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ENVIRONMENTAL IMPACT OF HUMAN ACTIVITIES ON WATER AND SEDIMENT COMPOSITION IN OGINIGBA/WOJI CREEK, PORT HARCOURT, NIGERIA

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Abstract
The environmental impact of human activities on water and sediment composition in Oginigba/Woji Creek, Port Harcourt, Nigeria, was investigated. The study has 7 objectives and 7 research questions. Four sampling stations were established along the study creek. The acid (HNO_3) digestion method and the Aqua-Regia digestion procedure were used for the digestion of water and sediment samples, respectively. The determination of heavy metals was done with the Atomic Absorption Spectrophotometer (AAS). The mean spatial values of physicochemical parameters and heavy metal concentrations in surface water ranged as follows: Temperature (26.43±1.95–27.05±0.60℃), pH (6.6±0.65–6.8±0.47), Conductivity(10570.7±7543.3–15055.4±7505.7µS/cm), TDS(5813.92±4148.95–8280.6±4128.28mg/l), DO(5.56±0.79–5.75±0.86 mg/l), BOD_5(1.95±0.07–2.28±0.07mg/l), Cd(ND), Pb(ND), Fe(0.19±0.17–0.28±0.17mg/l), Cu(0.09±0.01–0.18±0.01mg/l), Zn(0.20±0.02–0.35±0.02mg/l) and Mn(0.01±0.00–0.04±0.00mg/l). Spatial mean concentrations of water parameters were within safe limits, except for conductivity and TDS. Seasonal mean values were higher in the dry season, except for DO, Fe, and Mn concentrations, and varied significantly across seasons, except Zn and Mn. The spatial mean concentrations (mg/kg) of heavy metals in sediment ranged as follows: Cd(0.13±0.0–0.31±0.0), Pb (0.89±0.7–5.18±0.8), Fe(951.3±122.5–1809.2±437.8), Cu(4.35±0.46–11.45±1.99), Zn(13.07±2.16–34.93±6.58) and Mn(7.95±1.18–24.68±5.93); the spatial means of Pb, the spatial and seasonal means of Fe, and the dry season means of Cd and Pb exceeded the MPL. The spatial and seasonal means varied significantly, except for Fe about stations and Fe and Mn about seasons. The seasonal mean of heavy metals in sediment was higher in the dry season. The investigation revealed the sediment enrichment of heavy metals, most of them above safe limits. The elevated levels of the non-essential metals Cd and Pb in sediments constitute risk factors for benthic organisms, especially during the dry season, hence the need for restoration and corrective actions to mitigate the toxicity levels of these metals, not only for the wellbeing of aquatic species but also for the safety of human consumers of sea foods.

Keywords: Anthropogenic, Physicochemical, Heavy metals, Sediment, Toxicity, Mitigate,

Introduction
Estuarine waters are the most anthropogenically altered ecosystems. Aside from the critical role they play in supporting the livelihood of millions of people living within the neighbourhood, they are regarded as receptacles for the disposal of sewage and domestic and industrial wastewater. Following population growth, urbanization, urban migration, and high industrial activities, there has been an increase in waste generation, and since most of these industrial activities are clustered on the banks of these water bodies, the water bodies consequently serve as effluent disposal sites for these industries and coastal populations. The introduction of sewage and domestic and industrial wastewater into the aquatic ecosystem constitutes a major threat to the physicochemical, flora and fauna characteristics of the aquatic ecosystem (Edokpayi & Nkwoji, 2000; Nkwoji et al., 2010). Moreso as most of these coastline dwellers and industries lack good sanitary and waste management facilities. Wastes discharged into the water without any form of treatment as a result of improper or deliberate channelling of the wastes into the aquatic environment cause extensive damage to the water quality and the ecology of the environment, and contribute extensively to heavy metals pollution.

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The physicochemical properties such as temperature, pH, electrical conductivity, salinity, total dissolved solids, total suspended solids, nutrient composition, dissolved oxygen and biochemical oxygen demand, and ecological and biological factors such as seasonal and local variations of pollutants content, weight, size, age, sex, life cycle and trophic levels of aquatic organisms determine the wellbeing of the biotic components of an aquatic ecosystem, and therefore the need to properly evaluate and monitor these parameters in water resources. Heavy metals are metallic elements that have a relatively high density (Lenntech Water Treatment Solutions, 2012), and constitute an underlying collection of pollutants in aquatic ecosystems for the reasons that they can change both aquatic species and ecosystem diversity due to their toxicity and accumulative behaviour (Al-Yousuf et al., 2000; Turkmen et al., 2005). They constitute a large percentage of the functional polluting substances affecting the quality of the ecosystem, with their long-term impact on living organisms, including food species (Censi et al., 2006; Ozturk et al., 2009).

