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Research Article

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Heavy-Metals as Environmental Health Indicator of the Lagos Lagoon Complex, Nigeria

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Abstract

The study was conducted on heavy metals contents of water, fish tissues and sediment from Lagos lagoon complex, Nigeria. The aim was to assess the current environmental health/pollution status of the lagoon from three sample stations: Ologe lagoon [1], Badagry creek [2] and Lagos island [3]; each having three (3) hotspots. In all, twelve (11) heavy metals were determined between June and November, 2018. Heavy metals: Zn, Fe, Pb, Cu, Na, Potassium, Ca, Mn, Cd, Hg and Nickel were determined using Atomic absorption spectrophotometer (AAS). Results of mean Heavy metals in fish tissues were: Zn (0.741±0.38), Fe (5.59±8.32), Pb (0.12±0.17mg/l), Cu (0.16±0.25), Na (9.38±0.25), Ca (116.68±41.53), Mn (0.76±0.96), Pb (0.01±0.0), Cd (0.02±0.0), Potassium (12.09±2.34), Ni (0.02±0.02) and Hg (0.01±0.0). Statistical analysis showed variations in the distribution of Heavy metals which are mostly within recommended limits of WHO, FME, & LASEPA. Except for iron (Fe), which was found in excess in fish tissues, and other metals (lead), found in higher conc. in sediments than in water and fish tissues combined. This is indicative of heavy metals bio-accumulation in the study area.

Keywords: Ecosystem, Fish Tissues, Heavy Metals, Health and Pollution

Introduction

Since the concept of ecosystem health emerged in the 1980s and brought with it new goals for environmental management, many attempts have been made to assess lake ecosystem health. In view of the above problems, an index system method covering various levels of ecological indicators was rapidly developed for lake/ lagoon/river ecosystem health assessment. Jørgensen proposed a tentative procedure for aquatic ecosystem health assessment based on ecological buffer capacities and concluded that a healthy ecosystem has relatively good physicochemical parameter indices compared with international and national recommended limits and this work provides an important reference for relative health indicators. Humans have been important component of ecosystem for millennia, and they always radically alter the system of which they have been component.

Previous studies have shown that anthropogenic activities can reduce water quality as well as degrade the channel bed and banks. Fish are particularly sensitive to these impacts. Furthermore, studies have also shown that in-stream mining can reduce water quality as well as degrade the channel bed and banks. For instance, salmons and trouts required freshwater stream for spawning. The female digs a depression in the gravel stream forcing fine gravel particles into the current, which carries them downstream, they deposit the eggs within the depression (pit) and the attending male releases milt over them. The female then loosens fine sand immediately upstream, which the currents carry downstream to cover the eggs. The eggs remains in the completed reed (nest) for a period of weeks or months, depending on the temperature. The embryos depend upon a flow of water through the gravel to supply them with oxygen and to remove metabolic wastes. After hatching, the fry continues to live within the gravel for a period of time, and then wriggle through the gravel surface, where they emerge to begin their lives as free swimming fish. From the above, any human disturbances through industrial pollution, municipal waste, fishing in breeding/ spawning ground would alter the needed balance.

According to Agboola et al.(2016), to determine the impact of these pressures, spatial changes are examined, through field sample collection and analyses of surface water, sediments, and fish tissues. To date, there are only few studies targeted at determining the health status of ecosystems in Nigerian aquatic ecosystems. Therefore, the aim of the study is to examine the effects of Heavy metal pollution on the ecosystem health of some parts of the Lagos lagoon complex (Ologe Lagoon and Badagry Creek) in order to produce baseline data/ information that could be used for the development of a sustainable management policy in Lagos State. Surface water conductivity, total suspended solids (TSS), alkalinity, chloride, biological oxygen demand (BOD), nitrate, phosphate and heavy metals (Zn, Cu, Fe, Na, Mn, Pb, Cd, K and Ni) exhibits relative spatial stability across the wetland areas.

