Ethiopian Journal of Environmental Studies & Management 9(4): 389 – 404, 2016.
ISSN:1998-0507 doi: http://dx.doi.org/10.4314/ejesm.v9i4.1
Submitted: October 13, 2015 Accepted: May 24, 2016

EFFECT OF EFFLUENTS DISCHARGE ON PUBLIC HEALTH IN ILORIN METROPOLIS, NIGERIA

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Abstract
The effects of effluent discharge on water bodies was assessed over the duration of 12 months (November 2013 to October, 2014) covering both the dry and wet seasons. Parameters collected at different points and measured include pH, Temperature, Salinity, Dissolved Oxygen, Nitrate, Zinc, Iron, Lead, Manganese, Potassium, as well as microbial qualities of the rivers. The pollution level of samples taken from all the main rivers in the study area was analyzed and compared with national and international standard for maximum permissible limit. It was observed that the values of pH, iron, Zinc, DO, Nitrate exceeded the permissible limit of the national standard and the World Health Organization. The coliform concentrations were unevenly distributed. It was highest at the downstream. The study revealed that there was an adverse effect on the physico-chemical characteristics of the receiving water bodies as a result of the discharge of effluents from industries, residential areas, abattoir and farms. This poses a health risk to several communities which rely on the receiving water bodies primarily as their sources of domestic water. Therefore there is urgent need for the intervention of regulatory agencies to ensure adequate monitoring of effluent discharge from industries and abattoirs as well as introduction of Environmental Sensitivity Index (ESI) which is a mapping tool for monitoring and management of effluent.

Key Words: *Effluents, Effects, Water bodies, Ilorin Metropolis*

Introduction

The significance of water to the health and well-being of human population is universally acknowledged. Water is essential to all forms of life and makes up about 70% the weight of human body. Water is also a vital resource for agriculture, manufacturing , transportation and many other human activities. Despite the importance, water is the most poorly managed resources in the world (Chutter, 1998). Water has a profound influence on health at the basic level. This means that a minimum amount is required for consumption each day for survival especially as it is the principal medium for preventing disease. World Health Organization (1996) recognizes that access to adequate water supplies is a fundamental human right.

All peoples, whatever their stage of development and social and economic

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conditions have the right to have access to drinking water in quantities and of a quality equal to their basic needs (WHO, 2014). Every human use water, whether for drinking irrigation and industrial processes or for recreation which has some quality requirements in order to make it acceptable. This quality criterion can be described in terms of physical, chemical and biological properties of such water (Gore, 1985).

The availability and quality of water always have played an important role in determining the quality of life. Hence, there has been increasing global concern in recent times, over the public health effects attributed to water pollution in particular, the global burden of diseases. Water pollution has become a growing threat to human society and natural ecosystem in the recent decades.

The World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today, occur due to prolonged exposure to water pollution. Water quality is closely linked to water use and to the state of economic development (Chennakrihnan *et al*., 2008). Ground and surface water can be contaminated by several sources. In urban areas; the careless disposal of industrial effluents and other wastes may contribute greatly to the poor quality of water (Mathuthnetal, 1997). Most of the water bodies in areas of the developing world are the end points of effluents discharged from industries and residential areas.

In Nigeria, like many other developing countries the primary risks to human health associated with the lack of potable water are enormous. In the cities and urban areas rivers and streams are facing a variety of pressure affecting both ecosystem and human health through industrial and sewage waste water discharge as well as disposal practices that may lead to introduction of high nutrients loads, hazardous chemical pathogen causing diseases. The relative importance of water quality to the maintenance of public health may vary with respect to a number of geographical, social, seasonal, chemical contamination and microbiological factors. It is becoming increasingly clear however is that all factors relating to the quality and availability of water are potentially important and must be taken into consideration. Many developing countries including Nigeria are now experiencing problems with chemical and faecal contamination of water caused through poor treatment and disposal of excreta, intensification of animal husbandry and large scale applications of inorganic and organic fertilizers (WHO, 2004).

However, some of these diseases and premature deaths can be prevented and avoided through proper and adequate care of the environment as these effluents treated or untreated have the potential to contain organisms that may compromise public health. Infection of these organisms may produce symptoms such as diarrhea, abdominal cramps, fatigue, nausea, vomiting and fever.

General Objective and Specific Objectives

This research work was aimed at assessing the effects of effluents discharge on public health in Ilorin metropolis. The general objective will be achieved through the following specific objectives:

(i) To identify the main streams/rivers receiving effluents from the industries or, farmlands and residential areas.

(ii) To determine the physicochemical characteristics (BOD, pH, EC Turbidity, Colour, TP, TN, and Metals (Na, Ca^{2+}, Pb^{2}, Cd^{2} and Zn) in effluents from industries, farmlands and residential areas into the water at selected points and their seasonal variation.

(iii)To determine the microbial quality (TAB, *E. coli, Salmonella/Shigella* count and Fecal coliform (cfu/ml) from residential/industrial areas at selected points.

(iv)To compare the concentrations of each pollutant with national and international effluent standards and emission guidelines.

(v) To establish the potential public health threat the water could pose and suggest appropriate recommendations for national planning and development.

Study Area

The study was conducted within the city of Ilorin, Kwara State. Ilorin comprises of three local Government areas namely; Ilorin West, Ilorin East, and Ilorin South. The city performs dual administrative functions of a state capital and headquarters for Ilorin West local Government Areas.

