## *Original Research Article*

# Water Quality Assessment of Elechi Creek Receiving Effluent Discharge from Industrial activities in Port Harcourt, Nigeria


**Abstract**

The Physico-chemistry and heavy metal analyses of Elechi creek were assessed to determine the level of contamination and concentration of metals in the water body. Standard procedures were used during the study. The study showed that pH was recorded as 7.00-7.35 in surface water; 6.60-7.00 in wastewater Temperature of the surface water samples ranged from 27.9-29.0°C, Wastewater samples also recorded temperatures values of 26.9-27.8°C in all sampled stations. The values of metals in the surface water ranged from 0.14 to 0.26 in Fe, 0.04 to 0.09 in Cu, 1.21 to 1.42 in Zn. The mean values of Pb, Cr, Mn and Cd were 0.001 in all the stations. The mean values in the wastewater samples ranged from 7.25 to 16.62 in Fe, 4.70 to 8.50 in Zn, 0.21 to 0.34 in Mn, 0.13 to 0.22 in Cr, 0.06 to 0.12 in Pb, 0.03 to 0.07 in Cu and 0.001 in Cd. There were no significant differences across the sampled stations; although some of the metals were below permissible limits their accumulated presence in the water can pose an environmental threat in the near future.



**Keywords:** Elechi creek, Physicochemistry, Heavy metals, Water, Port Harcourt.


## 1. Introduction

Water is a valued natural resource for the existence of all living organisms. Water is used for domestic activities, irrigation in agriculture, as a means of transportation and recreational activities among others. Water quality monitoring and evaluation is a major step to water quality management; thus, there has been an increasing demand for monitoring water quality of many rivers by regular measurements of various water quality variables (Bartram and Balance 1996). Assessment of seasonal changes in surface water quality is an important aspect for evaluating temporal variations of river pollution due to natural or anthropogenic inputs of point and nonpoint sources (Ouyang*et al*., 2006).

The present paper describes the physico-chemical properties and heavy metals concentration in the water of the Elechi creek with its tributaries criss-cross other water bodies. It provides a scientific basis for pollution control and its monitoring. The obtained data provide essential information for the preventive measures and/or remedial actions to be taken to overcome the risk and impact of increasing pollution in the river.Several studies reveal that polluted water is one of the leading causes of diseases and deaths worldwide hence it is the most used natural resource of man (West 2006; Ogbonna 2014). Water contamination and pollution by organic materials, solid wastes, sewage and effluents from industries have been on the

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increase, hence shallow water bodies serves as sink for these waste materials (Meme *et al.,* 2014; Essien*et al.,* 2016).

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Elechi creek among other creeks has been as a dumping site of these waste products, there are three major categories of pollutants that cause pollution in water. The first category includes disease-causing agents such as viruses, protozoa, parasitic worms, and bacteria, which enter sewage systems and untreated waste. Because of the abundance of these microbes, wastewater acts as the common source of transmission of diseases such as dysentery, cholera, and typhoid (Basavaraja*et al.,* 2011; Ochuko and Thaddeus 2013).

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The second category of water pollutants includes oxygen-demanding waste, which includes the biodegradable matter such as plant residues and animal manure, which are added to the water naturally or by human beings. In natural process, this biological waste uses oxygen present in the sewage water and thereby results in oxygen depletion. Once all the oxygen has been depleted, bacteria are able to take control of the sewage, by making the water polluted (Chauhan *et al.,*2012).

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The third category of water pollutants includes water-soluble inorganic pollutants such as caustics, salts, acids, and toxic metals (Chauhan *et al.,*2012). Another kind of water pollutants includes ammonium salts, nitrates, phosphates, and so on. The pollutants such as nitrates and phosphates are the important nutrients, and these favor the growth of algae and thereby results in eutrophication (Chauhan *et.,al* 2012). Water pollution over the years has been a major issue as it results in waterborne infections and disease such as Cholera, Shigellosis, and Dysentery among others these infections occur due to pathogenic organisms existing in the water. The quality of good water is dependent on temperature, pH, heavy metal concentration and other parameters, the amount of rainfall and tidal wave tell a lot of the status of the water (Lawson 2011).