Nigeria (10°N, 8°E) has an extensive coast line of 960km, and 15% of the 925,000km^2 land areas consists of inland waters such as rivers, streams, swamps, and natural and man-made lakes [1]. These water bodies have multiple uses including irrigation, aquaculture, drinking water supply, hydroelectric power generation, fisheries, flood control and recreation, among others [2]. The Nigerian climate is tropical, consisting of rainy season (April – October) and a dry season (November – March): Diurnal temperatures are high, reaching 34°C-40°C. Elevation levels of relative humidity prevail throughout the year, rarely dropping below 60%. High rainfall of between 3000mm and 4000mm is experienced from May- September with a short break in August (Awosika et al.).

In urban areas, the indiscriminate disposal of industrial effluents and other wastes may contribute to the poor quality of the water. The industry is the source of pollution, accounting for almost fifty percent (50%) of the pollutants present in the biosphere. Pollutants given off by various industries and factories are often considered to be one of the prim e factors contributing to air and water pollution. In Nigeria, especially Lagos being the commercial and industrial hub of the country, industrial waste water (effluents) and heavy-metals are key environmental toxins contaminating the fresh and brackish water systems, due to their constant and relentless existence. The high level of urbanization and industrialization of the city of Lagos and its environs with the inevitable generation of domestic and industrial waste, have led to biological consequences in the Nigerian coastal aquatic environment. Since the past two decades, the Lagos lagoon complex has served as the ultimate sink for the disposal of untreated domestic sewage, with the lagoon being the worst culprit. Primary concerns are the effects of domestic and industrial effluents on the general health of aquatic life, the maintenance of viable artisanal commercial fisheries and the safety of the humans occupationally exposed to the pollution.

The objective of the research is to survey three sample areas within Lagos lagoon, for water dynamics, heavy-metals in the sediment, fish and shell fishes with a view to assess the impact of the anthropogenic activities within the industrialized state. Specifically to determine the heavy-metals in water, sediment and fish species (Tilapia spp, Chrysichthys nigrodigitatus,) caught from the three sample areas; To compare the results with recommended pollution standards e.g. World Health Organization (WHO), Federal Ministry of Environment (FME) and Lagos State Environmental Protection Agency (LASEPA).

Materials and Methods

Geographical Position and Study Area

The coordinates {Longitude and latitude} were measured using the GPS system, Model –12 (June - November, 2018) as presented in table 1. While the graphs describing the differences or changes in altitude and mean depths are shown in figure 2. The dynamics of water transparency and mean surface water temperature across nine sample stations in the whole lagoon system are also shown in figure 3. Lagos lagoon complex in Nigeria is located between latitude 3°20' and 3°50'W and longitude 6°28' and 6°35'N as indicated in table 1. It is the largest lagoon system in the West African coast, covering 208km^2. The lagoon is open tidal water; fed in the north by Ogun River. The southern margin bounded by five cowries and Badagry creek and in the east by Lekki and Epe lagoons. The lagoon opens into the Atlantic Ocean through the Lagos harbour. The lagoon is shallow in most part; not more than 1.5meters deep. Due to seasonal distribution of rainfall, Lagos lagoon experiences seasonal flooding which introduces a lot of detritus and pollutants from the land. The lagoon serves presently as a major draining channel receiving domestic wastes as well as industrial effluents from industries in the areas. The experimental areas within the Lagos lagoon complex are: Ologe lagoon [1], Badagry creek [2] and Lagos lagoon [3]. Each of these areas have (3) three sample stations in the following order: Ologe lagoon [1]; Ibiye jetty[1a], Agbara[1b] & Otto[1c], Badagry creek [2]; Market[2a], Toppo[2b] & Akarakumo[2c] and Lagos lagoon[3]; Ebute-ero[3a], Unilag water front[3b] & Oworo [3c] respectively. The mapping of the area and selection of study points are done to traverse the entire Lagos lagoon complex and also based on variations of anthropogenic activities/hotspots in Lagos state, Nigeria.

Figure 1: Hydrological map of the Lagos lagoon complex. Sample stations [1], [2] & [3] are indicated on the lagoon.

