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EVALUATION OF SOME PHYSICO-CHEMICAL PARAMETERS OF THE TIN CAN ISLAND CREEK, LAGOS, NIGERIA.

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ABSTRACT

The anthropogenic impact on coastal waters has increased due to activities and increasing population around the coastal environments. The physico-chemistry parameters of the Tincan Island creek were investigated for five (5) months (May to September, 2018) at three stations. The parameters were determined using standard ecological analytic procedures. PAST and SPSS were used for the statistical analysis. Some physicochemical parameters showed monthly variations linked with flood water inflow and tidal lagoon water incursion. These include rainfall, air temperature (25.2-33ºC), water temperature (27-31ºC), salinity (2-18‰), pH (5.94-7.33), total dissolved solid (1569.20-15189mg/L), conductivity (2760-24900µS/cm), turbidity (2.72-39.20NTU), dissolved oxygen (0.36-5.12mg/L), biochemical oxygen demand (3-211mg/L), chemical oxygen demand (12-1769mg/L), nitrate-nitrogen (1.7-4.83mg/L), phosphate-phosphorus (0.03-6.29mg/L) and sulphate (19.1-1177.7mg/L). Most of the recorded parameters from this study were found fluctuating with season and were not within acceptable limit of tolerance as recommended by WHO. The presence study showed that the Tincan Island creek is an organically polluted environment which might lead to significant alteration of the water chemistry if nothing is done on time. This finding would help environmentalist and other agencies to regulate activities such as indiscriminate disposal of waste around the creek.

Key-words: *Physico-chemistal Parameter, Tincan Island creek, WHO*

INTRODUCTION

The physico-chemistry refers to the physical and chemical properties of a water body which could be fresh, brackish or marine. They include temperature, rainfall, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand salinity, turbidity, etc. Creeks are streams especially those that flow into a river or an aquatic system especially enroute the sea. They are a valuable part of the aquatic resources serving as feeder-rivers, providing flood control and storm water drainage (Popoola *et al.*, 2015). According to Onyema and Nwankwo (2009), Creeks are common hydrological features in the southwestern part of Nigeria and are essentially of two types; the tidal freshwater/brackish water and the marine creeks. They are transitional zones draining water from fresh to more saline environment (Nwankwo, 2004). A variation in some of the physicochemical parameters such as temperature, rainfall, salinity, nitrate-nitrogen, phosphate-phosphorous, sulphate, biochemical oxygen demand and chemical oxygen demand have been reported to influence phytoplankton abundance (Adesalu *et al.*, 2008).

Over the years, the anthropogenic impact on the coastal waters has increased due to activities and increasing population around the coastal environment. The proliferation of urban settlement and slums in the city has resulted in increased human pressure and the generation of domestic effluents which eventually find their way into Lagos Lagoon. The activities impacting the Nigerian coastal waters especially the Lagos Lagoon and adjoining waters are raw or partially treated sewage, wood waste, domestic waste, industrial effluents, coolant water etc. (Onyema *et al.*, 2007).

According Osibanjo (1994), human health and environmental quality are undergoing continuous degradation by the increasing amount of wastes being produced. Although some types of environmental pollution are as a result of natural causes, most are caused by human activities (Erondu and Chindah, 1991). There are increasing direct and indirect costs to society and to individual citizens in connection with the generation, handling, and disposal of such wastes. Solid wastes of anthropogenic sources have polluted virtually all the lagoons and creeks in Lagos (Ajao *et al.*, 1996). Most of these debris, e.g. high- and low-density polythene, empty cans of food or sprays, glass bottles, used needles and syringes, used car tyres, etc. are non-biodegradable. The aim of this project was to investigate the effects of human stressors and seasonal variations on the physicochemical parameters of the Tin Can Island Creek. To determine the monthly variation in the physicochemical parameters of the Tin Can Island Creek.

STUDY AREA

Tin Can Island is located in Lagos, Nigeria. The estimated terrain elevation above sea level is 7 metres. It is located between Latitude N 6°26'2" and Longitude E 3°21'23". The creek is shallow at some point and is open all-year round via the Lagos Harbour to the sea. Sea water associated with the semi-diurnal tidal oscillation experienced in the entire Gulf of Guinea Coast, and fresh water from the adjoining wetlands are important factors that determine the hydrological conditions and hence, the plankton of the creek (Onyema *et. al.*, 2003). While freshwater inflow dilutes the water during the rains, increasing brackish/marine conditions from the harbour marks the dry season. The tidal range in this region is low (between 0.4 m and 0.9 m), and tidal effects are delayed inland in proportion to the distance from the harbour.

Dense rainforest vegetation preceded by littoral mangrove assemblages characterize this area especially in places with reduced anthropogenic influence. This riparian mangrove community is also typified by mangrove swamps which possess mudflats, mud banks and mangrove roots which are inhabited by polychaetes, amphipods, isopods, barnacles, oysters, periwinkles, fiddler crabs, sea cucumbers, hermit crabs, crabs, mudskippers and shrimps among others.