Cadmium (Cd) and Lead (Pb), and their compounds including organic and inorganic are non-essential, persistent, bioaccumulative, toxic substances, even at low concentrations, and are possible human carcinogens found in all components of the environment, including air, soil and water (Martin & Griswold, 2009), dispersed as a result of anthropogenic activities. Their solubility decreases with increasing pH and alkalinity (Krol et al., 2020). Soltan et al. (2019), reported that the solubility of Pb compounds is highest in acid pH, whereas sediment is the sink for Pb and Cd at alkaline pH. Human exposure above baseline levels has been reported to cause damage to the brain and kidneys and ultimately lead to death. Reproductive toxicity, such as stillbirth and miscarriage in pregnancy, and damage to the male sperm-producing cells have also been reported in Pb toxicity (Martin & Griswold, 2009). Pb-induced toxicity in fish is primarily due to bioaccumulation in specific fish tissues and the accumulation mechanisms, depending on the water habitat and mode of exposure. Pb bioaccumulation in fish has been reported to cause oxidative stress due to excessive production of reactive oxygen species (ROS), neurotoxicity, and undesirable immune responses (Ju-wook et al., 2019), whereas Cd has been reported to damage fish kidneys and liver, impair reproductive capacity, and cause hypertension (Mansour & Sidky, 2002).

Iron (Fe), Copper (Cu), Zinc (Zn) and Manganese (Mn), though are essential dietary metals for humans and other living organisms needed for the transport of oxygen, known to play vital metabolic and homeostatic functions and require enzyme cofactors in living organisms including fish species, intoxication as well as their deficiencies or a homeostatic imbalance can induce the formation of reactive oxygen species (ROS) in the system (Orino et al., 2001), which causes tissue damage and leads to oxidative stress. The characteristic behaviour of heavy metals in natural water bodies is a function of the substrate sediment composition, the suspended sediment composition and water chemistry (Harikumar et al., 2009; Barakat et al., 2012). Sediments act as the ultimate reservoir for metals and other chemical and biological contaminants from anthropogenic activities (Adeleye et al., 2012). These metals are adsorbed by organic and inorganic substrates or form chemical bonds with components of the sediment, and undergo subsequent sequestration (Vincent-Akpu & Babatunde, 2013). Heavy metals adsorbed onto sediments are made available to aquatic organisms in the aqueous phase following changes in physicochemical conditions and organic matrix concentrations. These factors also go a long way in influencing the availability of metals to aquatic organisms.

The Oginigba/Woji Creek is a natural coastal ecosystem that plays an important ecological role and provides essential ecosystem services to dependent communities. It consists of a rich collection of flora and fauna species constituting a unique tropical biodiversity. However, an exploding population, increasing industrial activities, urbanization and urban migration, discharge of untreated industrial and municipal effluents into the Creek, lack of environmental awareness and strict regulatory guidelines and penalties to mitigate aquatic pollution can adversely affect the water quality and lead to metal toxicity, and even death of aquatic organisms. This consequently poses serious health risks to human consumers of these seafoods therefore on this premise this study seeks to evaluate the environmental impact of human activities on water and sediment composition in Oginigba/Woji Creek Port Harcourt, Nigeria.

Statement of the Problem

The Oginigba/Woji Creek ecosystem is confronted with a severe environmental crisis marked by the degradation of water quality and the contamination of sediments. The physicochemical properties of the surface waters have deviated from recommended standards, and heavy metal concentrations in both water and sediments have reached alarming levels. This poses a critical threat not only to the aquatic ecosystem but also to the health and livelihoods of the surrounding communities. To address the escalating environmental issues in Oginigba/Woji Creek, various stakeholders, including government agencies, non-governmental organizations (NGOs), and community initiatives, have undertaken several efforts. These initiatives have included periodic water quality monitoring, public awareness campaigns, and limited pollution control measures. However, these actions have not been sufficient to comprehensively mitigate the problem, as the pollution sources persist and the ecosystem continues to deteriorate. To provide a holistic approach to tackle the multifaceted challenges facing Oginigba/Woji Creek, the study seeks to evaluate the environmental impact of human activities on water and sediment composition in Oginigba/Woji Creek Port Harcourt, Nigeria.

Purpose of the Study

The study aims to evaluate the environmental impact of human activities on water and sediment composition in Oginigba/Woji Creek Port Harcourt, Nigeria. Specifically, the study seeks to determine:

1. Physicochemical and heavy metals concentration in surface water from Oginigba/Woji Creek about stations.
2. Physicochemical parameters of surface water from Oginigba/Woji Creek for 12 months.
3. Effects of seasons on physicochemical parameters and heavy metals concentration in surface water from Oginigba/Woji Creek.
4. Heavy metal concentrations of surface water from Oginigba/Woji Creek in relation to months.
5. Comparison between physicochemical parameters and heavy metal concentrations in surface waters of Oginigba / Woji Creek of the present study with previous studies.
6. Heavy metal concentrations in sediments from Oginigba/Woji Creek about stations.
7. Monthly heavy metal concentrations in sediments from Oginigba/Woji Creek.

