International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 7, July - 2014

Assessment of Surface Water Quality in Some Selected Locations in Port Harcourt, Nigeria

Arimieari, L.W.[1]*, Sangodoyin, A. Y.[2] and Ereoforiokuma, N. S.[3]
[1,3]. Department of Civil Engineering,
Rivers State University of Science and
Technology, Port Harcourt, Nigeria.
[2.] Department of Agricultural and Environmental Engineering
University of Ibadan, Ibadan, Nigeria.

Abstract - In this study, an assessment of surface water in Port Harcourt, Nigeria was undertaking using standard methods. The study determined the level of pollution and the effect on the quality of water in the creeks. Water quality analysis was performed for 15 parameters ranging from physico-chemical properties, microbiological and heavy metals at 3 locations to identify the factors influencing the water quality and to ascertain whether the water are within the acceptable standard set by WHO. The result from the present study indicates slight variation in pH between stations. High pH was found in the commercial and industrial areas as compared to the residential area. The level of microbial pollution follow the trend, Island > Amadi > Bonny/Belle creek. The total hardness, total alkalinity, total dissolved solid, sulphates, chlorine, magnesium and calcium follow the trend of Bonny/Belle > Island > Amadi. The statistical analysis of the parameters indicate that Port Harcourt surface water is highly polluted. The DO, BOD, and total dissolved solids are not within the permissible limits given by WHO. This necessitates the need for water treatment plant, a constant monitoring of the heavy metals concentrations and waste disposal habit in the study area.

KEYWORDS: Surface Water, Quality Analysis, Pollution, Port Harcourt, Nigeria.

INTRODUC`TION

Water is one of the most important of all natural resources. It covers 71% of the earth's surface and is vital for all known form of life. Human existence is threatened by inadequate quantity of good quality water. In the Niger delta region of Nigeria, surface water is an essential and vital resource for the people and it is a source of water for drinking in some rural areas, and in farming and manufacturing especially during the dry season or when the public water supply is irregular.

Contamination of surface waters have also been linked with the deterioration of water in adjacent aquifers. The high values of coliform reported for some river water samples confirm faecal pollution from domestic sewage, dumping sites and abattoir activities [2]. High coliform values are typical characteristics of many rivers in Nigeria. High population of faecal coliform has also been reported in Ikpoba River, Edo state of Nigeria [5]. Coliform values in the range of 3,100-150, 000 cfu /100 ml at Iddo area of the Lagos lagoon was also reported [4].

It has also been observed that pathogenic contamination of Nigeria's rivers come from aquaculture practices involving fertilization of ponds with cow and poultry manures and direct dumping of feacal matters into the rivers [3]. Assessment of water is not only for suitability for human consumption but also in relation to its agricultural, industrial, recreational, and commercial uses and its ability to sustain aquatic life. Water quality monitoring is therefore a fundamental tool in the management of freshwater resources.

Water quality assessment is the overall process of evaluation of the physical, chemical and biological nature of water in relation to natural quality, human effects and intended uses [6]. At present, the assessment of surface and groundwater in Nigeria is carried out mostly by Research Institutions, individual researchers in the Universities, Government Agencies and some other organizations. The data on the water quality of major rivers, stream, creeks, wells and boreholes in Nigeria may not be comprehensive since monitoring is not properly coordinated and quality assurance programs is not incorporated in most of the studies.

Environmental monitoring of surface water indicated that streams and rivers in Nigeria are showing increasing trend of water pollution due to increased population, industrialization and urbanization [1]. Waste generation by industries and households has continued to increase and are impacting on surface water quality.

This study is aimed at assessing surface water quality in Port Harcourt city, Rivers State, Nigeria and to determine the extent to which various waste disposal habits in the city impact on water quality.