The notable macro-floral species present here include *Paspalum virginatum, Cocos nucifera* (coconut tree), water fern, *Laguncularia racemosa* (Linn.) Gaertn, *Rhizophora racemosa* (red mangrove), *R. harrisoni, Avicennia geminanas, Phoenix reclinata, Raphia hookeri, Elaeis guineensis, Pinus* sp. (pine tree) and *Acrotiscum aureum.*

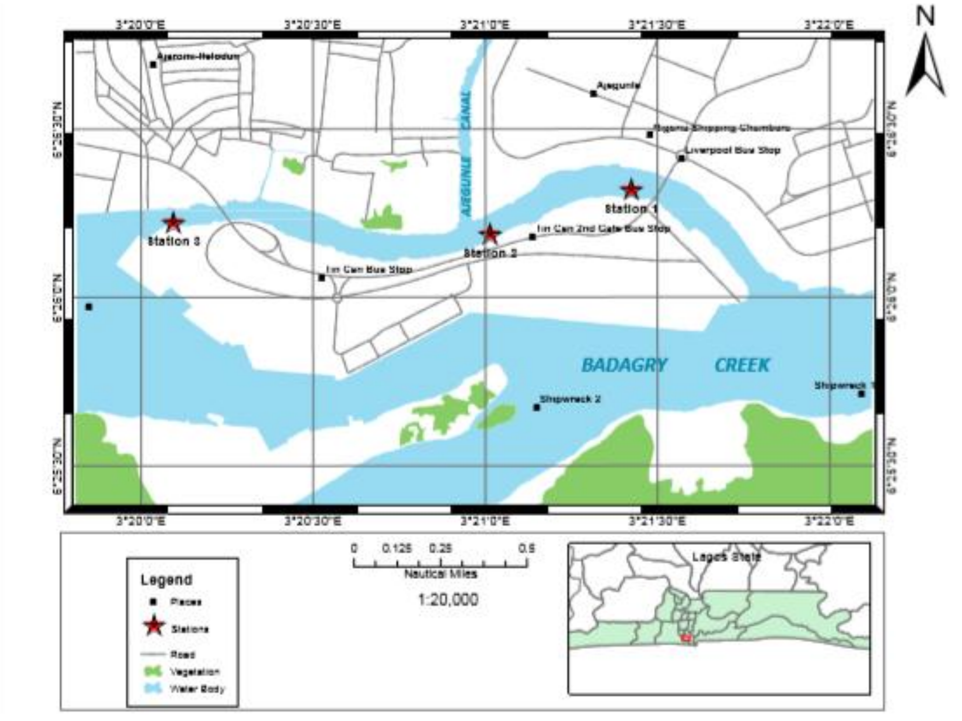


Fig. 1: Map showing the study area of tin Can Island located in Lagos, Nigeria

MATERIALS AND METHODS

Collection of Water Samples

The samples were taken once monthly during the wet season (May- September 2018). Water samples were collected each time using a pre-cleaned high-density Schott glass bottles with each indicating the month of collection at the study site. Sampling was carried out between 09.00 and 12.00 hours on each sampling day. The plastic bottles were dipped into the water to collect the water samples and were taken to the laboratory for physical and chemical analysis. Analysis of physico-chemical properties: Standard methods were used. Some parameters like Temperature, pH, Transparency were carried out in-situ. While other sample for DO was fixed in the BOD bottle at the sites and then taken to the Laboratory for analysis. Winkler's method was followed for this analysis, while remaining analysis was made by the standard methods of APHA (2005) and Trivedy and Goel (1984).

DETERMINATION OF PHYSICO CHEMICAL PARAMETERS

Determination of Air Temperature (^{0}C)

Air temperature was taken using a mercury-in glass thermometer. The thermometer was held up in air for two minutes while shielding its bulb from direct sunrays to avoid error in the reading. During the process of shielding the bulb, the resulting temperature is read at a meniscus off the eye level and recorded in degree Celsius (^{0}C).

Determination of Water Temperature (^{0}C)

The surface water temperature was determined in-situ using mercury-in glass thermometer. This is done by collecting 75cl of water from the surface (about 30 cm depths) at the site with a plastic container and dipping the thermometer into it for two minutes for acclimatization before taking the reading. The temperature is read off the eye level and the value recorded in degree Celsius (C^0)

Determination of Total Suspended Solids (TSS) (mg/L)

This is estimated by using the APHA, 1998. The total suspended solids is retained by a standard filter and dried to constant weight. A filter dish is dried at 103± 2^0C in an oven for 1hour. The filter is removed and allowed to cool in a desiccator before being weighed. 50ml of a well-mixed sample was filtered through the filter unit and allowed to drain. The filter dish was removed and dried at 103± 2^0C in an oven for 1hr. The Total Suspended Solid for each sample was estimated using the formula below and the values expressed in mg/L.

$$\text{TSS (mg/L)} = \frac{(\text{A} - \text{B})(10^6)}{\text{Volume of sample taken (ml)}}$$

Where A = weight (g) of dish + residue

B = weight (g) of dish before use

Determination of Total Dissolved Solids (TDS) (mg/L)

The Total dissolved solids were determined using Gravimetric Method 254^0C (APHA, 1998). A well-mixed portion of the sample was filtered and evaporated to dryness in a weighed dish, dried to constant weight. The increase in the weight of the dish determines the Total dissolved solid (TDS). The evaporating dish was dried at 180 ± 2^0C for 1hr and put in a desiccator, prepare filter by wrinkling its side up, in a filter dish and measure the volume of the well mixed sample at 25 -50ml and filter. Wash with successive 10ml distilled water and drain completely. Repeat cycle drying, cooling, desiccating and weighing until constant weight is obtained. The Total Dissolved Solid for each sample was estimated using the formula below and the values expressed in mg/L.

$$\text{TSS (mg/L)} = \frac{(\text{A} - \text{B})\text{X}1{,}000{,}000}{\text{Sample volume (ml)}}$$

Where A = Dish + Dry sample (g)

B = Dish before use (g)

Collection of Rainfall Data (mm)

Rainfall data between May – September 2018 were kindly supplied by the Nigerian Institute for Oceanography and Marine research, Victoria Island, Lagos State.

