Analysis of heavy metals concentration in different media of Iwofe Creek, Niger Delta, Nigeria

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ABSTRACT

This study investigated heavy metals concentration in *Penaeus monodon,* surface water and sediment for six months in Iwofe creek, in Niger Delta, Nigeria. Samples were collected from three stations and were analyzed for lead (Pb), chromium (Cr), cobalt (Co), Zinc (Zn), copper (Cu) and nickel (Ni) use of atomic absorption spectrophotometer. The results showed the level of heavy metal concentrations in *P. monodon,* surface water and sediment. From the results, lead, chromium and copper recorded the least concentrations across the three media (fish, sediment and surface water). Cobalt recorded the highest concentration for all test media followed by nickel and zinc. No significant difference ($p>0.05$) was observed across the test media (*P. monodon*, sediment and the surface water) for the six months of study. Monthly changes in surface water physico-chemical parameters were also analyzed during the study period; January 2018 to June 2018. Physico-chemical parameters analyzed for surface water were Temperature (ºC), pH, Dissolved Oxygen (mg/l), Total Suspended Solid (ppt) and Salinity (ppt). The highest concentration of the physico-chemical parameters was observed in the dry season (January to March 2018) and lower concentrations were observed in the rainy season (April to June 2018). The fluctuating levels were found throughout the year. The Physico-chemical parameters of the water were compared with Department of Petroleum Resource (DPR, 2002) and Federal Environmental Protection Agency (FEPA, 2003) standards and all the values were within the permissible limit. To reduce and avoid aquatic biota loss, there is need to monitor and minimize heavy metals generation and discharge into the aquatic environment by applying relevant regulatory control measures. It is therefore recommended that the Federal Ministry of Environment and other relevant regulatory agencies in Nigeria ensure regular monitoring of the aquatic resources and provide a proper management control to indiscriminate discharge and effluence in to the aquatic environment.

Keywords: Heavy Metals, *Penaeus monodon,* Sediment, Surface Water and Iwofe Creek**.**

INTRODUCTION

Water pollution is the introduction of contaminant by physical, chemical, disease causing microbial agents or radioactive agents to the natural water body (Ghosh and Singh, 2005). The introduction of these contaminant into the environment is called Pollution (Obasohan and Eguavoen, 2008). According Oluyemi *et al.* (2008) it has become more challenging to maintain the quality of the aquatic ecosystem. There are pollutants that naturally enter the River system e.g. natural fires, volcanoes and oil seeps etc (Hossain *et al.* 2012).

Clearly the preceding definitions and descriptions of water pollution is highly indicative of it is a common phenomenon, especially in areas where surface waters, such as rivers, streams, lake and brackish/coastal waters are exposed to anthropogenic activities. The coastal and brackish water environment is usually known by large industrial settlements and urban areas by impact of effluent discharge which causes accumulation of heavy metal (Ogbonna *et al.*, 2009). The brackish water environment is been endangered by discharges of untreated wastes and industrial effluents (Nenibarini, 2004). This eventually causes harm to the sustainability of the living resources and public health. The waste transports high level of toxicants, especially the heavy metals which have the ability to accumulate in the basic food chain and also move up to the higher trophic level Nagajyoti *et al.*, 2010). Heavy metals are important environmental pollutants and their toxicity is a challenge because of the ecological, nutritional, environmental and evolutionary effects (Jaishankar *et al.*, 2014).

Water pollution affects rivers, oceans, lakes and drinking water for humans and some sources of water pollution include marine dumping, industrial waste, atmospheric deposition, underground storage leakages, eutrophication and global warming (Espinoza-Quiñones *et al.*, 2012). The direct contaminants that bring about pollution in water are pathogens, wide spectrum of chemicals and physical or sensory changes e.g. increased temperature and water discolouration (Maduka *et al.,* 2008).

Marine pollution is a principal problem in the world today (Useh *et al.,* 2015). Activities of human and industries have caused various discharge of pollutants into the marine environment endangering the health of the population and destroying the quality of the environment by making the water bodies unfit for human use (Abowei and Sikoki, 2005). Pollution in marine environment has a wide array of implications for human health. Most sea food, particularly fish can get contaminated and affected humans when they are consumed. Also, use of marine water resources for recreation could pose serious health hazards as a result of pollutants effects.

