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Effects of human activities on water quality assessment of Ala River in Akure, Ondo State, Nigeria

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Abstract

The purpose of this study was to assess the water quality parameters of Ala River found in Akure, Ondo State, Southwest Nigeria. The river is considered as one of the most important irrigation and drinking water resources in Akure, Nigeria. Three locations were chosen spatially along the watercourse to reflect a consideration of all possible human activities that are capable of affecting the quality of the river water. The water samples were collected monthly for three consecutive months (February to April 2015) at the three sampling sites. The water samples collected were analysed for physicochemical parameters which include pH, total dissolved solids, dissolved oxygen, biochemical oxygen demand, total hardness, phosphate, temperature, calcium, magnesium, chlorine, nitrate, iron and zinc using standard methods and their environmental effects on the river were investigated. There were variations in the quality of the sampled water when compared with the World Health Organization standards for domestic and commercial water for the selected parameters. The traces of some hazardous physical and chemical impurities in the river were above the acceptable limits, and thereby pose a health risk to several rural communities who rely heavily on the river primarily as their source of domestic water. Therefore, the law should be enforced to discourage unnecessary waste dumping and discharging of another form of pollutants into surface water in Nigeria.

Keywords: Ala River, assess, water quality, human activities, impurities, health risk.

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1. Introduction

Water is an abundant natural resource, crucial for the sustenance in all aspects of life and it is a valuable resource that needs to be well-cared-for (Kumar, Kumar, Dhindwal & Sewhag, 2011). About 75% of the earth's surface is covered with water but fresh water accounts only less than 2.7% (Kumar et al., 2011). The increasing human population has exerted massive pressure on the water all over the world especially in developing countries as a source of provision for safe drinking and irrigation purpose (Umeh, Okorie & Emesiani, 2005). Water is vital to life, well-being, food security and socio-economic development of mankind. The challenge of water quality has become a global issue. In many developing countries, it has become a critical problem of great concern to many families and communities relying on non-public water supply system (Okonko, Adejoye, Ogunnusi, Fajobi & Shittu, 2008).

Water is used for domestic, industrial and agricultural purposes by a human. The sources of water supply in nature include ground and surface water—lakes, ponds, rivers, streams, springs and rain (Adetoro & Popoola, 2014). Access to safe drinking water become imperative; hence, water needs to be conserved and valued. Despite that it is an essential commodity, access to safe drinking water in many parts of the world has been threatened basically due to the contamination of water by human activities.

The challenges of continuing population growth and urbanisation, rapid industrialisation and expanding food production are all putting pressure on water resources. A couple of these facts is the increasing unregulated or illegal discharge of contaminated water within and beyond national borders. This paper presents a global threat to human health and well-being, with both immediate and long-term consequences for efforts to reduce poverty whilst sustaining the integrity of some of our most productive ecosystems.

The sources of water supply in nature include ground and surface water—lakes, ponds, rivers, streams, springs and rain. Absolutely, pure water is unavailable in nature. The impurities in water vary from dissolved gasses and chemical compound to suspended matter such as disease, organisms and dirt. However, these impurities are acquired through contact with the environment and exist in solution, colloid and suspension forms. Impurities in water depending on the method of detection can be characterised as biological, physical and chemical while the pathogenic presence describes biological characteristics of such water (Adetoro & Popoola, 2014).

Ala River is one of the major tributaries of River Ogbese in the southwestern Akure, Nigeria. The river has a total length of about 58 km, out of which about 14.8 km is within Akure township (Ayeni, Balogun & Soneye, 2011). It took its source from the northwestern part of Akure town and flow towards the southeastern part of the town. Akure township (Figure 1) dominated upstream of River Ala while rural towns such as Ilado, Ehinala, Ajegunle, Owode Aiyetoro and Araromi are located in the downstream where the water is being used for drinking and other domestic purposes.

The purpose of this study was to assess and analyse the effect of the water quality parameters of Ala River found in Akure, Ondo State, Southwest Nigeria. Also, to investigate if the water qualities can significantly affect its utilisation for both human consumption and irrigation purposes.