DETERMINATION OF CHEMICAL PARAMETERS

Determination of pH

The pH values were determined by the Electrometric Method using the Cole Parmer Test. The pH meter was calibrated and standardized. Three pH buffers (pH 4.0, 7.0, and 10.0) were used for the calibration. Each sample pH was determined at 26°C with the calibrated water and immersing the probe into the water sample.

Determination of Salinity (‰)

Salinity was determined using Saline Test Meter (Hanna Instrument HI 98203). The calibration standard prepared from reagent grade (1.0, 5.0, 10.0, 20.0, 50.0 g). Nacl was separately weighed and dissolved separately in distilled water. The final volume of each set then adjusted to one litre with distilled water. The meter was calibrated by immersing into solution and taking reading after a few seconds when display stabilizes. After calibrated, each sample was determined similarly by immersing the probe and taking reading in parts per thousand (‰).

Determination of Conductivity (µS/cm)

This is determined by using Philips PW9505 conductivity meter (Range 3-100,000µ S/cm). Conductivity standards were prepared from traceable commercial standards. The following standards were used: conductivity standard equivalent to 100, 255, 500, 1000, 20,000µS/cm. Calibration standards with conductivity value close to those of the samples were used to calibrate the meter before sample determination. The sample conductivity was determined by immersing the probe into a portion of the sample.

Determination of Alkalinity (mg/L)

The alkalinity was determined using the Titration Method 2320B. Alkalinity of water is its acid neutralizing capacity. It is the sum of all titrateable bases. An appropriate volume of the sample was titrated against standard acid of p- and m- alkalinities, using specific indicators. The end-point was recorded and used to determine the alkalinity using the equation below. All values were expressed in mg/L.

$$A\text{lkalinity as CaCO}_3\left(\frac{\text{mg}}{\text{L}}\right) = \frac{\text{Titre (ml)x Molarity x 50,000}}{\text{Aliquot titrated (ml)}}$$

Determination of Acidity (mg/L)

Acidity of each water sample was determined using the titration method 2310B (APHA, 1998). A known amount of the sample was titrated against standard (0.02m) sodium hydroxide (NaOH) to p- and m- acidities, using Methyl orange as indicator. The titration end-point was recorded, and used to calculate the acidity of water samples as follow:

$$Acidity\ (mg/L) = \frac{Titre(ml) \times Molarity \times 50 \times 10^3}{Aliquot\ titrated\ (ml)}$$

Determination of Dissolved Oxygen (DO) (mg/L)

The Dissolved Oxygen was estimated by Titrimetric (Iodometric) Method using the Azide Modification procedure 4500^0C. The method involves the addition of Divalent Manganese solution followed by strong alkali, to the sample in a glass-stopper bottle. DO rapidly oxidize an equivalent amount of dispersed divalent manganous hydroxide precipitate to hydroxides. To the sample in 100ml DO bottle was added two drops of $MnSO_4$ solution followed by two drops of alkali-azide reagent. When precipitate settled, two drops of H_2SO_4 was added and the solution was mixed by inverting until dissolution was completed.

A volume corresponding to 100ml original sample after correction of the sample loss by displacement with reagents was titrated with 0.025M $Na_2S_2O_3$ to first disappearance of the color using starch as indicator. The titration end points were recorded.

For Titration of 100ml sample, two drops of 0.025M $Na_2S_2O_3$ = 1mg DO/L

Determination of Biochemical Oxygen Demand (BOD) (mg/L)

This is the amount of dissolved oxygen that could be depleted from the water body during natural biological or degradation of organic compounds by the organisms presents especially bacteria. This is done after dissolved oxygen has been measured. Three standard 300ml bottles were filled to the brim with the water sample. In the first bottle, the Winkler method was used to determine the amount of dissolved oxygen present. The other bottles were kept in the dark at 20^0C for five days. The Winkler method was then used to determine the oxygen content of the bottles at the end of the five days and the average calculated.

The difference between this average and the initial concentration of the dissolved oxygen content of the first bottle is the Biochemical Oxygen Demand expressed in micrograms of oxygen per litre.

Determination of Chemical Oxygen Demand (COD) (mg/L)

The COD is determined by using the Closed Reflux Method 5220C with higher concentration of potassium dichromate solution. Most types of organics are oxidized by a boiling mixture of chromic and then titrated with Ferrous Ammonium Sulphate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidizable matter is calculated in terms of oxygen equivalent. This was prepared by dissolving 4.903g $K_2Cr_2O_7$ (dried at 150^0C, 2hr.) in 500ml distilled water, followed by the addition of 167ml H_2SO_4 and 33.3g $HgSO_4$. The solution was allowed to cool before diluting to 100ml with distilled water. Each reaction tube washed with 20% H_2SO_4 before use.

