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Full Length Research Paper

Physico-Chemical Parameters and Heavy Metals Concentrations in Eleyele River in Oyo State, South-West of Nigeria

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Abstract

A quarter of all the metals released to the seas by human activities was estimated to enter via rivers. This therefore motivated this study, carried out in Ibadan in Oyo State, Nigeria, to determine the extent of pollution that arises from the activities that take place around the Eleyele river. Composite samples of surface water were collected from five different locations along the river bank where the dam empties into the river and also where major activities take place. The samples were subjected to laboratory analysis using Atomic Absorption Spectrophotometer (AAS) to assess the levels of heavy metal pollution such as Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Nickel (Ni) and Zinc (Zn). Standard procedures (including on site analyses) were used to determine the physicochemical parameters such as pH, temperature, electrical conductivity, solids, nitrate, DO, and total hardness of the surface water samples. The ranges of values of the observed parameters were temperature: (27.2 – 28.2) ^{o}C; pH: (6.66 – 7.02); electrical conductivity: (242 – 291) µs/cm; total solid: (134 – 155) mg/L; nitrate: N.D. dissolved oxygen: (3.20 – 3.74) mg/L; total hardness: (49.63 – 66.0) mg/L. All the values were within the WHO, WHO/UNICEF and the USEPA guidelines but the river water requires little treatment to meet the environmental quality on WHO standard limit for potable water.

Keywords: Physico-chemical parameters, Heavy metals, pollution, surface water, Eleyele River, Oyo state.

INTRODUCTION

Human needs are viewed as a means of meeting the needs of the current generation without compromising the ability of the future generation as well. One of such resources needed to achieve this in order to meet the Millennium Development Goals (MGDs) is water. Most livelihood activities depend on the availability of water. However, in many semiarid and arid regions of the world, freshwater is a scarce resource. Fresh surface water is usually available in sufficient quantities during the rainy season but the rainy season only last for 4 months during which rainfall can be erratic, necessitating irrigation. Water for irrigation is also required for the long dry season. Groundwater may be expensive to access because of low water tables that translate into high costs associated with drilling wells and pumping the water. Seeking other sources of water to support livelihoods therefore becomes critical to the question of poverty reduction. However, the best of this vital resource is being lost as a result of its continuous pollution. Pollution which is majorly an environmental problem has been seen as the introduction by man of substance(s) or energy(ies) into the environment and in the process, prevent(s) or alter(s) the intended use of the environment (Egborge and Fagade, 1999; Fakayode, 2005; Nubi et al., 2008). These polluting substances are referred to as pollutants (Duruibe et al., 2007). Air, land and water are the primary media through which these

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pollutants penetrate the environment and are also being increasingly stressed through the action and inaction of man leading to environmental pollution (Ibe et al., 1992).

Every human use of water, whether for drinking, irrigation and industrial processes or for recreation 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).

Water is the major component of the biosphere and is essential in the lives of living things on earth and its usefulness depends on the intended purpose. The introduction of foreign substances into water bodies may either pollute the water or increase nutrients for aquatic microorganisms (Boukori et al., 1999). Water is polluted or contaminated if its chemical and physical properties are altered and these alterations affect the aquatic lives adversely (Eletta, 2007). One of such pollutants is metal through anthropogenic activities like mining, ultimate disposal of treated and untreated waste effluents containing metals (Amman et al., 2002).

Metals have the potential to be toxic to living organisms if present above threshold levels. Most industrial and urban runoffs contain a component of trace metals in the dissolved or particulate form. Contaminations caused by trace metals affect the ocean waters, continental shelf and coastal zone, besides having longer residence time. Metal concentrations are higher due to the input and transport by runoff and the proximity of industrial and urban zones hence, metals from incoming tidal water and fresh water sources are rapidly removed from the water body and are deposited onto the sediment (Fernandez et al, 1994 and Watt et al, 2000). Since heavy metals cannot be degraded biologically, they are transferred and concentrated into plants and animal tissues from soil and water posing long term damaging effects on the affected species. It is noteworthy that different species react differently to wastewater. Some are more resistant to heavy metals while others are not. The potential hazard to the marine environment of pollutants depends mostly on their concentration and persistence. Persistent pollutants, such as heavy metals, can remain in the environment unchanged for years and thus may pose a threat to man and other organisms. The pollution levels of our environment suggest that heavy metals must be considered a serious threat (Idowu et al., 2004). The bio toxic effects of heavy metals refer to the harmful effects of heavy metals to the body when consumed above the bio recommended limits set by various regulatory bodies (WHO, 2000; 2006; 2009 and USEPA, 2000). The nature of effects can be toxic, neurotoxin, carcinogenic, mutagenic or teratogenic hence necessitated the present study.