Research Questions

1. What is the physicochemical and heavy metals concentration in surface water from Oginigba/Woji Creek in relation to stations?
2. What are the physicochemical parameters of surface water from Oginigba/Woji Creek for 12 months?
3. What are the effects of seasons on physicochemical parameters and heavy metals concentration in surface water from Oginigba/Woji Creek?
4. What are the heavy metal concentrations of surface water from Oginigba/Woji Creek in relation to months?
5. What is the comparison between physicochemical parameters and heavy metal concentrations in surface waters of Oginigba / Woji Creek of the present study with previous studies?
6. What are the heavy metal concentrations in sediments from Oginigba/Woji Creek in relation to stations?
7. What are the monthly heavy metal concentrations in sediments from Oginigba/Woji Creek?

Materials and Methods

A total of four sampling stations were selected along the course of the Creek at about 2000 meters apart. Two stations were established at the Oginigba section and two stations at the Woji section. Sampling was done at low tide once a month for twelve months, covering two seasons, Dry and Rainy seasons. The Rainy season sampling was done from April to September, while the Dry season sampling was done from October to March. Water and sediment samples were collected from each sampling station along the study Creek aboard a rowboat. Heavy metals (Cd, Pb, Fe, Cu, Zn and Mn) determination was done using the acid-treated water samples. The Nitric acid, HNO_3 digestion method was used (APHA, 2018). 50 ml of the well-mixed acid-treated water sample was transferred to a 125 ml beaker; 5 ml concentrated HNO_3 and a few boiling chips were added. The sample was brought to a slow boil and evaporated to about 5ml on a hot plate before precipitation. Heating continued with occasional adding of conc. Sediment samples were digested using the Aqua-Regia Digestion procedure (Ang & Lee, 2005). Sediment samples were air-dried at ambient temperature and sieved through 2 mm mesh size sieve. 5gm of the air-dried sample was accurately weighed and transferred into a 100-glass beaker. To enhance the reliability and accuracy of data, samples were collected from various distinct sampling stations. Whereas some physicochemical parameters were measured *in situ*, others were analyzed at Analytical Concept Limited, Elelenwo Port Harcourt, Rivers State; a government-accredited laboratory, very close to the study area. The data obtained from field and laboratory analysis were subjected to one- and two-way analysis of variance (ANOVA) and t-test to evaluate the difference between sample means. The significance level was set at P<0.05. Statistical analysis was done using the window-based statistical package for social sciences (SPSS) software version IBM SPSS version 23.0, 2015 IBM corporation, and Microsoft Excel 20. The concentration of heavy metals in water was reported as mg/l, while sediment metals concentration was reported as mg/kg dry weight. Results were compared with maximum permissible limits (MPL) set by national and international regulatory agencies, as well as previous studies.

Results

Table 1: Mean physicochemical and heavy metals concentration in surface water from Oginigba/Woji Creek in relation to stations.

Physicochemical parameters	Stations 1	Station 2	Station 3	Station 4	p-value	Reference limit (WHO, 2007) FEPA(2003)/ FMENV(2001)	Rmk.
Temp.(°C)	26.88±0.75	27.05±0.60	26.43±1.95	26.89±0.63	0.38	20 – 30	NS.
pH	6.6±0.65	6.8±0.47	6.7±0.48	6.7±0.52	0.338	6.5-9	NS.
Cond.(μS/cm)	11695.5±7874.18	10570.7±7543.3	12989.9±7556.3	15055.4±7505.7	0.000	<2000	SIG.
TDS(mg/l)	6432.7±4330.89	5813.92±4148.95	7144.5±4155.98	8280.6±4128.28	0.000	500	SIG.
DO(mg/l)	5.74±0.88	5.56±0.79	5.64±0.86	5.75±0.86	0.026	>4	SIG.
BOD_5 (mg/l)	1.95±0.07	2.28±0.07	2.04±0.07	2.06±0.07	0.020	50	SIG.
Cd(mg/l)	0.001±0.00	0.001±0.00	0.001±0.00	0.001±0.00	-	0.003	ND.
Pb(mg/l)	0.001±0.00	0.001±0.00	0.001±0.00	0.001±0.00	-	0.01	ND.
Fe(mg/l)	0.21±0.11	0.28±0.17	0.26±0.19	0.19±0.17	0.002	0.3	SIG.
Cu(mg/l)	0.14±0.01	0.18±0.01	0.11±0.01	0.09±0.01	0.003	2.0,1	SIG.
Zn(mg/l)	0.35±0.02	0.32±0.03	0.30±0.02	0.20±0.02	0.001	15.0,5.0	SIG.
Mn(mg/l)	.02±0.00	0.04±0.00	0.01±0.00	0.01±0.00	0.000	0.5	SIG.