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Seasonal spatial and temporal variations play a vital role in the physical and chemical changes of water as the increase or decrease of required nutrient demand may determine the survival of the organisms and aquatic habitats in the water (Lawal*et al.,* 2014). Water quality is dependent on natural processes, such as precipitation, erosion, weathering of crystal materials as well as anthropogenic sources like urbanization, mining and agricultural activities (Diersing 2009;PravatRanjan 2013; Ogbonna*et al.,* 2019). Different sources of water around the world are increasingly been polluted, and this occurs in both rural and urban areas due to increased population and human activities. The pollutants are mostly organic substances, from open drainages, and residents around the creek who use the water for agricultural and industry related activities and these can be described as non-point source pollutants (Meme *et al.,* 2014; Ogbonna*et al.,* 2019).

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## 2. Methodology

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### 2.1 Description of study area

The study area is the Elechi creek, close to Eagle Island, extending to Iloubuchistreet in Diobu, Port-Harcourt. The Eagle Island is located on the South-West of Port Harcourt between longitude 04˚46'743"N and 007˚00'557"E; latitude 04˚48'217"N and 006˚48'989"E (Figure 1), and bounded on the North by the Rivers State University NkpoluOroworukwo area of Diobu. The Elechi creek is a brackish water system influenced by tidal fluxes with amplitude of about 1.20m and receives high sea inflow and low fresh water input from adjoining swamp forest with minimal current flow velocity of about 3m/s. It has mangrove vegetation of various types. It receives municipal effluents (>1500 litre/day), solid waste (3500kg/day), oily waste from garages (150 litre/day) in addition to other discharges from sand mills and other activities on the creek (Davies *et al*., 2006).

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**Table 1.: Study Area Coordinates**

| S/N | Stations | Longitude | Latitude | Samples Collected |
|---|---|---|---|---|
| 1 | Car wash | 6°97’43.8E | 4°79’07.6N | Surface water and Wastewater |
| 2 | Boat making | 6°97’41.6E | 4°79’14.0N | Surface water and Wastewater |
| 3 | Transportation | 6°97’34.4E | 4°79’17.6N | Surface water and Wastewater |
| 4 | Sewage treatment plant | 6°97’32.1E | 4°79’23.6N | Surface water and Wastewater |
| 5 | Sand dredging site | 6°97’32.0E | 4°79’30.2N | Surface water and Wastewater |

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### 2.2 Sampling Locations

Samples for this study were obtained from Elechi creek situated in Port Harcourt, Nigeria. The choice of the stations was based on the high effluent discharge deposited into the creek by surrounding industries and other anthropogenic activities around the creek. A total of five (5) sampling stations were designated along the creek. Sampling stations were chosen approximately 6 to 10 meters from the creek banks and about 50 meters apart from each other using a Garmin 45 Ground Positioning System (GPS).The geographical locations and types of samples collected from each sampling station are presented on Table 1 and a map showing the sampling Stations is presented in Fig. 1.

