ABUAD Journal of Engineering Research and Development (AJERD) ISSN: 2645-2685
Volume 1, Issue 3, 290-294

River Water Quality Assessment: A Case Study of River Ona, South Western Nigeria

Ochuko Mary OJO

Department of Civil Engineering, the Federal University of Technology, P.M.B. 704, Akure, Nigeria
omojo@futa.edu.ng

Corresponding Author: omojo@futa.edu.ng

Date of First Submission: 21/03/2018
Date Accepted: 03/08/2018
Date Published: 31/12/2018

Abstract*: This study considered the use of World Health Organization (WHO) water standard to describe the level of pollution at both the upstream and downstream sections of River Ona. River Ona, which is the only river in Oluyole Industrial Estate of Ibadan, serves as alternative source of potable water for some of the dwellers at the upstream section of the river. There are various types of industries in the area and they all discharge their wastewater into this river. Water samples were collected and tested for physical, chemical and bacteriological parameters. Although the physical and chemical characteristics of the river water did not significantly deviate from permissible standard, the bacteriological quality of the water was poor. The value of total coliform obtained from the result of the laboratory analysis were 160 and 92 MPN/100L at the downstream and upstream sections of the river respectively. Also, the numbers of e-coli found in the water sample were 84 and 49 MPN/100mL at the downstream and upstream sections of the river respectively. These values far exceed WHO permissible limits for potable water. The study revealed an unacceptable level of bacteriological contamination, hence, water from River Ona is not suitable for human consumption without adequate treatment.*

Keywords: *River Ona, Potable water, Upstream, Downstream, Treatment*

1. INTRODUCTION

Rivers and other water bodies are the final depository of man's wastes, they are sometimes used for the disposal of garbage, sewage and waste waters [1, 2, 3]. Some major rivers worldwide are affected by water pollution [4]. Rivers are presently susceptible to contamination as a result of human population growth, complemented by the increased growth of agricultural and industrial activities [5]. Hence, regular river water examination is essential for proper watershed management in order to maintain water quality according to recognized standards [5]. The search for clean water is as old as mankind. Without water life, as it exists on our planet, is impossible [6]. In spite of the numerous importance of water, there is an increase in the daily demand of the earth's limited fresh water. In fact, scarcity of clean, fresh water is one of the world's most pressing environmental problems. [7] estimated that 2.1 million people die annually from diarrhea and 10% of the population in less developed countries suffer from parasitic worm infections and 80% of all sickness and diseases in less developed countries can be attributed to water borne infection agents and unsafe water and sanitation conditions. While 90% of the people in developed countries have adequate (safe) sewage disposal and 95% have access to clean drinking water, at least 2.5 billion people in developing countries lack safe drinking water and adequate sanitation [7]. The conditions are especially worst in the remote, developing urban centers where sewage treatment is usually not available or too expensive to obtain [7]. The poor and marginalized people living in rural and peri-urban settlements are most in need for improved and safe drinking water, appropriate forms of sanitation and access to water for other domestic purposes [8]. The increasing water demand linked to population growth and harsh climatic conditions notwithstanding, obtaining safe water for drinking and other domestic activities has remained a prerogative to the privileged few. Piped water supplies do not exist in major towns and rural settlement in Nigeria. There is prevalence of water borne diseases arising from ingestion of water contaminated with pathogen [9]. This has manifested in diseases like typhoid fever, amoebic dysentery and cholera, gastrointestinal and infectious hepatitis, which has resulted in deterioration of health and in some cases death.

One of the problems facing the people of Ibadan is inadequate supply of potable water. Rivers, streams and wells water are the alternatives to the scarce pipe borne water. Most especially in Oluyole Estate, people depend on well and river water for domestics and industrial water use since the area is not connected to any water supply grid in Ibadan. River Ona, which is the only river in the area, is being used by people for their domestic and industrial water use and also serves as a point of discharge of domestic and industrial wastewater. The concentration of industries within a particular environment or area has its various and broad advantages and disadvantages as well. One of the major disadvantages of industrial concentration is environmental pollution [10]. Monitoring water quality is very essential, consequently the assessment of the presence of pathogenic bacteria in water represents a major concern for public health protection [11, 12] Environmental pollution in the form of

water pollution is a serious concern for water resources engineers around the world. Consumption of river water with little or no treatment and discharge of domestic and industrial waste in river without adequate treatment can be hazardous, hence the aim of this paper is to assess the water quality of River Ona both at the upstream and the downstream section and to compare the results obtained with WHO standard for potable water.