Legend: SIG = Significance, NS = No Significance, ND= Not Detected. Station 2 differs significantly from the other three stations for measured parameters, except in temperature and pH of surface waters.

Table 2: Mean Physicochemical parameters of surface water from Oginigba/Woji Creek for 12 months.

Months	Parameters

	Temperature (℃)	pH	Conductivity (μm/cm)	Total Dissolved Solid(Mg/l)	Dissolved Oxygen (Mg/l)	BOD_5 (Mg/l)
April	27.15±0.06	6.65±0.13	13043.50±598.58	7174.00±329.12	5.30±0.05	2.34±0.13
May	26.88±0.10	6.30±0.07	7251.00±883.96	3988.25±486.17	5.97±0.06	1.15±0.13
June	26.13±0.25	6.05±0.05	4446.50±1131.11	2445.50±622.14	6.67±0.22	0.86±0.13
July	25.38±0.25	5.88±0.05	3282.75±1317.07	1805.50±724.40	7.52±0.04	0.65±0.13
August	25.28±1.56	6.67±0.08	6041.25±1261.76	5521.75±1534.55	6.10±0.07	1.08±0.13
September	26.53±0.05	6.20±0.04	5837.75±951.42	3210.75±523.31	6.27±0.04	0.93±0.13
October	27.25±0.06	7.02±0.09	11015.75±590.82	6058.75±324.85	5.20±0.04	2.60±0.13
November	27.50±0.00	7.10±0.04	12735.50±959.81	7004.50±528.05	5.00±0.04	3.20±0.13
December	27.35±0.06	7.17±0.05	18921.00±672.13	10406.75±369.87	5.17±0.25	2.77±0.13
January	27.43±0.05	7.15±0.03	22200.00±1117.66	12210.50±614.71	5.02±0.06	3.16±0.13
February	27.53±0.03	7.17±0.03	25190.25±915.91	13854.75±503.74	4.75±0.15	3.32±0.13
March	27.40±0.04	7.07±0.05	20969.50±1511.03	11533.25±831.08	5.12±0.04	2.88±0.13
SEM	26.81±0.16	6.70±0.06	12577.89±1091.77	7101.18±591.92	5.67±0.11	2.08±0.13
p-value	0.004 SIG.	0.000 SIG.	0.000 SIG.	0.000 SIG.	0.000 SIG.	0.000 SIG.

Table 3 Effects of seasons on physicochemical parameters and heavy metals concentration in surface water from Oginigba/Woji Creek.

Parameters	**Rainy season (April _ Sept 2019)**	**Dry season (Oct. 2019 – March 2020)**	**p-value**	**Reference Value (FAO/WHO, 2013; FEPA, 2003; /FMENV, 2001)**	**Rei**
Temperature (℃)	26.2±0.33	27.4±0.02	0.012	20-30	SIC
pH	6.29±0.03	7.1±0.01	0.000	6.5-9.0	SIC
Conductivity(μS/cm)	6371.3±1209.41	18505.3±920.31	0.000	<2000	SIC
TDS(mg/l)	3657.8±557.55	10180.1±505.53	0.000	500	SIC
DO(mg/l)	6.31±0.06	5.04±0.03	0.000	>4	SIC
BOD_5(mg/l)	1.17±0.25	2.99±0.11	0.000	50	SIC
Cadmium(mg/l)	<0.001	<0.001	-	0.005	ND
Lead(mg/l)	<0.001	<0.001	-	0.01	ND
Iron(mg/l)	0.26±0.02	0.13±0.02	0.003	0.3	SIC
Copper(mg/l)	0.03±0.01	0.23±0.03	0.001	2.0	SIC
Zinc(mg/l)	0.14±0.02	0.37±0.12	0.110	15.0,5.0	NS
Manganese (mg/l)	0.07±0.02	0.06±0.03	0.867	0.5	NS

Legend: SIG = Significance, NS=No Significance, ND=Not Detected.

The Dry season mean levels were significantly different from the Rainy season mean concentrations, except for Zinc and Manganese levels. Cd and Pb were below detectable limits in surface waters.

Table 4: Mean heavy metal concentrations of surface water from Oginigba/Woji Creek in relation to months.

Months	Parameters					
	Cd (Mg/L)	Pb (Mg/L)	Fe (Mg/L)	Cu (Mg/L)	Zn (Mg/L)	Mn (Mg/L)
April	0.001	0.001	0.274	0.057	0.249	0.027
May	0.001	0.001	0.358	0.001	0.198	0.001
June	0.001	0.001	0.453	0.037	0.133	0.016
July	0.001	0.001	0.565	0.01	0.015	0.002
August	0.001	0.001	0.148	0.089	0.126	0.020
September	0.001	0.001	0.217	0.002	0.098	0.001
October	0.001	0.001	0.136	0.404	0.866	0.079
November	0.001	0.001	0.194	0.176	0.363	0.007
December	0.001	0.001	0.158	0.153	0.209	0.027
January	0.001	0.001	0.197	0.181	0.318	0.009
February	0.001	0.001	0.008	0.186	0.509	0.024
March	0.001	0.001	0.242	0.285	0.395	0.031
SEM	ND	ND	0.245	0.132	0.290	0.020
Ref. value	0.005	0.01	0.3	2.0	15.0	0.5
p-value	ND	ND	0.239	0.000	0.000	0.000
significance	ND	ND	NS	SIG.	SIG.	SIG.