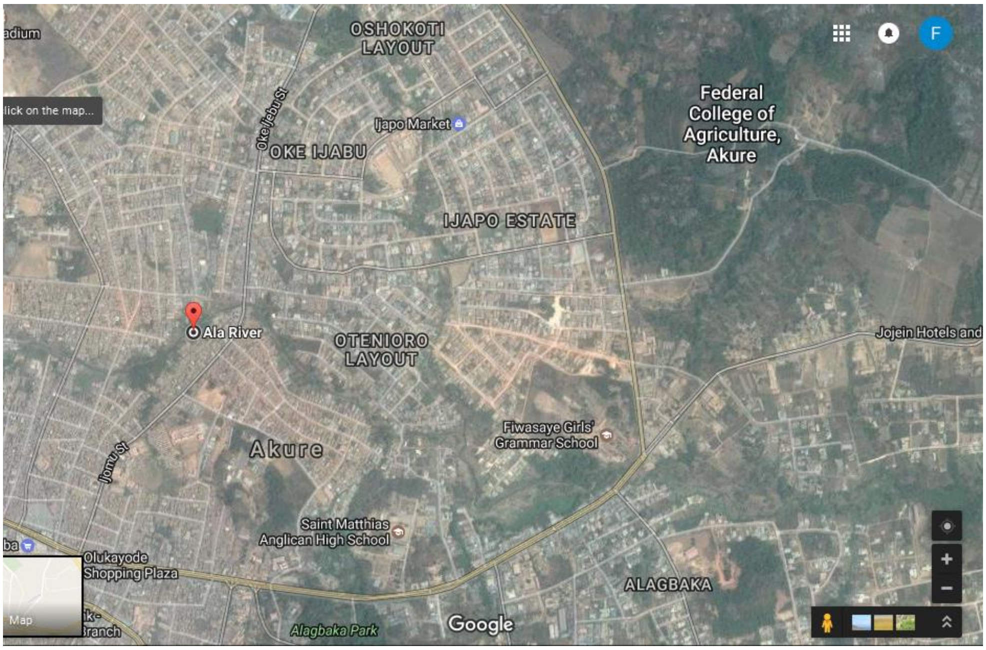

Figure 1. Google Map showing course of the Ala River in Akure, Ondo State, Nigeria

2. Materials and methods

Water samples from Ala River were collected for the study following the standard procedure as described by American Public Health Association (APHA) (1998). Samples were collected from three locations representing upstream (Araromi), midstream (Oke Ijebu) and downstream (Fiwasaye) of Ala River (Figure 1). The collection was done using sterilised plastic containers of 1.5 L capacity. The containers were dipped into the river at about 0.3 m below the water surface. The mouths of the containers were directed to the direction of flow (current) and when enough water (2 L) had entered, immediately they were corked. The temperature, total solids and pH were determined with a portable *in situ* pH meter. Sampling containers were labelled immediately using different identification marks. Water samples were temporarily stored in an ice-packed cooler and transported to the laboratory before stored in a refrigerator at about 4°C prior to analysis. These samples were collected on a monthly basis consecutively for a period of 3 months (February to April 2015). The analysis was carried out at Ondo State Water Cooperation, Alagbaka, Akure. All the tests carried out were conducted following the United States Environmental Protection Agency (USEPA) (2001) standard methods. The tests carried out on each of the selected samples are physical and chemical tests. The physical tests carried out include appearance, colour, temperature, odour, total dissolved solids, turbidity and total hardness. While the chemical tests carried out are contents of calcium, nitrogen, iron, magnesium, chloride, zinc, phosphate, total alkalinity (TA), dissolved oxygen and biochemical oxygen demand (BOD) levels of the water samples of the study area. The results obtained were compared with the World Health Organization's (WHO) (2011) water quality standard values and previous studies as shown in Tables 1–3. The statistical tool used for this analysis was Minitab version 16 software.

Table1. Physical analytical results of the water samples

S/No	Tests	Source				WHO (2011) standard
		Upstream/ Ala point 1: Araromi	Midstream/Ala point 2: Oke Ijebu	Downstream/Ala point 3: Fiwasaye	Mean value	Permissible/tolerance limit
1	Temperature (°C)	23 ± 0.8	21 ± 0.5	23 ± 0.5	22.33 ± 0.5	Cool temperature values
2	Appearance	Cloudy	Turbid	Turbid	–	Unobjectionable
3	Colour (TCU)	23 ± 1.5	26 ± 1.5	27 ± 1.5	25.33 ± 1.5	<15.0
4	Odour	Deep odour	Deep odour	Deep odour	Deep odour	Unobjectionable
5	Turbidity (NTU)	42.1 ± 1.7	36.2 ± 1.5	28.6 ± 1.5	35.63 ± 1.9	<1.0
6	Total dissolved solids (mg/L)	51.3 ± 2.4	56.2 ± 2.5	58.5 ± 2.5	55.33 ± 2.5	<600
7	Total hardness (mg/L)	210.0±10.3	198.0 ± 9.5	186.0 ± 9.5	198.0 ± 9.5	<500–1000
8	Electrical conductivity EC (μS/cm)	51.4 ± 2.0	46.5 ± 2.4	64.2 ± 2.7	54.0 ± 2.5	300

NTU = nephelometric turbidity units; TCU = true colour units.

