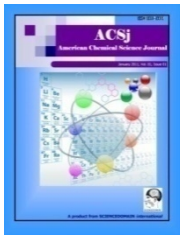

American Chemical Science Journal
3(4): 459-467, 2013

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Level of Selected Metals in Water, Sediment and Fish Samples from Itapaji Dam, South-Western, Nigeria

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Author's contribution

This work was carried out by author AOS who designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript, managed the analyses of the study and managed the literature searches. The author read and approved the final manuscript.

Research Article

Received 23rd May 2013
Accepted 4th July 2013
Published 30th July 2013

ABSTRACT

The level of metals (Zn, Fe, Pb, Cu, Mn, Cr, Na, Mg, Ca and K) in water, sediment and fish samples from Itapaji dam for both dry and wet seasons in two years were determined using standard analytical methods. The concentrations of metals were higher in dry season than those of wet season for the two years of study. In all the samples, concentrations of metals in sediment samples were higher than those of fish samples while the concentrations of the fish samples were higher than that of water samples. However, concentration of metals in water and fish samples were below the safety limit, hence the water can be purified for domestic use and the fish sample can be consumed by man. A close monitoring of the dam year by year is necessary.

Keywords: Water; sediment; fish; dam; Itapaji; metal; Nigeria.

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1. INTRODUCTION

Water is one of the most important resources, therefore it is assumed that this vital resource must have great interest and appreciation of humans and humans seek to maintain and preserve its purity [1]. Water is a vital environmental factor to all forms of life and also it plays a great role in socio – economic development of human population [2].

Pollution is any damage to the water quality in reducing its fitness for specific purposes. Heavy metal constitutes a major category of pollution in water because in high doses (above World Health Standard) can prove lethal to organisms including humans. These metals can be released into aquatic system by both natural and anthropogenic sources and during the course of their transportation can be distributed in water bodies, suspended sediment and aquatic organism like fish [3].

The presence of water pollutant in both fresh and marine water has been found to disturb the delicate balance of the aquatic ecosystem [4]. Fishes are notorious for their ability to concentrate metals in their body tissue and since they play important role in human nutrition they need to be screened to ensure that unnecessarily high levels of some toxic metals are not being transferred to man through fishes [5,6]. Heavy metal when once introduced into the water may be adsorbed on solid surface by fauna and flora, eventually accumulate in water organism like fishes which are consumed by man. Heavy metal availability in aquatic organisms is influenced by many external factors such as seasonal variations, pH, hardness of water, concentration and composition of particulate matter [7].

Despite the possibility of continuous metal exchange between a fish and its habitat which include surrounding water and soil sediment, there is a need to study inter-relationship of metals distribution in these three matrices (water, sediment and fish), similar studies have been carried out and the results obtained have assisted in assessing the pollution level and nutrition value in fish [4,5,6,8,9].

Itapaji dam (Fig. 1) in Ikole Local Government Area is one of the major dams in Ekiti state, Nigeria. This dam which is located in Northern senatorial district of the state, supplies water to the communities in the senatorial district and the fishes are sold to the communities for consumption. There is a need to monitor the pollution status of water, sediment and fish from these dam to ascertain whether the result conform with the World Health Organisation standard and the data generate would serve as reference point for future studies since no such work has been reported in literature for Itapaji dam. It will also create environmental awareness in the consumption of water and fishes from the dam.

