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Assessment of Some Physicochemical Parameters in River Rido: A Tributary of River Romi, Kaduna Nigeria

[1]Ali Williams Butu, [1]Victor Andrew Odoh & [1]Aliyu Dadan-Garba
[1]Department of Geography,
Faculty of Arts and Social Sciences,
Nigerian Defence Academy, kaduna
Email: adgtonga@gmail.com
Corresponding Author: A. Dadan- Garba

ABSTRACT

The study examined the status of some physicochemical parameters in River Rido one of the tributaries of River Romi, Kaduna. Water samples were collected from January to October 2016 at four sampling points. A total of 40 samples were collected in dry and wet seasons. The physicochemical parameters were analyzed using standard methods. The results show that the Conductivity, Turbidity, Total Hardness, TSS, TDS, COD, and Oil and grease are above the permissible limit of NESREA and WHO guidelines indicating some level of pollution in the stream. Chemical Oxygen Demand (COD) with mean value ranging from 105.2mg/l -161.4mg/l and 72.4 mg/l -197.6 mg/l for dry and wet seasons respectively, these values are above the acceptable limit of WHO and NESREA guidelines for surface water of 15 mg/l and 40 mg/l respectively. Result of the t-test shows that there is no significant difference in the levels of concentration of the parameters between the dry and wet seasons. The result also shows that there is an adverse impact on the physiochemical characteristics of the receiving river as a result of the effluents discharge from Kaduna Petrochemical Refinery, sewage waste water, surface run-off and from agricultural chemicals. This may pose a health risk to the communities which rely on the receiving water bodies as their sources of domestic water and for agricultural uses. The study therefore, recommends that industrial waste water should be properly treated.

Keywords: *Effluents, health risk, tributaries, pollution, physicochemical*

INTRODUCTION

Water is an essential ingredient for our wellbeing and a healthy life. Unfortunately polluted water and air are common throughout the world (European Public Health Alliance, 2009). The WHO (2004) states that one sixth of the world's populations; approximately 1.1 billion people do not have access to safe water and 2.4 billion lack basic sanitation. Polluted water consists of industrial discharged effluents, sewage water and pollution by industries, agriculture or households causes damage to human health and the environment. This water pollution affects the health and quality of soils and vegetation (Ashraf *et al.*, 2010). The effects of water pollution are said to be the leading causes of death for humans across the globe, water pollution affects our oceans, lakes, rivers, and drinking water, making it a widespread and global concern (Gauderman *et al.*, 2005). As a result of ineffectiveness of purification systems, waste water may become seriously dangerous, leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the ecosystem (Beg *et al*., 2003; Aghalino and Eyinla, 2009). The Rido area is host to the Kaduna Refinery, Rido Village, Nigerian National Petroleum Company (NNPC) Housing Estate which generates large quantities of effluents; other activities also generate sewage water, weathering, automobile tire dust, runoff, refuse dumps, and chemicals from farmlands among others. These effluents, heavy metals and other contaminates are discharged into natural water bodies. Though the compositions of the effluents and contaminates are regulated by various laws, it is not known whether they comply 100 % with the legally accepted toxicant levels for the environment and industries in Nigeria. The discharge of industrial effluent into water bodies is one of the major causes of environmental pollution and degradation in many cities, especially in developing countries. Many of these industries lack liquid and solid waste regulations and proper disposal facilities, such waste may be infectious, toxic or radioactive (WHO, 2004). In most countries the principal risks to human health associated with the consumption of polluted water are microbiological in nature as well as chemical contamination. The significance of water to human and other biological systems cannot be over emphasized and there are numerous scientific and economic facts that water shortage or its pollution can cause severe decrease in productivity and deaths of living species (Garba *et al*., 2010).