3. Results and discussion

Table 1 shows the results of water samples tests conducted and it is observed that the temperature values of the water samples ranged between 21°C and 23°C. The mean temperature value from upstream to downstream is 22.3°C. The temperatures values obtained from the samples could be as a result of the presence of faecal organisms and waste dumping from nearby houses (domestic wastes) and the nearby waste from the roadside mechanic.

The appearance of the water samples from upstream is cloudy, while at midstream and downstream parts of the river it indicated turbidity. The colour values vary from 23 to 27 total colour units (TCU). Values increased from upstream to downstream. Upstream, midstream and downstream are having the following values 23, 26 and 27 TCU, respectively. None of the values was within the permissible limits when compared with WHO standard values. The results show that the river is not good for drinking/consumption but may be good for irrigation purpose. The variation in the impurity levels from a different location from upstream to downstream are the reasons responsible for the changes in the colour values of the sampled water. The samples collected from the river at various points had a deep odour that indicates the polluted aquatic environment. This may due to the contamination resulting from wastes dumping by the roadside mechanic and the residents living around the river course.

The turbidity of the sampled water values was extremely higher than the permissible WHO limits, which is between 28.6 and 42.1 nephelometric turbidity units (NTU). The mean value of the turbidity of water sampled is 35.63 NTU. The values obtained varied due to the level of impurity. It is observed that the turbidity decrease in value with the length of the river course with upstream having the highest turbidity and downstream water having the lowest. Upstream value is 42.1 NTU, while midstream and downstream values are 36.2 NTU and 28.6 NTU, respectively. The reduction in the level of impurities could likely result from soil filtration of the water as the river flows. River turbidity represents a key issue regarding the microbiological quality and disinfection.

Total dissolved solid values ranged between 51.3 and 58.5 mg/L. These values are within the WHO limits and it is observed that the total dissolved solids increases in value with the length of river course (i.e., the values decreased from upstream to downstream points) with the upstream water having the least total dissolved solids and the downstream water having the highest. The river water picks up substances, which are soluble gasses along the length of the river course, which renders the water unfit for consumption.

The values of the total hardness obtained from the analysis at various sampled points varied from 186 to 210 mg/L with the mean value of 198 mg/L and decreasing from upstream to downstream levels. All the samples had the total hardness concentrations below the WHO recommended levels.

Electrical conductivity (EC) is the measure of the capacity of a substance or solution to conduct electrical current through the water. The EC of all collected water samples from three (streams) locations were within the range of 46.5–64.2 µS/cm with a mean value of 54.0 µS/cm. The minimum and maximum EC obtained were found as 46.5 µS/cm at midstream and 64.2 µS/cm in downstream. All these values were below the permissible WHO limits or standard values. Low EC values indicated the little amount of dissolved inorganic substances in ionised form.

Table 2. Chemical analytical results of the water samples

S/No	**Tests**	**Source**				**WHO (2011) standard**
		Upstream/Ala point 1: Araromi	**Midstream/Ala point 2: Oke Ijebu**	**Downstream/ Ala point 3: Fiwasaye**	**Mean value**	**Permissible /tolerance limit**
1	pH	5.7 ± 0.5	6.1 ± 0.5	6.5 ± 0.5	6.10 ± 0.5	6.5–8.5
2	DO (ppm)	4.01 ± 0.5	4.21 ± 0.5	4.67 ± 0.5	4.3 ± 0.5	5–14
3	BOD (ppm)	16.12 ± 1.0	14.91 ± 1.0	13.99 ± 1.0	15.00 ± 1.0	10
4	Iron (mg/L)	4.0 ± 0.5	3.0 ± 0.5	3.8 ± 0.5	2.93 ± 0.5	< 0.30
5	Magnesium (mg/L)	49.2 ± 2.0	41.0 ± 2.0	39.1 ± 2.0	43.1 ± 2.0	150
6	TA (mg/L)	85 ± 3.0	115 ± 3.5	138 ± 3.0	112.67 ± 3.0	600
7	Chloride (mg/L)	241.3 ± 4.0	268.5 ± 4.0	273.2 ± 4.0	261.0 ± 4.0	250
8	Phosphate (mg/L)	26 ± 1.0	35 ± 1.5	42 ± 1.5	34.33 ± 1.0	50
9	Zinc (mg/L)	5.19 ± 0.5	5.15 ± 0.5	5.11 ± 0.5	5.15 ± 0.5	5
10	Calcium (mg/L)	91.9 ± 4.0	84.5 ± 3.0	81.2 ± 3.0	85.87 ± 3.0	150
11	Nitrate (mg/L)	0.51 ± 0.5	0.22 ± 0.5	0.16 ± 0.5	0.30 ± 0.5	50

DO = dissolved oxygen.