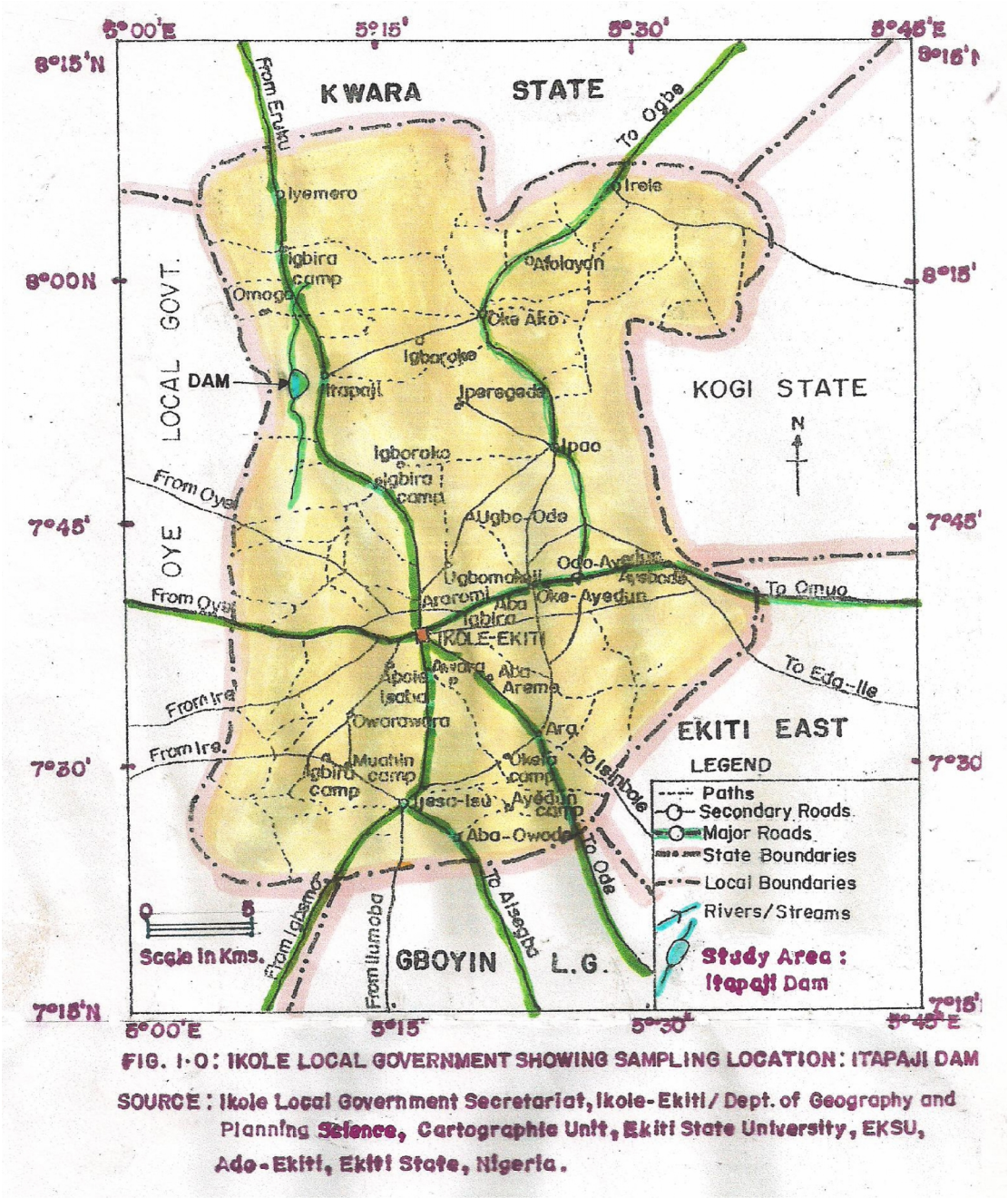

FIG. 1·0: IKOLE LOCAL GOVERNMENT SHOWING SAMPLING LOCATION: ITAPAJI DAM

SOURCE: Ikole Local Government Secretariat, Ikole-Ekiti/ Dept. of Geography and Planning Science, Cartographic Unit, Ekiti State University, EKSU, Ado-Ekiti, Ekiti State, Nigeria.

2. MATERIALS AND METHODS

2.1 Sampling

Three (water, sediment and fish) samples were collected during dry season (January) and wet season (July) for two successive years; 2010 and 2011.

Representative water samples were collected from the dam by dipping just below the water surface one litre plastic bottle that had been previously washed with detergent rinsed with distilled water and leached with mixture of acids. The water samples were stored in deep freezer prior to analysis. Grab sediment samples were collected by divers at the point where the water samples were taken and stored in a polythene bag.

Two pieces of fresh fish (*Tilapia mossambicus*) were brought from fishermen at the bank of the dam. The fish samples were rinsed with distilled water immediately to remove any adhering contaminants and stored prior analysis.

2.2 Sample Treatment

250 mL of each of the water samples were measured into a beaker, 5 mL of concentrated Hydrochloric acid (HCl) was added. The mixtures was evaporated to 25mL, transferred into 100 mL standard volumetric flask and made to mark with distilled water [10]. The sediment samples were air dried and sieved using 200 mm mesh. 5 g of the sediment samples were digested with a mixture of HNO3:HClO4:HF in ratios 15:2:15 and placed on a hot plate at a temperature of 85ºc for 3 hour [11]. On cooling, the samples were filtered into 100ml volumetric flask and made to mark with distilled water. The fish samples were dried in an oven at 105ºC for 3h, cooled, and ground with mortar and pestle. 2.22 g of the fish samples was digested with concentrated HNO3 and 72% HClO4 acid in ratios 5:3 (15 mL: 9 mL) [8], the solution were placed on water bath at a control temperature for 3hours. The resultant solution were filtered into 100mL volumetric flask and made to mark with 0.5% nitric acid. The filtrate from water, sediment and fish samples were analysed for metals using atomic absorption spectrophotometer (Buck model 200A). The results were subjected to statistical analysis (mean, SD, CV) using analysis of variance (ANOVA) procedure and the mean separated by Duncan' Multiple Range Test (DMRT) using SPSS 15.0.