Ilorin is located on latitude 8 º24′ N and 83º6′ N and longitude 4º10′ E and 4º 36′ E. It is situated at a strategic point between the densely populated South-Western and the sparsely populated middle belt of Nigeria. Ilorin is located in the transitional zone between the deciduous woodland of the South and dry savannah of North Nigeria (Jimoh, 2003). Figure 1 shows the map of Kwara State and the study area.

The choice of Ilorin as the state capital has resulted in its rapid increase in population and urban development. The 2006 population census figures showed that the city has a population of 766,000 (NPC, 2006).Ilorin has grown from what can be describes as “foot city” with residential houses located around the Emir’s palace to an 'automobile city' (Aderamo, 2003).

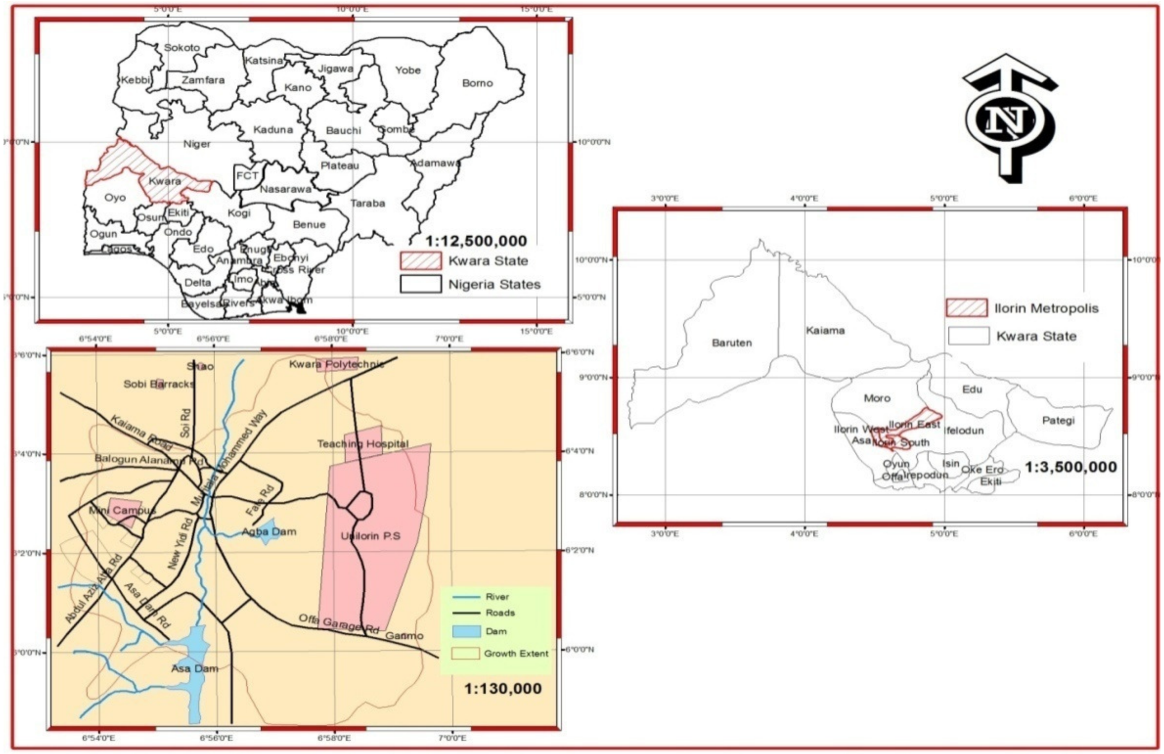

Figure1: Map of Nigeria showing Kwara State and the study area

Climate

The climate of Ilorin is characterized by both wet and dry seasons. The rainy season begins towards the end of April and last till October while the dry season begins in November and ends in April. The temperature of Ilorin ranges from 33 ºC to 35 ºC from November to January while from February to April; the value ranges between 34 ºC to 37 ºC. Days are very hot during the dry season.

The total annual rainfall in the area ranges from 990.3mm to 1318mm. the rainfall in Ilorin city exhibits the double maximal pattern and greater variability both temporarily and spatially. The relative humidity at Ilorin city ranges from 75% to 88% from May to October, while in the dry season it ranges from 35% to 80% (Ajibade and Ojelola, 2004).

Geology and Drainage

Ilorin consists of Precambrian basement complex rock. The soils of Ilorin are made up of loamy soil with medium and low fertility. Because of the high seasonal rainfall coupled with the high temperature, there is tendency for lateritic soil to constitute the major soil types in Ilorin due to the leaching of minerals nutrients of the soil (Ajibade and Ojelola, 2004).

The elevation of the area varies from 273m to 333m in the western side with isolated hill (Sobi Hill) of about 394m above the sea level while on the eastern side it varies from 273m to 364m (Ajibade and Ojelola, 2004). The lowest level is along the river valley of Asa and Oyun while the highest point is Sobi Hill.

Ilorin is mainly drained by Asa River which flows in a South-North direction

(Ajibade and Ojelola, 2004). The pattern of the drainage system of Ilorin is dendritic. Asa River occupies a fairly wide valley and goes a long way to divide Ilorin into two parts; namely the eastern and the western part. The eastern part covers those areas where the GRA is located while the core indigenous area of Ilorin falls under the western part. Other rivers in Ilorin that drains into Asa river are river Agba, river Alalubosa, river Okun, river Osere, river Aluko, river Yalu, river Odota and river Loma. Figure 2 shows the drainage pattern of Ilorin.