WHO = World Health Organization water quality standard values (Source: WHO, 2011).

Table 3. Comparison of the present study with the previous ones

S/No	Parameters	References			
		Our study mean value	Abulude and Akinnusotu (2015)	Yisa and Izuogu(2015)	Yonnana, Kaigamma and Jacob (2015)
1	pH	6.10 ± 0.5	4.3–7.1	6.88 ± 0.2	7.83 ± 0.06
	DO (ppm)	4.3 ± 0.5	4.21 ± 0.5	3.00 ± 1.09	5.13 ± 0.12
3	BOD (ppm)	15.00 ± 1.0	14.91 ± 1.0	0.64 ± 0.40	3.73 ± 0.06
4	Iron (mg/L)	2.93 ± 0.5	3.0 ± 0.5	–	–
5	Magnesium (mg/L)	43.1 ± 2.0	49.0 ± 2.0	–	19.11 ± 0.02
6	TA (mg/L)	112.67 ± 3.0	225 ± 3.5	2.33 ± 1.05	–
7	Chloride (mg/L)	261.0 ± 4.0	208.5 ± 4.0	–	9.12 ± 0.09
8	Phosphate (mg/L)	34.33 ± 1.0	39 ± 1.5	–	0.24 ± 0.02
9	Zinc (mg/L)	5.15 ± 0.5	5.25 ± 0.5	–	–
10	Calcium (mg/L)	85.87 ± 3.0	91.5 ± 3.0	–	24.6 ± 0.02
11	Nitrate (mg/L)	0.30 ± 0.5	0.92 ± 0.5	–	5.5 ± 0.01

DO = dissolved oxygen.

The mean (average) values for pH, dissolved oxygen, BOD, TA and other cations determined in the river water samples are shown in Table 2.

The mean (average) values of pH of the samples from upstream to downstream levels ranged from 5.7 to 6.5. These are within the ranges observed by Abulude and Akinnusotu (2015), Yisa and Izuogu (2015) and Yonnana et al. (2015). The pH levels were within WHO optimum limits of between 6.5 and 8.5. pH values lower than 6.5 are considered to be acidic for human consumption which can result in health problems such as acidosis. Also, pH values greater than 8.5 are considered to be too alkaline for human consumption.

Apart from rocks, industrial waste and sewage are sources of calcium and magnesium in their natural form. Findings show that hardwater plays a major role in heart diseases. Higher concentration of magnesium makes the water unpalatable and act as a laxative to human beings (Neha, Krishna, Vinit & Deepak, 2013). The calcium concentration of the samples from upstream to downstream ranged from 81.2 to 91.9 mg/L and magnesium concentration of these samples ranged from 39.1 mg/L to 49.2 mg/L. Values of calcium and magnesium were within the acceptable limit of WHO recommended values.

The average values for the dissolved oxygen of each point source analysed are upstream 4.01 mg/L, midstream 4.21 mg/L and downstream 4.67 mg/L, is shown in Table 2. In comparison with Abulude and Akinnusotu (2015), Yisa and Izuogu (2015) and Yonnana et al. (2015) results in Table 3, there were not many differences. These values had not met the WHO limits of 5–14 mg/L.

For the values of BOD as shown in Table 2, all the samples had not met the acceptable standard of 10 mg/L set out by WHO. High BOD means that there is lessser amount of oxygen to support life and indicates organic pollution. It denotes the amount of oxygen needed by microorganisms for stabilisation of decomposable organic matter under aerobic conditions. They do not actually indicate water quality but the potential for removing oxygen from water.

TA is the measure of the capacity of water to neutralise the acids. Alkalinity increases as the quantity of dissolved carbonates and bicarbonates increases (Neha et al., 2013; Smitha, Byrappa & Ramaswamy, 2007). TA level from the three sampling points varied from 85 to 138 mg/L with the mean value of 112.7 mg/L. Level of alkalinity increases from upstream to downstream level. Thus, TA value for all the investigated samples in upstream, midstream and downstream was found to be lower than the limit prescribed by WHO (2006).

Chlorides are mostly found in the form of salts as NaCl, $CaCl_2$ and KCl. The presence of chlorides in water has to do with the quality of taste than with health. The average maximum value was recorded at downstream level (273.2 mg/L) while the average minimum value was recorded at upstream level (241.3 mg/L). Salt contents of the river increase to downstream levels. This might be due to wastes being dumped along the river course. Hence, all the values obtained in the results were above the permissible limits of 250 mg/L set by WHO (1995).