MATERIALS AND METHODS

Port Harcourt City as a case study is located within the Niger Delta Basin of Southern Nigeria. Port Harcourt is located within the eastern lower Niger Delta in the south eastern part of Rivers State of Nigeria. It is situated at the right bank of the Bonny River approximately 65km inland from the Bight of Bonny. Geographically, the area lies between latitudes $4^0$30' and $5^0$00'N and longitudes $6^0$45' and $7^0$30'E. It is bounded on the East and West by meandering Creeks, on the South by first the blockyard creeks, then the Bonny River and finally mangrove swamps and on the north by Abia State. The southern part of the town stands largely on raised levees with silts and clay foundation. These afford permanently dry and firm points within the zone of its fresh water swamps of the Niger Delta. It covers an area of 290km^2 and the mean annual temperature is about 28^0C. Fishing, small scale agriculture and huge oil exploration and exploitation dominate economic activities in the area. The main source of water supply is the creek and is mainly for fishing.

The study adopted both field and laboratory based procedures to generate the data required. Water samples were collected at different locations of Port Harcourt representing Commercial (Borikiri axis), Industrial (Trans Amadi axis) and Residential (Diobu axis) zones. The sample points were the Amadi creek, Eagle island creek and Bonny/Belle creek.

All these creeks located in the city of Port Harcourt were also linked with other streams and rivers like Ntawogba Stream which lies on the extreme west of the municipality and drains the marshy swamp forest upstream of Rumueme and Rumuepirikom and empties into Amadi creek. The Miniweja Stream system drains the freshwater (Rumuigbo/Rumuola) forest and passes through various communities and empties into Diobu Creek of Bonny River. Miniokoro Stream drains the freshwater swamp forest into Woji creek from where it eventually empties into the Bonny estuary. Agboncha which lies in the east flank of Port Harcourt drains the freshwater swamp forest and empties through Obufe /Elelenwo creek into the Bonny estuary. Minichida drains the freshwater swamp forest, meanders through communities and empties into Elelenwo creek in Bonny estuary. All these rivers and creeks drain into the Bonny River and have a direct link with Aggrey creek (the Borokiri creek). These areas were selected for clear assessment of Port Harcourt water quality.

Water samples for Dissolved Oxygen and Biochemical Oxygen Demand was collected in 2 separate 250ml sample bottles. The DO samples was fixed immediately after collection with Winkler I and II reagents while the BOD_5 was stored alongside the DO samples after collection before they were taken to the laboratory for further analysis.

Sample for other parameters such as alkalinity, total hardness, nitrate, ammonia, sulphate, phosphate, and chloride was collected in a 500ml plastic bottle from each station, stored in an ice chest and transported to the laboratory. All analysis was done using Standard Methods.

RESULTS AND DISCUSSION

The physico-chemical properties of the samples of surface water from the three locations in Port Harcourt, representing impact on water quality from residential, industrial and commercial areas of Port Harcourt is shown in Table 1.

A comparative analysis of the physical, chemical and microbiological characteristics of the water samples indicate that all the parameters are above desirable limits, with the exception of pH which range from 6.8 to 7.1(Table 1). Salinity range from 3.1 to 17.2 while temperature range from 26.3 to 26.8^{0}C. The sulphate and magnesium concentration in Amadi creek were 131.7 and 46.7mg/l respectively. The Iron and Manganese range from 0.176 to 0.866mg/l and 0.026 to 0.088mg/l respectively and are within the limits prescribed for various uses of water including drinking [8].

The pH was found to have slight variations between stations. High pH was found in the commercial and industrial area as compared to the residential area. The lower pH value of 6.77 in Island/Diobu creek is associated with the high freshwater emptying into the creek from the adjoining creeks. Municipal drains, standing water body, numerous open drains, pit latrines and domestic waste disposal into the creek impact on both the flow and water quality of the creek.

The value of conductivity, Total dissolved solids, Total hardness, calcium and magnesium were high in Belle Creek as compared to Island and Amadi creeks. The high total dissolved solid content of the sample from Belle Creek could be due to the dumping of refuse at the bank of the creek by traders in the area. Total hardness of the samples is higher than the desired level in the present study. The water appears to be hard since it is above the limit and it is not economically desirable or good for industrial application. In general the water quality parameters follow the trend Bonny/Belle > Island > Amadi.