The main entry routes of toxic substances into the surface water are normally via point source, industrial discharges and run-offs (Aghoghovwia, 2008). Niger Delta is the key zone for the extraordinary biodiversity on the conservation in Western coast of Africa (Nenibarini, 2004). According to Ogamba *et al*., (2015), heavy metals go into the Niger Delta environment through anthropogenic activities. Mgbakor *et al*. (2011) listed some of the anthropogenic activities as industrial waste, chemical waste, mining. Others includes battery manufacturing, soldering, painting, refining, gasoline, electrical wiring, stained glass production and ceramic glazing (Srivastav *et al*., 2013). Mgbakor *et al*. (2011) stated that these substances cause serious effects on biological processes in production of the coastal ecosystems. The careless discharge of liquid wastes of organic and inorganic forms affects the physico-chemical properties of water and further causes danger to the flora and fauna of the marine ecosystem and man (Subhashini and Selvi, 2019). The quality of a particular environment determines the kind of organisms that will be found in that environment (Vidali, 2001). Environmental experts from the UK, USA and Nigeria has rated the Niger Delta area as the highest oil-impacted environment and polluted region in the world (Ikelegbe, 2005).

This status of the Niger Delta area as the highest oil impacted region in the world could be explained and justified by the high level of hydrocarbon activity exploration/exploitation and the very poor environmental control standards to control spills and other associated wastes released into the environment. Additionally, there are rampant acts of sabotage of oil installation facilities that leads to release of enormous amount of crude ito the environment.

Similarly, as is typical of most oil producing areas of the Niger Delta region, the environment surrounding the study creek is highly urbanized and industrialized as part of the chain of water resources applied for the sprawling chain of crude oil and other natural resources facilities used for the exploitation in the region. The effluents discharge from human waste, pipeline leakage, accidental discharges, discharges from refineries and sabotage (illegal bunkering) loading activities may be detrimental to the quality of the creek. Therefore, this study shall help to provide scientific data/information on the current levels of heavy metals (Lead, Iron, Cadmium, Zinc and Copper) in *Penaeus monodon,* surface water and sediments of Iwofe Creek. Fishing is the major occupation of the populace of the area; recent interactions have resulted in complaints from the fishers of low catch due mainly to pollution of the aquatic body. It is expected therefore that through the results of this study, some of the effects on the aquatic environment, inhabitants of the community and the current level of pollution along Iwofe Creek and it's bio-resources in particular will be established and used as a basis to plan remediation and control policies and programmes.

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MATERIALS AND METHODS

Study Area Description

The study was carried out in Rumuolumeni community area of Obio/Akpor Local Government Area, Rivers State, Nigeria. The study area is located between latitude 4.8^0 N and longitude 6.9^0 E and has a very busy human and automobile traffic in it's surrounding neighborhoods. The creek connects Tombia waterside, another populated area in Rivers State. The major land mark intersections through which the creek could be accessed include Whimpey junction, Aker/Okocha Road, Eagle Cement Factory road and Ignatius Ajuru University of Education. Fishing has been the traditional occupation of the locals. The climate of the area is typically tropical, with a clearly distinct rainy period between April and October. This results in enormous fluctuation in the water levels and other physio-chemical parameters of the river. Contrary to the conventional trend and notion that there is always an increase in water levels in all water bodies during rainy season; Iwofe creek exhibit some contrary characteristics. It exhibits a reduction in its water level during rainy season. The reason for this trend is that the creek is located within a valley, so when the rainfalls, the runoffs that flows into the creek generates large quantities of sand and directly into the creek, thus reducing the water depth and volume during the rainy season. There are several anthropogenic activities in the area with several oil serving companies, open local markets were different produce are sold including firewood, banana, fish etc. Other uses that the water is put into direct use for include swimming, transportation and fishing depending on the time.