The study area is Eleyele river along Eleyele – Oluguneru road in Ibadan. Ibadan is the largest city in the West African sub-region located within the coordinates; 7°23′47″N 3°55′0″E-/-7.39639°N 3.916667°E in Nigeria, has an area of 828 km^2 and a population of approximately 2.6 million by the 2006 census (Wikipedia, 2010). The river serves as a major source of drinking water for over 20% of the population in Ibadan

The river is claimed to receive effluents discharged from the cassava processing site, waste water from domestic activities from the neighboring homes and also water from the dam site. This river links many other rivers such as the Nihort River, Eleyele dam and communities such as Nihort/Idishin etc. However, since Eleyele does not host any major company at the moment, this river is expected to suffer minor pollution but the river is also a source of water used for cassava processing, construction purpose, domestic use, recreational activities and even as means of transportation of goods from the farm.

The present study was aimed at accessing the quality of water use for drinking and domestic purposes especially with the recent events (flooding) which resulted in lost of lives and property in Ibadan, the capital of Oyo state in the south-western part in Nigeria.

MATERIALS AND METHODS

Sample Collection

Sampling was done during the rainy season, precisely, on the 29th October, 2012; between 01.15 hours and 01.40 hours. This is to allow for stillness of the river and to avoid undue interference by the users of the river. The Eleyele river was segmented into five (5) locations (Table 1) based on the activities going on within the area

Composite water samples were collected from five different points in the river. This was done by lowering pre-cleaned plastic bottles into the bottom of the water body, about 30 cm deep and was allowed to over flow before withdrawing. The five (5) sampling points used were approximately 5 -7m apart. The co-ordinates of the points were read using a Garmine Trex H Geographic Position System (GPS) as depicted in Table 1.

Instrumental Analysis

Atomic Absorption Spectrophotometry (AAS) was

Table 1. The points and positions at which samples were collected from the river

Point	Point Description	Coordinates of point
A	Area where washing of clothing and bathing usually take place	N07.41497^o E003.85229^o Elevation: 177m
B	Area where cassava processing and washing are usually carried out	N07.41492^o E003.85232^o Elevation: 174m
C	Area where residents and others fetch water for drinking and other domestic purposes	N07.41491^o E003.85237^o Elevation: 173m
D	This is where the Water-tankers' drivers get their water supply to construction sites and for selling to others for domestic purpose	N07.41565 ^{o} E003.85254^o Elevation: 175m
E	Under the bridge constructed on the river water.	N07.41574^o E003.85253^o Elevation: 174m

adopted for the analysis of heavy metals concentrations because of its relatively low cost. The chemical procedural method used are as spelt out in Whiteside and Milner (1984) and the guidelines of Ekpo et al., (2013) are strictly followed.

Some part of the samples were taken for the determination of the physico-chemical parameters such as Total solids (TS), Total dissolved solids (TDS) and others. The samples were immediately taken to the Laboratory and were refrigerated at 4^0C until processed analyses while the samples for the AAS were acidified with few drops of HNO_3 to keep the metals in solution.

RESULTS

The obtained results of the Physico-chemical analysis are as depicted in Table 2. Also Table 3 shows the results obtained from the analyses of heavy metals concentrations in the river.

DISCUSSION, CONLUSION AND RECOMMENDATIONS

Discussion

The research findings clearly show that the observed temperatures are in agreement with the World Health Organization, WHO (1999 and 2006) that recommended that the temperature of any river water should be between 27^{o}C and 28^{o}C. Similarly the observed pH values are between 6.00 and 7.00 which fall in the range of Class II otherwise called "Acceptable Quality" as classified by Prati et al., (1971) when assessing the quality of surface water. The electrical conductivity as well as the Total Dissolved Solids values of the tested samples is very much below the WHO level of 400µs/m and 500 mg/l respectively. However, the values of the Dissolved Oxygen (DO) in mg/l are between 3.20 and 3.70 which are under category B of class III as reported by Prati et al., (1971). This is an indication that the river water is slightly polluted.