Sample Collection

The study was carried out between June and November, 2018. The period corresponds to peak of raining season and consequent flooding into the lagoon. Samples of water, sediments and fish species were collected monthly from each of the experimental stations as mentioned above in ice- chest/cooler and using 5litre plastic kegs for water collection below water surface and filled to capacity. All samples were immediately transported to the Lagos State Environmental Protection Agency (LASEPSA) Laboratory using their research buses and Lab instruments. All analyses were based on standard methods as prescribed in [3].

Water Quality Parameter and Heavy Metals Determination

Water samples, sediments and fish (*Chrysichthys nigrodigitatus*) were taken monthly between June – November (2018) and this was with respect to three (3) sample stations each from three study area (Ologe lagoon, Badagry creek and Lagos lagoon). The sample stations were plotted to traverse the lagoon system, these are Ologe lagoon (Ibiye [1a], Agbara [1b], Otto [1c]), Badagry creek (market [2a], Toppo [2b], and Akarakumo [2c]) & Lagos lagoon (Ebute-ero [3a], Unilag water front [3b], and Oworo[3c]). Heavy-metal contents in the sediments and fish species were determined using the Atomic Absorption Spectrophotometer (AAS).

The following parameters analyzed are:

Heavy metals determination was done in test materials (according to APHA, 1998) by atomic absorption spectrophotometric methods (Perkins Elmer AAS model 3110). The samples were prepared by wet digestion methods. In a 500 ml Taylor flask, 0.5ml of concentrated H_2SO_4 was added to 100 ml of sample. This was allowed to boil down to the white fume stage. The solution was allowed to cool; 1 ml of 60% $HCLO_4$ and 5ml conc. $HN0_3$ was added and digested until clear. Also, a blank was digested in the same way. The prepared samples was then diluted to appropriate volume and read in the AAS. Some of the methods are as follows:-

Zinc standard was obtained by preparing a www.ccsenet.org/enrr Environment and Natural Resources Research Vol. 3, No. 2; 2013 31 stock solution (0.4398 g $ZnSO_{47}H_2O$ in water and made up to I liter). The standard solution was diluted to give a range of 0-5 ppm Zn which was used as the working standard. The prepared sample was diluted as appropriate and read on the AAS using 213.8 nm wavelength. A calibration curve was prepared from standard range and Zinc concentration was obtained.

Chromium (Cr) Standard was prepared, from the stock solution (1 ml = l mg Cr) by dissolving 2.82 g $k_2Cr_2O_7$ in water and made up to a liter. A working range of 0-2 ppm Cr was used and 357.9 nm wavelengths was selected. The acetylene and air flow and other settings as specified were adjusted. A calibration curve was prepared from the standard readings and was used to calculate the chromium concentration.

Lead standard was prepared from the stock solution 100 ppm Pb) by dissolving 0.1599 g PbCNo3 in 20ml 1% v/v HNO_3 and made up to 1 liter. A working range of 0-l00 ppm Pb was prepared by diluting the stock solution and including the acid as appropriate to match the sample condition. The lead concentration was read by selecting 283.3nm wavelength. The acetylene and airflow was adjusted and a calibration curve was prepared.

Chloride was measured using the agentometric method. The water sample was titrated against silver nitrate solution ($AgNO_3$) using 10% potassium chromate solution as indicator. Titer value was equivalent to the amount of chloride presents.

Results

Geographical Position of Sample Area

Geographical position and Characteristics of the sites in coordinates {Longitude and latitude} are presented in table 1, this includes the differences in altitude, mean depths, dynamics of water transparency and mean surface water temperature across nine sample stations in the whole lagoon system. The minimum altitude and depth are found in Ibiye jetty [1a] which is 18.3m & 0.9ft, while the maximum altitude and depth are 35.05m & 11.2ft as found in Oworo [3c], the variance may be as a result of sand dredging and geological modifications. Results also showed that Badagry axis is the most transparent water body having 52.5cm as compared to 20.5cm in Ebute-ero axis of Lagos lagoon.