Legend: Cd and Pb were not detected on the surface. Fe in May, June and July were significantly different from the other months, and Cu levels in October and March were significantly different from the rest of the months. Zn concentration in October was significantly different from all other months. There were no significant differences in Mn levels over the months, except concentration levels in October which varied significantly with the rest of the months.

Table 5: Comparison between physicochemical parameters and heavy metal concentrations in surface waters of Oginigba / Woji Creek of the present study with previous studies.

Parameters	Present study	Previous studies

		Edoghotu (1998)	Ojiesanmi & Ibe (2012)
Temperature (°C)	26.81	28.40-29.10	27.78-28.39
pH	6.70	6.30-6.60	6.33-6.73
Conductivity (µS/cm)	12577.80	-	14525.50-15075.00
TDS (mg/l)	7101.18	55.10-1293.90	4625.00-10170.00
DO (mg/l)	5.67	4.60-6.30	4.61-5.07
BOD5(mg/l)	2.08	4.30-6.90	3.11-3.29
Cd (mg/l)	ND	-	-
Pb (mg/l)	ND	-	<0.01-0.10
Fe (mg/l)	0.245	-	<0.01-1.60
Cu (mg/l)	0.132	-	<0.01-2.85
Zn (mg/l)	0.290	-	1.17-16.75
Mn (mg/l)	0.020	-	-

Legend: Physicochemical parameters and heavy metal concentrations of Oginigba/Woji Creek of the present study were similar to those reported in previous studies, except for the TDS.

Table 6: Mean heavy metal concentrations in sediments from Oginigba/Woji Creek in relation to stations.

Heavy metals (Mg/Kg)	Stations 1	Station 2	Station 3	Station 4	p-value	Reference limit (FEPA, 2003/ FMENV, 2001)	Rmk.
CADMIUM	0.23±0.0	0.31±0.0	0.25±0.0	0.13±0.0	0.002	0.03-0.3	SIG.
LEAD	0.89±0.7	3.46±0.5	5.18±0.8	1.95±0.4	0.001	0.5	SIG.
IRON	951.3±122.5	1809.2±437.8	1473.2±363.8	1265.4±221.1	0.085	20	NS.
COPPER	8.37±1.58	11.45±1.99	8.2±1.59	4.35±0.46	0.000	20	SIG.
ZINC	13.07±2.16	21.65±3.81	34.93±6.58	15.72±3.23	0.000	50-300	SIG.
MANGANESE	12.15±3.46	24.68±5.93	11.54±2.04	7.95±1.18	0.000	-	SIG.

Legend: Cd concentration in station 4 was significantly different from other stations. In Pb, station 1 was significantly different from station 2. There were no significant variations in the Fe levels across the stations except between stations 1 and 2. Cu level in station 2 was significantly different from levels in stations 1, 3 and 4. Zn concentration in station 3 differed significantly from other stations, whereas there was a significant difference in Mn concentration between station 2 and other stations.

Table 7: Mean monthly heavy metal concentrations in sediments from Oginigba/Woji Creek

MONTHS	CADMIUM	LEAD	IRON	COPPER	ZINC	MANGANESE
APRIL	0.06±0.0	2.63±1.4	880.7±118.1	8.53±1.55	17.19±4.2	8.34±1.28
MAY	0.00±0.0	0.00±0.0	634.2±42.8	4.11±0.27	13.12±3.15	6.02±1.64

JUNE	0.00±0.0	0.00±0.0	563.8±4.58	4.37±0.69	8.76±2.36	4.51±1.48
JULY	0.00±0.0	0.00±0.0	315.8±83.5	2.49±0.31	2.80±0.69	4.39±1.85
AUGUST	0.04±0.0	0.08±0.0	1346.3±140.9	4.51±0.19	14.32±0.90	8.59±1.93
SEPTEMBER	0.00±0.0	0.16±0.01	929.8±85.6	5.54±0.17	11.52±1.08	7.42±1.97
OCTOBER	0.17±0.0	0.63±0.05	1635.7±550.7	7.75±0.73	30.65±10.25	10.94±2.06
NOVEMBER	0.31±0.0	2.86±0.5	1830.3±895.5	8.59±0.63	39.63±9.91	25.07±8.59
DECEMBER	0.59±0.0	5.35±0.1	1911.2±505.4	7.89±0.89	38.83±15.02	27.17±11.25
JANUARY	0.39±0.0	8.81±0.5	2780.9±584.5	14.18±2.16	29.39±5.0	28.74±9.14
FEBRUARY	0.96±0.0	8.43±0.6	2763.1±642.2	15.53±2.08	29.91±5.97	20.51±6.26
MARCH	0.24±0.0	5.52±0.3	905.3±70.4	13.742.39	20.02±5.55	17.22±1.95
SEM	0.23±0.09	2.87±0.97	1374.8±237.71	8.10±1.25	21.35±3.48	14.08±2.65
P-VALUE	0.000	0.000	0.001	0.000	0.000	0.000

