 6.68 and 8.25 mg/L respectively. However the result was within range of the detection at the time of initial collection. Chemical oxygen demand and dissolved oxygen values also dropped after one week of storage. This also implies that the components in the water interfering with oxygen demand and uptake could have settled down due to gravitational force.

The mean results of well water samples collected from Wukari town are presented in table 4. The mean temperature was found to be 21.6^{o}C. Turbidity, suspended solids and total dissolved solids were found to be 10.33 N.T.U, 10 mg/L and 246 mg/L respectively. Turbidity and suspended solids values were higher in the hand dug well waters than the boreholes. This may be attributed to the fact that hand dug wells though covered were more exposed to contamination by particulate matter than the borehole waters. The TDS value is however the same with that of the borehole sample which could be an indication that this same particles present in the well water was also present in the bore hole water. The value was however low when compared with a similar study done on well water in Abeokuta, Nigeria (Shittu, Olaitan and Amusa, 2008).

The mean conductivity values were lower in the well water (329 μS/cm) than in the borehole (436 μS/cm) which suggests that the mobility of dissolved ions is more in borehole waters than in the well waters. This variation could not be accounted for but other physical properties of the waters which were not studied such as viscosity may be responsible. This assertion is not with certainty until further studies are carried out.

The mean pH was found to be 6.28 which is weakly acidic is as in the borehole water. The results falls within the range of a similar work done on well waters in Doko village in Niger state were pH was determined in the range of 6.2-7.5(Yisa *et al*, 2012) .

Mean values for nitrate nitrogen, phosphate and chloride were found to be 2.05 mg/L, 1.93 mg/L and 70.91 mg/L , respectively. Concentrations of phosphates and chlorides were higher in the well water than that determined for the borehole samples. This could be attributed to the fact that well waters are prone to contamination from activities in the environment such as discharges from washing of clothes, animal wastes among others.

Alkalinity values were slightly lower but within the range of the values for the borehole samples. The mean values for hardness was found to be 130 mg/L which is described as hard. The Chemical oxygen demand and dissolved Oxygen values were found to be 93 mg/L and 4.45 mg/L respectively. The COD value is higher than that for the well water in Doko. This implies that there are more chemicals in the Wukari ground waters than Doko competing for oxygen.

The results of analyzed parameters in well water samples after one week of storage are displayed in table 5. It shows mean values for temperature, turbidity, suspended solids, total dissolved solids and conductivity to be lower than that originally collected. Also pH and phosphate presented lower concentrations than when they were collected. Chloride, alkalinity and dissolved oxygen had mean values as that for when they were collected.

Tables 6 and 7 displays water quality index values for borehole water on collection and after one week of storage. The result showed that water quality index based on the parameters provided from the Nigerian standards for drinking water show the borehole water to be good on collection but improved to excellent after one week of storage.

Tables 8 and 9 similarly show water quality index for well water on collection and after one week of storage. The result shows that the water quality index values indicated that well water was unfit for drinking at collection and still very bad for drinking after one week of storage (139 and 89, respectively). The value in both borehole and well water after storage indicated marked improvement. The implication therefore is that leaving water for a longer period of time could improve the quality further. The study therefore showed that borehole water collected during the rainy season in Wukari town presented a better quality for drinking than well water even after storage for a week.

4. Conclusion

The study conducted to assess the quality of borehole and well water by way of their indices at collection and after storage for one week showed that borehole in Wukari town based on physico-chemical parameters was deemed to be good. This was however not the case with well water which was found not be fit for drinking and was still bad even after one week of storage. Furthermore, the study proved that storage of water over a period of time probably with mild treatment for bacteriological elimination would present a better quality of water for drinking than consuming water from borehole or wells at collection. The study also showed that both water from bore holes and wells are hard water. This may not be a problem for drinking since it would help to improve calcium and magnesium content in the body. It would only pose problems when the water is used for washing since more soap would be consumed.