Physicochemical Parameters in Sediment of the Lagos Lagoon Complex

The mean values of physical and chemical parameters in sediments from the Lagos lagoon complex are presented in table 2. The overall results of sediment samples showed variations in the distribution of their range (mean): Temperature (°C); 24.2 – 28.2 (26.62±1.4) , pH; 4.29 – 6.66(5.53±0.8), Conductivity (µS/cm); 2.41 – 16.4 (5.8±5.1), Moisture contents (MC); 1.0 – 16.6 (6.37±5.5), Nitrates (mg/Kg N); 0 – 335.0 (43.42±109.0), Phosphate (mg/Kg P); 1.8 – 37.1 (22.43±18.4), Sulphate (mg/kg S); 0 – 215 (92.3±76.3), Organic carbon (%); 6.4 - 29.9 (19.58±6.1) and Organic matter (%); 11.0 – 51.7 (33.86±10.6). In this study, phosphate was not detectable in all the sample stations except in Lagos lagoon area [3a], [3b] and [3c].

Table 1: Geographical position and Characteristics of the sites. Longitude and latitude were measured using the GPS system, Model –12 (June-November 2018)

Sample stations	Ologe Lagoon [1]			Badagry Creek [2]			Lagos Lagoon [3]		
	Ibiye jetty [1a]	Agbara [1b]	Otto [1c]	Market [2a]	Toppo [2b]	Akarakumo [2c]	Ebute-ero [3a]	Ebute-ero [3a]	Oworo [3c]
(Geographical Positions)									
Longitudes	06°28'N	06°30'N	06°30'N	06°30'N	06°29'N	06°29'N	06°27'N	06°29'N	06°31'N
Latitudes	03°42'W	03°43'W	03°44'W	03°46'W	03°47'W	03°46'W	03°23'W	03°23'W	03°24'W
Altitude (ASL).	18.30m	24.01m	22.57m	23.18m	22.27m	29.4m	31.20m	35.99m	35.05m
Depth (ft)	0.9	1.2	1.9	2.4	3.2	3.5	2 – 12.5	5.0 – 10	6.2 - 11.2
Mean Transparency (cm)	25.5	24	28	32	52.5	25	20.5	23.5	25.5
Mean Surface Temperature (°C)	29	31.5	31.5	32	32	31	29	31	30.5

Heavy Metals in Water, Fish Tissues and Sediment of the Lagos Lagoon Complex

The mean values of some heavy metals in water, tissues and sediments from the Lagos lagoon complex are presented in Tables 2 & 3. In the water, mean results and standard deviations of the water samples showed variations in the distribution of the following heavy metals: Ca^+(0.74±1.4mg/l), Zn (0.01±0.0), Cu 0.01±0.0), Fe (0.09±0.1mg/l), Na (1942.37±58.14), Cobalt (0.01±0.1), Mn (0.01±0.0), Pb (0.01±0.0), Cd (0.1±0.0), Potassium (0.7±0.7), Ni (0.03±0.0) and Hg (0.01±0.0). Calcium was highest in Ebute-ero [3a] -4.2mg/l, zinc was generally low with maximum mean of 0.06mg/l. Cu was high in the stations: [1c] [2a] [2c] and [3c]. Sodium was highest in Otto [1c]. However, most of the heavy metals in the water were highest in Otto axis of Ologe lagoon [1c], these are shown in figures 3a – d. Mean results and standard deviations of the tissue samples showed variations in the distribution of the following heavy metals: Zn (0.741±0.38), Fe (5.59±8.32), Pb (0.12±0.17mg/l), Cu (0.16±0.25), Na (9.38±0.25), Ca (116.68±41.53), Mn (0.76±0.96), Pb (0.01±0.0), Cd (0.02±0.0), Potassium (12.09±2.34), Ni (0.02±0.02) and Hg (0.01±0.0). The metals were higher in the tissues than in surface water of the lagoon system; showing actual bio-accumulation over time. The graphical distributions of metals in the tissues are also shown in figures 3a – d.

