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Assessment of Water Quality in River Kurafe for Domestic Use in Nasarawa Township, Nasarawa State, Nigeria

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Abstract

Human activities along water courses have impacted negatively on water quality culminating in water quality problems. The increase in pollution load along many rivers in the developing countries has reduced the potentials of this important water sources for a variety of purposes. The study assessed the suitability of water in Kurafe River for domestic use in Nasarawa Township. The river cut across Nasarawa Township providing it the potentials for a variety of uses such as recreation, domestic and irrigation. Though the water is widely used for these purposes however, little work has been done to determine its suitability. Ten water samples were taken along the river during the dry season (a period of endemic water shortages in the study area). Using standard laboratory techniques the water samples were analysed. Properties analyzed included, pH and total dissolved salt using portable Hanna meter specific ion toxicity by atomic absorption spectro-photometric screening and coli concentrations by Mac Conkey Agar method. Findings from this study revealed that pH between 7.47 to 8.10 and total dissolved solids 110 to 202 mg/l were within the level considered safe for domestic water use .While calcium carbonate with a mean of 116.5mg/l and alkalinity 145.5mg/l were above WHO, (2012) threshold limit for domestic water use, means of trace metals 1.01mg/l, 0.05mg/l, 0.0004mg/l and 0.006mg/l for fluoride, iron, copper and chromium respectively fall within the safe limit considered for domestic water use except for lead which recorded 0.57mg/l. The detection of e-coli at substantial level in the water of the river indicates that the water poses health problems and so caution must be observed in the use of the water for domestic purposes. The study recommends that monitoring of the water quality especially at the point of human activities into the river should be taken serious, alternative water sources should be provided to the inhabitants of the town to reduce their dependence on the river and the risk they are likely to face in the use of water from the river and other uses such as irrigation and watering of yards and gardens that require less stringent quality can be done with water from the river.

Keywords: Kurafe, domestic water usage, quality, palatable and wholesome, water quality, etc.

Introduction

Water is a universal solvent and a major constituent of every living organism and essential for the sustainability of life on earth. It has no substitute as such mankind uses it for a variety of purposes including industrial, irrigation, recreation and domestic. The use of water may affect the inherent physical, chemical and biological characteristics culminating in water quality problem. Water quality comprises of numerous variables most of which affect the use of water for specific or general purposes. The choice of the variables to be evaluated depend on the source of water, nature of wastes, climatic condition, geology and most importantly the intended use of the water. As observed by

Samaila, (2007) different water uses have different water quality requirements, as such water considered not useable for a given purpose can be utilized for other uses. To support this Hansen and Stringham, (1979) observed that no water should be pronounced as fit or unfit for a particular use without carefully considering all the factors concerned. The quality of water whether from surface or underground sources depends on a number of interrelated factors. Water as its moves through the ecosystem has the ability to react with the minerals it comes in contact with, either in rocks or soils, and in the process absorb a wide range of minerals, thus affecting its natural state. It is as result of this that water contains a variety of organic and inorganic solutes and large amounts of insoluble minerals held in suspension.

Under natural condition as observed by Cunningham, *et.al* (2007) hardly does substances considered as pollutants in water overwhelm water quality. This is because under natural condition quantities of pollutants are so small that they can be ignored as the natural healing condition of surface water restores it to a useable state. Human activities however have raised the level of pollution of most surface receiving sources above the levels at which natural healing process can be achieved. This has therefore resulted in the pollution of most water recipient surfaces culminating in water quality problems. The water quality has depleted to such levels at which they cannot meet most requirements for a variety of uses. Therefore, before any water is used for any purpose, its suitability must be ascertained and compared with water quality and or standards. Water when is used for any purpose without taking into considerations its quality, may lead to the built up of ionic substances at levels to impair the developmental processes of living organisms. As pointed out by Wright, (2007) small amounts of substances seen as pollutants in water are not only harmless but stimulate good health and growth. The high concentration of these substances in water as observed by Samaila and Gimba, (2007) however are likely to result in adverse effects on humans and environmental systems.

Ibrahim, (2002) observed that water quality should satisfy the requirement and standards set for specific or general use. Where this condition is not met, it is accompanied by serious after effects on the environment and endangers the users of such water. The quality of water for domestic use should fall within the recommended allowable limit considered safe. The maintenance of the physical, chemical and biological properties of water at tolerable limits is necessary for domestic water supply which requires a most stringent water quality. The physical properties of water such as colour, taste, temperature, odour, turbidity and suspended materials affect the esthetic value and palatability of water. Water therefore must be significantly free from colour, turbidity, taste, suspended materials and heat (Helmer, 2003).