It is thus suggested that enlightenment campaign programmes be run across Wukari town to educate the teeming population of the need to collect borehole water and store for a while before drinking. Furthermore they should be discouraged from drinking well water even after storage.

The level of hardness observed in the water could point to the fact that minerals such as lime stone, dolomite among others may be present in the soils of Wukari town. This information would provide baseline data on water quality index for borehole and hand dug well water in Wukari and for comparison with other settlements.

Table 2: Mean result of parameters in boreholes in wukari town on collection

	Location			
Parameters	**Avyi ward ([a]Mean+ SD)**	**Puje ward ([a]Mean + SD)**	**[b] Mean**	**SON standard**
Temperature (^{o}C)	21.40±0.13	21.3 ±0.13	21.35	Ambient
Turbidity (NTU)	1.66 ±0.01	0.84±0.02	1.25	5
SS (mg/L)	1.00±0.14	3.00±0.13	2.00	-
Conductivity (µS/cm)	301.00±2.53	571.00± 0.63	436.00	1000
TDS (mg/L)	165.00± 3.22	327.00±1.26	246.00	500
pH	6.84±0.01	6.38±0.01	6.61	6.5-8.5
Nitrate nitrogen (mg/L)	1.84±0.02	2.68±0.01	2.26	50
Phosphate (mg/L)	0.72±0.01	1.56±0.01	1.14	-
Chloride (mg/L)	42.55±0.02	85.16±0.02	63.86	250
Alkalinity (mg/L)	8.10 ±0.06	7.90±0.01	8.00	-
COD (mg/L)	90.00±1.26	88.00±2.83	89.00	-
Hardness (mg/L)	120.00±1.26	160.00±1.79	140.00	150
DO (mg/L)	4.90±0.06	4.80±0.11	4.85	-

a-Mean values of six determinations
b-Mean of mean values from two wards studied
SD-standard deviation

Table 3: Mean result of parameters in Borehole samples in Wukari town after one week of storage

	Location			
Parameters	**Avyi ward ([a]Mean+ SD)**	**Puje ward ([a]Mean + SD)**	**[b] Mean**	**SON standard**
Temperature (^oC)	20.10±0.64	20.2 ±0.13	21.15	Ambient
Turbidity (NTU)	0.23 ±0.01	0.84±0.01	0.54	5
SS (mg/L)	0.006±0.01	1.00±0.09	0.53	-
Conductivity (µS/cm)	216.00±1.27	321.00± 1.79	268.50	1000
TDS (mg/L)	76.00± 3.22	142.00±1.41	109.00	500
pH	6.92±0.01	6.44±0.01	6.68	6.5-8.5
Nitrate nitrogen (mg/L)	1.76±0.02	2.52±0.02	2.14	50
Phosphate (mg/L)	0.70±0.01	1.54±0.01	1.12	-
Chloride (mg/L)	42.51±0.02	85.14±0.02	63.34	250
Alkalinity (mg/L)	8.40 ±0.01	8.10±0.01	8.25	-
COD (mg/L)	64.00±1.27	80.00±1.79	72.00	-
Hardness (mg/L)	120.00±1.27	80.00±1.79	100.00	150
DO (mg/L)	4.10±0.06	3.70±0.11	3.90	-

a- Mean values of six determinations
b- Mean of means values from two wards studied
SD-standard deviation

Table 4: Mean result of parameters in hand dug well waters in wukari town on collection

