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Research Article

Seasonal Variation of Physico-Chemical Parameters and Heavy Metals in Water Samples From Gold Mine Reservoir, Osun State, Nigeria

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Abstract: Concentrations of some heavy metals (Fe,Pb,Zn,Cd,Cu and Ni) and physicochemical parameters were determined in water of Igun gold mine reservoir both in wet and dry seasons. Concentrations of heavy metals in the sediment were also evaluated. The concentration of the six heavy metals in water did not differ between seasons likewise the physicochemical parameters such as total dissolved solid, total hardness, sulphate, nitrate, temperature and oxygen but pH and alkalinity had seasonal variation (P=0.05). Heavy metal concentrations were found to be higher in sediment than in water and their concentrations also were in decreasing order of Fe>Pb>Zn>Cu>Cd>Ni in the sediment. All physicochemical parameters examined in the reservoir water were within permissible limit while concentrations of Cd, Fe, Pb and Ni exceeded the maximum allowable limit set by World Health Organization. Hence the water is considered unsuitable for domestic use and aquaculture purposes.

Keywords: Heavy metals, Reservoir, physico-chemical, Seasonal Variation, gold mine, Igun.

INTRODUCTION

Water bodies are often the recipient of harmful and non-harmful waste generated from human activities especially in Nigeria and other regions of the world. The quests for urbanization in most African countries especially in Nigeria is an ideology that leaves inland water with the only choice of accommodating pollution of natural and anthropogenic origin. The most important challenge being faced by densely populated country like Nigeria and developing countries generally is the industrial waste contaminating natural water bodies. Human activities in populated and industrial environment constitute contaminants to nearby estuaries and inland bodies of water that serve as sources of portable water in Nigeria and some other developing countries (Sangodoyin, 1995). One of the problems in developing countries is the lack of suitable portable water, this is because the usual sources of drinking water are from streams, rivers, wells and bore holes which are not treated (Agbaire and Obi, 2009). Despite the fact that water is important to life, it is a resource poorly managed all over the world (Fakayode, 2005) especially in Nigeria where it seems there is less effective methods of monitoring the environment (Agbaire and Obi, 2009). It is important to evaluate and monitor the composition of pollutants such as heavy metals in aquatic environment in different parts of Nigeria exposed to pollution hence the needs for the study of Igun reservoir that serve as source of water and aquatic resources to the villagers in this particular part of the country.

MATERIALS AND METHODS

Study Area

The studied reservoirs are located in Igun, Igun is a small rural community, in Atakumosa West Local Goverment Area of Osun State, Nigeria. The reservoir is located on latitude $07^0$31.7'N and longitude $004^0$40.5'E. The Igun community is partially surrounded by man made fresh water lakes in the abandoned gold mine locations.

These reservoirs were created as a result of mining activities previously carried out in the area by Federal Government of Nigeria between 1980 and 1983. The prevailing air temperature range between 23^0C-27^0C and the community experience a long period of wet season (April-October) and short period of dry season (November-March).