Anthropogenic processes may introduce to water surfaces biological contaminants comprised of disease causing organisms such as viruses and bacteria which will affect the healthy and productive life of most living organisms. Dissolved ionic substances in water at high intensity may impair human health and cause serious aquatic degradation. Fair, (1971) therefore observed that water most be wholesome and free form disease causing organisms, poisonous substances, excessive amounts of mineral salts and organic matter. In addition to this Helmer, (2003) was of the opinion that for water to be safe and potable it must agree with water quality characteristics such as;

a. It should be free from pathogenic organisms.
b. Low in toxic elements with serious long term effects.
c. Clear of turbidity and colour.
d. Free from salinity
e. Free from compounds that cause offensive odour and
f. Non-corrosive to avoid encrustation of pipes or stains.

River Kurafe also referred to the Uke River takes its source from the Karu hills north-west of Nasarawa state. The river en-route its flow into the Benue trough passes through Nasarawa town as the major drainage system. Since the town is characterised by seasonal deficit in water distribution, the river provides ample potentials for a variety of uses, especially in the dry season when water shortage is endemic. Human activities have however introduced contaminants into the river at intensities likely to affect the quality of water. The use of the water especially for domestic purposes which is a common practice in the area, endangers the health of the inhabitants and results in some of the health problems common in the area. Water borne diseases such as diarrhea, cholera and typhoid fever have been recorded over the years which have resulted in loss of life in some cases. If the water in the river is to be used without after effects, then the observance and maintenance of water quality becomes imperative. This study therefore assessed water quality in River Kurafe for domestic use in Nasarawa Township, Nasarawa State, Nigeria.

Materials and Method

Data for this study was obtained from both primary and secondary sources. Water samples were taken along the river in the month of March, 2016 a period when water scarcity was at its peak in the study area. Documented data on water quality standards were obtained for the study from existing literature. A total of ten water samples were taken along the river at 30 metres interval. The water samples were taken at different sections of the river i.e. upstream, midstream and downstream. This was done to observe if there was spatial variation in the distribution of water quality along the river and at points of sampling. The water samples were fed into a two litre plastic container and were geo referenced with a Germin Etrex hand held GPS and treated with four mills nitric acid for preservation.