Dissolved oxygen (DO) is one of the most vital factors in assessing stream quality. Its deficiency directly affects the ecosystem of a stream due to several factors which include physical, chemical, biological and microbiological processes. DO is needed to support biological life in aquatic systems. The levels observed for the study creek range from 0.8 - 7.3mg/l and 4.0 – 24.0mg/l for DO and BOD respectively. The DO of samples from Amadi and Belle Creeks representing industrial and commercial area with 0.8mg/l and 0.4mg/l, are so low that they may not sufficiently support aquatic life. The objectionable low concentration of DO may be associated with municipal discharges and attendant organic load.

The surface water sample that had high conductivity values indicate the presence of dissolved salts. The values of sulphates, chlorine, magnesium and calcium follow the trend of Bonny/Belle > Island > Amadi creek. The result of microbial population show total coliform ranging from

80-390/100ml and faecal coliform bacteria of 80/100ml concentrations in Island and Amadi creeks. Coliform was not-detected in Belle Creek. The values of total heterotrophic bacteria (THB) ranged from 2.6×10^{2}-16.8×10^{3}cpu/ml and indicate the seriousness of the impact of municipal wastewater on the receiving surface waters. The health hazards implication to ignorant users is high as the water is likely to sustain high growth of pathogenic organism. The level of microbial pollution follow the trend Island > Amadi > Bonny/Belle. The water samples in general fail to meet the standard of drinking water set by WHO [7].

The presence of Iron and Manganese in the study area could be attributed to high organic matter and low dissolved oxygen content. Iron and Magnesium in Amadi creek is traced to industrial and consumer waste in the highly industrialised area.

STATISTICAL VARIATION OF SURFACE WATER

Table 2 shows the statistical variation in the parameters of surface water of the study area. The mean of the different parameters shows that the surface water in Port Harcourt area is highly polluted. The high level of pollution indicates that Port Harcourt surface water is not good as a means of water supply in its present state because of its quality impact.

The high salinity shows that the intrusion of seawater into the surface water is high. It also confirms the effect of discharge of wastes.

Table 1: Characteristics of surface water quality in Island, Amadi and Bonny/Belle creeks in Port Harcourt, Nigeria.

Parameters	STN1 CREEK	STN2 CREEK	STN3 CREEK	WHO HDL	WHO MPL
pH	6.77	7.07	7.08	5	5
conductivity(μS/m)	14000	5850	27800	5	25
Salinity (%)	8.1	3.1	17.2	7-8.5	6.5- 9.2
Temp. (℃)	26.8	26.8	26.3	NIL	NIL
TDS	9800	4095	19460		
Sulphate	792.7	131.9	1116.5	200	400
Phosphate	<0.05	<0.05	<0.05		
Chlorine	4248.4	1679.6	10374	200	400
Total Hardness	1150	575.0	3832	100	500
Total Alkaline	64	24	68		
Calcium	230.0	153.3	766.6	75	200
Magnesium	140.0	46.7	466.5	50	150
DO	7.3	0.8	0.8		
BOD	2.4	0.4	0.4		
Nitrate	0.60	0.51	< 0.05	45	50
Iron	0.451	0.866	0.176		
Manganese	0.082	0.088	0.026		
Faecal Coliform bacteria/100ml	80	80	0		
Total heterotrophic bacteria (cpu/ml)	16.8×10^3	7.6×10^3	2.6×10^2		
Total coliform/100ml	390	250	80		

N/B STN = STATION
All parameters in mg/l except where stated.

Permissible limits:

(WHO, 1996) Total Heterotrophic bacterial (cfu/ml) <1000 (unpiped water), <100 (piped water). Total coliform bacteria (coliforms/1OOml): 0-10 (unpiped water), 0-2 (piped water). Faecal coliform bacteria (coliforms/lOOml): 0 (unpiped and piped water).