	Location			
Parameters	**Avyi ward ([a]Mean+ SD)**	**Puje ward ([a]Mean + SD)**	**[b] Mean**	**SON standard**
Temperature (^oC)	21.60±0.18	21.6 ±0.28	21.60	Ambient
Turbidity (NTU)	20.00 ±1.79	0.66±0.02	1.25	5
SS (mg/L)	18.00±1.27	2.00±1.10	10.00	-
Conductivity (µS/cm)	86.00±1.79	572.00± 2.19	329.00	1000
TDS (mg/L)	165.00± 3.22	327.00±1.26	246.00	500
pH	5.90±0.01	6.66±0.02	6.28	6.5-8.5
Nitrate nitrogen (mg/L)	1.96±0.01	2.14±0.02	2.05	50
Phosphate (mg/L)	2.64±0.02	1.22±0.02	1.93	-
Chloride (mg/L)	70.91±0.01	70.91±0.01	70.91	250
Alkalinity (mg/L)	7.20 ±0.06	7.90±0.01	8.00	-
COD (mg/L)	94.00±1.26	92.00±2.83	93.00	-
Hardness (mg/L)	140.00±1.10	120±1.10	130.00	150
DO (mg/L)	4.20±0.06	4.80±0.11	4.85	-

a-Mean values of six determinations
b-Mean of means values from two wards studied
SD-standard deviation

Table 5: Mean result of parameters in hand-dug well waters in wukari town after one week of collection

Parameters	Location: Avyi ward ([a]Mean+ SD)	Location: Puje ward ([a]Mean + SD)	[b] Mean	SON standard
Temperature (°C)	20.40±0.14	20.5 ±0.28	21.45	Ambient
Turbidity (NTU)	12.60 ±1.79	0.12±0.02	6.36	5
SS (mg/L)	10.00±1.27	0.17±1.10	5.09	-
Conductivity (µS/cm)	74.00±0.89	461.00± 0.89	267.50	1000
TDS (mg/L)	17.00± 1.67	214.00±1.79	115.50	500
pH	6.00±1.41	6.72±0.01	6.36	6.5-8.5
Nitrate nitrogen (mg/L)	1.94±0.73	2.12±0.01	2.03	50
Phosphate (mg/L)	2.60±1.10	1.12±0.01	1.86	-
Chloride (mg/L)	70.91±0.01	70.90±0.02	70.91	250
Alkalinity (mg/L)	7.30 ±0.18	7.50±0.13	8.00	-
COD (mg/L)	84.00±1.67	82.00±2.83	93.00	-
Hardness (mg/L)	140.00±1.27	120±1.27	130.00	150
DO (mg/L)	4.20±0.06	4.70±0.13	4.45	-

a-Mean values of six determinations
b-Mean of means values from two wards studied
SD-standard deviation

Table 6:Water quality index of borehole water collected in wukari town.

S/No	Parameter	Mean	Std Permisible level	Ideal value	Unit Weight(w)	Q rating	Q*W
1	**Turbidity**	1.25	5	0	0.2	25	5
2	**Conductivity**	436	1000	0	0.001	43.6	0.0436
3	**TDS**	246	500	0	0.002	49.2	0.0984
4	**Hardness**	140	150	0	0.0067	93.33	0.625
5	**pH**	6.61	8.5	7	0.1176	26	3.0576
6.	**Nitrate Nitrogen**	2.26	50	0	0.02	4.52	0.0904
7	**Chloride**	63.86	250	0	0.004	25.54	0.102
					$\sum W = 0.3513$		$\sum QW = 9.017$

WQI= $\frac{\sum QW}{\sum w}$ **=9.017/0.3513**

=26

Table 7: Water quality index of borehole water stored for one week after collection in wukari town.

S/No	Parameter	Mean	Std Permisible level	Ideal value	Unit Weight(w)	Q rating	Q*W
1	**Turbidity**	0.54	5	0	0.2	10.8	5
2	**Conductivity**	268.5	1000	0	0.001	26.85	0.0436
3	**TDS**	109	500	0	0.002	21.8	0.0984
4	**Hardness**	100	150	0	0.0067	66.67	0.625
5	**pH**	6.68	8.5	7	0.1176	21.33	3.0576
6.	**Nitrate Nitrogen**	2.14	50	0	0.02	4.28	0.0904
7	**Chloride**	63.34	250	0	0.004	25.34	0.102
					$\sum W = 0.3513$		$\sum QW = 5.37281$

WQI= $\frac{\sum QW}{\sum w}$ **=5.37281/0.3513**

=15

Table 8: Water quality index of well water collected in wukari town.