Physicochemical parameters and heavy metals occur as natural constituents of the earth crust. They could be persistent environmental contaminants because they cannot be degraded or destroyed, although they are lacking in abundance they are not lacking in significance (Chen and Chen, 2001). Common heavy metals in the environment include lead (Pb), nickel (Ni), cadmium (Cd), chromium (Cr), mercury (Hg), iron (Fe), zinc (Zn), copper (Cu), aluminium (Al), cobalt (Co), manganese (Mn) and arsenic (As) (Sharma, 2010). Heavy metals are considered as toxic pollutants because they are non-biodegradable and due to their extensive accumulation in the aquatic ecosystems (Sharma, 2010). They are continuously released into the aquatic ecosystem by natural processes (weathering/ runoff) and anthropogenic activities: such as burning of fossil fuels, garbage, street dust, industrial processes and domestic sewage discharge and these get distributed into the water body during the course of their transport (Veena *et al*., 1997). Valavanidis and Vlachogianni (2010) observed that anthropogenic activities, rapid urbanization activities, combustion of fuels, urban sewage and agricultural practices appear to be the most important input of metals and physicochemical parameters into water bodies. Chemicals are also leached from refuse dumps during the rainy seasons. Defew *et al* (2008) posits that heavy metals and other organic pollutants have the potential of causing lethal toxicity effect on aquatic organisms if present at levels above the threshold level. Water pollution occurs when unwanted substances with potential to threaten human and other natural systems enter it (Kreamer *et al*., 2001). Sharma (2010) defines water pollution as the addition of excess undesirable substances to water that makes it harmful to man, animals and aquatic life, or otherwise causes significant departures from the normal activities in or around water. Pollution decreases the suitability of water resources, thus, disturbs the normal use of water for irrigation, agriculture, industries, public water supply and aquatic life. Pollution not only makes freshwater undrinkable, but also unsuitable for industrial and agricultural purposes (Adekola and Eletta, 2006).

The quality of water is important for drinking, irrigation, fish production, recreation and other purposes. The deterioration of water quality in rivers usually results from acidification, heavy metal contamination, organic pollution, industrial effluents, obnoxious fishing practices and excessive nutrient input that leads to eutrophication. The effects of these imports into the river not only affect the socio-economic functions of the river negatively, but also lead to the loss of structural biodiversity of the river. The physicochemical properties of water quality assessment give a proper indication of the status, productivity and sustainability of a water body (Hutton, 1996). The changes in the physicochemical characteristics like temperature, transparency and chemical elements of water such as dissolved oxygen, nitrate and phosphate provide valuable information on the quality of the water.

Water has a wide range of physical and chemical characteristics that affects its quality and treatability (Hutton, 1996). Physical and Chemical testing of surface water is necessary to assure that treated water is safe for agricultural and domestic purposes. Having good quality water is a problem in most developing countries (Ongley, 1994). The main water pollution causes in the Nigerian context are, industrial activities, sewage, domestic, rural wastewater and agricultural activities. Several contaminants have been known to be harmful to human, animal health (Abate, 1994: Lekwot *et al*., 2012). Since various economic activities and industries are taking place in cities or urban areas the prevalence of water pollutant and water quality deterioration is high. As correlated to the urban population growth the extent of urban river pollution is becoming very serious. No matter how little the contaminants may be in the discharged waste water, the interactions of such residual chemical or biological contaminants with the existing physical environment at risk may subject the environmental composition therein to partial or outright pollution and loss of environmental esthetics (Kanu and Achi, 2011). River Rido has served as the recipient water body where the Kaduna Refinery effluents and run off are discharged for several years.