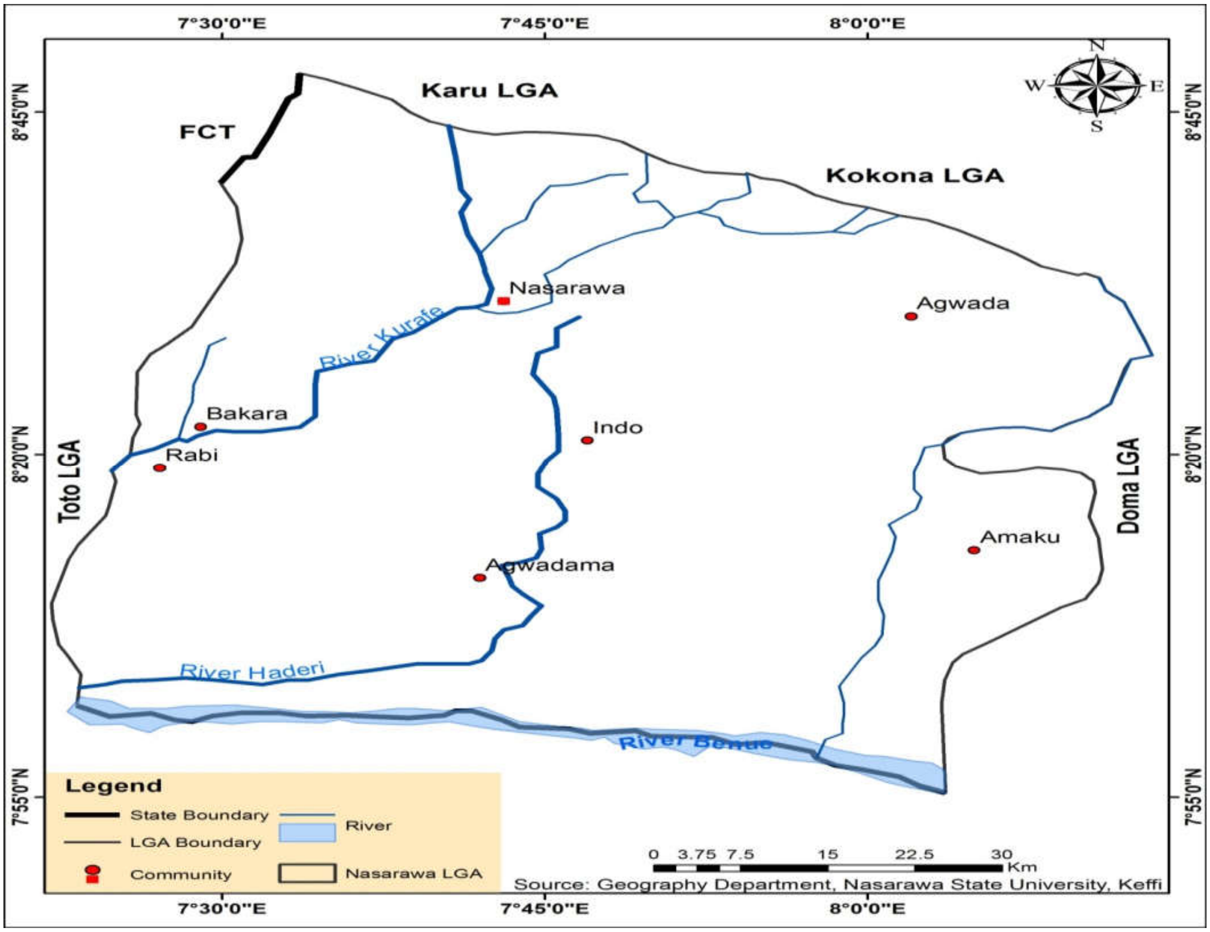

Fig. 1: Nasarawa Local Government Area Showing River Kurafe.

Standard laboratory techniques were employed in the analyses of the parameters covered by this study. Temperature, pH, electrical conductivity, total dissolved solids and turbidity were determined by Hanna portable meter model H198703, alkalinity by sodium hydroxide method, gravimetric method for suspended solids, total hardness by ammonium chloride, sodium, nitrate, iron, manganese and lead by spectrophotometric screening, chloride by argentometric method while total coli and e-coli were determined using Mac Conkey method. The results were summarized in tabular formsbiasin descriptive statistics. The results were compared with the WHO, (2012) and NSDWQ, (2007) permissible standards for domestic water use.

Results and Discussion

The results in tables 1, 2 and 3 showed the concentration of the physical, chemical and biological properties of water of the river. Electrical conductivity ranged between 218µS/cm to 404µS/cm with the lowest recorded upstream and the highest at midstream where most human activities in the river seemed to occur. Turbidity was between 3.6 Nephelometric Turbidity Unit NTU and 12.6 NTU and was high for most of the samples especially at mid and upstream points at which bathing and washing was observed to be common practices along the river. The temperature was between 32.3˚C to 34.1˚C with the highest recorded downstream while the least was observed for water midstream.

Total coli concentration recorded was between 0mg/l to 129mg/l both at midstream. The domestic effluents which drained into the river at this point and the possible defecation by children swimming in the river could account for the high concentration of total coli observed for the water at this point. In a similar study Akpan *et.al*, (2012) and Obi *et.al, (*2002) also observed high concentration of total coli form of water in Okpauku River in Cross River State. Chloride was between 0.28mg/l to172.3mg/l with the highest chloride concentration recorded midstream. The concentration was generally low for the river and was within the level considered safe for domestic water use (WHO, 2012). A study by Amos *et.al,* (2012) also observed less chloride in waters of River Ngadda. The pH recorded for water in the river was between 7.47 to 8.1 and a mean of 7.76. The result showed the water was slightly alkaline. The pH recorded for this study was not far from that observed for River Ngadda (Amos, et.al. 2012).

Total dissolved solids of 110 to 202mg/l and a mean of 165.80mg/l was recorded. Total dissolved solids were high mid stream where human activities along the river were common. Total suspended solids showed little variation in distribution along the river and were between 23 to 26mg/l.