2. METHODOLOGY

2.1 Case Study Area

Ibadan is the capital of Oyo state and the third largest metropolitan city in Nigeria, after Lagos and Kano with a population of 1,338,659 according to the 2006 census. It is located between coordinates 7023'47" N and 7.396390 N, 3055'0"E and 3.9166670E. On the northern part of the city, River Ona is the main river, adjoining streams [13]. River Ona is one of the two major rivers draining the city of Ibadan, Oyo state. The river has a length of 55 km and area of 81.0 km^2 [14]. Oluyole Industrial Estate has a population of 282,585 people based on 2006 census figure. It is blessed with social amenities such as, schools, hospitals and recreational centers. It also has a well-built road network and has the largest concentration of industries in Ibadan. Oluyole Industrial Estate is blessed with 19 large-scale industrial establishments as well as some small-scale industries [15]. Some of the industries are 7-Up Bottling Company, Nigerite, Procter and Gamble, Zartech, Sumal Nigeria Limited, Calex Aluminum and Yale Foods. Oluyole Industrial Estate is basically an industrial area with some residential building located in the area through which River Ona flows and serves as a major recipient of untreated effluent and domestic waste in the area [14]. A map of the study area is shown in Figure 1. The river receives a lot of wastes ranging from industrial, agricultural and domestic sources including organic and inorganic matter and also serves as source of water for domestic purpose such as cooking, washing and bathing. The upstream part of the river is used by the residents of Oluyole Estate to meet their water needs, while the industries discharge their waste into the downstream portion of the river.

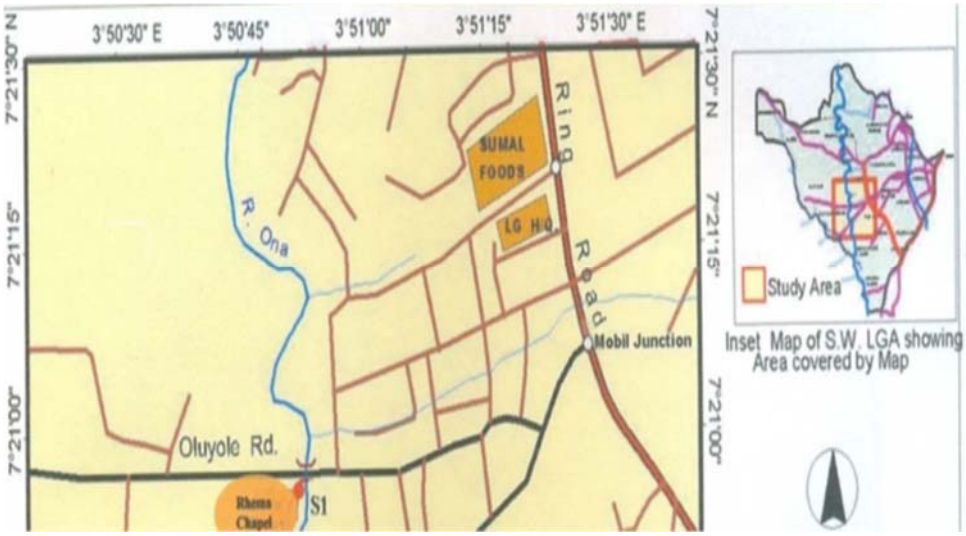

Figure 1: Map of Oluyole Industrial Estate showing River Ona.
Source: [14, 16]

2.2 Sampling Technique

Water samples were collected at both upstream section and downstream section of River Ona in clean plastic bottles which were pre-washed with the river water. The samples for physical and chemical analysis were collected in 1- liter plastic containers, while the samples for bacteriological analysis were collected in sterile bottles. All samples were taken to the laboratory within 4 hours of collection. A comprehensive physical, chemical and bacteriological analysis was carried out on the water samples.