River Rido is of great importance to the neighbouring communities, it is used for human activities such as; fishing, irrigation, car washing, domestic uses, and watering of livestock. It is a site where industrial effluents and storm drain from the Kaduna Refining and Petrochemical Company and the surrounding environment are deposited. Al-Amin (2013) described the River Romi as a medium of "treated" waste water discharged by the Kaduna Refinery and Petrochemical Company (KRPC). The discharge of industrial effluents into water bodies is one of the main causes of water pollution, which poses risks to both human health and the entire quality of the water body. There have been some studies on river Romi, Idise *et al* (2009); Al-Amin (2013) and Sadiq (2016) all worked on the physicochemical characteristics and heavy metal concentration in River Romi with emphasis on one season. Idise *et al* (2009) is of the opinion that the input of the Kaduna Refinery and Petrochemical Company's effluents into River Romi through River Rido has a negative impact on the water quality. The waste water constitutes a potential health risk to the residents who use the river for irrigation, domestic and consume the fish therein. Eating of contaminated fish can cause a series of health problems like intestinal diseases to the residents. Lekwot *et al* (2012) look at the level of total suspended solids (TSS), total dissolved solids (TDS), pH, dissolved oxygen (DO), chemical oxygen demand (COD), oil and grease, temperature, electrical conductivity, turbidity, hardness, benzene, cyanide, mercury and cadmium in the water sample from River Romi which were shown to be quite high and they confirmed that with the exception of pH and oil and grease, all other physicochemical parameters measured were between 100% and 120% higher and have exceeded the maximum permissible limit given by the National Standard Water Quality (Nigeria) and World Health Organization (WHO).Thus, the need to assess the levels of these chemical parameters in the most important tributaries of River Romi cannot be overstressed.

The Study Area

River Rido is located in the southern part of the Kaduna metropolis in Chikun Local Government Area (LGA). The Local Government Area is located between latitude 10^0 7' N and 10^0 36' N and longitude 7^0 41' E and 8^0 40' E. The study area is marked by distinct wet (rainy) and dry seasons. The two seasons are determined by two prevailing air masses blowing over the area at different periods during the year. The Tropical Continental Air Mass brings dry season while the Topical Maritime Air Mass brings wet season. The rainy season lasts from May to October, whereas the dry season is from November to April. The average annual rainfall ranges between 1000mm and 1350mm respectively. The study area experiences high temperature all year round, which is a characteristic of the tropics. The mean daily temperature range is between

27-33ºC and having a relative humidity of 70% and 40% for wet and dry seasons respectively (Al-Amin, 2013).

The study area is found on the extensive crystalline basement complex of the Northern Nigeria, the basement complex rocks are intrusive igneous rocks which have been in existence since the Precambrian time (Olugboye,1975). The study area consist predominantly metamorphic rocks of the Nigerian Basement Complex consisting of biotite gneisses, schist and older granites. In the south eastern corner, younger granites and batholiths are evident. The study area is capped by laterites. The laterites are sometimes highly consolidated especially at the surface and weathered into lateritic nodules with silt and sandy clays (Ogbeni, 2007). River Rido adopts a course down to where it flows into River Romi in a South-westerly direction. The river has a seasonal flow pattern and is used for irrigation, fishing, laundry, swimming and livestock watering. It is navigable in the dry season and sometimes carries as much wastes as freshwater (Olugboye, 1975).

MATERIALS AND METHOD

The main types of data for this study were information related to the uses of River Rido and physicochemical parameters. The sources of data for the research were water samples that were collected on site and taken to the laboratory for analysis. Water samples were collected monthly from January to October 2016 at four sampling points as shown on Figure 1. GPRS was used to identify the sampling points. Point 'A' which serves as the control point was approximately 150 meters up stream of Rido village and is at coordinates N $10^{0}23.783'$, E $007^{0}29.376'$ and elevation of 1941ft, Point 'B' was at the Refinery wastewater discharge at Rido is located at coordinates N $10^{0}24.669'$, E $007^{0}28.813'$ and elevation of 2071ft and Point 'C' was 400 meters away from Refinery wastewater discharge point and is located at the following coordinates N $10^{0}24.756'$, E $007^{0}28.712'$ and elevation of 1984ft while Point 'D' was 800 meters from point B as shown on Figure 2 and is located at the following coordinates of N $10^{0}24.850'$, E $007^{0}28.635'$ and elevation of 1967ft. A total of 40 samples were collected. These sampling points were carefully chosen because of the dominant petrochemical industry and other human activities along the course of the River and ensured that the points are within a close radius from each point to capture major physicochemical parameters in the water. The samples were collected from the four different points because of possible mixing of these physicochemical parameter contaminants in the river. Samples were collected in 1 liter plastic bottles for physiochemical parameters, pre-cleaned by washing with non-ionic detergents, rinsed in clean water. The samples were then transported in cooler boxes and taken to the laboratory within twenty-four hours for analysis. Samples were collected through two seasons, the Dry season (January – May, 2016) and the Wet season (June –October, 2016).