Table 2: Descriptive Statistics of surface water

Parameters	**Surface water**	
	Mean	**Standard deviation**
pH	6.97	0.176
Conductivity (µS/m)	15883	11095.5
Salinity (%)	9.5	7.15
Temp. (℃)	26.6	0.29
TDS	11118	7766.9
Sulphate	680.3	501.9
Chlorine	5434	4466.8
Total Hardness	1852.3	1738.4
Total Alkaline	52.0	24.3
Calcium	383.3	334.2
Magnesium	217.7	220.4
DO	3.0	3.8
BOD	1.1	1.2
Iron	0.498	0.347
Manganese	0.065	0.034
Faecal Coliform bacteria/100ml	53.3	46.2
Total heterotrophic bacteria (cpu/ml)	8.2×10^{3}	8287.5
Total coliform/ 100ml	240	155.2

All parameters in mg/l except where stated.

CONCLUSION

Port Harcourt creeks have been subjected to various contaminated materials capable of initiating the impairment of water quality. The present study of physical, chemical and biological characteristics as well as heavy metals of the surface water provided a considerable insight into the quality of surface water. The increasing concentration of chemicals generated from industries, the domestic wastewater and their subsequent release to surrounding raise a wide spread and increasing public concern over the use of the surface water. The present study shows that the surface waters are highly polluted with nitrates, chlorides and sulphates. Similarly, the DO, BOD, and total dissolved solids values are not within the permissible limits given by WHO. There is an urgent need to arrest the problem of pollution in Port Harcourt creek to protect the water body, maintain its water quality and enhance its use for domestic purposes. To this end, the

Establishment of operational team to provide local and regional planning and environmental management authorities with data is necessary. The team will check for compliance with guidelines and prescribe standards for effective water usage and environmental protection measures.

There is need for enactment of law that will prohibit manufacturing industries from discharging harmful chemical waste into the creek without treatment.

REFERENCES

[1] A. M. Taiwo, O. O. Olujimi, O.Bamgbose, and T. A. Arowolo, "Surface Water Quality Monitoring in Nigeria: Situational Analysis and Future Management Strategy", Water Quality Monitoring and Assessment, Dr. Voudouris (Ed.), ISBN: 978-953-51-0486-5, InTech, DOI: 10.5772/33720. Available from: http://www.intechopen.com/books/water-quality-monitoring-and-assessment/surface-water-quality-monitoring-in-nigeria-situational-analysis-and-future-management-strategy. pp. 302-315, 2012.

[2] A. Y. Sangodoyin, "Interaction between ground and surface water qualities; A case study of Ogunpa stream," Proceedings of the third Annual conference/symposium of Nigeria Water and Sanitation Association 19-18 October, Port Harcourt, pp 4.1-4.27, 1989.

[3] E. E. Obasohan, D. E. Agbonlahor, and E. E. Obano, "Water pollution: A review of microbial quality and health concerns of water, sediment and fish in the aquatic African ecosystem," Journal of Biotechnology, Vol. 9, No. 4, pp. 423-427, 2010.

[4] E. O. Nwankwu, "Microbial quality of Lagos lagoon water and important commercial fish species," In: Annual Report, Nigeria Institute for Oceanography and Marine Research, Lagos, pp. 37-38, 1992.

[5] J. F. K. Tatah, and M. J. Ikenebomeh, "Influence of brewery effluent on heterotrophiccounts and some physical parameters of Ikpoba Tropical River, Nigeria," Nigerian Journal of Microbiology, Vol. 13, pp. 55–58, 1999.

[6] United Nations Educational, Scientific and Cultural Organization , World Health Organization and United Nations Environment Programme Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring- Second Edition, UNESCO/WHO/UNEP, 1996.

[7] World Health Organization (WHO), "Guidelines for Drinking Water," Health criteria and other supporting information, Geneva, Switzerland, pp 940-9, Addendum to vol 2, pp 281-3, 1996.

[8] World Health Organization, "International Drinking Water Standards," 3rd Edition, Geneva, WHO, 2007.