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Collection of Samples

Water samples from abandoned Igun Goldmine Lake were collected. Data on water quality from the samples were determined and recorded on monthly basis for three months (July, August and September) during wet season and three month (January, February and March) during dry season. Water quality parameters such as temperature, dissolved oxygen, pH were determined. The Igun abandoned gold mine reservoir used was marked at three points, first point at inlet of the reservoir, second point at the centre of the reservoir and third point at the outlet. From these three points, samples were taken. The water samples were collected in liters labeled rubber bottles, which have been previously washed with 10% HNO_3 and 1:1 HCl for 48 hrs. Standard methods were followed by adding few drops of HNO_3 to the water samples to prevent loss of metals, bacterial and fungal growth. The labeled samples were filtered through Whatman filter paper No.1 and 1000ml of filtered sample were acidified to pH 2 with 20ml of 6 N HNO_3. Temperature was determined at the site using mercury in glass thermometer. Digital P^H meter was used in the laboratory to determine the P^H. Dissolved Oxygen was determined using Winkler test. Other parameter of the sampled water such as Total dissolved solids, Sulphate, Nitrate, Total hardness and Total alkalinity were determined using standard methods by APHA (1998). Heavy metals such as Cd, Zn, Fe, Cu, Pb and Ni were estimated in the laboratory by using Standard Methods as prescribed by APHA (1985). Water samples for heavy metal analysis from Igun abandoned reservoir were taken by dipping litre labeled bottle few centimeters below water surface, samples were taken from the marked spots on the abandoned reservoir. According to analytical methods for atomic absorption spectrophotometer, standard solution for Cd, Zn, Fe, Cu, Pb and Ni were prepared (Kalfakakou and Akrida-Demertz, 1987 and Mathis and Cummings, 1973) and the concentrations of the heavy metals were determined using atomic absorption spectrophotometer. Heavy metals concentrations of Cd, Zn, Fe, Cu, Pb and Ni in the bottom sediments were also determined using flame atomic absorption spectrophotometer (APHA, 1998).

RESULTS AND DISCUSSION

Table 1 shows that paired sample Student T-test for physico-chemical parameters of Igun abandoned gold mine reservoir. Most of the parameters such as total dissolved solid, hardness, sulphate, nitrate, temperature and oxygen did not differ significantly between seasons but others such as Alkalinity and pH varied significantly between seasons (P=0.05). The variation in value of Alkalinity and pH between seasons could be due to increase in water volume in wet season and its reduction in dry season. Manjare *et al.* (2010) reported that there could be higher concentration of Alkalinity and pH during summer than the winter which was obtained in this study. Hujare (2008) reported similar result that alkalinity could be higher in summer than in the winter due to high photosynthetic process. Raji *et al.* (2015) reported alkaline pH value in water sample from river Sokoto during dry season and generally acidic during rainy season. The reason given was increment in water level during rainy season which was similar to the result of this study. The results obtained on total dissolved solid, hardness, sulphate and nitrate were not significant different between seasons this might be due to effects of remnants of gold in the reservoir or may be due to the effects of debrils or pollutants being washed from the upstream by run-off into the reservoir. The values of water physico-chemical parameters of Igun abandon gold mine reservoir are within the WHO permissible limits as recorded (WHO, 2008).

Heavy metals concentration in water of Igun abandoned gold mine reservoir show no significant difference between seasons as shown in table 2. Concentrations of Zn, Fe, Cu, Pb and Ni were higher in wet season than dry season but not significant different from each other (P= 0.05). The report of this study is different from that of Zohra *et al.* (2014) and Sayyed *et al.* (2014) where they reported significant difference in their study on land fill draining system ponds (Etueffont, France) and reservoir of Shahid dam, north Iran.

TABLE 1: T-Test For Wet and Dry Seasonal Variations of Physico-Chemical Parameters of Igun Abandoned Gold Mine Reservoir, Osun State

PARAMETER	PAIR	MEAN±STD.ERROR	n	STD.DEV	d.f	tcal	P=0.05	Rmks
TDS	Wet season	70.889±0.484	3	0.839	4	1.553	2.776	NS
	Dry season	86.556±10.078	3	17.456				
HARDNESS	Wet season	131.148±30.518	3	52.858	4	0.024	2.776	NS
	Dry season	130.000±36.168	3	62.644				
SULPHATE	Wet season	228.339±29.550	3	51.183	4	0.021	2.776	NS
	Dry season	227.437±32.289	3	55.926				

ALKALINTY	Wet season	58.222±17.509	3	30.327	4	10.355	2.776	S
	Dry season	247.111±5.115	3	8.859				
NITRATE	Wet season	4.383±1.098	3	1.902	4	0.875	2.776	NS
	Dry season	3.367±0.378	3	0.655				
pH	Wet season	7.411±0.090	3	0.158	4	3.949	2.776	S
	Dry season	7.811±0.044	3	0.077				
TEMPERATURE	Wet season	24.156±0.097	3	0.168	4	1.927	2.776	NS
	Dry season	24.733±0.283	3	0.491				
OXYGEN	Wet season	9.142±0.078	3	0.135	4	1.817	2.776	NS
	Dry season	8.991±0.029	3	0.049				
PHOSPHATE	Wet season	ND		ND		ND		ND
	Dry season	ND		ND		ND		ND