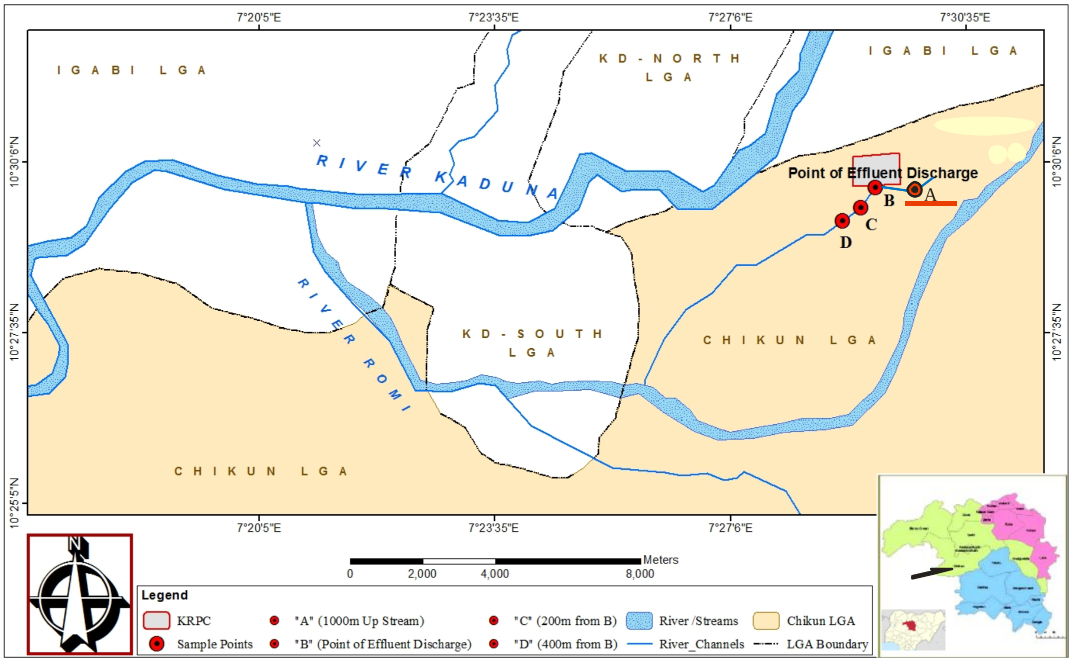

Figure 2: Location of Sampling Points (Point A-D)
Source: Adopted and Modified from Administrative Map of Kaduna State (2013).

Laboratory Analysis and Technique: The following parameters were analysed; Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Conductivity, Temperature, Turbidity, Nitrate, Oil and Grease, Total Suspended Solid (TSS), Total Dissolved Solid (TDS), Total Hardness and pH. Information on the effects of physicochemical parameters on humans was also obtained from desk review methods. Table1 shows the instrument and methods used to analyse the water samples. These techniques were used because they are affordable and reliable. The water analysis was conducted at the Kaduna State Environmental Protection Authority. The results obtained from the laboratory analysis were subjected to simple descriptive statistics such as mean, standard deviation (SD) and coefficient of variation. The t-test was used to test the temporal variation of the physicochemical parameters in the stream.