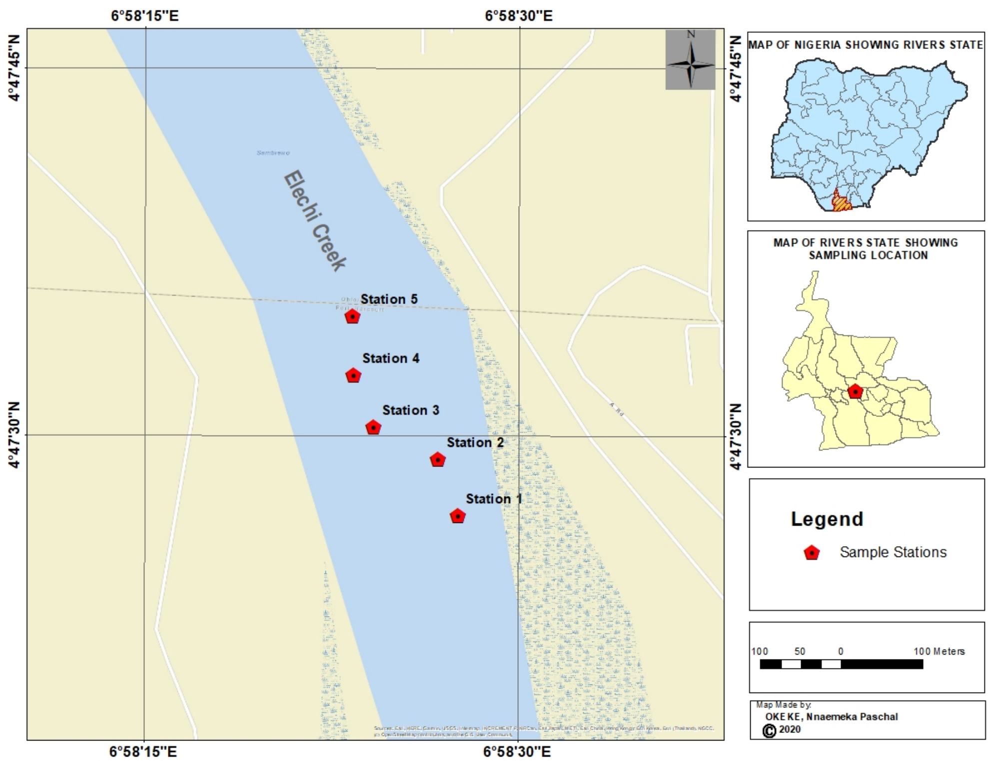


**Fig. 1: Map of Elechi Creek showing the Sampling Stations**

### 2.3 Sample collection

The surface water and wastewater samples were collected using the method of Odokuma and Okpokwasili (1993). At each sampling point two sets of samples were collected in separate 1-

litre labelled plastic bottles for both samples which were previously sterilized with 70% alcohol 24 hours before the collection.The bottles were rinsed 3 to 4 times with the water sample before the final collection. Samples were collected from five stations along the creek to represent the different activities on the creek. Water samples were collected with the base of the sample bottle held with one hand and plunged below the water surface with the mouth of the bottle in the opposite direction of water flow at a depth of about 30cm and allowed to fill and corked under water. After collection of samples, the samples were put in an ice pack cooler and transported to the laboratory for analysis. A total of 70 surface water and 70 wastewater samples were collected twice a month for a period of seven (7) months from February 2019 to August2019.At the laboratory, samples were stored in refrigerators at 4°C until analysis.

**2.4 Sample analyses**

The physical and chemical parameters (pH, Temperature, Dissolved Oxygen (DO), Total Dissolved Solids(TDS), Electrical Conductivity (EC), Turbidity, Salinity, Chloride and Bromine)of the water samples were measured *in situ* using digital electronic multi-parameterwater meters [HANNA instruments Model HI 9812, Lutron DO-5509 meter, TDS scan 10m 170308-034, Surgefield Conductivity meter SM3030, Turbidity Meter Model SGZ-200BS (NTU), HANNA salinity meter, and Astaplus pool and spa kit]. Calibration of meters wasperformed before every sampling and was rinsed three times with distilled water andthe samples to be tested before each use. The measurement of $BOD_5$ was carried out according to methods by APHA (2012). Surface water and Wastewater samples were drawn into a 250 ml bottle respectively and incubated in the dark for five days at 20°C and at the end of five days, the final dissolved oxygen (DO) content wasdetermined. Decrease in DO between the final DO reading and the initial DO reading was corrected for sampledilution and recorded as the BOD of the sample.Measurement of nutrients and heavy metals such as (Nitrate, Sulphate, Phosphate, Iron, Lead, Copper, Chromium, Zinc, Manganese and Cadmium) were analysed using an Atomic Absorption Spectrophotometer (AAS) according to (APHA 2012).

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**3. Results and Discussion**

Results of Physicochemical Characteristics and Heavy metal concentration of the surface water and wastewater are presented in Table 2 and Table 3 respectively. Generally the results obtained revealed no significant difference across the stations. The quality of water is basedon the colour, smell, taste and amount of metals and these features help to determine its safety for aquatic habitats and health of humans. Physicochemical parameters used to determine the quality of water are considered below as well as the levels of heavy metal concentration.