Phosphate values obtained ranged from 26.0 to 42 mg/L with a mean value of 34.0 mg/L. Values increases from the upstream to downstream levels. All the values obtained were within the acceptable standard of WHO (1995).

Zinc ranged from 5.11 to 5.19 mg/L with the average maximum value obtained at upstream and the least average value obtained downstream level. This was the only heavy metal detected from the samples analysed. In all these samples, the concentration of zinc discovered was above permissible limits of 5 mg/L as recommended by WHO. This shows that the water from the river is not safe to drink.

4. Conclusions and recommendation

The results of the analysis showed a variation in the river water quality parameters. In most parameters, the water samples are above permissible or standard limits of WHO while in many parameters the water quality of the river falls below or rises above the recommended standards set by the World Health Organization (Kumar et al., 2011; WHO, 2006; 2011).

Therefore, the presence of some hazardous physical and chemical impurities in the river which were above the acceptable limits could pose a health risk to several rural communities who rely heavily on the river primarily as their source of domestic water and even livestock production.

Therefore, it is recommended that the quality of the river should regularly be assessed before consumption and environmental laws should be enforced to prevent indiscriminate dumping of wastes especially by residence and motor mechanics along the river course.

References

Abulude, F. O. & Akinnusotu, A. (2015). Source characterization of metals in rainwater: case study of akure, Ondo State, Nigeria. *International Journal of Environment and Bioenergy, 11*(2), 65–77.

Adetoro, A. E. & Popoola, O. (2014). Effects of waste—dumping site on water quality of Ado-Ekiti metropolis, Southwestern Nigeria. *International Journal of Engineering Innovation and Research, 3*(6), 27–36.

Ayeni, A. O., Balogun, I. I. & Soneye, A. S. O. (2011). Seasonal assessment of physico-chemical concentration of polluted urban river: a case of Ala River in Southwestern-Nigeria. *Research Journal of Environmental Sciences, 5*, 22–35.

American Public Health Association (APHA) (1998). *Standard methods for the examination of dairy products* (12th ed., pp. 90–110). New York, NY: American Public Health Association Inc.

Kumar, S., Kumar, P., Dhindwal, A. S. & Sewhag, M. (2011). *Manual on irrigation water management* (p. 104). Haryana, India: CCS Haryana Agricultural University.

Neha, G., Krishna, K. Y., Vinit, K. & Deepak, S. (2013). Assessment of physicochemical properties of Yamuna river in Agra City. *International Journal of ChemTech Research, 5*(1), 528–531.

Okonko, I. O., Adejoye, O. D., Ogunnusi, T. A., Fajobi, E. A. & Shittu, O. B. (2008). Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos Nigeria. *African Journal of Biotechnology, 7*(5), 617–624.

Smitha, P. G., Byrappa, K. & Ramaswamy, S. N., (2007). Physicochemical characteristics of water samples of Bantwal Taluk, South-western Karnataka, India. *Journal of Environmental Biology, 28*(3), 591–595.

Umeh, C. N., Okorie, O. I. & Emesiani, G. A. (2005). Towards the provision of safe drinking water: the bacteriological quality and safety of sachet water in Awka, Anambra State. In *The Book of Abstract of the 29th Annual Conference & General Meeting on Microbes as Agents of Sustainable Development, organized by Nigerian Society for Microbiology (NSM)* (p. 22). Abeokuta, Nigeria: University of Agriculture.

United States Environmental Protection Agency (USEPA). (2001). *Supplemental guidance for developing soil screening levels for super fund sites* (OSWER 9355.4-24). Office of Solid Waste and Emergency Response.

World Health Organization (WHO). (1995). *World Health Organization guideline for drinking water quality*. Geneva, Switzerland: WHO Summit.

World Health Organization (WHO). (2006). *Fluoride in drinking-water* (pp. 1–3, 83–95). London, UK: IWA.

World Health Organization (WHO). (2011). *WHO guidelines for drinking water quality* (4th ed.). Retrieved October 20, 2016, from http://www.who.int

Yisa, T. A. & Izuogu, N. E. (2015). Determination of some physico-chemical parameters of Dan-Zaria dam in Niger State, Nigeria. *Continental Journal of Environmental Sciences, 9*(2), 1–11.

Yonnana, E., Kaigamma, I. & Jacob, J. V. (2015). Assessment of water quality for human consumption from selected lakes in the Upper Benue Valley of Adamawa State, Northeastern Nigeria. *Continental Journal of Environmental Sciences, 9*(2), 12–21.