Table1: Instruments, Model and Methods Adopted

Parameters	Instrument/ Materials	Method	Model	WHO (2006)	NESREA
Ph	Suntex pH Meter	Potentiometer	TS-2	6.5–8.5	6.5–8.5
Tempt ^{0}C	Suntex pH Meter	Insertion	TS-2		Ambient
Conductivity (μS/cm)	Conductivity Meter	Potentiometer	Suntex Sc-120	0.05–0.5	1000
Turbidity (NTU)	Turbidity Meter	Nephelometric	Jenway 6035	5	5
Dissolved Oxygen	DO Meter	Electrochemical	Lutron DO meter 5511	>4	4
TSS (mg/l)	Drying	Gravimetric	WHA TMAN NO. 42	30	10
TDS (mg/l)	HACH TDS Meter model 44600	Gravimetric	HACH-44600	500	500
Nitrate (mg/l)	Spectrophotometer	Spectrophotometry	HACH DR 2010 Series	50	50
Total Hardness (mg/l)	Burette, Beaker, EDTA, Erichrome black	EDTA Titrimetric		150	200
COD (mg/l)	COD Reactor	Dichromate COD	HACH DR 2010 Series	40	15
Oil & Grease (mg/l)	Separatory Funnel, Dissicator, Filter-paper, Analytical balance and n-Haxane.	Extraction Gravimetry	n-Hexane	0.003	0.003

RESULTS DISCUSSION

A total of eleven physicochemical parameters are identified in each of the sampling points in River Rido, the concentration of each of the parameters differs from one sampling points to another as shown on Table 2.The concentration of these physicochemical parameters could be attributed to industrial effluents, surface run-off, weathering, sewage, automobile tire dust, runoff, refuse dumps, and chemicals from the farmlands among others. The mean values of each of the selected physicochemical parameters contaminants in the River was compared with the World Health Organization (WHO) guidelines and National Environmental Standards and Regulations Enforcement Agency (NESREA) for drinking water in order to ascertain the pollution status of the chemical contaminants because of the harmful nature of these physicochemical parameters they might have health implications on humans. The results on Table 2 also shows that the water from this tributary of River Romi is becoming contaminated by effluents discharge from industrial effluent, sewage, and surface run-off and from agricultural chemicals. The result shows that most parameters considered are not within the permissible limit for NESREA and WHO guidelines for drinking water. With the confirmation that the water has pollutants throughout its course mean that there will be health challenges for the residents using this water for domestic and agricultural purpose.

The suspended solids and total solids present in Rido River are high as compared with the acceptable guideline by NESREA (10 mg/l and WHO 30 mg/l). The total suspended solid in the dry season ranges from 30.86 mg/l to 56.01 mg/l the values on Table 2 shows that all the values recorded in the dry season are not within the permissible limit of NESREA and WHO for drinking water and the range for the wet season is from 21.6 mg/l to 39.24 mg/l this also shows that the values for the wet season are also not within the NESREA guideline but only points A and point B with the following values of 21.6 mg/l and 22.2 mg/l respectively are within the acceptable limit of WHO. High content of suspended solids in streams has been shown to exert different effects. For example, solids of organic matter need to undergo slow biodegradation and required energy from the sun. In the process, it causes a reduction in the amount of dissolved oxygen in the water. Consequently, it will influence the purification capacity of the water body by limiting the functions of the aerobic bacteria (Chauhan, 2011). Accumulation of suspended or total solids in the stream or river bed have been found to reduce the effects of solar energy absorption, resulting in a lower rate of photosynthesis and slow down natural water purification processes. Thus, the whole river ecosystem may breakdown to develop into water pollution Chauhan, 2011).