Mean results and standard deviations of heavy metals in the sediment samples from the Lagos lagoon complex showed variations in the distribution of the following heavy metals: Zn (8.96±10.77), Fe (286.5±85.7), Pb (3.62±7.11mg/l), Cu (0.99±1.68), Na (21.6±34.87), Pottasium (25.38±44.5), Ca (15.44±16.9), Pb (0.01±0.0), Mn (25.47±35.5), Cd (0.34±0.4), Ni (0.94±11.6) and Hg (0.02±0.04). The metals were most concentrated in the sediments than in surface water and in the tissues combined. Showing bio-accumulation and sedimentation in the bottom area of the lagoon over time. The graphical distributions of metals and comparison of concentration in the three (3), (i.e. water, tissues and sediments) biota is presented in figure 4.

Table 2: Physicochemical parameters in Sediment from Lagos lagoon Complex

Parameters	Station A (Ologe lagoon)			Station B (Badagry creek)			Station C (Lagos lagoon)			Regression Analysis
	Ibiye	Agbara	otto	Market	Toppo	Akara-kumo	Ebute-ero	Unilag water front	Oworo	
Temperature (°C)	27.3	27.2	27.1	24.2	25.1	25.2	27.6	27.7	28.2	24.2 - 28.2(26.62±1.4)
pH	4.29	5.28	4.59	5.48	6.33	6.66	5.59	5.83	5.76	4.29 - 6.66(5.53±0.8)
Conductivity (uS/cm) 16.4	16.4	8.83	10.8	2.92	2.65	2.41	2.9	2.8	2.5	2.41 - 16.4(5.8±5.1)
Moisture Contents	6.71	10.1	16.6	1.28	10.9	1	1.85	1.54	7.31	1 - 16.6(6.37±5.5)
Nitrates (mg/kgN)	335	18	0	28	0	0	1.3	5	3.5	0 – 335(43.42±109.8)
Phosphate (mg/kgP)	ND	ND	ND	ND	ND	ND	1.8	37.1	28.4	1.8 - 37.1(22.43±18.4)
Sulphate (mg/kgS)	215	36	36	92	125	0	82	205	40	0 – 215(92.33±76.3)
Organic carbon (%)	20.7	20.9	19.9	22.5	20.1	6.4	18.2	17.6	29.9	6.4 - 29.9(19.58±6.1)
Organic matter (%)	34.5	36.2	35.8	38.9	34.8	11	31.4	30.4	51.7	11 - 51.7(33.86±10.6)

Note: Regression Analysis = min - max (Mean±SD), ND = not detected.

