VOL 8, NO 1, JUNE 2022.
ISSN: 2276-7924
www.ijssyabatech.com

THE ASSESSMENT OF THE PHYSICO-CHEMICAL PARAMETERS AND HEAVY METAL CONTENT OF TOTO-OWU RIVER OGUN STATE NIGERIA

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ABSTRACT

Toto-owu River in Ado-Odo LCDA of Ogun state, South West, Nigeria has in recent times become the "unchartered smugglers' route" for vehicles and other banned items. The attendant likely pollution of the water body was investigated by determining the physico-chemical parameters and heavy metals load. Samples were collected from three sections of the river: the smuggling route, 100 m up-field and 100m down-field and analysed for twelve physico-chemical parameters and heavy metals using standard methods. The results show that the temperature, conductivity and pH of the water have mean values of 26.03^{o}C, 123.33 µS/cm and 6.34 respectively. The result also revealed a total dissolved solid of mean value of 533.33 mg/l while total suspended solid has a mean value of 233.33 mg/l. The mean total hardness of the samples was 57.50 mg/l while that of biological oxygen demand, chemical oxygen demand were 3.95 mg/l and 7.88mg/l respectively. Nitrate and chloride were present in the samples at mean values of 0.32 mg/l and 55.54 mg/l respectively. The sulphate content of the samples was below detectable limit. The mean concentration of zinc, nickel, cadmium, lead and chromium were 0.708 mg/l, 0.005 mg/l, 0.011 mg/l, 0.381 mg/l and 0.065 mg/l respectively. The result showed that most of the parameters were within the maximum permissible limit of W.H.O except for total suspended solid, biological oxygen demand, cadmium, lead and chromium.

KEYWORDS: Toto-owu River, Pollution, Smuggling, Heavy metals.

INTRODUCTION

Water is the principal need of life on planet earth and is an essential component of all forms of lives ranging from plants to animal. The entire fabric of man is woven around it. Sources of water available to mankind are; atmospheric water (precipitate), surface water (including rivers, streams, ponds etc) and ground water (including well water).

The accumulation of water that is characterised by unidirectional current with a relatively high average velocity gives rise to the water body known as river. Rivers are among the oldest water bodies in the world (Higler, 2012). Rivers have important multi-usage components such as; source of drinking water, irrigation, fishing, and energy production (Iscen *et al.*, 2008). In most urban-rural communities in the developing countries (especially the sub Saharan Africa), surface water such as rivers have been the most available source of water for domestic purposes (Dimowo, 2013). Rivers that are situated in rural areas are in addition used for washing/laundry, refuse disposal, car/motorbike washing, municipal and human waste disposal and sometimes for religious activities. Despite the multi-usage nature of rivers, expanding human population, urbanization, industrialization and discharges of wastes into them have resulted in the deterioration of their water quality (which is the chemical, physical, biological and radiological characteristics of water). The impacts of these anthropogenic activities have been so extensive that the water bodies (e.g. rivers) have lost their self-purification capacity to a large extent (Sood *et al.*, 2012) and has resulted in a kind of crises situation that has made getting clean water a serious problem (Anjum *et al.*, 2013).

Water pollution is the contamination of water bodies such as lakes, rivers, oceans, aquifers and ground water. It is a global problem which requires ongoing evaluation and revision of water resource policies at all levels (Okonko, 2008). This form of environmental degradation occurs when pollutants from various sources are directly or indirectly discharged into water bodies without adequate treatment to remove the harmful compounds. Rivers are usually polluted by pollutants such as industrial effluents, domestic wastes, oil spillage etc. When these pollutants of various types find their way into these rivers, they change the physical, chemical, and biological properties of such river (Asubiojo, 2016). It is a known fact that when pure water is polluted, its normal functioning and properties are affected (Anjum *et al.*, 2013). Adefemi & Awokunmi (2010) reported that faucal pollution of drinking water causes water borne diseases which have led to the death of millions of people.