Temperature is the degree of coldness or hotness of a body; it affects and influences pH, alkalinity, acidity and dissolved oxygen in water. Temperature influences the growth of microbes and aquatic inhabitants, colour, odour, and taste of water. Also change in temperature determines the increase or decrease of chemical reactions in water. Similarly the rate of biochemical reactions usually double for every rise in temperature.The variations in temperature ranged from 27.9 to 29.0°C across the stations while the mean temperature values of the wastewater ranged from 26.8°C to 27.8°C(Table 2).However Obire*et al* (2005) reveal that variations of water body temperature can be attributed to sunlight due to the shallowness of the water, similarlya temperature between 26-30°C are influenced by organic matter and undissolved solids from industrial discharge into the creek. Temperature values obtained in this study indicates that Elechi creek is polluted with both organic and inorganic pollutants and could pose a threat to the aquatic life existing in the creek as well as human health and alterations in the environment.

The pH is a measure of the hydrogen ion activity of the water. It is also an indicator of the acidic or alkaline nature of a water body, whether high or low pH determines the type of aquatic species which can survive in such water environment. The results of the surface water pH showed that the values were tending towards neutral with values ranging from 7.00 – 7.35, the least values were recorded as 7.00 in station 5 while the highest value were recorded as 7.35 in station 1(Table 2). The results of the surface water could be as result of fresh water influx into the creek. The pH revealed that the wastewater is slightly acidic with values ranging from 6.60 in station 5 to 7.00 in station 2. This could be due to the constituents of the wastewater arising from storm water runoffand other anthropogenic activities in the settlements around the creek.The pH values are in consonance with previous research reports by other workers (Obire*et al.,* 2005; Ogamba*et al.,* 2008; Ngah*et al.,* 2017). Although the values obtained in this study were within WHO permissible limits of 6.5-8.5. However,pH is important in water quality assessment as it influences many biological and chemical processes within a water body (WHO 2011).

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Turbidity refers to the ability of scattered light to be absorbed rather than to be transmitted in a straight line through water. Water turbidity is caused by suspended matter or impurities such as clay, silt, organic and inorganic matter or compounds, plankton and other microscopic organisms which interfere with the clarity of water. The variations in turbidity of both surface water and wastewater samples across all sampled stations varied in different stations with values ranging from 1.90 NTU in stations 2 and 5 to 2.95 NTU in station 1, similarly turbidity values of the wastewater ranged from 4.55 to 6.55 NTU with the highest value recorded in station 1 and the lowest in station 5 (Table 2).

Dissolved oxygen is simply the amount of oxygen of a water body which is readily available for biochemical activities; it also serves as indicator of degree of pollution in water bodies. The amount of oxygen which is dissolved in water depends on the rate of aeration, salinity, temperature and air pressure, thus the exact amount of oxygen that can be dissolved in water depends on the rate of respiration by the aquatic animals and microscopic organisms in the water and also photosynthetic activity by plants. In this study, the variations of DO of the water samples across the stations in both surface water and wastewater ranged from 2.90 mg/l to 3.15 mg/l in stations 1 and 4 respectively for surface water and while2.55 mg/l was recorded in station 5 and 3.30 mg/l in station 3 (Table 2). These values are in agreement with studies by other researchers(Obire*et al.,* 2005; Ngah*et al.*,2017). According to Ekubo and Abowei (2011), fishes can die if they are exposed to less than 0.3mg/l of DO for a long period of time, but can survive in water bodies of DO of 8.0mg/l and above. The DO values recorded in this study is considerably low and this can be attributed to the presence of degradable organic matters, industrial discharges and surface runoffs from various sources which could cause ecological imbalances for aquatic organisms in the water environment.

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**Table 2. Mean Variation of Physicochemical Parameters of Surface Water and Wastewater**