Legend: February Cd level was significantly different from other months, and Pb in January and February were significantly different from other months except December and March. Similarly, Fe concentrations in January and February varied significantly from other months. November. Cu levels in January, February and March were different from other months. For Zn, significant differences exist across the months, whereas Mn levels in November, December, January and February were statistically different from Mn levels in April, May, June, July, August and September.

Discussion

The present study revealed high Cd and Pb enrichment of sediments across the four stations. The presence of Cd and Pb in sediment could probably be because sediment serves as a major depository for heavy metals. Whereas station 2 recorded the highest Cd level followed by station 3, Pb was highest in station 3 followed by station 2. Fe, Cu and Mn were also observed to be highest in station 2, while Zn was highest in station 3. Generally, station 2 recorded the highest pollution levels with respect to water and sediment heavy metal concentrations. The relatively higher levels of heavy metals found in stations 2 and 3 reflected the high input rate from the anthropogenic sources at these points of the Creek, dominated by organic wastes of plant and animal origin from abattoir and market activities, untreated industrial and municipal wastewater, oil spills from boating and boat building activities, as well as direct and open dumping of sewage and plastic materials. Stations 1 and 4 with relatively lower concentrations of metals are far from these points. This finding is in agreement with Franc et al. (2005) who reported that sediments containing more sand and lower values of organic matter exhibit low metals enrichment and that heavy metal concentration in sediment increases with an increase in the content of organic material (Tsai et al., 2003).

All the heavy metals studied showed significant variations across the stations except Fe. Iron (Fe) has been reported to occur naturally in high concentrations in sediments of Nigerian waters (Akan et al., 2012). In relation to seasonality, all sediment metals were higher in the Dry season. However, only Cd, Pb, Cu and Zn were significantly higher, while there were no significant differences in Fe and Mn mean seasonal concentrations. The higher levels observed in the Dry season could be due to increased sedimentation of heavy metals from the water column under high pH the adsorption of heavy metals onto organic matter, and their settlement at the bottom of the system (Goher, 2002). This is in addition to the overwhelming effect of the Dry seasons which tend to concentrate the metals via evaporation. A comparison between heavy metals concentrations in water and sediment revealed that sediments were highly burdened with heavy metals. This is because sediment serves as a reservation for all pollutants and dead organic matter descending from the aqueous phase.

Mean concentrations of heavy metals in sediment obtained in this investigation were relatively lower than those reported by Ibanga et al. (2018) in sediments of Woji Creek, and Marcus and Edori (2016) in Bomu and Oginigba Creek sediments, except Cd which was not detected in sediments of Bomu and Oginigba. The relatively lower levels of metals in the present study could be attributed to the reduced volume of industrial activities due to the economic downturn which necessitated the shutting down of operations of some companies and industries within the Trans-Amadi Industrial Area, with sustained pollution of the Creek waters from illicit discharges from municipal and domestic sewage, and industrial wastewaters. The presence of Cd in sediments of this present study as against its absence in one of the previous studies (Marcus & Edori, 2016), could be due to overtime sedimentation of the metal, since sediment serves as a depository for heavy metals. The mean concentrations of Cd, Pb and Fe exceeded the given guidelines, while Cu and Zn were within guidelines set by national and international regulatory bodies. No established reference limit yet for Mn concentration in sediment, since concentrations so far reported pose no serious environmental challenges.

Cadmium (Cd) concentration in sediments of Oginigba/Woji Creek was highest in station 4 in April and station 3 in January. In August, October, November, December, February and March Cd concentration was highest in station 2, while in May, June, July and September Cd concentration was insignificant in all stations (Fig. 2). However, analysis of data obtained showed that the spatial mean concentration (0.31±0.0 mg/kg) of Cd was highest in station 2, and lowest (0.13±0.0 mg/kg) in station 4 (Table 6), while monthly mean (0.96±0.0 mg/kg) was highest in February (Table 7). There were significant variations in mean Cd concentration levels in relation to stations and months at $p<0.05$. The results obtained indicated that the mean Cd concentrations in sediment across the four stations were within the maximum permissible limit of 0.03–0.3 mg/l set by FEPA (2003) and FMENV (2001). However, mean Cd concentrations higher than the maximum permissible limit were observed in December, January and February.