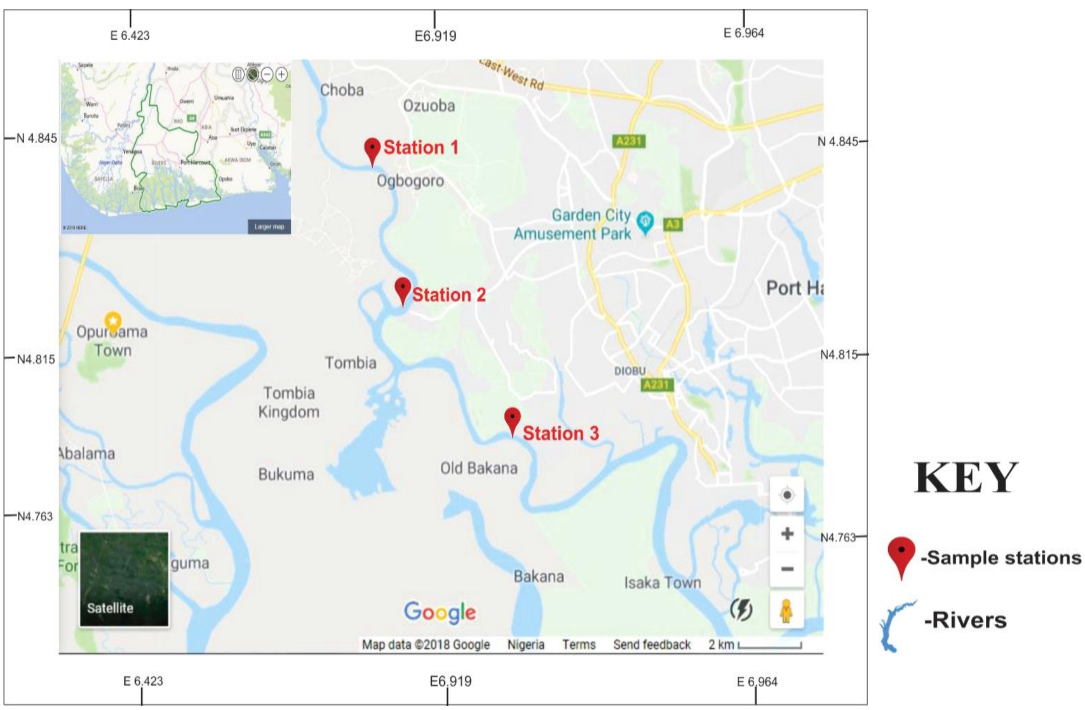

Figure 1: Map Showing the study Area along the Iwofe Creek in Rivers state.

Sampling Techniques

Sampling was carried out once a month for six months (January-June 2018) according to the Bonny tide table for six months using a composite sampling technique. The sampling stations were at least 1,000 meters apart along the Iwofe creek in Rivers State. The sampling locations were geo-referenced and purposely selected to cover areas of the river receiving effluents and wastes form different anthropogenic activities of the area. Figure 1 shows the map of the study area.

A composite sampling technique was used in the three sample stations along the creek. The sediments were collected using an 'Ekman grab' sampler, while the surface water samples were collected in pre-cleaned high-density Schott glass bottles and the swimming crabs were collected from the local fishermen and stored in an ice pack to maintain the freshness and later transported to the laboratory. The different sampled media of the Iwofe creek for which heavy metals (Lead (Pb), Chromium (Cr), Cobalt (Co), Zinc (Zn), Copper (Cu) and Nickel (Ni)) were analyzed using standard laboratory procedures include surface water, sediment and Giant tiger prawn (*Penaeus monodon*) (Plates 1 to 4).

The sampling stations are shown in figure 1 above. A total of three stations were chosen and were at least 1000 meters apart along the Iwofe creek. Based on the peculiarities and features observed around the study area of this creek, three sampling stations were selected within the creek to reflect different activities in the areas: Station I, Station II and Station III (Plate 1,2,3 and 4). Samples collected for analysis include water, sediment and biota. All sites were geo-referenced using a handheld global positioning system (GPS) receiver unit (Magellan GPS 315) to generate geographic coordinates (longitudes and latitudes) of the sampling area.

A comparative analysis of the levels of these three metals in water, sediment and tiger prawn was carried out to determine the extent of heavy metal concentrations in them using the Atomic Absorption Spectrophotometric Machine (API-RP 45).

Plates 1: Showing station I (Midstream)

Plates 2: Showing station II (Downstream)

Plates 3: Showing station III: (Upstream)

Plates 4: Showing the giant tiger prawn (*Penaeus monodon*)

RESULTS

Physicochemical Parameters

The mean values of the physicochemical parameters are presented in table 1 to table 6 and Figure 2. The month of March (29.2±0.00ºC) recorded the highest temperature and the least was observed in the month of June (26.9±0.00ºC). Temperature across the stations showed little variation, ranging from 26.9-27.4ºC for the month of January. The result show that there was significant difference ($P<0.05$) between the stations and the months. The pH across the stations showed little variation and ranges from 6.4-7.2 throughout the months. The result shows slight significant changes across the stations and the months. Although the pH values recorded (7.21±0.00) were highest for the month of January and lowest (6.4±0.00) for the month of June. The Dissolved Oxygen (mg/l) recorded for the stations showed little variation. The DO value recorded for the six months ranges between 2.6-5.3. The mean value for station 1 was 4.90±0.00, station 2 was 3.8±0.00 and station 3 was 4.3±0.00. There was significant difference ($P<0.05$) across the stations and the months. The salinity (ppt) recorded for the six months ranges between 106-197ppt. The result shows significant difference ($P<0.05$) between stations and months although station 1 (190.0±0.00) recorded the highest value of salinity while station 2 (129.00±0.00) recorded the least value across the months. Total Suspended Solid (TSS) varied across the stations and months. The TSS value ranges between 107-178ppt. The result shows significant difference ($P<0.05$) across the stations and months. Although March recorded (178.0±0.00) the highest TSS while the least value (107±0.00) was recorded in the month of January.