The physicochemical examination of the water samples were completed within six hours of sample collection. The colour and turbidity of the samples were examined with a digital spectrophotometer. A calibrated conductivity meter was employed for the determination of the Conductivity of the water samples. The pH of each water sample was determined immediately after receiving the sample at the laboratory using a calibrated pH meter. Heavy metals were determined by digesting a known volume of the water sample with analytical grade HNO_3. The water extracts were analyzed for heavy metals by atomic absorption spectrometer. Other chemical analyses of the samples were done using methods specified in [17].

3. RESULTS AND DISCUSSION

The results of the water quality analysis performed on the water samples is presented in Table 1.

Table 1: Result of water quality analysis on River Ona

S/N	Parameters	Downstream Section	Upstream Section	WHO Guideline
1	Appearance	Brown	Brown	No guideline
2	Taste and Odour	Odourless	Odourless	Odourless
3	Colour (HU.)	70	50	15
4	Turbidity (NTU.)	1.98	1.30	5
5	Conductivity (µS/CM)	306	390	1000
6	PH	7.0	7.6	6.5 – 9.5
7	Temperature (^oC)	25	25	-
8	Salinity	144	186	-
9	Dissolved Oxygen (mg/L)	15.5	13.7	-
10	Total Alkalinity (mg/L)	140	130	-
11	Total Hardness (mg/L)	114	130	500
12	Calcium Hardness (mg/L)	62	104	100 – 300
13	Calcium ion (mg/L)	24.8	41.6	20
14	Magnessium Hardness (mg/L)	52.0	26.0	-
15	Magnessium ion (mg/L)	12.69	6.34	-
16	Chloride (mg/L)	39	46	2.5
17	Iron as Fe_2O_3 (mg/L)	0	0	1 – 3
18	Silica (mg/L)	<4	<4	-
19	Nitrate – NO (mg/L)	0	0	-
20	Nitrate - NO_3 (mg/L)	0	0	50
21	Nitrite – NO_2 (mgLl)	0	0	3
22	Sulphate (mg/L)	35	46	100
23	Total Dissolved Solid (mg/L)	282	364	500
24	Total Filterable Solid (mg/L)	68	88	-
25	Total Non-Filterable Solid (mg/L)	214	276	500
26	Chlorine Demand (mg/L)	3.1	3.3	5
27	Flocculation (mg/L)	50	40	-
28	Coliform Org. (MPN/100mL)	160	92	10
29	E – Coli (MPN/100mL)	84	49	0

NTU - Nephelometric Turbidity Unit, HU – Hazen Units, mg/L – milligramme per Litre, MPU – Most Probable Number, µS/cm - one millionth of a siemens per cm

3.1 Physical Parameters

The turbidity values obtained for the downstream and the upstream sections respectively were 1.98 and 1.30 NTU. The turbidity values obtained did not exceed the WHO guideline of 5 NTU. The river water was odourless at both upstream and downstream sections with a colour value of 70 HU at the downstream and 50 HU at the upstream. The colour of the water exceeded the WHO guideline of 15 HU. The total solids were 282 and 364 mg/L at the downstream and upstream sections of the river respectively. The values obtained did not exceed WHO maximum permissible limit of 500 mg/L. The value of suspended or filterable solids were 68 and 88 mg/L at the downstream and upstream sections respectively while dissolved or non-filterable solids were found to be 214 and 276 mg/L at downstream and upstream sections respectively. The temperatures of the water upstream and downstream were normal with a value of 25^{o}C. The total solids and other physical parameters of the sections of the River Ona according to WHO water standard fell within permissible limits.

3.2 Chemical Parameters

Chloride salts are common water contaminants which originate from sewage, industrial effluents and urban runoff containing salt. Chloride value of 39mg/L and 46mg/L were observed for downstream and upstream sections of the River Ona respectively. This exceeded permissible limits. According to WHO standard, chloride concentration in excess of 2.5mg/L can give rise to detectable taste in water.