Table 1: Concentration of Physical and Biological Properties of Water in River Kurafe

Sampling Points	Concentrations				
	Conductivity (µs/cm)	Turbidity (NTU)	Temperature (˚C)	TCC (Cfu/ml)	E. coli (Cfu/ml)
1 Upstream	218.00	7.50	33.20	34.67	29.67
2 Upstream	223.00	6.30	33.70	121.33	77.00
3 Midstream	404.00	3.60	33.60	2.67	50.33
4 Midstream	329.00	5.60	32.60	20.67	32.33
5 Midstream	385.00	11.80	33.00	59.67	3.67
6 Midstream	347.00	12.60	32.70	0.00	0.00
7 Midstream	343.00	10.20	32.30	1.67	43.33
8 Midstream	361.00	10.10	33.00	129.00	60.33
9 Downstream	293.00	11.80	34.10	37.00	1.00
10 Downstrean	395.00	9.60	32.80	47.50	19.34
NSDWQ/UNEP Standards	380	5	33	10	0.00
Range	218 – 404	3.60–12.60	32.3 – 34.1	2.67 – 129	0.00–77.00
Mean	329.80	8.91	33.10	45.42	31.70
Std. Deviation	66.26	3.02	0.56	46.62	26.34
Variance	4389.73	9.09	0.31	2173.23	693.83

The values are low as the water carries little suspended materials during the dry season and the lack of widespread disposal of domestic effluents. Calcium ranged between 9.63 to 14.92mg/l with a mean concentration of 11.68 mg/l. The concentration slightly varied at the different portions of the river covered by this study. Sodium concentration was between 0.30 to 3.70mg/l. Sodium was generally low for the water along all the sampling points. Fluoride was highest (10,08mg/l) upstream and lowest (0.86mg/l) midstream. The concentration however varied along the river. A study by Akpan, (2012) observed a fairly high fluoride concentration of water in the same river. Magnesium was between 3.0 to 5.09mg/l and was high in the water. High magnesium content observed could be attributed to weatherable minerals from rocks, fertilizer application and manure which find their way into the drainage system.

Nitrate was between 0.14 to 1.23mg/l with a mean of 0.61mg/l. The low nitrate observed for the water of the river could have been due to low domestic effluents drained into the river. Nitrate is toxic to infants less than 3 months resulting in the blue baby syndrome. Phosphate ranged between 0.25 to 0.62mg/l with a mean of 0.36. Phosphate was generally high for the water and can cause extreme proliferation of algal growth which may result in eutrophication of fresh water in the river. High phosphate observed for water of the river can be attributed in parts to decay of organic matter, excretion by organisms and weathering of phosphate rich rocks. Calcium carbonate was between 45.40mg/l to 182.60mg/l and with a mean of 116.5mg/l. Calcium carbonate in water indicates hardness, at high concentration water becomes hard and cannot produce foams easily from detergents during washing.

Alkalinity ranged from 82mg/l to 261mg/l and a mean of 145.47mg/l. The distribution of alkalinity along the river varied with the highest recorded downstream and the lowest upstream. The level concentration of alkalinity indicates the ability of the water to neutralize acids. Cadmium was between 0.01 to 0.014mg/l, copper had a concentration of 0.00 to 0,002mg/l, iron was between 0.02 to 0.2mg/l, zinc was 0.03 to 0.16mg/l, lead was between 0.36 to 0.67mg/l. chromium was 0.022mg/l to 0.042MG/l but was not detected for most of the samples along the river and manganese was not detected in the water. Results of the trace elements covered by this study were generally low for the water implying that toxicity associated to these metals will not result to affect the health of the people in the area.