Heavy Metal (mg/l) in Giant Tiger Prawn (*P. monodon*)

Tables 7 shows the heavy metal concentrations in the Giant tiger prawn (*P. monodon*) sample from three stations along the Iwofe creek from January to June. The level of Lead was less than 0.001±0.0 mg/l across the three stations for the six months and there was no significant difference ($p>0.05$) observed between the stations and the months. The value for copper ranges between 0.01mg/l to 0.02 mg/l across the three stations and months with no significant different ($p>0.05$) across the three stations and the month. Chromium value was 0.01mg/l for all the stations and months and no significant different was observed ($p>0.05$) across the stations and months. Nickel ranges between 0.105 mg/l to 0.210mg/l for the six months. With the highest value recorded in the months of January (0.156mg/l) and the least value in the month of May (0.81mg/l). There was significant difference ($p<0.05$) between the stations and across months. Cobalt showed variations between 0.113mg/l to 0.198mg/l. With the highest value of Cobalt recorded in the months of May (0.230mg/l) and the least value in the month of June (0.113mg/l). A significant difference ($p<0.05$) was observed between the stations and months. Zinc showed little significant difference ($p<0.05$) with values ranging between 0.81 to 0.158mg/l for the stations across the months. The highest value (0.156mg/l) was observed in the month of January and the least (0.81mg/l) was in the month of May.

Heavy Metal (mg/l) in the Sediment Sample

Tables 8 shows the mean heavy metal concentrations in the Sediment sampled from three stations along the Iwofe creek from January to June. The mean value of lead recorded for the three station and six months were less than 0.001±0.0 mg/l and no significant difference ($p>0.05$) was observed between the stations and the months. Copper ranges from 0.01mg/l to 0.03 mg/l across the three stations for the six months with no significant different ($p>0.05$) across the three stations for each month. Chromium value was 0.01mg/l all through the stations for the six months and no significant different was observed ($p>0.05$). Nickel ranges between 0.170mg/l to 0.274mg/l for the six months. With the highest value recorded in the months of January (0.274mg/l) and the least value in the month of June (0.129mg/l). There was significant difference ($p<0.05$) between the stations and across months. Cobalt showed variations between 0.121mg/l to 0.256mg/l. With the highest value recorded in the months of March (0.256mg/l) and the least value in the month of February (0.121mg/l). A significant difference ($p<0.05$) was observed between the stations and the six months. The mean value of Zinc was significant difference ($p<0.05$) with the values ranging between 0.001mg/l to 0.288mg/l across the stations for the six months. The highest value (0.288mg/l) was observed in the month of January and the least (0.001mg/l) was observed across the other months.

Heavy Metal (mg/l) in the Surface water Sample

The mean values of the heavy metal concentrations in the Surface water sampled from the three stations along the Iwofe creek from January to June can be seen in Table 9. Mean values recorded for lead in the three station for six months were less than 0.001±0.0mg/l and no significant difference (p>0.05) was observed between the stations and across the six months. The values recorded for Copper was 0.001mg/l across the three stations for the six months and no significant different (p>0.05) was observed across the three stations for all the months. Chromium values were 0.001mg/l across the stations for the six months and no significant different was also observed (p>0.05). the range of values for Nickel was between 0.101mg/l to 0.249mg/l for the six months. With the highest value recorded in the months of January (0.294mg/l) and the least value in the month of June (0.101mg/l). There was significant difference (p<0.05) between the stations and across the months. Cobalt values range from 0.214mg/l to 0.292mg/l. With the highest value recorded in the months of February (0.292mg/l) and the least value in the month of June (0.214mg/l). A significant difference (p<0.05) was observed between the stations and the six months. The values for Zinc across the stations for the six months were significant difference (p<0.05) with the values ranging between 0.94mg/l to 0.170mg/l across the stations for the six months. The highest value (0.170mg/l) was recorded in the month of January and the least (0.94mg/l) was observed in the months of April.