Recently, great concern has been universally voiced regarding environmental pollution and degradation which is arising as a side effect of rapid industrialization and urbanization (Jaspal *et al.*, 2012). Today, the main concern of bodies such as the World Health Organisation (WHO), Third World Academy of Science (TWAS) and the United Nation Educational, Scientific and Cultural Organisation (UNESCO) with water pollution is with its impact or effect on the health of the present generation and the future ones. Their concern is based on the fact that water pollution affects water quality which is a critical factor that affects human health and welfare. The quality of any water is a measure of the condition of the water relative to the requirements of one or more biotic species and to any human needs. Majority of world's population does not have access to safe drinking water. This is certainly true in most part of Africa and Asia (TWAS, 2002). In the same year, WHO (2002) reported that over 2.6 billion people were still suffering from the effect of poor water around the world. In addition, the World Health Organization estimates that 3.4 million people, mostly children, die every year from water-related disease (WHO, 2004). Most people in the world do not have access to safe drinking water and this has led to increase in water borne diseases such as diarrhoea, cholera, tuberculosis etc. Globally, 4 billion cases of diarrhoea are reported every year causing 1.8 million deaths, out of which 90% are children under age 5 (UNESCO, 2007). Estimate of annual total mortality from diarrheal diseases range from 2.5 - 3.5 million and more than 80% are among children under 5 years (Kosek *et al.*, 2003). The quality of any water body is governed by its physico-chemical and heavy metal factors. Therefore, the monitoring of the physico-chemical characteristics of rivers is vital for both long term and short evaluation of its quality. It is generally accepted that water bodies with good water quality produce healthier humans than one with poor water quality. Lack of access to safe drinking water is strongly correlated with poverty and the provision of safe drinking water is considered to be a fundamental step in a community's transition out of poverty (Sachs *et al.*, 2005).

In Nigeria, availability of quality water has become a significant and imperative challenge posing a great concern to families, communities and the government (Okonko *et al.*, 2008). For this reason, several studies and reports have been directed towards the assessment of the quality of rivers in the country.

The monitoring of the physico-chemical parameters of Ogun river within two locations (Akin Olugbade and Lafenwa) in Ogun State, Nigeria by Osunkiyesi, (2012) revealed that parameters such as alkalinity, pH, chloride, and magnesium were in the normal permissible range set by WHO (2003), SON (2003) while heavy metals such as chromium, lead, zinc, cadmium were below detection limit. Parameters such as nitrate, TDS, TSS, iron, potassium were found to be out of the permissible level of WHO (2003), SON (2003). The water samples collected were organoleptically observed to be brown in

colour. This was attributed to the high level of particle suspension in the river.

The high nitrate level of the river was attributed to the wastes that are being added to the river as these wastes are used by bacteria for metabolism which give out nitrite as by-product.

Dimowo (2013) studied the physico-chemical parameters of River Ogun, Abeokuta, Ogun state, Nigeria in comparison to national and international standards. Water samples were collected on monthly basis from 4 different sampling locations along the river course between the December 2011-June, 2012. A majority of water samples collected exceeded the maximum permissible limit set by SON, FEPA, USEPA, EU, WHO, NSDW for hydrogen ion concentration, total hardness and nitrate content. The dissolved oxygen level was very low during the first four months. This was attributed to the amount of effluents discharge into the river. Parameters such as the total dissolved solids and alkalinity were within the permissible limit of all the standards aforementioned while temperature which was reported to range between 26.9-32.0 ° C exceeded the maximum permissible limits of FEPA but was within the permissible limit of WHO. This is similar to the result reported by Fafioye *et al.*, (2005) in which the water temperature of Omi River, at Ago- Iwoye, Ogun State was reported to range between 26.5- 31.5˚c. The pH of the river was reported to be between 7.7± 0.15 in March, 2012 and 9.1±0.13 in December, 2011. This value also exceeded the maximum permissible limit of all the standards excluding NSDW. This value shows that the river contains soft water. Generally, the water was reported to be unfit for domestic uses, drinking, and aquaculture purposes because most of the parameters were above the maximum permissible limits of both national and international standards.

Ogun river of South-west Nigeria has been studied extensively for water quality parameters. Jaji *et al.*, (2007) studied the physico-chemical parameters of Ogun River during the rainy and dry season. He reported that deterioration in river water quality could be attributed to urban run-off, discharge of untreated sewage, industrial effluents and runoffs from agricultural field. In his study, the most important factor determining water quality of Ogun River was found to be rainfall which was responsible for the high variation in water quality parameters during rainy season and dry periods of the year. The aim of this present research is to determine the Physico-chemical parameters and heavy metals content of Toto-owu river with a view to ascertain its level of pollution.

MATERIALS AND METHODS

Study Area and Sampling Stations

Water samples were collected from Toto-owu River in Ado-Odo LCDA of Ogun state, South West, Nigeria. Ado-Odo LCDA has an estimated population of 528,242 people (Male 262,523 & Female 265,719) (2006 Census) with about four hundred and fifty (450) towns, villages and settlements (Olukayode *et al.*, 2012). Totowu River is geographically located between latitude 6°33'0.04"N and longitude 3°11'44.7"E. It links Ogun state to Igando-Isuti area of Lagos state. The river is about 350m long and takes its source from Ogun River. It is a known site for smuggling activities. It was described by the Nation newspaper of June 29, 2004 as the "unchartered smugglers' route". Three sampling stations were chosen for the study; station A is about 100m up-field from the bank of the river at the Lagos axis while station B is about 150m from station A (i.e. the middle of the river). Station C is also about 100m down-field from the Ogun state axis of the river.