| Stations | pH | | Temperature | | Turbidity | | Dissolved Oxygen | | Total dissolved solids | | Electrical Conductivity | | Salinity | | Chloride | | Bromine | | BOD | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW |
| Station 1 | 7.35 | 6.75 | 29.0 | 27.8 | 2.95 | 6.55 | 2.90 | 3.05 | 15637.50 | 16587.50 | 26650.00 | 22488.50 | 0.56 | 0.45 | 0.06 | 0.15 | 0.06 | 0.25 | 7.50 | 6.67 |
| Station 2 | 7.35 | 7.00 | 28.5 | 26.8 | 1.90 | 5.70 | 2.90 | 3.00 | 14937.50 | 14562.50 | 24650.00 | 11753.50 | 0.53 | 0.44 | 0.06 | 0.15 | 0.06 | 0.25 | 7.90 | 7.36 |
| Station 3 | 7.05 | 6.85 | 28.0 | 27.5 | 2.40 | 5.25 | 2.95 | 3.30 | 16637.50 | 21437.50 | 28550.00 | 25554.00 | 0.49 | 0.45 | 0.06 | 0.15 | 0.06 | 0.25 | 8.45 | 9.63 |
| Station 4 | 7.15 | 6.95 | 27.9 | 27.5 | 2.20 | 5.10 | 3.15 | 3.05 | 16687.50 | 18537.50 | 26130.00 | 20713.50 | 0.47 | 0.44 | 0.06 | 0.15 | 0.06 | 0.25 | 9.50 | 4.78 |
| Station 5 | 7.00 | 6.60 | 29.0 | 26.9 | 1.90 | 4.55 | 3.10 | 2.55 | 16037.50 | 16137.50 | 22180.00 | 15683.50 | 0.37 | 0.39 | 0.06 | 0.15 | 0.06 | 0.25 | 5.75 | 5.80 |
| WHO Limit | 6.5-8.5 | | 25-36°C | | 5.0 | | 7.5-10 | | 500 | | 1000 | | - | | 250 | | - | | 15-30 | |

**Key**: SW – Surface water, WW – Wastewater

**Table 3. Mean Variations of Heavy Metals Concentration of Surface Water and Wastewater**

| Stations | Nitrate | | Sulphate | | Phosphate | | Iron | | Lead | | Copper | | Chromium | | Zinc | | Manganese | | Cadmium | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW | SW | WW |
| Station 1 | 1019.23 | 1529.45 | 1415.93 | 2470.83 | 2.68 | 5.45 | 0.17 | 16.62 | 0.001 | 0.08 | 0.09 | 0.03 | 0.001 | 0.17 | 1.27 | 8.51 | 0.001 | 0.29 | 0.001 | 0.001 |
| Station 2 | 1131.30 | 1477.54 | 1051.52 | 2610.37 | 7.09 | 7.91 | 0.26 | 11.37 | 0.001 | 0.06 | 0.08 | 0.05 | 0.001 | 0.13 | 1.4 | 5.99 | 0.001 | 0.34 | 0.001 | 0.001 |
| Station 3 | 969.54 | 1572.04 | 1009.54 | 2243.71 | 5.23 | 6.77 | 0.25 | 9.47 | 0.001 | 0.12 | 0.05 | 0.06 | 0.001 | 0.19 | 1.42 | 7.49 | 0.001 | 0.29 | 0.001 | 0.001 |
| Station 4 | 1122.35 | 1391.95 | 960.37 | 2511.94 | 3.82 | 7.48 | 0.19 | 8.77 | 0.001 | 0.07 | 0.06 | 0.04 | 0.001 | 0.22 | 1.41 | 5.98 | 0.001 | 0.29 | 0.001 | 0.001 |
| Station 5 | 1009.80 | 1246.99 | 851.95 | 2427.84 | 4.40 | 6.01 | 0.14 | 7.25 | 0.001 | 0.06 | 0.04 | 0.07 | 0.001 | 0.15 | 1.21 | 4.70 | 0.001 | 0.21 | 0.001 | 0.001 |
| WHO LIMIT | 10 | | 250 | | 200 | | 0.30 | | 0.001 | | 1.0 - 2.0 | | <1.0 | | <1.0 | | <1.0 | | <1.0 | |

**Key**: SW – Surface water, WW – Wastewater

Biochemical Oxygen Demand (BOD) is used as an index to determine the amount of dissolved oxygen required by aerobic biological organisms (microorganisms) to decompose organic materials and also biological activity in the water. Hence high concentrations of BOD are an indication of organic pollution. The $BOD_5$ values which ranged from 5.75 mg/l to 9.50 mg/l in surface water and 4.78 to 9.63 mg/l in wastewater, indicates that both the surface water and wastewater are polluted(Table 2). The high BOD in surface water could also mean that the oxygen present is been used up for decomposition of the pollutants, and is not readily available for aquatic life anymore. Previous studies have revealed that $BOD_5$ values more than 2-4 mg/l is an indication of serious pollution(Obire*et al.,* 2005; Ngah*et al.,*2017). According to Ekundayo 1997, contamination of water with faeces increases the $BOD_5$ hence it contains organic matter which makes oxygen deplete faster and unavailable to desirable organisms. The values of $BOD_5$ obtained in the study were considerably high compared to the previously reported values by (Ngah*et al.,* 2017; Nwidu*et al.,* 2018), this clearly means that the pollution of the creek by organic matter and industrial discharges have increased and it must be attended to before it causes serious damage to the water environment.The BOD of a river must generally not exceed 4.0 mg/l as this would reduce DO from saturating to 5.0 - 6.0 mg/l which is still capable of supporting aquatic life (Nartey*et al.,*2012; Ogbonna 2014).