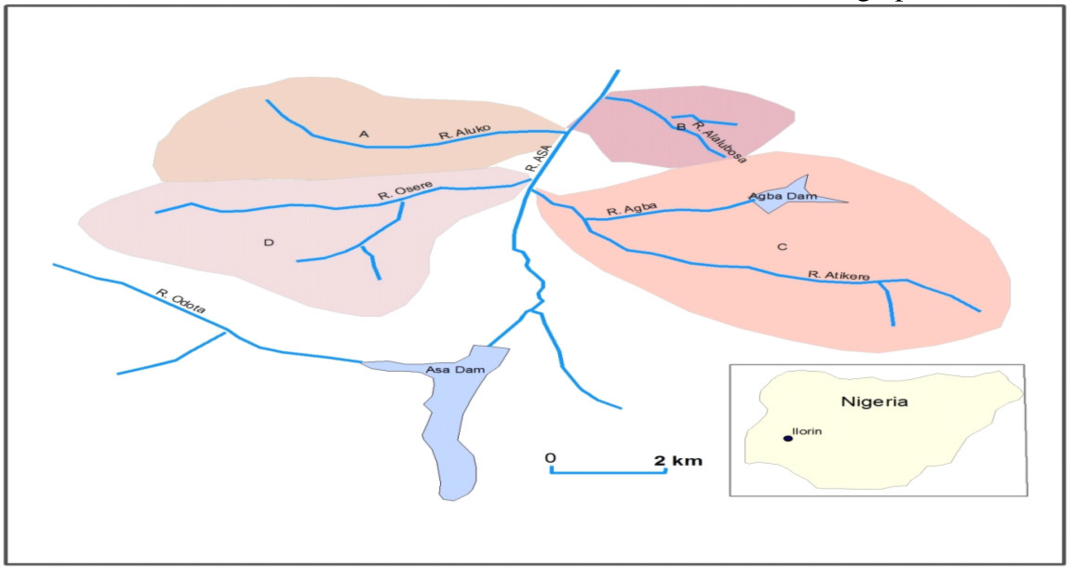

Figure 3: Ilorin showing four (4) drainage basins in the study area
Source: Adapted from Oyegun (1983)

Social Economic Activities

The socio-economic activities in Ilorin has increased tremendously from agricultural practices of growing food crops to local craft of cloth weaving, leather works, pottery, embroidery, tie and dye, mat making etc to modern commerce with viable trading industry and administrative activities (Olorunfemi, 2001). Agricultural activities in Ilorin are limited to small garden plots of maize, beans, and vegetables which are cultivated mainly for domestic consumption. Cultivation of tuber\ crops like yam and cassava are mainly done at the outskirts of the city.

Ilorin has been described aptly as the “Gate way” between northern and southern Nigeria. Due to this geographical proximity; Ilorin plays some key roles in the socio-economic development of the surrounding towns and cities. It is important to note that given the nature of the socio-economic activities of the inhabitants, the level of poverty is very severe with households barely affording a decent living. This is more serious in the indigenous areas of the city where low level of education had virtually excluded majority from the western styled paid job and enjoys only a restricted opportunity for enhanced purchasing power.

Materials and Methods

Ten rivers in the metropolis were selected for this study. Water samples were taken at both the downstream and upstream. These rivers include Asa, Aluko, Agba, Yalu, Alalubosa, Oyun, Odota, Moro, Odokun. Collection of water samples was done in the morning between 7.3am and 9am.This is to allow for stillness of the river and to avoid undue interference by the users of the rivers. These water samples were collected using grab method. This method according to World Bank (1988) involves samples collected into clean 1 litre plastic bottles and was stored in an ice box of 4^oC and was taken to the laboratory within twenty four hours for analysis. Water samples were collected by lowering pre-cleaned plastic bottles into the bottom or the water body, 30cm deep, and allowed to overflow before withdrawing. Seventeen sampling points were used, and two samples were collected from each of the seventeen points.

The first location was 2km upstream, and the second points were at the 8kms; 12kms and 20kms downstream where there are heavy human agricultural and industrial activities. Samples were collected between November 2013 and October 2014 covering both dry season and wet seasons. The sampling area was mapped using GPS within a grid located around the effluent outlet especially in the downstream side. The co-ordinates of the points were read using a Germine Trex H Geographic Position System (GPS). Table 1 shows the location of the samples and their coordinates.

Physicochemical parameters in the study include pH, temperature, salinity, total solids, total dissolved solids, water, temperature, dissolved oxygen, fluoride, zinc, nitrate and iron. Others are: copper, sulphate, manganese, magnesium, zinc and nitrate. Biological parameters taken for measurement include; *E. coli* count, *Salmonella/Shigella* count and fecal coliform.

Table 1: Locations of Sample and their Coordinates

S/No	Sample Location	Source	Sample Number	Coordinates of the sample points	Local Government
1	Oyun	Oyun River (Upstream)	A	683199, 936259	Ilorin East
2	Unilorin	Oyun River (Downstream)	B	676290, 943009	Ilorin South
3	Flower Garden	Alalubosa River (Upstream)	C	674181, 938363	Ilorin South
4	Mubo Street	Alalubosa River (Mubo street)	D	672856, 939402	Ilorin East
5	Kuntu	Aluko (Upstream)	E	668605, 938703	Ilorin West
6	Emir's Road	Aluko River (Downstream)	F	671659, 938685	Ilorin West
7	Princess Hotel	Agba dam (Upstream)	G	674788,937259	Ilorin South
8	Pipeline Road	Agba dam (Downstream)	H	674780, 937256	Ilorin South
9	Gaa Akanbi	Yalu River (Upstream)	I	673883, 935473	Ilorin South
10	Cocacola	Yalu Rive (Downstream)	J	671978, 936892	Ilorin South
11	Asa Dam	Asa River (Upstream)	K	671746, 936994	Ilorin South
12	Amilegbe	Asa River (Downstream)	L	672391, 939305	Ilorin East
13	Okoerin	Odo Okun (Upstream)	M	669271, 936764	Ilorin West
14	Tuyil Conpany	Odo Okun (Downstream)	N	671248, 937284	Ilorin West
15	Odota	Odota (Upstream)	O	666668, 934755	Ilorin West
16	Asa River (Beside Coca cola Plants)	Asa River (Beside Coca cola Plants)	P	674780, 937256	Ilorin South
16	Okolowo	Moro River (Okolowo)	Q	662356, 944629	Ilorin South