Determination of Total Hardness (mg/L)

Total hardness of unfiltered water samples was determined by the burette titration method. An aliquot of the test sample was titrated with standard 0.01M EDTA titrant, with eriochrome black T as end-point indicator. The total hardness was:

$$\text{Total Hardness (mg/L as } CaCO_3) = \frac{\text{(Titre (ml) x 2500)}}{\text{Sample Volume (ml)}}$$

Determination of Chloride (mg/L)

Chloride was determined in unfiltered water samples by the buret titration method. An aliquot of the test sample was titrated with standard 0.014M silver nitrate titrant, with potassium chromate as end-point indicator. The chloride concentration was calculated as follows:

$$\text{Chloride (mg/L)} = \frac{\text{(Titre (ml) x 35450 x molarity of titrant)}}{\text{Sample Volume (ml)}}$$

DETERMINATION OF CATION CONTENT

Determination of Calcium (Ca^{2+}) (mg/L)

The calcium content was estimated using the EDTA Titrimetric Method (APHA, 1998). The reagent used were Sodium Hydroxide, NaOH, Muxeride (Ammonium purpurate) as an indicator and a standard EDTA Titrant (0.01M). Sample preparation and titration was carried out immediately due to high pH of the medium. 0.5ml of 1ml NaOH or speck of NaOH crystal was added to 10ml of sample followed by a speck (0.1 – 0.2g) of calcium specific indicator mixture. The mixture was titrated with standard EDTA to the proper end point.

$$\text{Ca (mg/L)} = \frac{\text{A x B x 1000}}{\text{Vol. of sample (ml)}}$$

Where A = ml titrant for sample
B = mg Ca equivalent to two drops of EDTA titrant at the calcium indicate end point.

Determination of Magnesium (Mg^{2+}) (mg/L)

The determination of Magnesium was estimated using the titrimetric method in a water sample diluting 1:000. The AAS was set in direct readout mode. A magnesium standard (0.5mg/L) was aspirated and used to set abundance to 0.5 units. The prepared samples were aspirated and the absorbance values noted (A) and all values expressed in mg/L.

Mg (mg/L) = Total hardness – Calcium concentration x 0.244.

DETERMINATION OF NUTRIENTS

Determination of Nitrate – Nitrogen (NO_3^-) (mg/L)

Nitrate concentration of each sample was determined using Colorimetric Method 4500D (APHA, 1998) using an APHA/HACH DR 2010 Colorimeter with internal standard. The pH of the sample was first adjusted to acidic range by adding 2 drops of Hydrochloric acid (HCl) to 25ml of the filtered sample. A drop of NED reagent was then added to the mixture and allowed to stand for 5-10 minutes before being tested for nitrate with the colorimeter at 543nm. All readings were recorded in mg/L.

Determination of Phosphate – Phosphorus (PO_4^-) (mg/L)

This was determined using the Colorimetric Method (Stannous Chloride Method 4500-PD). Molybdophosphic acid is formed and reduced by stannous chloride to intensely coloured molybdenum blue which absorbs at 625 – 690nm. 10ml sample was acidified with dilute H_2SO_4. 1ml of ammonium molybdate reagent and 0.5ml stannous chloride reagent was added, mixed and allowed to stand for 5mins. The colour is determined at 650nm phosphate concentration was then read off the display. The colorimeter was previously calibrated with phosphate standards before use. All readings were expressed in mg/L

Determination of Sulphate (mg/L)

This was determined using the Turbidimetric Method 4500 E (APHA, 1998). 10ml of the sample was mixed with 10 drops of already prepared conditioning reagent and then mixed. A pinch of Barium chloride ($BaCl_2$) salt was added and the solution left standing for 5min. A colorimeter, previously calibrated with sulphate standards was used to read the sulphate concentration in each sample and the readings expressed in mg/L.

Determination of Silica (S_iO_2) (mg/L)

The Silica is measured using a colorimeter. To 10ml of the sample was added 0.2ml Hydrochloric acid (HCL) followed by 0.4ml molybdate reagent. The mixture was allowed to stand for 5min and 0.4ml of an already prepared reducing solution was added. Silica concentration was determined at 600nm using a pre-calibrated colorimeter (DR2010) and the readings expressed in mg/L.

Determination of Dissolved Inorganic Nitrogen (DIN) (mg/L)

A portion of the sample was filtered through a 0.45 µm Glass Fiber filter. The filtrate was used for the determination of DIN (NO_3-N, NO_2-N, and NH_3-N).

Nitrate-nitrogen was determined on 10 ml aliquot by cadmium reduction method (HACH Method 8039), with NitraVer-5 reagent powder. Test solutions were measured at 500 nm using HACH DR 3900 spectrophotometer.

Nitrite-nitrogen was determined on 10 ml aliquot by diazotization using NitriVer 3 reagent powder (HACH Method 10019). Test solutions were determined at 507 nm, using HACH DR 3900 spectrophotometer.

Ammonia-nitrogen was determined by the salicylate method using AmVer reagent powder, on 10 ml aliquot. Test solutions were measured at 655 nm (HACH Method 8155)

The concentration of dissolved inorganic nitrogen (DIN) is the sum of NO_3^-N,NO_{2-}N, and NH_3-N. The concentrations of dissolved organic nitrogen (DON) were estimated by subtracting DIN from TDN.

Determination of Total Dissolved Nitrogen (TDN) (mg/L)

A 2ml aliquot of the filtered sample was used for the determination of Total Dissolved Nitrogen (HACH Method 10072), following an alkaline persulphate digestion, at 105 °C for 30 min, which converts all forms of nitrogen to nitrate. Nitrate then reacts with chromotropic acid under strongly acidic conditions to form a yellow complex, in proportion to the TDN concentration. The test solution was measured at 410 nm.

Determination of Dissolved Organic Nitrogen (DON) (mg/L)

DON was the determined by difference

DON = TDN – DIN (by difference)

Where;

TDN is Total Dissolved Nitrogen after per-sulphate oxidation

DIN is the sum of the Dissolved Inorganic Nitrogen species.