Table 1. Variations in the Physico-Chemical Parameters of Iwofe Creek for January

Parameter	Station 1	Station 2	Station 3	DPR (2002)	FEPA (2003)
Temp (ºC)	27.20 ± 0.00^a	26.9 ± 0.00^b	27.4 ± 0.01^a	30	27.8/30
Ph	7.21 ± 0.02^a	6.81 ± 0.00^a	6.83 ± 0.00^a	6-9	6.5-8.5
DO (mg/l)	4.90 ± 0.00^a	3.8 ± 0.00^c	4.3 ± 0.00^b	20	-
TSS (ppt)	139.3 ± 0.01^b	107.4 ± 0.00^a	162.0 ± 0.00^c	2000	1000/2000
Salinity (ppt)	190.0 ± 0.00^a	129.0 ± 0.00^c	132.0 ± 0.00^b	-	-

*At p>0.05
*With same superscript there is no significant difference.
*With different superscript there is a significant difference.

Table 2. Variations in the Physico-Chemical Parameters of Iwofe Creek for February

Parameter	Station 1	Station 2	Station 3	DPR (2002)	FEPA (2003)
Temp (ºC)	28.1 ± 0.00^a	27.6 ± 0.00^b	27.1 ± 0.01^b	30	27.8/30
pH	6.8 ± 0.02^a	6.72 ± 0.00^a	6.8 ± 0.00^a	6-9	6.5-8.5
DO (mg/l)	5.3 ± 0.00^a	4.7 ± 0.00^b	4.8 ± 0.00^b	20	-
TSS (Ppt)	168.7 ± 0.01^a	159.5 ± 0.00^b	122.4 ± 0.00^c	2000	1000/2000
Salinity (ppt)	197.0 ± 0.00^a	134.0 ± 0.00^b	138.0 ± 0.00^b	-	-

*At p>0.05
*With same superscript there is no significant difference.
*With different superscript there is a significant difference.

Table 3. Variations in the Physico-Chemical Parameters of Iwofe Creek for March

Parameter	Station 1	Station 2	Station 3	DPR (2002)	FEPA (2003)
Temp (ºC)	29.2 ±0.00[a]	28.7 ±0.00[a]	28.1 ±0.00 [b]	30	27.8/30
pH	7.1±0.00[a]	6.9 ±0.00 [a]	6.7 ± 0.00 [a]	6-9	6.5-8.5
DO (mg/l)	4.5 ±0.00[a]	3.4 ±0.00[c]	3.8 ±0.00[b]	20	-
TSS (ppt)	178.5 ±0.00[a]	127.4 ±0.00[c]	162.0 ±0.0[b]	2000	1000/2000
Salinity (ppt)	143.0 ±0.00[a]	122.0 ±0.00[c]	139.0 ±0.0[b]	-	-

*At p>0.05
*With same superscript there is no significant difference.
*With different superscript there is a significant difference.

Table 4. Variations in the Physico-Chemical Parameters of Iwofe Creek for April

Parameter	Station 1	Station 2	Station 3	DPR (2002)	FEPA (2003)
Temp (ºC)	28.0 ±0.00[a]	27.5 ±0.00[b]	27.5 ±0.00[b]	30	27.8/30
pH	6.6±0.00[a]	6.8 ±0.00[b]	6.6 ± 0.00[a]	6-9	6.5-8.5
DO (mg/l)	3.1 ±0.00[b]	4.1 ±0.00 [a]	3.2 ±0.00[b]	20	-
TSS (ppt)	173.0 ±0.00[a]	121.0 ±0.00[a]	157.0±0.00[b]	2000	1000/2000
Salinity (ppt)	113.0 ±0.00[b]	132.0 ±0.00[a]	138.0±0.00 [a]	-	-

*At p>0.05
*With same superscript there is no significant difference.
*With different superscript there is a significant difference.

Table 5. Variations in the Physico-Chemical Parameters of Iwofe Creek for May

Parameter	Station 1	Station 2	Station 3	DPR (2002)	FEPA (2003)
Temp (ºC)	27.0 ±0.00[a]	26.5 ±0.00[b]	26.8 ±0.00 [b]	30	27.8/30
pH	6.6±0.00[b]	6.8 ±0.00[a]	6.5 ± 0.00[b]	6-9	6.5-8.5
DO (mg/l)	2.8 ±0.00[c]	3.9 ±0.00[a]	3.2 ±0.00[b]	20	-
TSS (ppt)	169.0 ±0.00[a]	119.0 ±0.00[c]	152.0±0.00[b]	2000	1000/2000
Salinity (ppt)	134.0 ±0.00[a]	119.0 ±0.00[c]	129.0±0.00[b]	-	-

*At p>0.05
*With same superscript there is no significant difference.
*With different superscript there is a significant difference