The Temperature of effluent in the River shown on Table 2 ranges from 26.74^{0}C to 28.74 ^{0}C. The values show that the temperature of the water samples at all the collection points for both the dry and wet seasons are within the tolerable level when compared with NESREA guideline and WHO acceptable limits, although there is a significant increase in temperature in the dry and raining seasons with the highest mean value of 28.74^{0}C and 27.51^{0}C at point B respectively. The high temperature in the dry season may be due to increase in atmospheric temperature during the summer and the low in temperature may be due to winter. In an established system the water temperature controls the rate of all chemical reactions, and affects aquatic life growth, reproduction and immunity. Drastic temperature changes can be fatal to aquatic life of the waterway. Table 2 shows the least acceptable value of 5.78 for pH; The following values of 5.78, 6.10 and 6.42 for pH recorded in the dry season are not within the permissible limit of NESREA Standard of 6.5-9 as shown on Table 2.This means higher corrosive nature of the water and high acidity especially at point 'B', A lower pH could affect mucous membrane. Lekwot *et al* (2012) observed a lower concentration of pH (3.5) in their study. The possible reasons for this difference in result may be due to variation in the sampling period. The result shows that the pH was more acidic in the dry season and normal to alkaline in the wet season. The higher alkaline state of pH in the wet season might be due to the enhanced chemical interaction that leads to buffering and release of alkaline ions (bicarbonate and carbonate ions) or salts in the river water. pH is most important in determining the corrosive nature of water. The lower the pH value the higher is the corrosive nature of water. pH has a positive correlation with electrical conductance and total alkalinity (Gupta *et al*., 2009).

For Electrical Conductivity (EC) the results show a higher value at the point of discharge for both seasons as shown on Table 2. The values of EC are all above the acceptable limit of 0.05 -0.5μS/cm for the WHO guideline as shown on Table 2 all the values for Electrical Conductivity are within the NESREA guideline of 1000 μS/cm. Electrical conductivity is a useful tool to evaluate the purity of water therefore the sample at point B has the highest impurity in all the sampling points collected in both the dry and wet seasons with a mean value of 4.17 μS/cm and 3.99 μS/cm respectively. Lekwot *et al* (2012) recorded higher values, the difference in the level of concentration of Electrical Conductivity between this work and Lekwot *et al* (2012) must have stemmed from probably different laboratory techniques and the extent of area coverage by the two studies. Dissolved Oxygen (DO) is one of the most important parameters. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification. (Vikal, 2009). Table 2 shows that dissolved oxygen content in the water samples indicates that while it is normal and within the acceptable limit for both the NESREA and WHO guideline

(>4) at all the points except the value of 3.66 mg/l recorded at point 'B' in the dry season. Dissolve Oxygen is low at this points due to the effluent discharged from Kaduna Refinery. Dissolved Oxygen corrodes water line and at low level marine animals cannot survive.

Table 2 shows that the value at point 'A' is the lowest followed by values at point 'D'. It also shows that Chemical Oxygen Demand for all the samples collected at the various points are above the acceptable limit of NESREA and (WHO 2006) guideline of 15 mg/l and 40 mg/l respectively, but in all these points the one at the point of discharge of Kaduna Refinery effluent (Point B) has the highest concentration for COD with a value of 161.4 mg/l and 197.6 mg/l for dry and wet season respectively. Lekwot *et al* (2012) recorded a mean value of 80 mg/l which is lower than the value that was recorded in our work. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water therefore the study reveals that the level of dissolved Oxygen in the River is low; COD is a key indicator of the environmental health indices of a surface water supply.