3. RESULTS AND DISCUSSION

The mean concentrations of metals in water samples for both seasons were presented in Tables 1 and 2 for the two years. During the wet season the concentration of Zn, Fe, Pb, and Mn ranged between 0.10-0.15, 1.20-2.00. 0.08-0.09, and 0.12-0.18 mg/100 mL respectively while during the dry season it ranged between 0.062 – 0.40, 2.00-3.52, 0.09-0.11 and 0.23-0.30 mg/100 mL respectively for the heavy metals. The concentration of Cr and Cu were not detected. For all the major elements analysed in the water samples during wet season, concentration of Na, Mg, Ca and K ranged between 1.00-1.24, 1.30-1.66, 0.80-1.37 and 1.60-2.01 mg/100 mL respectively while for the dry season it ranged between 1.45-1.75, 1.52-1.90, 1.20-1.61 and 2.11-2.33 mg/100 mL respectively. The concentration of both heavy metals (Fe,Zn,Pb,Cu,Mn,Cr) and major metals (Na,Mg,Ca,K) were higher in the dry season than wet season. This is similar to the observation of Asaolu et al. [8], Adefemi et al. [9]. Of all the heavy metals examined, Iron has the highest value, there is no identifiable source, though it has been reported that iron occurs at high level in Nigeria soils [4,12,13,14]. The level of heavy metal in the water sample is below the WHO [15] standard for drinking water.

Table 1. Concentration (mg/100 mL) of metals in water samples dry and wet season (2010)

Metals	Wet season	Dry season	WHO (mg/l)Standard (2008)
Zn	0.10	0.40	5.00
Fe	1.20	2.00	3.00
Pb	0.08	0.09	0.10
Cu	ND	ND	2.00
Mn	0.12	0.23	0.40
Cr	ND	ND	0.05
Na	1.00	1.45	200.00
Mg	1.30	1.52	20.00
Ca	0.80	1.20	200.00
K	2.01	2.11	NS
Mean	0.67	0.90	
SD	0.70	0.84	
CV%	104.00	93.00	

SD: Standard deviation; CV: Coefficient of Variation

Table 2. Concentration (mg/100 mL) of metals in water samples for dry and wet season (2011)

Metals	Wet season	Dry season
Zn	0.15	0.62
Fe	2.00	3.52
Pb	0.09	0.11
Cu	ND	ND
Mn	0.18	0.30
Cr	ND	ND
Na	1.24	1.75
Mg	1.66	1.90
Ca	1.37	1.61
K	1.01	2.33
Mean	0.77	1.21
SD	0-77	1.19
CV%	100.00	98.00

The mean concentrations of heavy and major elements for both wet and dry season in the sediment for two years are present in the Tables 3 and 4. Chromium and Copper were not detected in the sediment samples. The concentration of Heavy and Major metals were higher in the dry season than those of the wet season. The result is similar to the observation of Awofolu [16] who studied the determination and seasonal variation of heavy metals in Algae and sediments in sewers from industrial area of Lagos state Nigeria and Adefemi et al. [17] when studying seasonal variation in heavy metal distribution in the sediment of major dams in Ekiti state. Of the heavy metal examined iron was found to be the most abundant, the high content of iron compared to other heavy metals in the sediment is expected because it has been reported by several workers,that it occurred at high levels in Nigerian soil [18,19,20], a similar high level of iron content was reported by Belabedel et al. [21] in the evaluation of metal contamination in the surface sediment of the Quberra Lagoon, Algeria. However, Turekian [22] has noted that in rural areas, the mutual content of soils can

be assigned to rock, erosion by gullying and waste that release these particulate materials to the streams. There is no doubt that most waste generated due to human activities are discharged on land or in streams around rural areas which would be transported by runoff water into the surrounding dam during rains. The knowledge of the heavy metal concentrations in sediment could give vital information regarding their sources, distribution and degree of pollution, since sedimentation is one of the most important fluxes in aquatic systems [17]. Among the major element, potassium has the highest value in the sediment; this might be due to the fact that potassium is well known as the most abundant element in fruits and plants [23]. Its level would be enhanced by dead plant residue. This is in close agreement with the report of Adeyeye [5]. There is a slight increase in the concentration of the element from year to year; this suggests that sediments get richer in the metals year by year.