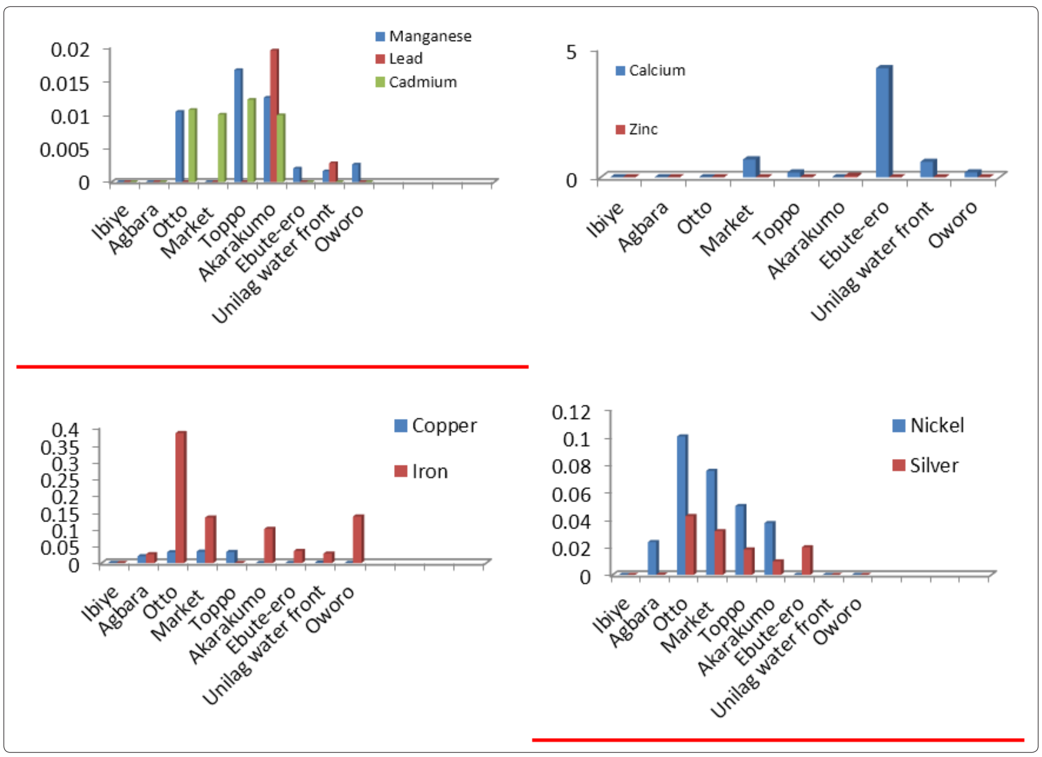

Figure 2a –d: Variation of heavy metal contents (mg/l) in water samples from Lagos lagoon

Heavy Metals in Sediments

The overall mean results and standard deviations of heavy metals in the sediment samples from the Lagos lagoon complex showed variations in the distribution of the following heavy metals: Zn (8.96±10.77), Fe (286.5±85.7), Pb (3.62±7.11mg/l), Cu (0.99±1.68), Na (21.6±34.87), Pottasium (25.38±44.5), Ca (15.44±16.9), Pb (0.01±0.0), Mn (25.47±35.5), Cd (0.34±0.4), Ni (0.94±11.6) and Hg (0.02±0.04). The metals were most concentrated in t he sediments than in surface water and in the tissues combined. Showing bio-accumulation and sedimentation in the bottom area of the lagoon over time. The distributions of metals and comparison of concentration in the three (3), (i.e. water, tissues and sediments) biota is presented in figure 4, which shows that sodium was highest in water, iron (fe) in sediment and calcium in fish respectively.

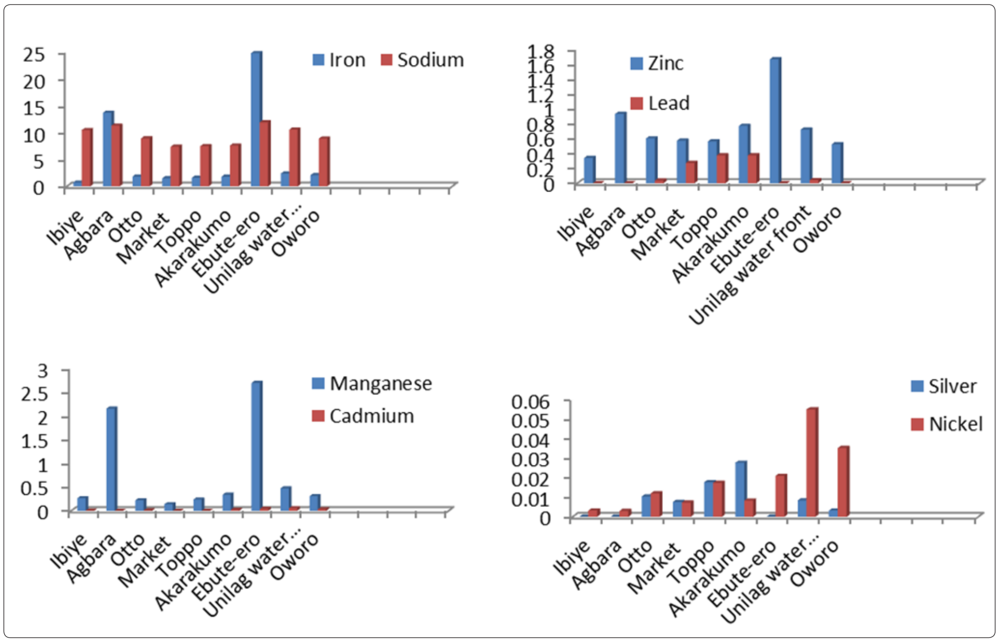

Figure 3a-d: Variation of Heavy-metals (mg/g) in fish tissues from Lagos lagoon complex