Determination of Dissolved Inorganic Phosphate

Reactive Phosphorus (Orthophosphate) (mg/L)

A portion of the sample was filtered through a 0.45 µm Glass Fiber filter. The filtrate was used for the determination of DIP (as PO_4). A 10ml aliquot of the filtrate was reacted with molybdate in an acid medium (PhosVer 3 reagent powder, Hach Method 8048)to produce a mixed phosphate/molybdate complex. Ascorbic acid in the reagent then reduces the complex to an intense blue color which is proportional to the phosphate concentration. Measurement was made at 880 nm, using a HACH DR 3900 spectrophotometer.

Determination of Oil and Grease (mg/L)

A 100ml aliquot of the water sample was acidified to pH < 2 and then extracted three times with15 ml hexane in a separatory funnel. The combined extract was dried by filtering through 1g of sodium sulfate, then diluted to 20 ml in a volumetric flask. Oil & Grease was determined by IR spectroscopy (EPA Method 418.1), following an ejection of 50µL of the extract unto the plate of the Total Oil & Grease Analyzer (InfraCal-2).

A calibration working solution (1-10 mg/mL total OG) was used to validate the method.

Statistical Analysis

The results were subjected to one-way Analysis of variance (ANOVA) using the Statistical Package for the Social Sciences (SPSS Version 23) to determine significant differences. The Duncan (1955) Multiple Range Test was used to separate differences among means. Differences were considered significant at (P<0.05).

RESULTS

Physical Parameters

Data for these are presented in table 2 and graphically in Figures 2, and 3.

Air Temperature (^{0}C)

Air temperature showed slight variation in value from May to September at all three sampling stations. The lowest air temperature value (26 °C) was recorded in July at Station 3, while the highest (30 °C) was recorded in May across all stations and in July at Station 1 (Fig. 2). The mean standard deviation (28.53±1.13) is seen in Table 1.

Surface Water Temperature (^{0}C)

Water temperature fluctuated slightly at all stations during the period of study. The lowest value (26 °C) was recorded in both June at Station 1 and August at Station 3, while the highest (30 °C) was recorded across varying stations in all months except August (Fig. 2). The mean and standard deviation is 28.60±1.55 (Table 1).

Total Suspended Solids (mg/L)

Similar values (30 mg/L) were recorded in September at both Stations 1 and 2. There were considerable variations in the TSS values recorded across the stations for each month especially May, June, July and August. Values ranged between 1.00 mg/L in June at Station 3 and 48.00 mg/L in June at Station 1. The mean and standard deviation is 14.73±13.16 (Table 1).

Total Dissolved Solids (mg/L)

Total dissolved solids values fluctuated significantly throughout the sampling months. The value ranged between 1569.20 mg/L in September at Station 1 and 15189 mg/L in June at Station 2. The mean and standard deviation is 6554.33±3495.04 (Table 1).

Rainfall (mm)

Rainfall values fluctuated throughout the sampling months. The lowest rainfall value (1569.20 mm) was recorded in July, while the highest (15189 mm) was recorded in September (Figs. 2 and 3). The mean and standard deviation is 248.32±68.42 (Table 1).

Turbidity (NTU)

There was slight variation in the turbidity value across the three stations throughout the five months. The lowest value (2.72 NTU) was recorded in May at Station 1, while the highest value (39.20 NTU) was recorded in September at Station 1 (Fig. 3). The mean and standard deviation is 13.94±11.42 (Table 1).

CHEMICAL PARAMETERS

Data for these are presented graphically in Figures 3, 4, 5, 7 and 8 and in Appendix 1.

pH Value

pH value varied between low acidic and low alkaline. The lowest value (5.94) was recorded in September at Station 1, while the highest value (7.33) was recorded in July at Station 3 (Fig. 3). The mean and standard deviation is 7.11±0.34 (Table 1).

Salinity (‰)

There were wide variations in salinity values among the stations in May, June and August. Slight variations were recorded in the other months. The lowest value (1.50‰) was recorded in September at Station 1, while the highest value (18.40‰) was recorded in May at Station 3 (Fig. 5). The mean standard deviation (7.47±4.93) is seen in Table 1.

Conductivity (μS/cm)

Conductivity fluctuated in value from May to September at all three sampling stations. The lowest conductivity value (2760.00 μS/cm) was recorded in September at Staion 1, while the highest (24900.00 μS/cm) was recorded in June at Station 3. Conductivity value at Station 1 dropped slightly in June, picked up in July through August and dropped drastically in September. At Station 2, the value dropped slightly in June, picked up again in July and plunged in August through September. At Station 3, the value rose in June, plunged in July, picked up slightly in August and plunged again in September. The and standard deviation (11059.49±6003.44) is shown in Table 1.

Dissolved Oxygen (mg/L)

DO values showed variation in value from May to September at all three stations. The lowest DO value (0.36 mg/L) was recorded in September at station 1, while the highest (5.12 mg/L) was recorded in June at station 3. DO value dropped sharply in June at Station 1, picked up in both July and August, remaining steady, and then, dropped sharply again in September. There was a slight drop in value in June at Station 2. It rose slightly in July and remained steady through August with a sudden drop in September. It recorded a sharp rise in June at Station 3, remained steady with a gradual drop in August through September (Fig. 5). The mean standard deviation (3.89±1.42) is represented in Table 1.

Biochemical Oxygen Demand (mg/L)

BOD_5 value fluctuated across the stations in the five months under investigation. The lowest BOD_5 value (3.00 mg/L) was recorded in September at station 2, while the highest value (211 mg/L) was recorded in September at station 1. At Station 1, the value rose steeply in July, dropped slightly in August, and then, rose sharply in September. On the other hand, Station 2 experienced the sharpest drop in value in September, while Station 3 experienced a steady decline in value across all the months (Fig. 5). The mean standard deviation (43.07±52.04) is represented in Table 1.