Table 3. Concentration (mg/100 g) of metals in sediment samples for both dry and wet season (2010)

Metals	Wet season	Dry season
Zn	7.10	9.50
Fe	35.60	56.01
Pb	3.40	4.20
Cu	ND	ND
Mn	2.00	3.30
Cr	ND	ND
Na	43.40	50.50
Mg	24.80	48.90
Ca	28.60	40.60
K	51.80	60.10
Mean	19.67	27.31
SD	19.62	25.82
CV%	99.00	94.00

Table 4. Concentration (mg/100 g) of metals in sediment samples dry and wet season (2011)

Metals	Wet season	Dry season
Zn	11.52	26.80
Fe	23.52	50.12
Pb	3.10	4.40
Cu	ND	ND
Mn	10.30	16.30
Cr	ND	ND
Na	43.42	50.51
Mg	49.20	53.20
Ca	49.10	57.20
K	63.80	66.80
Mean	25.40	32.53
SD	23.90	29.92
CV%	94.00	92.00

Tables 5 and 6 present the mean concentration of heavy and major metals in fish sample for both seasons in two years. The concentration (mg/100 g) of Zn, Fe, Pb, Mn, Na, Mg, and Ka

ranged between 8.60-9.20, 12.50-13.60,0.80-4.80,38.20-42.10, 40.10-50.40, 33.20-49.20 and 25.60-63.80mg/100 g respectively for wet season while for dry season it ranged between 9.40-10.11, 20.10-44.69, 1.43-6.20, 45.60-46.30, 49.80-50.80, 40.41-53.00 and 38.60-64.80mg/100 g respectively. Lead and chromium were not detected in the fish sample for the two years. As observed in water and sediment, the concentration of metal in fish samples were higher in the dry season than the wet season. This has been reported by Asaolu and Olaofe [4] for fishes and crayfish from coastal water of Ondo-State, the extent of the concentration of these metals in the fish sample can suggest to what degree a particular fish picks up particulate matter from the surrounding water and sediment when feeding; the high level of these metal in the fish sample is a reflection of the metals in the surrounding water and sediment, therefore the fish could be used to monitor the level of metal pollution in the dam. The major element determine in fish sample are not toxic, their bioaccumulation could be very beneficial to man since they are essential minerals in human nutrition [5].

Table 5. Concentration (mg/100 g) of metals in fish samples dry and wet season (2010)

Metals	Wet season	Dry season
Zn	8.60	9.40
Fe	12.50	20.10
Pb	ND	ND
Cu	ND	ND
Mn	0.80	1.43
Cr	ND	ND
Na	38.20	45.60
Mg	40.10	49.80
Ca	33.20	40.41
K	25.60	38.60
Mean	15.90	20.23
SD	16.76	20.59
CV%	105.00	102.00

Table 6. Concentration (mg/100 g) of metals in fish samples dry and wet season (2011)

Metals	Wet season	Dry season
Zn	9.20	10.11
Fe	12.60	44.69
Pb	0.10	0.10
Cu	ND	ND
Mn	4.80	6.20
Cr	ND	ND
Na	42.10	46.30
Mg	50.40	50.80
Ca	49.20	53.0
K	63.80	64.80
Mean	23.22	27.60
SD	25.12	26.36
CV%	108.00	96.00

The concentrations of metals in water, sediment and fish samples are higher in dry season than wet season and it increases year by year. This is an agreement with the one reported for Ureje dam in Ekiti state [9,24]. The increase in dry season might be due to an increase in

water volume during raining season, thereby diluting the concentration; moreso the dam has a stagnant nature.

The concentrations of metals in the sediment for both season and for the two years of study were higher than what was observed in fish and water sample. This has been attributed to the fact that bottom sediment in an aquatic environment used to act as traps for most of the metals due to high level of organic substance [8].

4. CONCLUSION

In conclusion, the values of metal under investigation are below the WHO [15] standard for drinking water. The fish studied in this research work contain reasonable levels of metals that are beneficial to human systems and are well below the safety limit. However, there is need for continuous monitoring of the levels of metals in the dam because of the increased human activities around the dam.

ACKNOWLEDGEMENT

The author acknowledges the staff of Ekiti State Water Corporation for the collection of the samples and Chemistry department FUTA, Akure for the AAS analysis.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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