Table 6. Variations in the Physico-Chemical Parameters of Iwofe Creek for June

Parameter	Station 1	Station 2	Station 3	DPR (2002)	FEPA (2003)
Temp (ºC)	27.4 ±0.00[a]	26.3 ±0.00[b]	26.5 ±0.00[b]	30	27.8/30
pH	6.4±0.00[c]	6.6 ±0.00[a]	6.5 ± 0.00[b]	6-9	6.5-8.5
DO (mg/l)	2.6 ±0.00[c]	3.4 ±0.00[a]	2.8 ±0.00[b]	20	-
TSS (ppt)	156.0 ±0.00[a]	114.0 ±0.00[c]	145.0±0.00[b]	2000	1000/2000
Salinity (ppt)	106.0 ±0.00[c]	129.0 ±0.00[a]	112.0±0.00[b]	-	-

*At p>0.05
*With same superscript there is no significant difference.
*With different superscript there is a significant difference

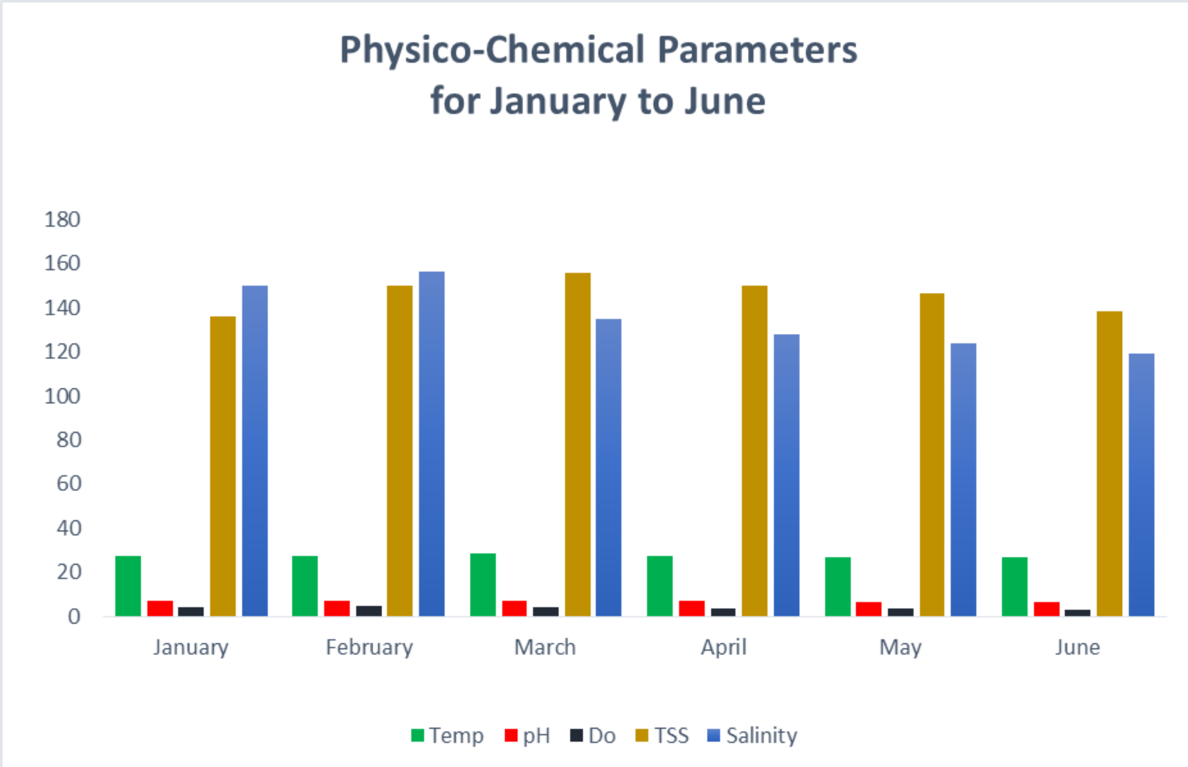

Figure 2: The Physico-chemical parameters from January to June 2018

Table 7. Mean Concentrations of Heavy Metal (mg/l) in Giant Tiger Prawn (*P. monodon)* from Iwofe Creek from January to June 2018.