Chemical Oxygen Demand (mg/L)

Chemical oxygen demand value fluctuated across the stations in the five months of investigation. The lowest Chemical oxygen demand value (12.00 mg/L) was recorded in September at station 2, while the highest value (1769.00 mg/L) was recorded in September at station. At Station 1 increased slightly in June, then in August and increased drastically in September. At Station 2, the value increased sharply in June, a little in July, steadily through August, and then, plunged further in September. At station 3, the value dropped sharply in June, rose slightly in July, dropped again in August and declined steadily through September (Fig. 5). The mean and standard deviation is 320.60±465.47 (Table 1).

Potassium (mg/L)

Potassium value fluctuated at all the stations during the period of study. The lowest potassium value (13.5 mg/L) was recorded in September at station 1, while the highest value (168.02 mg/L) was recorded in May at station 3. Potassium value plummeted in June and rose steadily through August, and then, dropped sharply in September at Station 1. At Station 2, there was a steep drop in value, which rose again in July and decreased steadily through September. The mean and standard deviation is 67.84±44.91 (Table 1).

Calcium (mg/L)

Calcium value fluctuated at all station during the period of study. The value ranged between 14.85 mg/L in September at Station 1 and 159.53 mg/L in June at Station 3. Calcium value dropped sharply in June at Station 1, it rose slightly in July, steadied through August, and finally, it plunged in September. At Station 2, the value dropped sharply, picked up again in July, and then, plunged in August through September. At Station 3, the value increased slightly in August, and finally, plunged in September. The mean and standard deviation is 69.69±42.46 (Table 1).

Silica (mg/L)

Silica values varied slightly in all three stations during the sampling period. The value ranged between 1.22 mg/L in May at Station 3 and 9.53 mg/L in June at Station 2. Silica value rose sharply in June at Station 1, dropped slightly in July, took a plunge in August and increased slightly in September. At Station 2, the value rose slightly, taking a plunge in July through August, then finally, increasing slightly in September. At Station 3, the value rose sharply in July, plunged in August, and finally, picked up sharply in September. The mean and standard deviation is 5.42±2.43 (Table 1).

Sodium (mg/L)

Sodium value fluctuated across the three station during the study period. The value ranged between 454.14 mg/L in September at Station 1 and 5659.21 mg/L in May at Station 3. Sodium value dropped considerably in June at Station 3, and plunged further in July through September. At Station 1, the value plunged drastically, picked up slightly in July, and then plummeted steadily through September. The mean and standard deviation is 2284.95±1528.26 (Table 1).

Oil and Grease (mg/L)

Oil and grease value remain constant across all the stations during the period of study. Oil and grease values recorded < 0.2 mg/L throughout the period of sampling at all stations. The standard deviation and mean were 0.02±0.00 (Table 1).

NUTRIENTS

Data for these are presented graphically in Figures 4 and 8, and in Appendix 1.

Reactive Nitrogen (NO_3 - N) (mg/L)

Nitrate value varied slightly in all three stations during the sampling period. The value ranged between 1.7 mg/L in August at Station 3 and 4.83 mg/L in June at Station 3. Nitrate value steadied between May and June. There was a steep drop in July at Station 3, and then, it dropped further in August at Station 3 as well as September at Stations 1 and 3, respectively. (Fig.4). The mean standard deviation is 2.89±1.11 (Table 1).

Reactive Phosphorus (PO_4 - P) (mg/L)

Phosphate value fluctuated in all three stations during the sampling period. The value ranged between 0.03 mg/L in May at Station 3 and 6.29 mg/L in August at Station 2. Phosphate value dropped sharply in June at Stations 1 and 2, steadied in July, then there was a sharp rise in August at Stations 1 and 2, and then in September, all values plummeted (Fig.4). The mean and standard deviation is 1.70±2.11 (Table 1).

Sulphate (SO$_4^{2-}$) (mg/L)

Sulphate value varied greatly in all three stations during the sampling period. The value ranged between 19.1 mg/L in September at Station 3 and 1177.7 mg/L in May at Station 3. Sulphate value dropped considerably in June at both Stations 1 and 2, with a steep rise in July at both Stations 1 and 2. These stations experienced a gradual drop in August, and then, there was a sharp drop in value in September across the three stations. Station 3 experienced a steady drop in value across the months until August, which had a slight increase (Fig.4). The mean standard deviation is 518.71±344.75 (Table 1).

Dissolved Inorganic Phosphate (DIP) (mg/L)

DIP value fluctuated in all station during the sampling period. DIP value ranged between 0.003 mg/L and 2.096 mg/L. The highest value (2.096 mg/L) was recorded in August at Station 2 and the lowest (0.003 mg/L) in May at Station 3 (Fig. 8). The mean value deviation is 0.57±0.70 (Table 1).

Dissolved Inorganic Nitrogen (DIN) (mg/L)

DIN value varied slightly across all three stations during the study period. DIN value ranged between 0.4 mg/L and 1.093 mg/L. The highest value (1.093 mg/L) was recorded in June at Station 3 and the lowest (0.003 mg/L) in September at Station 3 (Fig. 8). The mean value deviation is 0.65±0.25 (Table 1).

Dissolved Organic Nitrogen (DON) (mg/L)

DON value varied slightly across all three stations during the study period. DON value ranged between 0.111 mg/L and 3.278 mg/L. The highest value (3.278 mg/L) was recorded in September at Station 1 and the lowest (0.111 mg/L) in September at Station 3 (Fig. 8). The mean value deviation is 0.93±1.09 (Table 1).