Data Analysis

The data obtained were subjected to both descriptive and inferential statistical analysis (95% confident limit).Simple percentage was used to determine the potential effluent effects on public health while the General Linearized Model (GLM) of SAS was used to generate analysis of variance,(ANOVA),mean values, standard error and range. Spearman correlation was used to test relationship between all the parameters concentrations in both dry and wet seasons. Cluster analysis was performed based on mean concentrations of indicator feacal coliforms to identify any at analogous behavioral pattern between different sampled points. Water samples were also benchmarked for compliance with National and WHO and suggested values for microbial, physical and chemical parameters.

Results and Discussion

Physicochemical Analysis

The results of the physico-chemical and microbiological features were presented in table 1a and b shwing the mean values of physio-chemical parameters for wet and dry season (November 2013 - October 2014) respectively. In the wet season, the neutral to alkaline pH values obtained in most sampling points is similar to the one obtained by Chikogu *et al*. (2012) while that of the dry season varies from 1.34-8..72 which is far below the National values and WHO ranges.

The mean temperature profile of the effluent receiving water bodies varies significantly at 0-005 significant level and ranged from 34 ºC to 36 ºC during dry season and 33 ºC to 35.8 ºC, though there is no national limit, the temperature of the water samples does not appear to pose any threat to the homeostatic balance of the receiving water bodies. Lower temperatures were observed upstream than at downstream. The dissolved oxygen profile throughout the seasons varied significantly at 0.005 significant levels and ranged from 4.92-8.02 in dry season and 3-36-6.92 in wet season. The DO values varied among the various rivers in the study areas. In Asa downstream, Yalu River downstream, the river water showed that low content of DO situated very close to the river bank. This is due to contamination of industrial discharge with high COD. The low DO is due to the discharge of industrial effluents and the toxicity of the combined effects from chemicals and heavy metals.

The nitrate profile of the water samples generally varied spatially and seasonally in the water bodies from 0.73 to 3.12 in the wet season to as much as between 16-48.7 in the dry season exceeding the National highest permissible limit and within the WHO maximum permissible limit and differ significantly at 0-005 significant level. High nitrate values were found in the dry season in all the receiving water bodies. The total nitrate levels obtained during the study period exceeded the regulatory limits and thus nitrate is considered to pose a problem. This may expose the communities to risk when the receiving water bodies are used for domestic purpose which was the situation in this study. This perhaps may give rise to methemoglobinemia in line with submission of Fatoki *et al.*, 2003.However, it is important to note that the nitrate from industries and homes effluents could be a source of eutrophication for the receiving water bodies as the values obtained in the wet season conform with the national standard but the dry season values exceeded the national maximum permissible limits of 50 mg/1.

The concentration of Biochemical Oxygen Demand (BOD) does not conform with the maximum acceptable limits for inland waters as earmarked by WHO (2004),as 10 mg/1 and 40 mg/1 are the respective acceptable limits .Even the dry season values shows3.3 mg/1 and 309.3 mg/1 respectively for BOD, It shows that the BOD values are very high even at the downstream where the value is supposed to be lower but the results indicate 414.70 which is forty times higher than the National Standard acceptable limits. The highest BOD value was obtained at the point of entry and varies seasonally and across the water bodies. There was little variation among BOD values for individual water samples.

Some samples tested for iron were in compliance with the WHO guideline value 0.2mg/1 and National Standard maximum limit of 0.3mg/1 while others exceeded this limit. The mean iron levels ranged from0.00 to3.18 in the wet season and from0.01 to 3.65 in the dry season.

The silicate concentrations were generally high in the whole study area..Silicate concentration had a negative correlation with salinity and positive with dissolved phosphate. Rivers and the watershed have been utilized by mankind for thousands of years to the extent that few of them are now in their natural condition (Ngoye and Machinwa, 2004).

The correlation of seasonal variation in water quality parameters through season, spearman correlation show that except pH, all other parameters are significantly ($p<0.01$) correlated with the season/Among these sodium, sulfate, nitrate, exhibited higher correlation as Spearman's R+,0.54,051 and 0.04 respectively. Seasonally various water quality parameters can be explained in terms of seasonal variation can be explained in terms of seasonal variation in hydrological and hydrologic characteristics associated with the wet and dry season .as you can see, higher value of all the parameters, EC, Sodium, iron, nitrate, fluoride, are observed in dry season and fall and lower values in the wet season. The parameters are reactive components that are partially of anthropogenic origin. EC qualitatively reflects the status of inorganic pollution and ions measure the TDS in water. Similarly, all these parameters are low in wet season. These are non-reactive components that are determined by natural hydro-geochemical process.,

Potential Impacts on Human Health

Table 2 shows the potential impact of water parameters on human health when values exceed the WHO maximum permissible limits. However, from the table, the values of the identified water parameters were less than the WHO maximum permissible limit..This implies that, based on the identified water parameters, water from the sampled rivers in the area has little potential impact on human health. The result of this present study was in contrast with the result of similar work by Chikogu *et al.* (2012) in Kaduna, Nigeria. The effluent discharge was mainly into River Romi from Kaduna Petrochemical Refinery. Their study indicated there was excessive level of pollution into the river Romi.