Months	Metals	Station 1	Station 2	Station 3	SE	WHO (2011)	FEPA (2007)
January	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.01	0.01	0.01	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.153	0.210	0.187	0.00	0.02	Less than 1
	Co	0.167	0.132	0.198	0.00	-	-
	Zn	0.156	0.102	0.114	0.00	3.0	Less than 1
February	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.02	0.01	0.01	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.174	0.150	0.170	0.00	0.02	Less than 1
	Co	0.171	0.137	0.121	0.00	-	-
	Zn	0.134	0.92	0.106	0.00	3.0	Less than 1
March	Pb	0.001	0.01	0.001	0.00	0.01	Less than 1
	Cu	0.01	0.01	0.01	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.128	0.168	0.163	0.00	0.02	Less than 1
	Co	0.169	0.117	0.133	0.00	-	-
	Zn	0.171	0.102	0.132	0.00	3.0	Less than 1
April	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.020	0.020	0.020	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.122	0.157	0.159	0.00	0.02	Less than 1
	Co	0.156	0.128	0.113	0.00	-	-
	Zn	0.128	0.84	0.098	0.00	3.0	Less than 1
May	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.02	0.02	0.02	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.163	0.118	0.134	0.00	0.02	Less than 1
	Co	0.230	0.148	0.152	0.00	-	-
	Zn	0.142	0.081	0.123	0.00	3.0	Less than 1
June	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.01	0.01	0.01	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.151	0.105	0.121	0.00	0.02	Less than 1
	Co	0.215	0.135	0.141	0.00	-	-
	Zn	0.131	0.069	0.109	0.00	3.0	Less than 1

Table 8. Mean Concentrations of Heavy Metal (mg/l) in the Sediment from Iwofe Creek from January to June 2018.

Months	Metals	Station 1	Station 2	Station 3	SE	WHO (2011)	FEPA (2007)
January	Pb	0.001	0.01	0.001	0.00	0.01	Less than 1
	Cu	0.030	0.030	0.030	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.170	0.235	0.274	0.00	0.02	Less than 1
	Co	0.160	0.243	0.238	0.00	-	-
	Zn	0.001	0.288	0.001	0.00	3.0	Less than 1
February	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.02	0.01	0.01	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.174	0.150	0.170	0.00	0.02	Less than 1
	Co	0.171	0.137	0.121	0.00	-	-
	Zn	0.134	0.92	0.106	0.00	3.0	Less than 1
March	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.050	0.030	0.040	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.141	0.191	0.210	0.00	0.02	Less than 1
	Co	0.238	0.156	0.230	0.00	-	-
	Zn	0.001	0.257	0.001	0.00	3.0	Less than 1
April	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.040	0.030	0.030	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.190	0.138	0.187	0.00	0.02	Less than 1
	Co	0.232	0.152	0.200	0.00	-	-
	Zn	0.251	0.001	0.001	0.00	3.0	Less than 1
May	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.04	0.040	0.040	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.183	0.132	0.184	0.00	0.02	Less than 1
	Co	0.228	0.148	0.196	0.00	-	-
	Zn	0.001	0.251	0.001	0.00	3.0	Less than 1
June	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.02	0.020	0.020	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.169	0.126	0.171	0.00	0.02	Less than 1
	Co	0.215	0.135	0.174	0.00	-	-
	Zn	0.251	0.250	0.001	0.00	3.0	Less than 1

Table 9. Mean Concentrations of Heavy Metal (mg/l) in Surface water from Iwofe Creek from January to June 2018.

Months	Metals	Station 1	Station 2	Station 3	SE	WHO (2011)	FEPA (2007)
January	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.001	0.001	0.001	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.172	0.249	0.191	0.00	0.02	Less than 1
	Co	0.286	0.220	0.237	0.00	-	-
	Zn	0.154	0.111	0.170	0.00	3.0	Less than 1
February	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.001	0.001	0.001	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.176	0.230	0.160	0.00	0.02	Less than 1
	Co	0.242	0.270	0.292	0.00	-	-
	Zn	0.151	0.101	0.148	0.00	3.0	Less than 1
March	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.001	0.001	0.001	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.172	0.121	0.140	0.00	0.02	Less than 1
	Co	0.264	0.239	0.289	0.00	-	-
	Zn	0.148	0.130	0.143	0.00	3.0	Less than 1
April	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.001	0.001	0.001	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.169	0.112	0.118	0.00	0.02	Less than 1
	Co	0.282	0.233	0.259	0.00	-	-
	Zn	0.145	0.94	0.138	0.00	3.0	Less than 1
May	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.001	0.001	0.001	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.163	0.113	0.116	0.00	0.02	Less than 1
	Co	0.278	0.229	0.253	0.00	-	-
	Zn	0.141	0.113	0.134	0.00	3.0	Less than 1
June	Pb	0.001	0.001	0.001	0.00	0.01	Less than 1
	Cu	0.001	0.001	0.001	0.00	2.0	Less than 1
	Cr	0.001	0.001	0.001	0.00	0.05	Less than 1
	Ni	0.152	0.101	0.108	0.00	0.02	Less than 1
	Co	0.265	0.214	0.252	0.00	-	-
	Zn	0.129	0.117	0.121	0.00	3.0	Less than 1