The result on Table 2 shows that the concentration of oil and grease in the River is quite high when compared with the NESREA and WHO guideline of 0.003 mg/l. The values range from 0.32 mg/l to 14.16 mg/l for the dry season and 0.001 mg/l to 6.01 mg/l for the wet season as. Table 2 also shows that the Total Hardness (TH) values in the following sampled locations of point 'B' is199 mg/l and 153.8 in dry and wet seasons and values in points 'C' 186 mg/l and 'D' 152.2 mg/l respectively are above the acceptable limit of the NESREA and WHO of 150 mg/l. Table 2 shows that the sample collected at point 'A' has the lowest Total Hardness value of 128 mg/l and 93.2 mg/l for dry and wet seasons respectively and are within the WHO and NESREA permissible limit of 150 mg/l. Therefore it can be deduced that the Kaduna Refinery effluent has an impact on Total Hardness in the water and this may have possible health implication when water is consumed, Total Hardness could also form poor lathering with soap and the deterioration of the quality of clothes. Table 2 shows that all the values for nitrate are within the permissible limit of 50 mg/l of the NESREA and WHO guideline, this agrees with Al-Amin (2013) on the concentration of nitrate in River Romi which was below the WHO limit, the highest values are the ones recorded at point 'B' with a value of 27.8 mg/l and 28.6 mg/l in the dry and wet seasons respectively though within the acceptable limits, this may be due to the pollution from the effluent released into the River at that point. Thus, the River is not polluted with nitrate but at a higher level it could have effect on infants below the age of six months and symptoms include shortness of breath and blue-baby syndrome. Table 2 shows that the Turbidity levels at all the sampled points are above the acceptable limit of WHO and NESREA of 5

NTU but with the highest non permissible limit of 8.8 NTU in the wet season. The readings in the wet season show higher values for Turbidity. Higher levels of Turbidity are associated with disease causing bacteria.

Table 2: Concentrations of the Selected Physicochemical Parameters in the Dry/Wet season of the River
Source: Fieldwork 2016, WHO 2006 and NESREA

The result of the total dissolved solid (TDS) as shown on Table 2 shows that all the mean values are above the permissible limit of 500 mg/l for NESREA and WHO guideline for drinking water. The result also shows lower values at point 'A' with a value of 1920 mg/l and 1606 mg/l for dry and wet seasons respectively. High TDS could lead to undesirable taste, corrosion or incrustation and gastro-intestinal irritation. The results also show that the water in River Rido is contaminated and the entire course of the sampled site is not suitable for domestic consumption without treatment or for agricultural uses. There is a possibility of contamination in vegetables and other crops eaten in their raw state. The mean total values of most of the parameters are quite high; this is unacceptable when compared with the World Health Organization (WHO) and National Environmental Standards and Regulations Enforcement Agency (NESREA) permissible limits. The result shows that the water is getting polluted and this implies that the water may pose a serious health risk to man, animals and plants in the near future.

	Dry season				Raining season					
Parameters	Point A	Point B	Point C	Point D	Point A	Point B	Point C	Point D	WHO (2006)	NESREA
P^H	6.89	5.78	6.1	6.42	7.49	6.71	7.31	7.212	6.5-8.5	6.5-8.5
Tempt ^{0}C	26.74	28.74	28.04	27.7	24.56	27.5	26.66	26.92	Ambient	
Conductivity	2.54	4.17	3.72	3.333	1.91	3.99	2.87	2.14	0.05-0.5	1000
(µS/cm)	5.72	6.66	5.63	6.28	8.8	6	6.6	7.2	5	5
Turbidity (NTU)	6.71	3.66	4.01	4.62	7.23	4.14	4.84	5.18	>4	4
Dissolved Oxygen	30.86	56.01	46.83	44.12	21.6	39.2	39.24	38.84	30	10
iTSS (mg/L)	1920	2317.4	2066	2002	1606	2570	2022	2027	500	500
TDS (mg/L)	14	27.8	23.4	22	12.94	28.6	15.4	15.4	50	50
Nitrate (mg/L)	128	199	186	152.2	93.2	153.8	146.2	1222.8	150	200
Total Hardness	105.2	161.4	160.2	140.8	72	197.6	146.4	105.2	40	15
(mg/L)	0.32	14.16	6.46	4.64	0.001	6.012	2.444	2.14	0.003	0.003
COD (mg/L)										
Oil & Grease (mg/L)										