Table 2: Toxic Substances Present in Major Rivers and Streams in Ilorin and Established Health Effects

Physico-chemical	Average Quantity in water sample	Maximum Permissible Limits		Potential ill-effects of exceeding the Maximum
		National Standard Nigeria	WHO Guideline	
Lead(mg/l)	0.02	NA	0.01	Impairment of neurological development suppression of the haematological system and kidney failure and mental retardation
Manganese(Mn)	0.00	0.2mg/l	0.2mgl	Taste, discolouration, deposits in pipe turbidity. Harmful to health
Nitrate (mg/l)	2.95	20 mg//l	50mg/1	Methaeglobinamenia in infants; carcinogenic potential in man, asphyxiation and death.
pH	6.74-7.83	6.-00-9.0	6.0-9.0	Tastes, corrosion, inflamed eyes and skin lesions.
Iron	1.74 mg/1	0.3 mg/1	0.35mg/1	Taste, discolouration, deposits and growth of iron, bacterial, turbidity and other forms of degenerative diseases and ageing.
Magnesium	39.84	150mg/1	200mg/1	Hardness, taste, gastrointestinal irritation
Fluoride	1.37mg/1	1.3mg/1	1.5mg/1	Endemic cumulative dental Fluorosis with resulting skeletal damage in both children and adults. Renal impairment.
Copper	0.01	1.5mg/1	1.5mg/1	Astringent taste. Harmful to health
Calcium	41.5 mg/	200mg/1	250 mg/1	Excessive scale formation
Sulphate	44	150	250mg/1	Gastrointestinal irritation and acute effects such as eye and respiratory disorder and Laxative effect.
Zinc		15.0 mg/1	15.0mg/1	Taste; opalesce; deposits gastrointestinal disorder, irritation muscular pain.
Total Dissolved Oxygen		150mg/1	500mg/1	Carcinogenic mutagenic and teratogenic effects in humans.
Phosphate mg/1	42	NA	45	Harmful to health
Colouring		50 units on the pb-Cb scale	50 units on the Pb-Cb scale	Colouration, Aesthetic effects.
Potassium	O.2 mg/1	1.0 mg/1	2.0 mg/1	Nervous and digestive disorders, Kidney heart disease, coronary artery disease, and hypertension.

Source: laboratory analysis, 2014, FEPA (1991) and WHO (2009).

Microbial Water Quality

Feacal coliform counts in the water bodies in Ilorin Metropolis are presented in Table 1a and b. The distribution was widespread as they were detected throughout the whole study area .Highest densities were recorded at the down streams (1.16 and 8.8) but the enteric bacterial load decreased with increasing distance from the sewage source. Lowest feacal coliform concentrations were recorded at points farthest away from the sewage disposal points especially residential areas. Bacteriological analysis showed that the colony forming unit in all the water samples was found to be above 20 and they all have MPN values more than others which could be termed negligible with presence of E coli and Fecal Coliform. This therefore implied that the microbial water quality of all the Rivers that is Asa, Oyun, Odo-Okun, Yalu, Agba, Moro, and Alalubosa is poor. Total and faecal coliforms pollution is wide spread and the entire courses of the rivers within the metropolis as sampled are not suitable for domestic consumption without treatment. For agricultural purposes, there is a possibility of contamination from vegetables and other crops eaten in their raw state particularly areas around Oyun, Alalubosa, Yalu and Asa Rivers. The mean total coliforms, THB count, *Salimonella* and Faecal Coliforms are quite high. This is unacceptable when compared to the World Health Organisation (WHO) permissible limits. The results have showed faecal pollution of the water in all these rivers in Ilorin Metropolis and this implies that the water poses a serious health risk to man, animals and plants. The poor microbiological quality of the water in all these rivers in Ilorin metropolis might be due to the effluents discharged from industries discharge from farms and residential areas in the study area. Consequence upon this, effluents discharge into water bodies through residential, agricultural and industrial wastes, fresh water has reduced impurity and has become almost unsuitable for water resources use. This polluted water has become dangerous to human health, plants and organisms. Consumption of water contaminated by disease-causing agents (pathogens) or toxic chemical can cause health problems such as diarrhoea, cholera, typhoid, dysentery, cancer and skin diseases. The results also indicate that Asa River downstream, Yalu downstream which are found to be nearer industrial discharge point have adverse impact on the environment. Toxic contaminants from these surface runoff, sewage discharge and industrial discharge have caused negative impacts towards the water bodies. This study further shows that about 30 percent of total hardness in both wet and dry season especially at the downstream exceeded the desirable limits at 100 mg/1.Naturally, the water hardness is due to the presence of alkaline earths such as calcium (Ca) and magnesium (Mg) High concentrations of magnesium and calcium can cause decrease in water quality .