Table 3: Analysis of Heavy-metals in sediment samples from Lagos lagoon Complex, Lagos

Heavy metals (mg/l)	Ibiye	Agbara	otto	Market	Toppo	Akara-kumo	Ebute-ero	Unilag Area	Oworo	Regression Analysis
Zinc	19.39	14.87	31.59	1.31	1.32	0.39	3.63	5.65	2.47	0.40 - 31.59(8.96±10.7)
Iron	171.5	235.55	313.7	340.02	447.79	211.3	217.12	337.87	304.04	171.5-447.80(286.5±85.7)
Lead	0	0.92	7.28*	0	0	0.98	21.56*	1.67	0.16	0.0 - 21.5(3.6±7.1)
Copper	0.27	0.69	1.17	0.25	0.4	0.25	5.39	0.35	0.12	0.11 - 5.39(0.99±1.68)
Sodium	0.91	25.85	1.51	0	0	0	58.24	98.89	8.99	0.0 - 98.9(21.6±34.8)
Potassium	1.69	6.47	0.46	10.69	21.09	3.13	26.207	141.57	17.11	0.46 - 141.5(25.38±44.5)
Calcium	30.6	12.97	0	0	0	0	18.16	41.43	35.74	0.0 - 41.4(15.4±16.9)
Manganese	2.6	3.85	1.27	12.23	31.73	11.43	8.75	111.75	45.61	1.27 - 111.7(25.5±35.6)
Cadmium	0.21	0.36	1.26	0	0	0	0.67	0.53	0	0.0 - 1.26(0.34±0.4)
Silver	0	0	0	0	0	0	0	0.003	0.13	0.0 - 0.13(0.02±0.04)
Nickel	0	0.38	5.15	0.35	0.36	0.25	0.41	1.19	0.34	0.0 - 5.15(0.94±1.6)

Note: Regression Analysis = min - max (Mean±SD), ND = not detected.

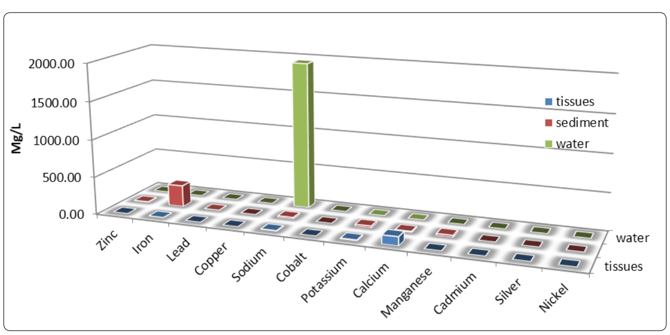

Figure 4: Comparison of mean heavy-metals in water, tissues and sediments from Lagos lagoon complex

Discussion and Conclusion

The present study elucidated results of physico-chemical parameters in sediments and heavy-meals in surface water, fish tissues and sediments from the Lagos lagoon complex sampled from three [3] study areas and three sample stations, Lagos-Nigeria between June to November, 2017. The variation in the depth and the topography of the lagoon system may be as a result of sand dredging and geological modifications. As shown in the data, Badagry axis is the most transparent water body being indicated in the turbidity values, when compared to other sampled area, e.g. Lagos lagoon. The mean surface water temperature (°C) remained stable throughout the study period within the study area. Statistical analysis of physical and chemical parameters for water in Lagos lagoon complex (table 2) revealed that temperature differences were not significant across the samples stations (P>0.05).

The environment of Lagos lagoon complex had anthropogenic impacts which include: fishing, sand mining & dredging, industrial and municipal influences. These negative interactions however affect the condition of water, benthic lives and fish in terms of quality and biomass. The turbidity was high, while Lagos lagoon axis remained clear, Ologe lagoon axis was relatively heavy with particulate matters arising from sand dredging and mining, having the highest values within the study area.