S/No	Parameter	Mean	Std Permisible level	Ideal value	Unit Weight(w)	Q rating	Q*W
1	**Turbidity**	10.33	5	0	0.2	206.6	41.32
2	**Conductivity**	329	1000	0	0.001	32.9	0.0329
3	**TDS**	246	500	0	0.002	49.2	0.0984
4	**Hardness**	130	150	0	0.0067	86.7	0.58089
5	**pH**	6.28	8.5	7	0.1176	48	5.6448
6.	**Nitrate Nitrogen**	2.05	50	0	0.02	4.1	0.082
7	**Chloride**	70.91	250	0	0.004	28.4	0.1136
					$\sum W = 0.3513$		$\sum QW = 47.87259$

WQI= $\frac{\sum QW}{\sum w}$ =47.87259/0.3513

=136

Table 9: Water quality index of well water after one week of storage.

S/No	Parameter	Mean	Std Permisible level	Ideal value	Unit Weight(w)	Q rating	Q*W
1	**Turbidity**	6.36	5	0	0.2	127.2	25.44
2	**Conductivity**	267.5	1000	0	0.001	26.8	0.0268
3	**TDS**	115.5	500	0	0.002	23.1	0.0462
4	**Hardness**	130	150	0	0.0067	86.7	0.58089
5	**pH**	6.36	8.5	7	0.1176	42.7	5.02152
6.	**Nitrate Nitrogen**	2.03	50	0	0.02	4.1	0.082
7	**Chloride**	70.91	250	0	0.004	28.4	0.1136
					$\sum W = 0.3513$		$\sum QW = 31.31101$

WQI= $\frac{\sum QW}{\sum w}$ =31.31101/0.3513

=89

References

Ademoroti,C.M.A(1995)Environmental Chemistry and Toxicology.Foludex Press Ltd.Ibadan

Adejo,Y., Bagudo,B.U., Tsafe,A.I and A.U Itodo (2013) Physico-chemical quality assessment of groundwater within Gusau Metropolis.International Journal of Modern Analytical and separation sciences.2(1):1-19

Agbazue,V.E(2008)The chemist and self employment. Book of Proceeding of the international conference of the chemical society of Nigeria Held in Effurun, Delta State.

Akinbile,C.O and Yusoff,M.S (2011)Environmental impact of leachate pollution on groundwater supplies in Akure,Nigeria.International Journal of Environmental science and Development.2(1):81-86

Akpoborie, T., Egbo,S.H.O., Ebenuwa,C.C and Emeshili,E.M (2008) Comparative study of the satchet water in Asaba Metropolis, South-South, Nigeria. Book of proceeding of international conference of the chemical Society of Nigeria held in Effurun,Delta State

Aremu,M.O.,Ozonyia, G.N and Ikokoh,P.P (2011) physico-chemical Properties of well,Borehole and stream waters in Kubwa, Bwari Area Council.,FCT, Nigeria.Electronic Journal of Environmental, Agricultural and Food Chemistry.10(6):2296-2304.

Aremu,M.O.,Gav,B.L.,Opaluwa,O.D Atolaiye,B.O,Madu,P.C and Sangari,D.U(2011)Assessment of physic-chemical contaminants in waters and fishes from selected rivers in Nasssarawa state , Nigeria.Research Journal of Chemical Sciences.1(4):6-17

Barti, N and Kartyal,D(2011) Water quality indices used for surface water vulnerability assessment.International journal of Environmental Sciences.2(1):154,155

Chatterji, C and Raziuddin,M (2002) Determination of water quality index(W.Q.I) of a degraded river in Asanil industrial area, Ranigunj,Burdwan,wet Bengal.Nature,Environment and pollution Technology.1(2):181-189.