Table 3: The Mean Values of Microbial Quality of water in the Study Area

S/ No	Sample Location	THB Count (Cfu/100/ml)	*E. coli* Count (Cfu/100/ ml)	*Sammonella Shigella* (Cfu/100/ml)	Feacal Coliform (Cfu/100/ml)	WHO Standard
1	Oyun	Oyun River (Upstream) $2.96*10^3$	$1.0 * 10^1$	$4.0*10^1$	$1.0*10^1$	$1\text{-}0*10^2$
2	Unilorin	Oyun River (Downstream) $1.4*10^3$	$8*10^3$	$5.0*10^1$	$1.16*10^3$	$1\text{-}0*10^2$
3	Flower Garden	Alalubosa River(Upstream) $3.0 *10^2$	NIL	$1.0*10^1$	$3.2*10^2$	1-0*102
4	Mubo Street	Alalubosa River(mubo street) $3.2 *10^3$	$3.2*10^3$	$3.5*10^2$	$2.16*10^3$	$1\text{-}0*10^2$
5	Kuntu	Aluko (Upstream) $3.0 *10^3$	$3.0*10^2$	NIL	NIL	$1\text{-}0*10^2$
6	Emir's Road	Aluko River(Downstream) $2.0 *10^2$	$3.0*10^3$	NIL	$1.9*10^2$	$1\text{-}0*10^2$
7	Princess Hotel	Agba dam (Upstream) $3.0 *10^3$	NIL	NIL	NIL	$1\text{-}0*10^2$
8	Pipeline Road	Agba dam (Downstream) $2.16 * 10^3$	NIL	NIL	NIL	$1\text{-}0*10^2$
9	Gaa Akanbi	Yalu River (Upstream) $2\text{-}16*10^3$	$10*10^1$	$2.0*10^1$	$4.0*10^1$	$1\text{-}0*10^2$
10	Cocacola	Yalu Rive (Downstream) $3.0*10^3$	$3.0*10^1$	$4.0*10^2$	$1.4*10^2$	$1\text{-}0*10^2$
11	Asa Dam	Asa River (Upstream) $8.0*10^3$	$3.2\ 10^2$	$1.5*10^5$	NIL	1-0*102
12	Amilegbe	Asa River (Downstream) $2.44*10^3$	3.510^4	$1.0* 10^3$	$8.8*10^2$	$1\text{-}0*10^2$
13	Okoerin	Odo Okun (Upstream) $2.12*10^3$	NIL	NIL	$3.8*10^2$	$1\text{-}0*10^2$
14	Tuyil Conpany	Odo Okun (Downstream) $1.8*10^4$	$9.0*10^1$	$1.5 * 10^1$	$2.44*10^3$	$1\text{-}0*10^2$
15	Odota	Odota (Upstream) $7.0*10^3$	$6.0*10^1$	$1.0* 10^1$	$3.8*10^2$	$1\text{-}0*10^2$
16	Asa River (Beside Cocacola Plants)	Asa River (Beside Cocacola Plants) $9.0*10^3$	NIL	$6*10^1$	$2.44*10^3$	1-0*102
17	Okolowo	Moro River (Okolowo) $2.12*10^3$	$3.0 *10^1$	NIL	$2.0*10^1$	$1\text{-}0*10^2$

The distribution pattern and levels of nutrients in this study indicate that the influence of sewage from residential areas on nutrients concentration within the downstream. The microbiological quality of water has been implicated in the spread of important infectious and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis. Many diseases are associated with water in other way. Water may act positively in the control of some through its use in hygiene, and may act as a source or vector for others where contact with water is required for disease transmission or where agents of disease or insect vectors require water in which to complete their life cycle.

However, waters within the study area showed high feacal coliform counts (8.8/100ml though below the maximum desirable limits of 10/100ml in some points and lower in others than the recommended limits for recreation and bathing waters and may present potential risk to human health. Thus in its present form, it is unsafe for human use (Table 3). This result is similar to that of Omoigberale *et al.* (2014) and that of Ayandiran *et al.* (2014). The former results revealed that the bacterial counts were shown to be highest in the rainy season and the least total viable counts were recorded in the month of January with total coliform counts ranged from 27 MPN/100 ml to 350 MPN/100 ml while the faecal coliform counts from 5 MPN/100 ml to 26 MPN/100 ml. Water quality assessment identified human, animal and agricultural activities as the major sources of water contamination, thus the water was considered unsuitable for direct human consumption. The later found that Oluwa River was not safe for public consumption from the microbial count of isolates from water samples range between 94.10810^2 Cfu/100 ml and $156.20 * 10^2$ Cfu/100ml.

Table 4: The Mean of the Parameters in the Dry Season (November 2013-March 2014)