The poor physicochemical quality of the water in River Rido is traced to the effluents discharged from Kaduna refinery, sewage water, weathering, automobile, tire dust, runoff, refuse dumps, and chemicals from the farmlands among others. The parameters in most of the points are above the permissible limit of NESREA and WHO guideline, they include Conductivity, Turbidity, Total Suspended Solid, Total dissolved Solid, Total Hardness, Chemical Oxygen Demand and Oil and grease however, these parameters are within the acceptable limit of the NESREA and WHO; pH, Temperature, Dissolved Oxygen and Nitrate. The student's T-test was used to test the significance of variation of the selected physicochemical parameters at 95% level of confidence in dry and wet raining seasons. The results on Table 3 show that there is no significant difference in concentration of these physicochemical parameters in River Rido between the two seasons. This therefore buttress that these parameters are from a constant and common source.

Table 3: Comparison in Concentrations of the Selected Physicochemical Parameters between the Dry Season and the Wet Season of the River Romi (points A-D).

	Dry Season Concentrations			Wet Season Concentrations				
Parameters	Mean	Standard Deviation	CV	Mean	Standard Deviation	CV	t-Calculation	Level of Significance at 95%
Ph	6.3	0.47	0.08	7.181	0.33	0.05	(3.04)	No Significance
Tempt ^{0}C	27.81	0.83	0.03	26.41	1.28	0.05	1.83	No Significance
Conductivity (μS/cm)	3.44	0.69	0.2	2.72	0.94	0.34	1.24	No Significance
Turbidity (NTU)	6.07	0.49	0.08	7.15	1.20	0.17	(1.66)	No Significance
Dissolved Oxygen	4.75	1.37	0.29	5.35	1.33	0.25	(0.63)	No Significance
TSS (mg/L)	44.46	10.39	0.23	34.72	8.75	0.25	1.43	No Significance
TDS (mg/L)	2076.35	171.45	0.08	2056.25	395.26	0.19	0.09	No Significance
Nitrate (mg/L)	21.8	5.76	0.26	18.09	7.11	0.39	0.81	No Significance
Total Hardness (mg/L)	166.3	32.26	0.19	129	27.27	0.21	1.77	No Significance
COD (mg/L)	141.9	26.22	0.18	130.3	54.21	0.42	0.39	No Significance
Oil & Grease (mg/L)	6.4	5.78	0.9	2.65	2.49	0.94	1.19	No Significance

Source: Fieldwork (2016)

CONCLUSION AND RECOMMENDATION

The study assessed the physicochemical parameter of surface water in River Rido a tributary of River Romi. The results show that there is considerable impairment in surface water quality with more deleterious effects on man far more than ever perceived by the local communities. The student's t-test was employed to test the temporal variability of the physicochemical parameters between the dry and wet seasons of the River. Simple descriptive statistics such as mean, standard deviation and coefficient of variation were used to show the results. The result shows high concentration of the physicochemical parameter contaminants in the water samples. Conductivity, Turbidity, TSS, TDS, COD, oil and grease recorded mean values above the NESREA and WHO guidelines recommended for drinking water. The high concentrations of the selected physicochemical parameters can pose severe consequences on the health of the human population that make use of water from the Rivers Rido and aquatic food from the River. Results of the t-test show that there is no significant difference in the concentration of these parameters between the dry and wet seasons. The study therefore concludes that the effluents from the Refinery and other contaminants from anthropogenic activities in the catchment area are responsible for the pollution of the River and therefore continuous usage of this water by surrounding communities for domestic and agricultural purposes will require some form of physicochemical treatment. The study therefore makes the following recommendations:

i. Indiscriminate disposal of untreated effluent into the River without prêt reatment should be discouraged.

ii. The treatment plant should be efficient enough to remove pollutant to appreciable level.

iii. Kaduna Environmental Protection Authority (KEPA) should ensure that the Refinery complies with the NESREA and WHO guidelines. The industrial wastewater must be closely monitored and properly treated. Limitation guidelines for industries have been prescribed by various regulatory national and international agencies to control water quality and effluents of industries.

iv. Environmental and health impact assessment should be conducted regularly.

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