Conclusion

The concentration and bioavailability of the heavy metals in the water column and sediments of the ecosystem were largely influenced by the physicochemical properties of the system and seasons. This investigation revealed that sediments were heavily burdened with metals most of them above safe levels, which reflects the sustained input of these metals from industrial and municipal wastewaters, and myriads of anthropogenic activities in and around the study area. Station 2 of the study area had the highest concentration of heavy metals which was attributed to the high concentration of industrial, market and slaughterhouse activities, and wastewater discharge points at that section of the study area. The absence of Cd and Pb in the water column and their accumulation in sediment indicated the adsorption of these heavy metals onto organic matter and their rapid sedimentation downward.

The low sediment metals concentration compared to previous studies was a result of a reduction in the volume of industrial activities occasioned by the economic downturn which necessitated the shutting down of some businesses within the Trans-Amadi Industrial Area, with sustained pollution of the Oginigba/Woji Creek.

The elevated levels of the non-essential metals, Cd and Pb in sediments constitute a risk factor for benthic and detritus feeders, and a pointer to serious health risks for human consumers of seafood, especially during the Dry season.

Recommendations

Based on the findings from the study, the following recommendations were made:

1 Regulatory authorities should establish and enforce guidelines for acceptable levels of these parameters to protect the aquatic ecosystem and public health.
2 Implementing water quality management practices and source control measures, such as reducing industrial discharges and runoff.
3 There should be public awareness campaigns to inform local communities about the risks associated with contaminated water and sediment.

References

Adeleye, A.O., Shelle, R.O.D., & Akinnigbagbe, A.E. (2012). Pollutant Dynamics and Distribution in sediments North of the Lagos Lagoon Ecosystem. *Nature and Science*, 9(5), 13-16

Akan, J.C., Abbagambo, M.T., Chellube, Z.M. &Abdulrahman. F.I., (2012). Assessment of pollutants in water and sediment samples in Lake Chade, Baga, North Eastern Nigeria. *Journal of Environmental Protection*, 3, 1428-1441.

Al-Yousuf, M.H., El-Shahawi, M.S., & Al-Ghais, S.M. (2000). Trace Metals in Liver, Skin and Muscles of *Lethrinus lentjan* fish species in Relation to Body length and Sex. *The Science of the Total Environment,* 256 (2-3), 87-94. Doi:10.1016/50048-9697 (99)00363-0.

Ang, H.H., & Lee, K.L. (2005). Analysis of Mercury in Malaysian herbal preparation. *Peer-review Journal of Biomedical Science*, 4(1), 31-36.

APHA (2018). American Public Health Association. Standard Methods for the Examination of Water and Wastewater, 23rd Edition (American Water Works Association, Water Environment Federation), Washington DC, U.S.A.

Barakat, A., El Baghdadi, M., Rais, J., & Nadem, S. (2012). Assessment of heavy metal in surface sediments of Day River at Beni-Mellal region, Morocco. *Research Journal of Environmental and Earth Sciences*, *4*(8), 797-806.

Censi, P., Spoto, S.E., Saiano, F., Sprovieri, M., Mazzola, S., Nardone, G., D., Geronimo, S.I., Unturo, R., & Ottonello, D. (2006). Heavy metals in coastal water system: A case study from the northwestern gulf of Thailand. *Chemosphere.* 64, 1167-1176

Edoghotu, A. J. (1998). The Ecological Quotient (EQ) of Point Sources of Pollution Along Okpoka Creek, Port Harcourt. M.Sc. Thesis, Rivers State University of Science and Technology, Port Harcourt, Nigeria.

Edokpayi, C.A., & Nkwoji, J.A. (2000). Annual changes in the physico-chemical and macrobenthic invertebrate characteristics of the Lagos Lagoon Sewage dump site at Iddo, Southern Nigeria. *Ecology, Environment and Conservation*, *13*,13-18.

FAO (2007). The State of the World Fisheries and Agriculture. *Food and Agriculture Organization of the United Nations*. Electronic Publishing Policy and Support Branch, Fisheries and Aquaculture Department. Rome, Italy.

FAO/WHO (2013). *Food and Agriculture Organization/ World Health Organization.* Guidelines for the safe use of wastewater and food stuff: Waste water use in Agriculture. World Health Organization, Geneva. 2, 988

FEPA (1999). *Federal Environmental Protection Agency* (Effluent limitation) Regulations. S. 18 FEPA. Lagos.

FEPA (2003). *Federal Environment Protection Agency.* Guidelines and Standards for Environmental Pollution Control in Nigeria. p 239.

FMENV (2001). *Federal Ministry of Environment,* National guidelines and Standards for Water quality in Nigeria. p 114.