N0	IDNo	PH	mg/l Ca	mg/l Mg	mg/l K	mg/l Na	mg/l Mn	mg/l Fe	mg/l Cu	mg/l Zn	mg/l Pb	mg/l Ni	mg/l Bi carbonate	mg/l Cl^-	mg/l NO3	mg/l SO4-S	mg/l DO	mg/l BOD	ODOUR	mg/l Salinity
A	Oyun River (Upstream)	1.56	22.13	5.22	4.96	13.21	0.31	0.42	0.01	0.06	0.00	0.00	6.1	93.54	22.88	39.22	6.27	131.4	Unobjectionable	19.97
B	Oyun River (Downstream)	1.56	14.69	5.05	3.94	12.32	0.12	0.32	0.02	0.07	0.00	0.00	6.10	79.20	21.56	27.16	7.95	3.3	Unobjectionable	0.28
C	Alalubosa River (Upstream)	1.38	5.97	2.12	3.28	11.21	0.11	0.11	0.07	0.06	0.00	0.00	6.10	108.00	22.17	30.64	6.34	123.60	Unobjectionable	16.81
D	Alalubosa River (Mubo street)	8.06	24.35	4.42	10.23	31.16	0.33	0.74	0.02	0.00	0.00	0.00	24.41	187.20	19.81	46.55	5.82	309.93	Unobjectionable	28.64
E	Aluko (Upstream)	8.72	39.87	8.12	26.75	61.78	1.34	1.24	0.00	0.00	0.00	0.00	6.08	163.47	19.24	31.46	5.2	365.27	Unobjectionable	130.02
F	Aluko River (Downstream)	8.02	44.75	8.56	24.45	58.72	0.11	0.22	0.00	0.00	0.00	0.00	24.5	309.60	22.85	57.76	5.13	414.70	Unobjectionable	143.26
G	Agba dam (Upstream)	1.33	18.16	3.23	3.56	18.64	0.46	1.20	0.01	0.02	0.00	0.00	6.10	151.20	9.58	48.71	5.54	379.80	Unobjectionable	141.85
H	Agba dam (Downstream)	1.22	18.01	3.11	3.66	15.53	0.29	0.65	0.00	0.03	0.00	0.00	6.10	93.60	16.75	23.71	8.03	2.50	Unobjectionable	0.16
I	Yalu River (Upstream)	7.96	34.77	5.06	7.75	32.65	0.11	0.11	0.00	0.00	0.00	0.00	16.63	180.00	19.10	18.10	6.59	117.3	Unobjectionable	14.58
J	Yalu Rive (Downstream)	7.75	23.33	3.48	5.54	21.85	0.09	0.01	0.02	0.00	0.00	0.00	30.50	144.00	15.52	16.14	7.89	4.30	Unobjectionable	0.52
K	Asa River (Upstream)	3.08	7.96	3.45	4.14	16.06	0.05	1.85	0.03	0.02	0.00	0.00	6.10	93.60	22.38	46.12	5.96	349.50	Unobjectionable	133.29
L	Asa River (Downstream)	6.33	23.68	9.09	11.67	40.17	9.19	0.68	0.08	0.01	0.00	0.00	26.51	177.60	14.32	56.90	8.02	3.05	Unobjectionable	0.35
M	Odo Okun (Upstream)	1.41	40.74	6.02	11.94	33.55	0.79	2.63	0.06	0.02	0.00	0.00	6.18	172.67	19.01	26.55	4.95	351.93	Unobjectionable	158.66
N	Odo Okun (Downstream)	1.37	40.31	6.08	11.14	33.49	0.86	2.79	0.11	0.03	0.00	0.00	36.50	13.60	14.83	32.33	7.11	83.37	Unobjectionable	7.90
O	Odota (Upstream)	7.25	3.69	8.03	10.02	30.62	0.75	2.22	0.01	0.01	0.00	0.00	6.10	180.00	18.21	34.31	6.21	156.27	Unobjectionable	77.97
P	Asa River (Beside Coca cola plants)	2.23	23.47	3.26	2.36	43.95	0.84	1.12	0.00	0.00	0.00	0.00	36.57	93.6	21.34	35.17	8.07	2.80	Unobjectionable	0.14
Q	Moro River (Okolowo)	1.04	6.56	5.87	2.52	12.26	0.22	3.65	0.00	0.03	0.00	0.00	9.44	169.67	15.85	35.53	5.90	137.63	Unobjectionable	70.18

Table 5: The Mean of the Parameters in the Dry Season (April 2014-October 2014)