Table 2: Concentrations of Chemical Properties of Water in River Kurafe

Sampling Point	pH	Cu (mg/)	Fe (mg/)	F (mg/l)	Zn (mg/)	Mn (mg/)	Pb (mg/l)	Cr (mg/)	TDS (mg/)	TSS (mg/)
1 Upstream	7.52	0.002	0.20	1.00	0.16	0.001	0.49	0.000	110.00	26.00
2 Upstream	7.47	0.000	0.09	0.87	0.06	0.000	0.46	0.000	110.00	24.50
3 Midstream	7.83	0.002	0.04	0.92	0.02	0.000	0.48	0.000	202.00	24.00
4 Midstream	7.88	0.000	0.02	0.86	0.03	0.000	0.49	0.000	162.00	23.50
5 Midstream	8.10	0.000	0.04	1.02	0.01	0.000	0.56	0.000	192.00	24.00
6 Midstream	7.65	0.000	0.03	1.12	0.05	0.000	0.62	0.02	172.00	25.00
7 Midstream	7.65	0.000	0.02	1.10	0.04	0.000	0.64	0.000	171.00	25.00
8 Midstream	7.61	0.000	0.03	1.08	0.07	0.000	0.67	0.000	181.00	26.00
9 Downstream	8.10	0.000	0.07	0.96	0.15	0.000	0.66	0.04	158.00	23.00
10 Downstream	7.76	0.000	0.03	1.15	0.03	0.000	0.63	0.000	200.00	23.00
WHO/NSDWQ Standards	7.5 - 8.5	2.00	0.300	2.00	0.050	0.100	0.010	0.050	500	100
Range	7.47 – 8.10	0 – 0.002	0.02 – 0.20	0.86 – 1.15	0.02 – 0.16	0 - 0.001	0.46 – 0.67	0 - 0.04	110 – 202	23.5 - 26
Mean	7.76	0.0004	0.05	1.01	0.06	0.0001	0.57	0.006	165.80	24.40
Std. Deviation	0.22	0.0008	0.05	0.104	0.05	0.0003	0.08	0.014	32.94	1.10
Variance	0.05	0.000	0.003	0.011	.003	0.000	0.007	0.000	1085.07	1.21

Table 3: Concentrations of Chemical Properties of Water in River Kurafe

Sampling Points	Concentrations									
	Cl (mg/l)	Na (mg/l)	Ca (mg/l)	$CaCO_3$ (mg/l)	NO_3 (mg/l)	Mg (mg/l)	Cd (mg/l)	Al (mg/l)	Alk (mg/l)	P (mg/l)
1 Upstream	0.28	1.30	10.26	116.60	0.65	3.73	0.14	0.83	120.00	0.440
2 Upstream	0.89	1.20	9.63	182.60	0.82	3.00	0.005	0.33	261.00	0.620
3 Midstream	0.37	0.30	12.12	52.60	0.67	4.40	0.002	0.34	84.20	0.272
4 Midstream	0.70	3.00	11.49	45.40	0.69	4.46	0.001	0.33	94.50	0.281
5 Midstream	0.84	3.70	12.68	115.77	1.23	5.04	0.001	1.00	213.00	0.521
6 Midstream	2.91	2.20	10.95	124.00	0.21	4.42	0.004	0.50	201.00	0.510
7 Midstream	172.30	2.70	11.95	90.00	0.14	4.39	0.002	0.33	117.00	0.270
8 Midstream	0.66	2.80	14.92	124.00	0.67	4.77	0.004	0.83	182.00	0.461
9 Downstream	0.33	2.20	12.16	144.00	0.28	5.10	0.007	0.67	100.00	0.252
10Downstream	2.41	2.80	10.67	170.00	0.70	4.50	0.003	1.50	82.00	0.262
WHO/NSDWQ Standards	250	200	75	500	10	50	0.003	0.200	250	0.100
Range	0.28 – 172.30	0.30 – 3.70	9.63 – 14.92	45.40 – 182	0.14 – 1.23	3.00 – 5.10	0.001 – 0.14	033 – 1.50	82 – 261	0.1 – 0.62
Mean	18.17	2.22	11.68	116.50	0.61	4.38	0.017	0.67	145.47	0.36
Std. Deviation	54.16	1.02	1.48	44.65	0.32	0.619	0.043	0.38	63.45	0.16
Variance	2933.69	1.03	2.20	1993.49	.105	0.38	0.002	0.15	4025.85	0.02

Suitability of water in Kurafe River for domestic use

The study evaluated the suitability of water for domestic use by comparing the results from this study with domestic water standard by World Health Organisation (WHO, 2012) and National Standard for Drinking Water Quality, (NSDWQ, 2007). Samaila (2006) observed that the assessment of water quality is meaningless unless it is related to a given use as such water quality should satisfy the requirements set for a specific use. Results from this study showed most variables covered by this study were low for the water of the river. Salinity as indicated by total dissolved solids was generally low and was within the levels considered safe for domestic use. Other variables such as calcium, calcium carbonate (hardness), nitrate, alkalinity, pH, manganese, chloride, chromium, iron and copper all fall within the allowable levels for domestic water use. The use of water from the river therefore will not be affected by the level of the concentrations of these variables to impact negatively on domestic activities and health of the people in the area.

The study observed the high concentrations of turbidity, total suspended solids, total coliform count, e-coli count, aluminium, phosphorus, magnesium, lead, temperature and cadmium at level exceeding the limit considered for domestic water use.