Table 1: Mean and standard deviation values for physiochemical parameters of the surface water at Tin Can Island Creek (May – September, 2018).

Parameters	Mean ±S. D.
Air Temperature (°C)	28.53±1.13
Water Temperature (°C)	28.60±1.55
pH @ 25°C	7.11±0.34
Conductivity (µS/cm)	11059.49±6003.44
TSS (mg/L)	14.73±13.16
TDS (mg/L)	6554.33±3495.04
Turbidity (NTU)	13.94±11.42
Salinity (ppt, at 25°C)	7.47±4.93
Acidity (mg/L, as CaCO3)	36.68±24.65
Alkalinity (mg/L, as CaCO3)	187.25±125.09
Total Hardness (mg/L, as CaCO3)	1227.59±720.01
DO (mg/L)	3.89±1.42
BOD5 (mg/L)	43.07±52.04
COD (mg/L)	320.60±465.47
Chloride (mg/L)	4046.71±2690.47
Nitrate (mg/L, as NO3-)	2.89±1.11
Sulphate (mg/L)	518.71±344.75
Phosphate (mg/L, as PO43-)	1.70±2.11
Silica (mg/L, SiO2-)	5.42±2.43
Calcium (mg/L)	69.69±42.46
Magnesium (mg/L)	254.07±151.55
Sodium (mg/L)	2284.95±1528.26
Potassium (mg/L)	67.84±44.91

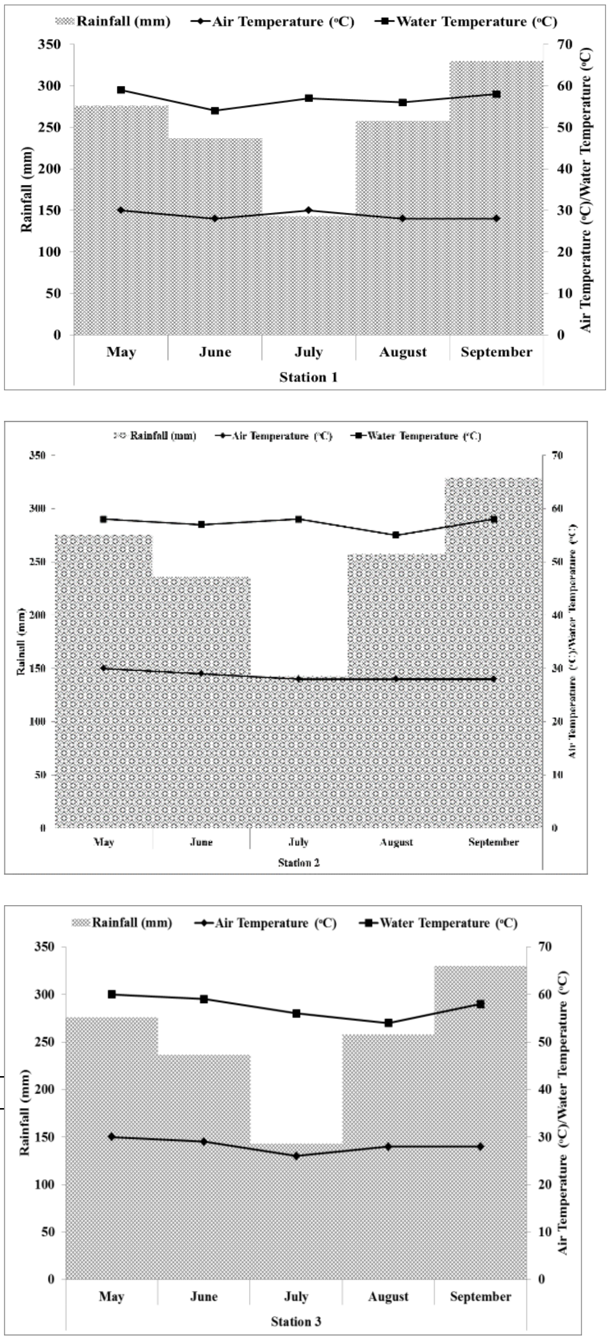
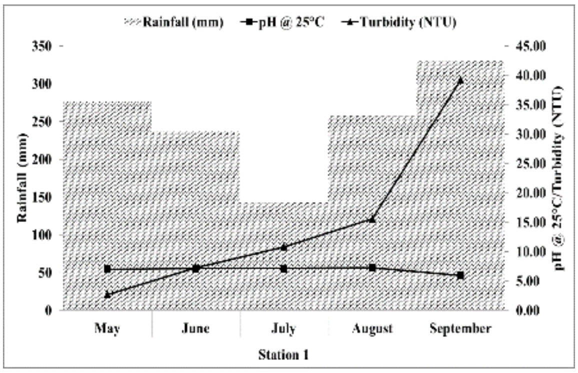
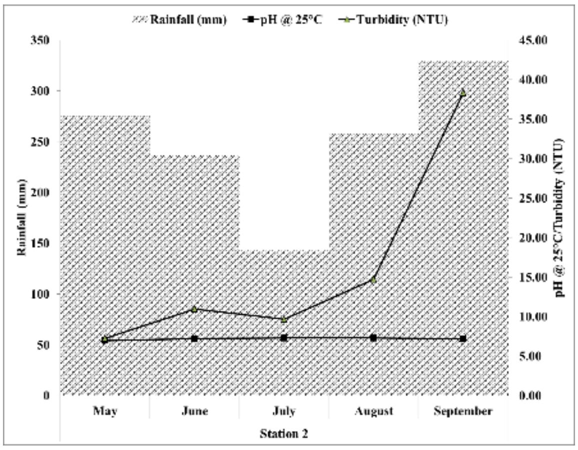


Fig. 2: Monthly variation in rainfall, air temperature and water temperature at Tin Can Island Creek (May – September, 2018).