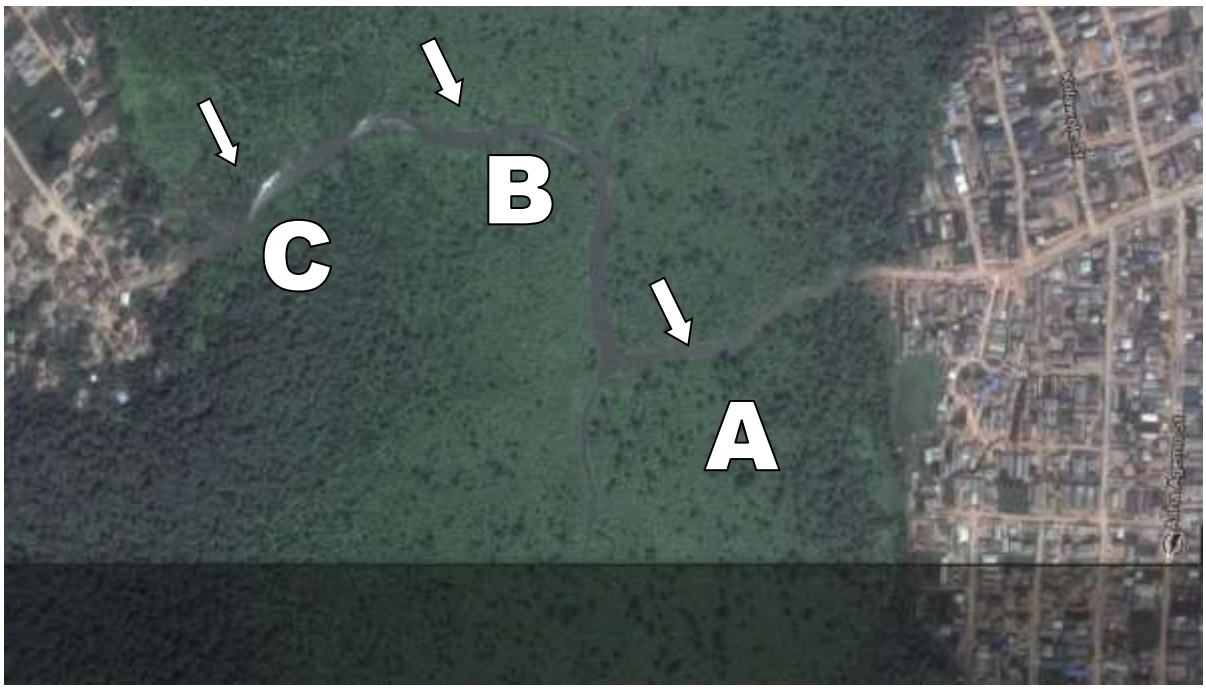

Fig1: Satellite Map showing Toto-owu River and sampling stations A, B and C in Ado-Odo LCDA, Ogun State, Nigeria.

Sampling Methods and Analytical Procedures

Water sampling was carried out in the early mornings and late evenings between 22nd and 26th of October, 2015. Ten water samples composite were collected from each station close to the right and left banks and in the middle of the river. Water samples were collected in 1.5 L Polyethylene bottles previously washed with 10% nitric acid and subsequently demineralised with water. The containers were pre-rinsed three times with the sample water before final collection according (APHA, 2003). Samples were transported to the laboratory in the Chemical Sciences Department of Yaba College of Technology and processed within 6 h of collection. Temperature, dissolved oxygen (DO), conductivity, and pH were measured insitu as field parameters by Hannar meter (model .

1945), while BOD5, COD, TSS, SO4, NO3, total hardness (TH) were analyzed in the laboratory. BOD5 was analyzed as described by 5-day test, and COD was assayed by means of the open reflux method (APHA, 2003). Additionally, total suspended solids (TSS) was determined by total solids dried at 103–105 °C. Moreover, sulfate and nitrate, were assayed by Acid Ascorbic, Sulfa Ver 4, and Nessler methods, respectively (APHA, 2003). Furthermore, total hardness was determined by titremetry with EDTA. The equipments were calibrated prior to use based on the manufacturer's directions.

Statistical analysis of data was fulfilled using SPSS version 20. Analysis of variance (ANOVA) was carried out to determine the significant differences between sampling stations

RESULTS AND DISCUSSION

Physico-chemical and heavy metal composition of the samples

The tables below show the physico-chemical and heavy metal composition of the three water samples collected from Toto-owu River.