The Total Hardness ranged from 50 to 66 which when compared with the qualitative classification of water hardness as classified by Tchobanoglous and Schrieder (1985); Miroslav and Vladmir (1999). Then the river water can then be said to be "Moderately Hard". This assertion is in agreements with the USEPA (2000), WHO (1999; 2006; 2009; 2011) and WHO/UNICEF (2012). Even though the values are within permissible limit in surface water but requires treatment before it could be said to be potable water. The Total solids values of the river water are between 121 and 145 which are much less than the recommended value of 500 as adopted by Federal Environmental Protection Agency, FEPA (1991, 2003 and NESREA, 2011).

The data presented in Table 3 are the measured values, the mean and the standard deviation of heavy metals concentrations of analyzed water sample collected at Eleyele river. A closer look at Table 3 suggests that there is a wider distribution of metals in the river water. The mean concentrations for copper, cadmium, nickel, zinc and lead reflect that these metals fall within the acceptable range for a river water as guided by WHO (2000; 2003; 2006; 2009; 2011). Even

Table 2. Results of obtained values, mean and range of physic-chemical parameters in the surface water samples

PARAMETER	A	B	C	D	E	MEAN	RANGE
Temperature ±0.1 (^{0}C)	28.2	27.6	27.4	27.4	27.2	27.6	27.2-28.2
pH ±0.15	6.66	6.99	6.94	7.02	6.99	6.92	6.66-6.99
Electrical Conductivity ±21 (µs/cm)	291	242	246	243	243	253	242-291
Total Dissolved Solid ±10 (mg/L)	145	121	123	121	123	126.6	121-145
Total Solid ± 11 (mg/L)	155	158	134	143	137	145.4	134-158
Nitrate (mg/L)	ND	ND	ND	ND	ND	ND	ND
Dissolved Oxygen ± 0.25 (mg/L)	3.67	3.32	3.20	3.74	3.72	3.53	3.20-3.72
Total Hardness ± 2 (mg/L)	62	50	66	60	62	60	50-66

ND: Not detected (with the AAS)

Table 3. Results of the heavy metals' concentrations in the surface water samples (mg/L) for the different points

Metal	A	B	C	D	E	Total	Mean	S/Dev.
Cu	0.164	0.003	0.001	0.001	0.004	0.173	0.035	0.0723
Cr	0.068	0.013	0.014	0.015	0.019	0.129	0.026	0.0237
Ni	0.076	0.018	0.028	0.029	0.031	0.182	0.036	0.0227
Cd	0.085	0.016	0.010	0.010	0.009	0.130	0.026	0.0331
Zn	0.214	0.028	0.026	0.048	0.060	0.376	0.075	0.0789
Pb	0.135	0.006	0.002	0.011	0.007	0.161	0.032	0.0576
Mg	0.349	0.257	0.258	0.253	0.242	1.359	0.272	0.0436
Ca	2.201	1.293	6.338	6.582	6.780	23.194	4.639	2.6639

though some metals may not constitute a health hazard to the people but may give room to the growth or presence of some microorganisms which may impair health in water (Nubi et al, 2008). However, Sastrel et al., (2001) affirmed that the movement of metals in the river water depends on the composition of the wastes dumped into the river.

Due to continuously increasing anthropogenic activities within Ibadan and its environs, there is evidence of regular discharge of different substances into the rivers. The location of the cassava processing site and the subsequent discharge of the waste water into this river contribute to a large extent to the changes in the physical and chemical state of the river otherwise the river water would have been classified as Class I which is termed "Excellent quality" state (Prati et al., 1971).

Conclusion and Recommendations

The findings of the study can be said that the observed physico-chemical properties and the levels of concentrations of heavy metals in the river water did not constitute any serious pollution threat presently. This is because all the parameters are within the permissible limits of WHO and still acceptable and conducive to both human and aquatic bodies but the river water needs little treatment to meet the WHO standard limit for potable water.

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Recommendations

The following recommendations are therefore made to ensure compliance to clean and quality water.

(i) A seasonal sampling should be carried out during dry, harmattan and wet season to ascertain the actual concentrations of these pollutants both in surface water and sediments before they are washed or diluted by the rainfall.
(ii) Government sanitation should not only be limited to the cleanliness of streets alone but also include educating the populace on the dangers of contaminating the water bodies through introduction of all sorts of waste.
(iii) There is need for enactment of laws and proper inspection of some industries situated within the vicinity of all the rivers in the local government and beyond to be able to monitor their waste disposal methods.
(iv) Above all, an extension of this research study should be carried out in the neighbouring rivers and the aquatic organisms present in them to determine their suitability for consumption by human beings and an epidemiological study should be carried out on the indigenes using the water for domestic purposes such as: bathing, cooking, washing, etc to ascertain the health impact of the levels of these pollutants.

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