TABLE 2: T-Test of Heavy Metals Variations during the Wet and Dry Season at Igun Abandoned Goldmine Reservoir

PARAMETER	PAIR	MEAN±STD.ERROR	n	STD.DEV	d.f	tcal	P=0.05	Rmks
Cd	Wet season	0.018±0.007	3	0.013	4	1.026	2.776	NS
	Dry season	0.029±0.007	3	0.013				
Zn	Wet season	0.125±0.009	3	0.015	4	2.049	2.776	NS
	Dry season	0.106±0.004	3	0.007				
Fe	Wet season	15.911±5.29	3	9.167	4	1.227	2.776	NS
	Dry season	8.598±2.739	3	4.746				
Cu	Wet season	0.069±0.043	3	0.075	4	0.163	2.776	NS
	Dry season	0.062±0.004	3	0.043				
Pb	Wet season	0.389±0.238	3	0.412	4	0.923	2.776	NS
	Dry season	0.138±0.131	3	0.227				
Ni	Wet season	0.150±0.077	3	0.133	4	0.686	2.776	NS
	Dry season	0.091±0.039	3	0.067				

Table 3: Mean And Standard Error Of Heavy Metal Concentration (Ppm) Of The Bottom Sediment Of Igun Abandoned Gold Mine Reservoir.

Stations	Cd	Zn	Fe	Cu	Pb	Ni
1	0.034±0.005	0.399±0.011	28.630±1.370	0.259±0.004	0.406±0.006	0.150±0.049
2	0.036±0.004	0.406±0.015	27.595±1.580	0.263±0.003	0.422±0.004	0.160±0.051
3	0.035±0.006	0.392±0.009	28.765±1.095	0.259±0.011	0.414±0.016	0.159±0.047
Min	0.035	0.392	27.595	0.259	0.406	0.150
Max	0.036	0.406	28.765	0.262	0.422	0.160
X	0.035±0.000	0.398±0.004	28.330±0.369	0.260±0.001	0.414±0.004	0.156±0.003

The water quality of Igun abandoned reservoir could have been suitable for sustenance of fishes and human benefit considering its physico-chemical characteristics; however, heavy metals in this study such as Cd, Fe, Pb and Ni exceeded the WHO (2011) maximum permissible limit while Zn and Cu fall within, hence the water is unfit for fishery and aquacultural activities.

Concentrations of heavy metals in the soil sediment of studied reservoir are presented in table 3. The metals concentration are presented in descending

order Fe>Pb>Zn>Cu>Cd>Ni. Heavy metal concentrations in the soil sediments of Igun abandoned gold mine reservoir were higher compared to their concentrations in the water samples. Higher concentrations of metal in sediments are indications of possible heavy pollutants retained from run-off and other anthropogenic processes in the water. Some authors such as Kpee *et al.* (2009) and Ogoji, *et al.* (2011) reported higher concentration of heavy metals in soil sediments than in water samples, this is in accordance with the outcome of this report. Among the heavy metals founded in the sediments of this work included Cd, Zn, Fe, Pb, and Ni which exceeded the maximum limit as reported by World health organization (WHO,2011) while Cu was within the range. Avila-Perez *et al.* (1999) reported in their study that heavy metal concentrations of the sediments decreased in the sequence of: Fe > Zn > Cr > Cu > Ni > Pb > Cd. They though reported that the concentration of Fe recorded highest concentration in both sediments and waters of their samples. Their reports corresponding what was reported here too. Heavy metal pollution in Igun abandoned gold mine reservoir could be said majorly of anthropogenic activities origin.

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