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Total dissolved solids are the measure of total inorganic waste materials dissolved or absorbed by the water. Table 2 represents the variations of the TDS values between the two water samples. The amount of the total dissolved solids in the surface water ranging from 14,937 mg/l to 16,687mg/l with the least value recorded in station 2 as 14,937 mg/l and the highest value recorded in station 4as 16,687mg/l. Total dissolved solids of the wastewater from the study area ranged from 14,562 mg/l in station 2 to 21,437mg/l in station 3. The spatial and temporal variations of the TDS values in both the surface water and wastewater can be attributed to the activity in the stations. High TDS values are an indication of pollution with solid waste materials from open drainage(Ogbonna 2014).

Salinity is a measure of salt content of a water body. The salinity values recorded in this study ranged from 0.37‰ in station 5 to 0.56‰ in station 1 in surface water, while in the wastewater the level of salinity recorded rangedbetween 0.39‰ in stations 5 and 3 respectively and 0.45‰ in station1 as shown in Table 2. According to a study by Ogamba*et al.,* (2010) it was revealed that low salinity values are attributed to the nature of the creek; (brackish water) and also through the inflow of fresh water discharge and rainfall.

Electrical conductivity is the measure of the water body to be able to conduct electric current, it is also used to monitor and estimate the amount of dissolved solids in the water. It is also an indication of pollutants through wastewater. The permissible limit is between 100-1000µS/cm. The study recorded high EC values across all stations in both the surface water and wastewater. The high EC values in the surface water ranged from 28,550µS/cm in station 3 and 22,180 µS/cm in station 5; this indicates that station 3 is highly polluted with the wastewater while station 5 is the least polluted. The mean electrical conductivity values of the wastewater varied from 11,753µS/cm in station 2 to 25,554 µS/cm in stations 3(Table 2). However these values are in agreement with previous findings of Elechi creek (Ogamba*et al.,* 2010; Ngah*et al.,* 2017; Nwidu*et al.,* 2018) similarly these spatial and temporal changes play an effective role in the condition of the creek.

Nitrogen exists in water bodies as nitrate which is a key ingredient in fertilizers, they are considered as pollutants in saltwater or brackish estuarine systems when nitrogen becomes limited, abundance of bioavailable nitrogen in water bodies can lead to eutrophication and algal blooms. The Nitrate concentration values in both surface water and wastewater ranged between 969.54mg/l in station 3 and 1131.30 mg/l in station 2 for the surface water samples while values of the wastewater ranged from 1246.99mg/l in station 5 to 1572.04 mg/l in station 3(Table 3). The values of nitrate concentration obtained in this study are higher than the value reported by Chindah*et al.,* (1993) and Ngah*et al.,* (2017) who in their respective studies recorded nitrate values ranging from 4.50-11.00 mg/l and<0.05 – 2.80 mg/l respectively. The high values indicates the abundance of nitrate in the surface water and this can be attributed to organic matter from sewage effluents, also the values obtained are all above permissible limits. The low values which were recorded by previous reportsof Ngah*et al.,* (2017) can be that the nitrate was used up by growing algal mats which were covering the mudflats that were exposed during low tide. Therefore, it can be concluded that the values obtained are above limit and thus the creek is polluted with nitrate.

Phosphorus is an essential nutrient which is readily available; it exists in many forms, one of which is phosphate. It is a major ingredient in fertilizers used in large scale and small scale agricultural practices. Phosphorus occurs in water through soil erosion or surface water runoffs since numerous forms of it are easily adsorbed to soil particles. Excess amounts of phosphate in aquatic environment may lead to proliferation of microscopic algae called phytoplankton. As shown in Table 3 phosphate concentrations ranged between 2.68mg/l in station 1 as the least value to 7.09 mg/l in station 2 as the highest value obtained in surface

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water while the values of the wastewater ranged between 5.45mg/l to 7.91mg/l, with the least value recorded in station 1 as 5.45mg/l and highest value in station 2 with 7.91mg/l(Table 3).