Metabolic rate and the reproductive activities of aquatic life are controlled by water temperature. As metabolic activities increases with an increase in temperature, fish's demand for oxygen increases. Grand mean temperature recorded in this study falls within the range (20 - 300C) suggested by [4], and the Nigeria Federal Environmental Protection Agency [5] for adequate support and propagation of tropical fishes. This indicated favourable condition for occurrence, growth and multiplication of overall aquatic resources of the Lagos lagoon complex.

Changes in water chemistry (ion concentration) are not visibly noticed from one sample station to another; though there are point sources of contaminants from domestic and recreational activities on daily basis, which may contribute to the water system; non-biodegradable substances (e.g. nylon sachet, paint containers, mosquitoes repellant containers e.t.c), organic wastes from large hotel outlets dumped directly into the water. These substances are carcinogenic with the potential of causing brain damage among other effects. Therefore, Environmental standards should be enforced to protect this water body from becoming potential threat to the health and well-being of the fish fauna and ultimately humans within the locality in future.

Heavy metals concentrations are prevalent in the water, sediment and fish tissues. The results revealed the presence of zinc in water, tissues and sediment, further analysis shows that highest amount of zinc were stored in the sediment /bottom of the lagoon and made the bottom dwelling species susceptible to zinc accumulation (crab, hell fishes and scallops). The values were far above the recommended limit of the WHO/FME/LASEPA. The relatively high Zn level is suggestive of the influence of refuse dump and domestic sewage sources. It could also be as a result of industrial effluents, correspondingly, the highest Zn level were detected in Ologe lagoon which is adjacent to the Agbara industrial area. This concentration may have been associated with domestic activities, including the use of chemicals and zinc based fertilizers by farmers [6]. Also zinc is a neurotoxin, causing neuronal cell death in a dose dependent manner. Unfortunately, the concentration of zinc during the present study was above those recommended FEPA, 1991 and [8], indicating that the present concentration of zinc in the Lagos lagoon complex may be harmful to the organisms in that environment. Cadmium occurs naturally in association with lead, or zinc. Its concentration in water (0.001) fish tissues (0.02±0.01) and sediments samples (0.34±0.43) during the present study revealed that it lesser than tolerable level. The concentration of lead in water (0.0), tissues (0.12±0.01) and sediments samples (3.62±7.11) in this study exceeded the tolerable levels in the sediments; hence consumers of bottom dwelling fishes from this region should take the present discovery seriously especially from Otto [1c] which had 7.28mg/kg from Ologe lagoon and Ebute-ero [3a] which had 21.56mg/kg from Lagos lagoon axis.

According to [9], the acute neurological effects of lead toxicity manifests in the form of nausea and abdominal cramps, bloody diarrhea and vomiting, dizziness and chest-pain. These diseases which were reported in Japan, after the Second World War, were traced to cadmium and lead contaminated rice field. It also resulted in rheumatic arthritis and muscular pain. Wassen [10] reported that coal and fossil fuels are known sources of lead and cadmium pollution. The residual deposits of the metal from oil spillage may be another source as reported by Obodo [11] in River Niger, Nwajei and Gagophien [12] in Lagos Lagoon. Copper is an essential substance required for normal functioning of the human life, but because its concentration exceeded the WHO [13] limit for portable water, it may result in anemia, damage to the liver and kidney, as well as cause stomach and intestinal irritation. These observations were also reported by (Asaolu and Olaofe, 2004). Persons suffering from these ailments were at greater risk of secondary infections. Copper normally occur in portable water from copper pipes as well as form additives designed to control algal growth as was reported by Adeyinwo [14] who sampled Warri River and also Hsua et al. who sampled terrestrial biota. However, copper (Cu) measured in this study were within recommended limits.

The present study revealed that surface water was contaminated with heavy metals, at levels not harmful to aquatic lives, but harmful to humans due to bio-accumulation of metals along the food-chain. The levels of heavy metals isolated from the study area, especially zinc was higher than those recommended by FEPA [15]. Iron concentration was relatively the highest in comparison to other heavy metals (copper, lead, zinc, manganese, chromium and cadmium) isolated. The concentration of these metal pollutants in this frequently used water body portends danger for its inhabitants (man and livestock).

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