N0	ID No	PH	mg/l Ca	mg/l Mg	mg/l K	mg/l Na	mg/l Mn	mg/l Fe	mg/l Cu	mg/l Zn	mg/l Pb	mg/l Ni	mg/l Bicarbonate	mg/l Cl^-	mg/l Salinity	mg/l Do	mg/l Fluoride	ODOUR	Hz Colour	mg/l NO3-N	mg/l SO4-S
A	Oyun River (Upstream)	6.74	2.39	2.09	2.85	6.09	0.00	1.77	0.02	0.00	0.00	0.00	42.74	75.65	1.52	3.36	0.96	Unobjectionable	9.72	2.12	3.87
B	Oyun River (Downstream)	7.18	1.37	1.56	3.14	6.12	0.00	3.18	0.01	0.02	0.00	0.00	24.42	108.02	3.02	3.74	0.86	Objectionable	12.8	0.78	1.31
C	Alalubosa River (Upstream)	6.14	2.74	2.98	34.75	22.54	0.00	0.00	0.02	0.00	0.00	0.00	30.51	115.26	2.63	1.67	0.58	Unobjectionable	8.90	1.76	16.38
D	Alalubosa River (Mubo street)	7.35	10.12	5.03	7.84	31.53	0.00	0.70	0.01	0.00	0.00	0.00	36.61	115.20	6.03	3.45	0.93	Objectionable	8.50	2.95	80.17
E	Aluko (Upstream)	7.85	20.10	15.20	50.23	329.22	0.00	0.12	0.00	0.00	0.00	0.00	48.87	579.63	15.34	7.85	2.14	Unobjectionable	4.82	2.28	12.27
F	Aluko River (Downstream)	7.64	55.61	14.02	45.62	112.45	0.00	0.32	0.03	0.01	0.00	0.00	54.92	554.42	14.67	5.69	1.24	Unobjectionable	6.80	3.12	25.17
G	Agba dam (Upstream)	7.14	5.54	4.33	6.03	24.26	0.00	0.63	0.02	0.00	0.00	0.00	34.59	187.42	2.94	6.22	1.56	Unobjectionable	7.88	2.55	25.73
H	Agba dam (Downstream)	7.09	5.73	3.15	5.69	22.69	0.00	0.26	0.03	0.00	0.00	0.00	26.47	135.24	2.94	6.36	1.77	Unobjectionable	7.25	2.20	58.59
I	Yalu River (Upstream)	7.43	8.27	4.68	7.71	32.78	0.00	1.66	0.03	0.01	0.00	0.00	36.64	182.03	4.06	3.47	1.37	Unobjectionable	10.22	2.28	26.40
J	Yalu Rive (Downstream)	7.58	20.12	5.14	8.48	37.86	0.00	1.10	0.02	0.00	0.00	0.00	19.35	153.61	3.68	6.57	1.74	Unobjectionable	7.92	2.68	59.75
K	Asa River (Upstream)	7.75	1.70	3.17	15.36	11.95	0.00	1.25	0.00	0.01	0.00	0.00	36.84	97.81	2.15	5.68	1.35	Unobjectionable	.03	2.52	34.88
L	Asa River (Downstream)	7.47	2.57	3.33	3.31	11.63	0.00	1.22	0.00	0.01	0.00	0.00	23.41	80.41	2.49	5.13	0.93	Objectionable	9.03	2.80	53.56
M	Odo Okun (Upstream)	7.34	25.64	8.76	3.63	47.88	0.00	0.97	0.01	0.01	0.00	0.00	24.44	198.16	4.79	3.79	1.85	Objectionable	10.8	2.74	16.38
N	Odo Okun (Downstream)	7.46	22.57	10.02	8.54	68.69	0.00	0.6	0.01	0.0	0.00	0.00	43.09	225.80	6.52	4.98	1.37	Unobjectionable	11.75	2.65	28.05
O	Odota (Upstream)	7.46	20.14	7.17	15.25	25.95	0.00	0.44	0.01	0.02	0.00	0.00	24.42	169.35	4.11	6.92	1.97	Unobjectionable	5.77	2.63	32.77
P	Asa River (Beside Coca cola plants)	7.54	22.13	6.15	8.83	41.45	0.00	1.01	0.01	0.00	0.00	0.00	30.51	208.85	5.22	4.67	1.16	Unobjectionable	10.37	2.66	36.24
Q	Moro River (Okolowo)	7.83	1.27	2.68	36.42	11.56	0.00	6.36	0.03	0.02	0.00	0.00	30.54	93.71	2.42	2.18	0.69	Objectionable	14.57	2.50	41.38

Implications of Findings and Recommendations

The study results suggest that the effluents being discharged into the rivers have considerable negative effects on the water quality in the receiving water bodies.With increased industrial activities in Ilorin metropolis, the load of nutrients and pollutants. The study has shown a need for a continuous pollution monitoring programme of the surface waters in the cities in Nigeria. Furthermore, the Federal and State government as well as their agencies concerned with environmental matter in Nigeria should evolve measures to check and ensure the discharge effluents comply with laid down rules and regulations

The following are therefore recommended to protect public health and healthy environment in Ilorin in particular and the country at large:

- Government at various levels should ensure and enforce cost-effective cleaner production technologies such as on-site waste separation and reduction, and perhaps effluent recycling.
- Government at all levels should discourage careless disposal of the wastes and encourage industries to install waste treatment plants with a view to treat wastes before being discharged into the water bodies.
- There is necessity for Federal Ministry of Environment and its relevant agencies to closely monitor the effluents from industries and sewage disposal from residential areas. It has been observed that these surface waters contribute greatly to the purification waste water therefore measures should be taken to protect these vital water resources. .
- An aspect of environmental mapping can be introduced using Environmental Sensitivity Index (ESI) as tool in urban monitoring and management of effluent discharges and pollution However, government presently appears to show little concern about this tool.
- Finally, Government should put appropriate legislation in place that will compel compost manufacturing firms to pay for discharging this hazardous substances into freshwater

Conclusion

The study showed that effluents from various sources including industries, residential areas and agricultural farms into the water contain some hazardous substances such as lead, nitrate, iron, zinc, and others. Their concentrations exceed the permissible limit of national and international standards in terms of their seasonal and spatial variation in Ilorin Metropolis. It was also observed that the effluents fell short of standard requirements that are short of .clean and safe water such as DO, BOD, nitrate among others. The results of this study therefore indicate that effluents could pose significant health and environmental risk to the public who rely on the surface water and the receiving water particularly well and boreholes nearer to the source of these effluent pollutants as their domestic water purpose without treatment The significance of seasonal variations of water quality was evaluated and the results indicates that the seasonal variation of the two seasons are significantly different. The chemical composition of the surface water in Ilorin

Metropolis is strongly influenced by the impact of anthropogenic processes especially industrial residential and agricultural activities and to some extent hydrological and weathering processes.

Finally, the study has revealed that there was an adverse effect on the physico-chemical characteristics of the receiving river waters in the metropolis as a result of the discharge of untreated and inadequately treated effluents from the industrial plants located within the study area. This is especially depicted through the spatial variation of concentrations of parameters analyzed which were higher downstream as opposed to the upstream in all the rivers under study. Although, the values in some cases were lower than the maximum allowable limits by National Standard the continuous discharge of un-treated effluents in the rivers may lead to accumulation of the contaminants which may have negative impact on human health.

Acknowledgement

The Authors wish to thank TETFUND Nigeria for making available the grant for this research and to the Management of Kwara State Polytechnic Ilorin, Kwara State, Nigeria.

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