Sulphate**($SO_4^{2-}$)**occurs naturally in water as a result of leaching from gypsum and other common minerals (Shrinivasa and Venkateswaralu, 2000). The results obtained shows that sulphate concentrations ranged from 851.95mg/l to 1415.93 mg/l in surface water with the least concentration in station 5 as 851.95mg/land the highest concentration recorded in station1 as 1415.93 mg/l. Similarly concentrations of the wastewater also showed variations with values ranging from 2243.71 as the least values recorded in station 3 to 2610.37 mg/l as the highest in station 2(Table 3).

The presence of Iron**($Fe^{2+}$)** in water indicates possible contamination from inflow of waste rock dumpsites, geology of the stream channel and rock mineral types present (Taiwo*et al.*, 2012). Table 3 shows the variations of iron in both the surface water and wastewater samples. Concentrations of iron in surface water ranged from 0.14mg/l in station 5 to 0.26mg/l in station 2. These values were relatively low and within the permissible limit, while the concentrations of iron in the wastewater samples ranged from 7.25mg/l in station 5 to 16.62 in station 2. These values are in agreement with reports of other studies(Table 3).

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Lead**($Pb^{2+}$)** is a toxic element that is accumulated in skeletal structures, it may be present in water due to discharge of industrial effluents from petroleum production. The toxic effects of lead decreases with increased water hardness and dissolved oxygen. Lead is also not essential for plant and animal life. The concentration of lead in both the surface water and wastewater in all stations were generally low the values of lead were recorded as 0.001mg/l in surface water and wastewater values were recorded as 0.06mg/l in station 5 and 2 respectively as the least values while the highest values were recorded in station 3 as 0.12mg/l as represented in Table 3 therefore there are no health risk concerns.

The presence of Zinc**(Zn)**in a water body is an indication of pollution via liquid and solid wastes from a dumpsite which may be close to the body of water Table 3 shows that Zinc levels were slightly above the WHO permissible limits of <1.0 in the surface water as the least values were recorded in station 5 as 1.21mg/l and highest in station 3 as 1.42mg/l(Table 3). Although wastewater samples showed relatively high concentrations of 4.70mg/l in station 5 as the least value obtained while the highest value were recorded as 8.51mg/l in station 1. Thus the occurrence of low levels of Zn in the surface water is unclear and this will require further investigation to determine the reasons for the low zinc values.

Heavy metals occur naturally as elements with high atomic weight and density which is at least 5 times greater than water, they can mostly be found in industrial, domestic effluents, agricultural, medical and technological applications and this led to their wide distribution in the environment, which poses a threat to human health and the environment. Their level of toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as status of exposed individuals and environment. Due to their high degree of toxicity, these metallic elements are of public health significance and considered as systemic toxicants that areknown to induce multiple organ damage, even at lower levels of exposure Paul et al., (2012).Heavy metal Concentrations of Copper (Cu), Chromium (Cr), Manganese (Mn), and Cadmium (Cd), were relatively low across the sampled station in both the surface water and wastewater. The values of Copper ranged from 0.09mg/l in station 1 to 0.04mg/l in station 5 in surface water while wastewater values ranged from 0.03mg/l in station 1 to 0.07mg/l in station 5. ~~obtained~~Obtained as represented in table 3 show low concentrations of these metals and this could be as a result of adsorption of the metals by suspended matter in the water. These values show that the Elechi creek is contaminated with heavy metals but may not be polluted.

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## 4. Conclusion

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The water quality of Elechi creek is deteriorating and based on the findings of this study there is need to create public awareness regarding the dangers associated with the consumption of water from the creek. Continuous monitoring of the creek is very essential in order to safeguard its users.Elechi creek is highly contaminated with inorganic and organic matter and also metals but it is not polluted by metals and there is still a chance that the aquatic habitats are safe for consumption but should be properly cooked before it is consumed. The indiscriminate use of the creek as a wastewater dumping ground should be stopped before the water becomes completely polluted and unsafe for any purpose. Proper regulatory policies should be put in place to monitor the discharge of effluents into the creek by the surrounding industries.

## References

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