Franc, S., Vinagre, C., Cacador, I. & Henrique, C. N. (2005). Heavy metal concentrations in sediment, benthic invertebrates and fish in three salt marsh areas subjected to different pollution loads in the Tagus Estuary (Portugal). *Marine Pollution Bulletin*, 50, 993-1018. Doi: 10.1016/j.marpolbul.2005.06.040.

Goher, M.E. (2002). Chemical Studies on the Preparation and Dissolution of some Chemical Elements in Lake Qarun. Chem. Dept. Fac. Sci. Al-Azhar Universiy, Egypt (2002). p278.

Harikumar, P. S., Nasir, U. P., & Rahman, M. M. (2009). Distribution of heavy metals in the core sediments of a tropical wetland system. *International Journal of Environmental Science & Technology*, *6*, 225-232.

Ibanga, L.B., Nkwoji, J.A., Usese, A.I., Onyema, I.C., & Chukwu, L.O. (2018). Hydrochemistry and heavy metals concentrations in sediment of Woji creek and Bonny estuary, Niger Delta, Nigeria. *Regional Studies in Marine. Science*, *25*, 1-11. Doi: 10: 1016/j.rsma.2018.10.004.

Ju- Wook, L., Hoon, C., Un- Ki, H., Ju Chang, K., Yue, J.K., Kwang, I.K. & Jun, H. (2019). Toxic Effect of Lead Exposure on Bioaccumulation, Oxidative Stress, Neurotoxicity and Immune responses in Fish. A review. *Environmental Toxicology and Pharmacology,* 68, 101-108. Dio: 10.1016/j.etap.2019.03010.

Krol, A., Mizerna, K., & Bozym, M. (2020). An assessment of pH-dependent releaseand mobility of heavy metals from metallurgical slag. *Journal of hazardous Materials,* 384, 121502. Doi: 10.1016/j.jhazmat.2019.121502.

Lenntech Water Treatment Solutions (2012). Chemical Properties, Health Effect and Environmental effects of Heavy metals. Lenntech, Netherland. Available online: (https://www.lenntech.com>elements and water). Accessed 23rdJuly, 2020.

Mansour, S.A. & Sidky, M.M. (2002). Ecotoxicological studies, 3 heavy metals contaminating water and Fish from Fayoum Governorate. *Egyptian Journal of Food Chemistry*, 78 (1),15-22.

Marcus, A.C., & Edori, O.S (2016). Assessment of contamination status of Bomu and Oginigba Rivers, Rivers State, Nigeria. Using some Trace Metals and *Callinectes gladiator* as Indices. *Chemical Science International Journal*, 17(4),1-10. Doi:10.97341CSIJ/2016/28499.

Martin, S., & Griswold, W. (2009). Human Health Effects of Heavy Metals. Environmental Science and Technology Briefs for Citizens. Centre for Hazardons Substance Research Kansas State University. 104 Ward Hall. Manhattan Ks 66506. 785-532-6519.15.

Nkwoji, J.A., Yakub, A., Ajani, G.E., Balogun, K.J., & Renner, K.O. (2010). Seasonal variations in the water chemistry and benthic macroinvertebrates of a South Western Lagoon, Lagos, Nigeria. *Journal of American Science,* 6, 85-92.

Orino, K., Lehman, L., Tsuji, Y., Ayaki, H., Torti, S.V., & Torti, F.M. (2001). Ferritin and the response to oxidative stress. *Biochemical Journal*, 357, 241-247. doi: 10.1042/0264-6021:3570241.

Ozturk, M., Ozozen, H., Minareci, O. & Minareci, E. (2009). Determination of Heavy Metals in Fish, Water and Sediment of Avsar Dam Lake in Turkey. *Iranian Journal of Environmental Health Science and Engineering*, 6(2),73-80.

Soltan, M.E., Al-ayed, A.S., & Ismail, M.A. (2019). Effect of pH values on the solubility of some elements in different soil samples. *Chemistry and Ecology,* 35(3), 270-283. doi: 10.1080/02757540.2018.1546294.

Tsai, L.J., Ho, S.T., & Yu, K.C. (2003). Correlation of extractable heavy metals with organic matters in contaminated river and sediments. *Water Science and Technology,* 47, 101-10

Türkmen, A., Türkmen, M., Tepe, Y., & Akyurt, İ. (2005). Heavy metals in three commercially valuable fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey. *Food Chemistry*, *91*(1), 167-172.

VanWalt (2014). The Methodologies for collecting sediment samples. Accessed 11th November, 2020, at www.vanwalt.com.

Vincent-Akpu, I.F., & Babatunde, B.B. (2013). Trace Metals in Water, Fish and Sediments from Elechi creek, Port Harcourt, Rivers State, Nigeria. *Tropical Freshwater Biology,* 22, 13-21. Doi .org/10.4314.tfb.v22i1.2.

WHO (2007). Guidelines for drinking water quality. World Health Organization, Geneva

WHO (2017). "Life expectancy at birth (M/F) estimate for Nigeria''

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