Dhakad,N.K.,Deepak,S and Choudhary,P (2008).Water quality index of Ground water(GWQI) of Jhabua Town, M.P(India).Journal of Environmental Research and Development2(3):443-446.

Dwivedi,S.L and Pathak,V (2007) A Preliminary assignment of water quality index to mandakini River,Chitrakoot.Indian Journal of Environmental protection.27(11):1036-1038.

Haruna,A.,Uzaini,A and Harrison, G. F. S (2008) Evaluation of water quality of shallow tube wells of some fadama lands in Zaria City, Nigeria. Book of Proceedings of the international conference of the chemical society of Nigeria held in Effurun, Delta State.

Iornumbe, E.N and Onah, J.O (2008) Determination of heavy metal accumulation by Erchornia Crassipes and Pollutants. Book of Proceeding of the international conference of the chemical society of Nigeria Held in Effurun, Delta State.

Ishaku,J.M., Kwada, I.A and Adekeye, J.I.D(2009) Hydrogeological characterization and water supply potential of basement aquifers in Taraba state,NE Nigeria. Nature and Science.7(3)

Ishaku,T.H., Hussain, A.M., Dama, M.F., Zemba,A.A and Peters,A.A (2010) Planning for sustainable water supply through partnership approach in Wukari town, Taraba State of Nigeria. Journal of water resource and protection.2:916-922.

Mahananda,M.R., Mohanty,B.P and Behera,N.R (2010) Physico-chemical analysis of surface and groundwater of Bargarh district ,Orissa, India IJRASS2(3):284-295.

Mandal, H.S., Das,A and Nanda,A.K (2012) Study of some physicochemical water quality parameters of Karola River,west Bengal-An attempt to estimate pollution status..International Journal of Environmental protection.2(8)16-22.

Odoh, R., Oko, O.J, Kolawole, S.A and Oche, E.O (2013) A comparative study of the heavy metal content of Drinking water in different storage vessels. International Journal of Modern Chemistry.5(3):166-180.

Ogundele, J.O (2010) Physico-chemical and metal analysis of water samples from Akure, Nigeria. Ecoservices international.

Okeola, F.O., Kolawole,O.D., and Ameen,O.M (2010) Comparative study of physic-chemical parameters of water from a River and it's surrounding wells for possible interactive effect.Advances in environmental Biology. 4(3):336-344.

Oko,O.J (2008) Transforming animal faeces for Agricultural and Environmental benefits in the college of Education Katsina-Ala community.Book of readings of the school of Sciences , College of Education, Katsina-Ala.PP 37-42.

Osunkiyesi, A.A (2012) Physicochemical analysis of Ogun River(water samples) within two locations (Akin-Olugbade and Lafenwa) in Aboekuta, Ogun State. IOSR Journal of Applied Chemistry.1(4):24-27.

Shittu,O.B., Olaitan,J.O and Amusa,T (2008) Physico-chemical analysis of water used for drinking and swimming purposes in Abeokuta, Nigeria.African Journal of Biomedical Research.11:285-290.

Shymala,R.,Shanthi,M and Lalitha,P. (2008) Physico-chemical analysis of Borewell water samples of Telungupalayam Area in Coimbatore district,Tamilnadu, India.E-journal of Chemistry.5(4):924-929.

Shultz, M.T (2001) A critique of EPA'S index of watershed indicators. Journal of environmental management.62(4):429-442.

Standardard Organisation of Nigeria (2007) Nigerian standard for drinking water, Abuja Nigeria

www.en.wikipedia.chem.oxygen demand

www.waterresearch.net/watrqualindex/index.htm

www.en.wikipedia.org/wiki/wukari

Yisa,J., Gana,P.J.,Jimoh,T.O and Yisa,D (2012) Underground water quality assessment in Doko community, Niger state, Nigeria Journal of Emerging Trends in Engineering and Applied Sciences.3(2):363-366