The high total coliform and e-coliform count recorded by this study implies that the water was contaminated by pathogens. The presence of these pathogens in the water may pose health risks to the users of the water. The use of the water especially for drinking is likely to be accompanied by diseases such as typhoid, diarrhea, cramps, headache and other related water borne diseases. The high temperature observed from the water may affect the recreational use and increase metabolism and reduce solubility of oxygen in the water thus affecting aquatic organisms.

High cadmium may cause anaemia, retards growth and cumulative poisoning. Similarly, excess concentration of lead in water can cause nausea, lethargy, loss of appetite, constipation, anaemia, abdominal pain, gradual paralysis in the muscles, and death. Phosphorus in concentration in surface water can lead to algal bloom and lower dissolved oxygen which is essential for aquatic life and may create water taste problem. The study has shown the presence of some of the substances is at high concentrations exceeding the permissible levels considered for domestic water use especially for drinking. Therefore the use of water from the river is likely to be accompanied by serious after effects on human health especially when precaution in the use of the water is not observed.

Conclusion

Water in River Kurafe is widely used in Nasarawa Township for a variety of purposes especially during the dry season when supply from other sources could not meet demand. Human activities have increased the substances in the river at levels which the water is not safe for use in the area.

This study has shown that though some substances are low in the water however, others are high and above the level considered safe for domestic use. The use of water especially for drinking is likely to be accompanied by health problems as the water is high in pathogens. The use of the water from the river therefore requires caution and proper management to reduce the possible after effects concomitant to the use of the water.

Recommendations

- Since the water in Kurafe River contain some substances above permissible levels considered for domestic water use, the study therefore proffer the following recommendations.
- There is the need for continuous monitoring of water quality of the river so as to guide and inform the inhabitants of the danger likely to be encountered in the use of the water in the area.
- The water should not be used directly in the river instead should be boiled before used for any purpose as doing this will destroy some of the substances observed in the water.
- The water can be used for other domestic purposes such as scrubbing, washing, watering of gardens and irrigation.
- The government should provide adequate water to community to reduce their dependence on the river for supply especially during the dry season.
- Alternative water sources should be should be utilised such as improved wells and boreholes. The community should begin to think on how to store rain water for use during the dry season.
- Researches on water quality for the river should be taken seriously by decisions makers as such researches will serve as important tools for managing water in the area.

References

Akpan-Idiok A.U., Ibrahim A. &Udo I.A., (2012). Water Quality Assessment of Okpauku River for Drinking and Irrigation Uses in Yala, Cross River State, Nigeria. Published:February 16, 2013. *Research Journal of Environmental Sciences, 6:pp 210- 221.*

Amos H, & Joshua E. N, (2012) Assessment of Drinking Water Quality of Alau Dam Maiduguri, Borno State. Department of Geography and Planning University of Jos, Plateau State, Nigeria International Journal of Scientific and Research Publications, 4(10): 234-248.

Cunningham, W. P, Cunningham, M.A and Saigo B.W (2007): Environmental Science: A Global Concern. Boston, USA; McGraw Hill pp 53-87.

Hansen, E. V and Stringham, G. E (1979): Irrigation Principles and Practices. London: John Wiley and Sons.

Helmer, R. (2003) "Water quality monitoring: national needs and international challenges", in Aina, E.D.A. &Adedipe, N.D. (eds.), First national seminar on water quality monitoring and status in Nigeria. Abuja: FEPA, pp. 11-25

Ibrahim, A.M (2002): Introduction to Environment Management. Kano: Wa'adallah Environmental Consult pp 76.

National Standard for Domestic Water Quality (NSDWQ, (2007). Nigerian Industrial Standard: Nigeria standard for drinking water quality approved by standard organization of Nigeria (SON) pp 15-18

Samaila, K.I (2006) Water Quality Depletion in the Industrial Axis of Kaduna South: The *Nigerian Journal of Tropical geography. Vol.1 No.1 March, 2006) pp 16-25.*

Samaila, K.I and Gimba, M.T.J (2007) The Influence of Wastewater on Soil Chemical Properties on Irrigated Fields in Kaduna South Township: *International Journal of Natural and Applied Sciences University of Calabar (IJNAS). Vol.2, No.2 (2007); pp 87-94.*

WHO, (2012). International standard for drinking water, Geneva: are the international reference point for standard setting and drinking-water safety.

Wright, R.T (2007) Environmental Science. India, Prentice Hall, pp 89.