Table *1.* Physicochemical parameters of the water samples.

Parameter	Sample A	Sample B	Sample C	Mean ± SD Values	WHO Standard
Colour	Brown	Brown	Brown		-
Temperature (˚C)	28.58	23.00	26.50	26.03 ± 2.30	30
pH	6.54	6.16	6.31	6.34± 0.16	6.5-8.5
Conductivity(µS/cm	140.00	130.00	100.00	123.33±17.00	8-10000
TDS(mg/l)	800.00	500.00	300.00	533.33±205.48	1,000
TSS (mg/l)	400.00	200.00	100.00	233.33±124.72	150
Total hardness(mg/l)	85.00	45.00	42.50	57.50± 19.47	500
BOD (mg/l)	4.21	3.51	4.14	3.95± 0.32	3
COD (mg/l)	9.02	6.49	8.18	7.88± 1.05	10
Sulphate (mg/l)	ND	ND	ND	ND	400
Nitrate (mg/l)	0.39	0.25	0.33	0.32± 0.06	5
Chloride(mg/l)	49.63	60.27	56.72	55.54± 4.42	250

Key:
SD: *Standard deviation.*
WHO: *World Health Organization;*
TDS: *Total Dissolved Solids*
BOD: *Biochemical Oxygen Demand;*
COD: *Chemical Oxygen Demand*
TSS: *Total Suspended Solids*

Table 2. Heavy metal composition of the water Samples

Heavy metal	Sample A	Sample B	Sample C	Mean ±SD Value	WHO Standard
Zinc (mg/l)	0.141	0.050	0.134	0.108± 0.040	5.000
Cadmium (mg/l)	0.021	0.000	0.012	0.011± 0.006	0.005
Lead (mg/l)	0.621	-0.089	0.610	0.381± 0.570	0.050
Chromium (mg/l	0.105	-0.005	0.094	0.065± 0.050	0.050
Nickel (mg/l)	0.012	-0.005	0.009	0.005± 0.007	---

DISCUSSION

The result obtained from the physico-chemical analysis shows the colour of all the water samples to be brown. The brownish colour of the water samples can be attributed to the presence of particle suspensions in the river. The temperature of the water samples has a mean value of 26.03 ºC. This value is below the maximum permissible limit of WHO (2006), with sample A having the highest value. This result is similar to that reported for Omi

water body in Ago-Iwoye, Ogun State by Fafioye *et al.*, (2005). The mean pH value of the water samples is 6.34 which indicate that the water is weakly acidic.

The result also show TDS, TSS to be present in water samples at mean values of 533.33 mg/l and 233.33 mg/l respectively. The TDS value is within the permissible limit of WHO but TSS is above the maximum permissible limit of WHO. The high TSS can be attributed to the dumping of municipal wastes into the river and urban run-off (Jaji *et al.*, 2007). This level of TSS is capable of causing laxative or constipation in human (Adhena *et al.*, 2015). Water hardness has a mean value of 57.50 mg/l, which is below the 500 mg/l maximum limit of WHO (2006). Based on the classification of water hardness by UNICEF (2008) & Kumar *et al.*, (2010), the water sample can be said to be soft.

The result also shows BOD and COD to have mean values of 3.95 mg/l and 7.88 mg/l respectively. The COD value is within the limit of WHO but BOD value exceeded the limit of WHO. This can be related to the reduce volume of water during the dry season and the presence of hydrophytes on the river. The sulphate content of the water samples is below detectable limit while nitrate and chloride content have mean values of 0.32 mg/l and 55.54 mg/l respectively. These values are within the standards of WHO.

The heavy metals analysis show that zinc is present in the water samples at mean value of 0.108 mg/l while nickel has mean value of 0.005 mg/l. Pb, Cr, Cd were all found to be slightly above the recommended standards of WHO with mean values of 0.381 mg/l, 0.065 mg/l and 0.011 mg/l respectively. The high level of Pb can be attributed to the corrosion of plumbing materials that pass through the river (Nor, 2007) while the Cd level can be related to the corrosion of Zn-coated galvanised pipes and machineries (such as cars, motorbikes) that are smuggled through the river. This level of Cd and Pb is capable of causing kidney diseases and delay in the physical or mental development of infants respectively.

CONCLUSION

This work presented the level of some physico-chemical parameters of Toto-owu River.

The result obtained showed that most of the parameters determined did not exceed the permissible limit of WHO except for parameters such as BOD, TSS, Cd, Cr, & Pb. Moreover, statistically significant differences were not found among sampling stations (ANOVA P>0.05,).

Due to the serious health implications of Cr, Cd and Pb it can be concluded that the water is unfit for human consumption and aqua cultural purposes.

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