DISCUSSIONS

Physico-Chemical Parameters

Samples collected from the different station from January to June 2019 are with the mean values and standard deviation of physico-chemical parameters of the Iwofe creek are represented in table 1 to 6 and figure 2 respectively. Physicochemical parameters of water are an indication of possible chemical reaction which determines the survival and growth of microorganisms in them varies according to the requirement of these organisms. The results of this study revealed that the mean values recorded for the different parameters across the stations for the six months were within stipulated standard limit of the Federal Environmental Protection Agency (FEPA) and Department of Resources (DPR) limits for substances discharge into water for domestic use in Nigeria (FEPA, 2003; DPR, 2002). A similar trend was reported by Usha (2015). High values were reported by Garg *et al.* (2006) and Nikam *et al.* (2011) in their study. The variation in the physioco-chemical parameters of the water across the study duration could be due to decrease in water level or either due to increased number of carbonates and or photosynthetic activities by producers (Abubacker *et al.* 1996) or due to dilution of rain water. Similar result was also reported by Latha *et al.* (2010); Shinde *et al.* (2011).

Metals in The Different Media

Heavy metals are environmental pollutants of major concern as they constitute hazardous substances, non-degradable and persistent with serious degradation on the aquatic ecosystem (Chinaiah and Digambar, 2011). The mean concentrations of Lead (Pb), Chromium (Cr), Cobalt (Co), Zinc (Zn), Copper (Cu) and Nickel (Ni) in the fish sample, sediment and surface water sampled from the different station from January to June 2019 of the Iwofe creek are represented in table 7, 8 and 9 respectively. From the results, lead, chromium and copper recorded the least concentrations across the three media (the fish, sediment and surface water). This could be attributed to report by Ogamba *et al*., (2015) who said that different level of heavy metals go into the aquatic environment through different levels anthropogenic activities. Cobalt recorded the highest concentration for all test media followed by nickel and zinc. No significant different ($p>0.05$) was observed across the test media (*P. monodon*, sediment and the surface water) for the six months of study. This could be attributed to the interaction between the exposure time and the Physico-chemical parameters associated with the water body at that time (Odu *et al*., 2013). The main entry routes of toxic substances into the surface water are normally via point source, and the concentration of cobalt could have been more from the industrial discharges and run-offs at that point (Aghoghovwia, 2008). Exposure to these environmental contaminants can lead to immunosuppression and increased susceptibility to disease in shell fish and other fin fish (Miller *et al*., 2002). Although the level of these metal observed within the fish, sediment and surface water were within permissible limit for drinking purpose is 50 mg/l to 150 mg/l. Similar results were reported by Ajagekar *et al.* (2011) on upper reach of New Calabar River. However, the values were lower (20.8-62.60 mg/Kg (Fe), 0.15-5.70 (Pb), 0.03-0.24 mg/Kg (Cd)) than what was reported in Ikot Ada Udo with history of oil spilled (Vincent-Akpu *et al.*, 2015). Similar trend was also reported by Narayana *et al.* (2005) and the maximum values were found to be below the desirable limit. The present values were also similar to results reported by Sawant and Chavan (2013); Pradeep *et al.* (2012).

CONCLUSION

Knowledge on the heavy metal concentrations of the aquatic environment is of utmost importance, as it helps in the management of the aquatic environment and human consumption of the aquatic biota. The effects of environmental pollution on aquatic ecosystem and its safety for human use are serious worldwide public issues. Although most of the metals that were found in the fish, sediment and surface water of Iwofe creek over the study period were generally of lower concentrations, with time it might bio-accumulate and affects humans after consumption and can cause some health challenges. Pollution of the aquatic environment from anthropogenic activities sources are the major cause of aquatic resources loss and this can lead to an imbalance in the food chain. To reduce and avoid aquatic biota loss in Iwofe creek, there is need to monitor and minimize heavy metals generation and discharge into its environment by applying relevant regulatory and control measures. It is therefore recommended that the Federal Ministry of Environment and other relevant regulatory agencies in Nigeria ensure regular monitoring of the aquatic resources of the Niger Delta region in general cum that of Iwofe creek in particular and provide a proper management control to indiscriminate discharge and effluence into the aquatic environment.

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