The chlorine demand was found to be 3.1mg/L at downstream and 3.3mg/L at upstream section of the river showing that the river is bacteriologically polluted.

Hardness is the presence of calcium and magnesium ions in water. It is caused by dissolved calcium and, to a lesser extent, magnesium. The total hardness of both the sections of the river was below 200mg/L so scale deposition will not occur on heating.

One of the problems created by silica is scaling in boilers and silica scale is difficult to remove. The concentration of

silicate for upstream and downstream sections of the river was less than 4mg/L.

Sulphate occurs naturally in numerous minerals and is also used commercially in the chemical industries. It is discharged into water in industrial wastes and through atmospheric deposition. The sulphate concentration of River Ona was 35mg/L and 46mg/L for downstream and upstream sections respectively.

Dissolved oxygen is very crucial for the survival of the aquatic organisms and also used to determine the freshness of a river. Besides the need of water for drinking, water resources play a vital role in various sectors of economy such as agriculture, livestock production, fisheries and other productive activities [18]. The water at the downstream and upstream sections of the river were rich in dissolved oxygen with values of 15.5 and13.7 mg/L respectively. A low level of dissolved oxygen in water which is an indication of pollution can lead to de oxygenation of blood through the consumption of such water and this can lead to death.

The measurement of water's electrical conductivity can provide assessment of total ionic concentrations. Electrical conductivity levels were 306 and 390µs/cm upstream and downstream respectively. This did not exceed the WHO standard.

3.3 Bacteriological Parameters

The spontaneous growth of housing units coupled with rapid population explosion has resulted in environmental health hazards [19, 20] such as bacteriological contamination of water bodies. Total coliform and *e-coli* are indicator organisms used to assess the level of bacteriological contamination of water. In this study, the value of total coliform were 160 and 92 MPN/100L at downstream and upstream sections respectively. The numbers of *e-coli* found in the water samples were 84 and 49 MPN/100mL at downstream and upstream sections of the river respectively. These values far exceed WHO permissible limits for potable water. Hence, the results showed that the river water is bacteriological contaminated and is not suitable for human consumption. E-coli occur in high numbers in human and animal faeces, sewage and water subject to recent faecal pollution.

4. CONCLUSION

River Ona in Oluyole Industrial Estate of Ibadan is highly polluted due to the many domestic and industrial activities in the area, and according to the WHO water standard is unfit for human consumption and other domestic purposes. Drinking of this water can cause various waterborne diseases such as diarrhea, cholera, typhoid, paratyphoid, meningitis and urinary tract infections. Contact with this water can cause water-washed diseases like trachoma, scabies and other skin infections. Based on findings of this study, River Ona water is unfit for domestic use without proper treatment.

5. RECOMMENDATION

It is recommended that wastes from industries in the area should be purified in a treatment plant before they are discharged into the river in order to reduce water pollution and its effect on health. The public should be educated on how to control water pollution, the effects of water pollution on public health and on how water can be treated locally before use.

ACKNOWLEDGMENT

The author acknowledges the contributions of Taofeeq Taiwo Oyelowo, who assisted in carrying out the experiments described in this study.

REFERENCES

[1] Adebowale, K. O., Agunbiade F. O. & Olu-Owolabi, B. I. (2008). Fuzzy comprehensive assessment of metal contamination of water and sediments in Ondo estuary, Nigeria. *Chemical Ecology*, 24: 269-283.

[2] Adeniyi, A. A., Yusuf, K. A. & Okedeyi, O. O. (2008). Assessment of the exposure of two fish species to metals pollution in the Ogun river catchments, Ketu, Lagos, Nigeria. *Environmental Monitoring and Assessment,* 137: 451-458.

[3] Yusuf, K. A. & Osibanjo, O. (2006). Trace metals in water and sediments from Ologe lagoon, southwestern Nigeria. *Pakistan Journal of Scientific and Industrial Research,* 49: 88-89.

[4] Besemer, K., Moeseneder, M. M., Arrieta, J. M., Herndl, G. J. & Peduzzi, P. (2005). Complexity of bacterial communities in a river flood plain system (Danube, Austria). *Applied and Environmental Microbiology,* 71:609– 620.

[5] Kolarevic´, S., Knez˘ evic´-Vukc˘ evic´, J., Paunovic´, M., Tomovic´, J., Gac˘ ic´, Z. & Vukovic´-Gac˘ ic´, B. (2011). The anthropogenic impact on water quality of the river Danube in Serbia: microbiological analysis and genotoxicity monitoring. *Archives of Biological Sciences*, 63: 1209–1217.

[6] Asthana, D. K. & W. Asthana (2001). Environment: Problems and Solutions. Second Revised Edition. S. Chand and Company Ltd, New Delhi. 444 pp.

[7] World Health Organization (2004). Water Sanitation and Health Programme. Managing water in the home: accelerated health gains from improved water sources. World Health Organization. www.who.int.

[8] Crow, B. (2001). Water: gender and material inequalities in the global south. Centre of Global, International and Regional studies. University of California, Santa Cruz.

[9] Onoja, S. B. & Adelakun, A. A. (2009). Water bone disease and their implications for Economic losses by farmers in Benue State. *Journal of Production Agriculture and Technology,* 5 (1): 246 – 256.

[10] Environmental Protection Agency, EPA (2006). Construction Site Stormwater Runoff Control. *National Menu of Stormwater Best Management Practices.* Available online at

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm. Retrieved on 8th July, 2015.

[11] Fey, A., Eichler, S., Flavier, S., Christen, R., Ho¨ fle, M. G. & Guzma´ n,C. A. (2004). Establishment of a real-time PCR-based approach for accurate quantification of bacterial RNA targets in water, using Salmonella as a model organism. *Applied and Environmental Microbiology*, 70: 3618– 3623.

[12] Straub, T. M. & Chandler, D. P. (2003). Towards a unified system for detecting waterborne pathogens. *Journal of Microbiological Methods*, 53: 185–197.

[13] Agaja, T. M., Ajibade, L.T. & Alabede.T.E. (2013). Pollution Impacts of Industries along Eleyele River in Oluyole Industrial Housing Estate, Ibadan, Nigeria. *Asian Academic Research Journal of Social Sciences & Humanities,* 1 (17): 411-426.

[14] Adjarho, U. B., Esenowo, I. K. & Ugwumba, A. A. A (2013). Physico-chemical Parameters and Macroinvertebrates Fauna of Ona River at Oluyole Estate, Ibadan, Nigeria. *Research Journal of Environmental* and *Earth* Sciences*,* 5 (11): 671-676.

[15] Adeoye, N. O. & Oluwadare, C. O. (2012). Behavioural Responses of Environmental Impacts of Industrial Establishments in Oluyole Industrial Estate, Ibadan, Nigeria. *Ife Research Publications in Geography*, 11 (1):22- 31.

[16] Adem, A.B., Udofia, U., Okorafor, K.A., Okete, J.A. & Ugwumba, A. A. A. (2012). A Study on Some Physical and Chemical Characteristics of Ona River, Apata, Ibadan South-west, Oyo State, Nigeria. *European Journal of Zoological Research*, 1 (2): 37-46.

[17] American Public Health Association (APHA) (2005). Standard Methods for the Examination of Water and Wastewater. 20th Edn., American Public Health Association, Washington C., U.S.A.

[18] Effendi, H. (2016). River water quality Preliminary Rapid Assessment using Pollution Index. *Procedia Environmental Sciences*, 33: 562 – 567.

[19] Awofemi, O. S. & Awokunmi, E. E. (2015). The Impact of Municipal Solid Waste Disposal in Ado-Ekiti Metropolis, Ekiti State Nigeria. *African Journal of Environmental Science and Technology*, 3 (8): 186 – 189.

[20] Ejiogu, C. C., Okpara, C. B., Opara, K. D., Onyeocha, I. O., Azubuike, C. & Emeh, A. A (2018). Effects of Solid Waste Disposal on the Physicochemical Properties of Borehole Water along FUTO Road, Eziobodo, Owerri-West, Nigeria, *Current Journal of Applied Science and Technology,* 26 (1): 1 – 7.