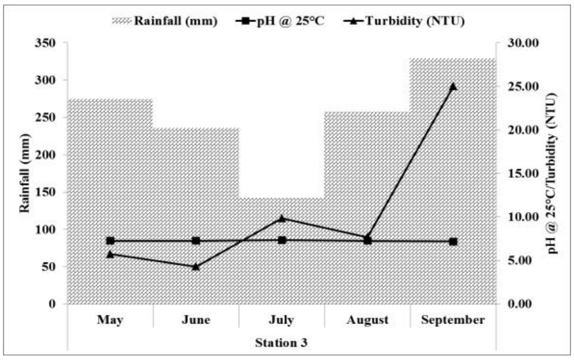
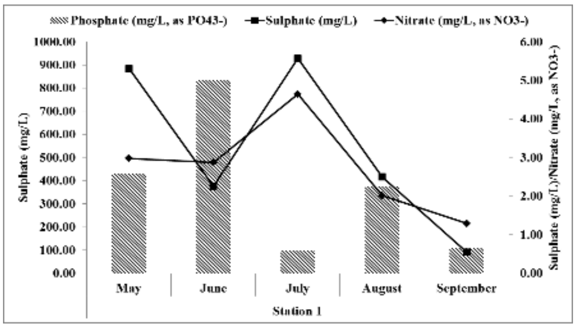
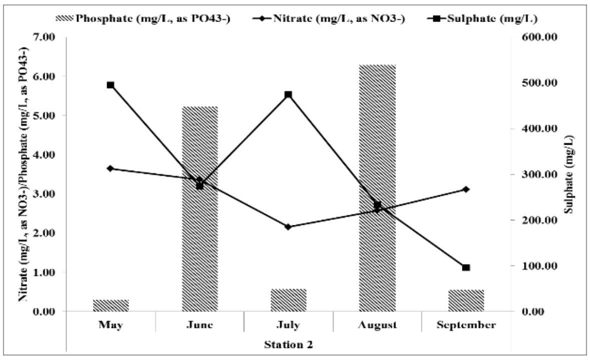


Fig. 3: Monthly variation in rainfall, pH and turbidity at Tin Can Island Creek (May – September, 2018).





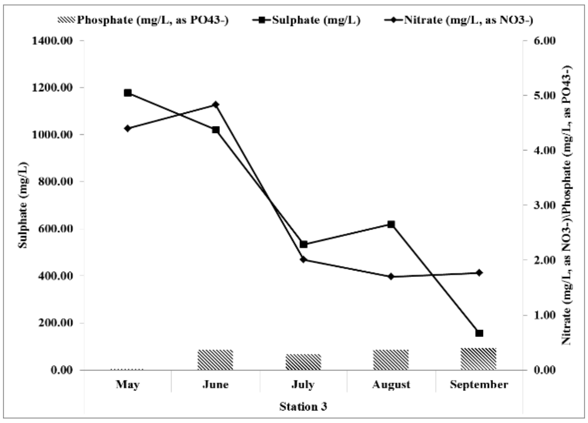
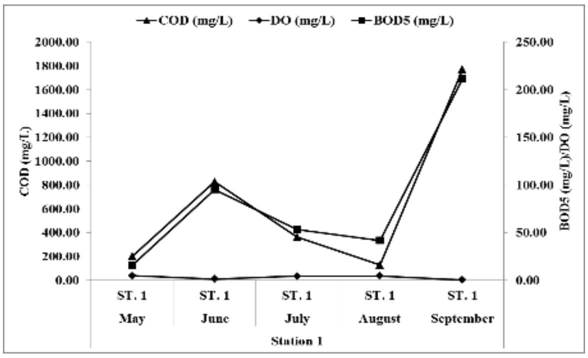
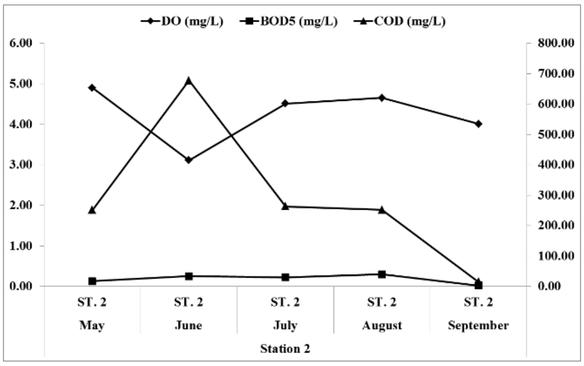


Fig. 4: Monthly variation in sulphate, nitrate and phosphate at Tin Can Island Creek (May – September, 2018).





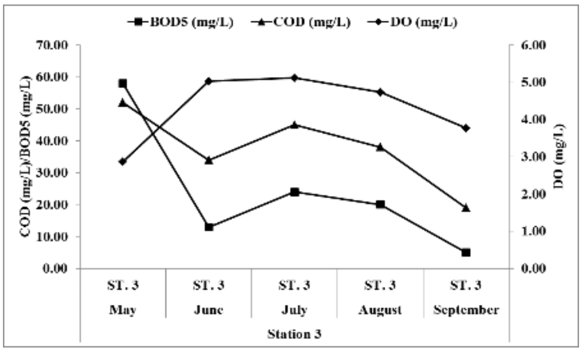


Fig. 5: Monthly variation in COD, DO and BOD_5 at Tin Can Island Creek (May – September, 2018).

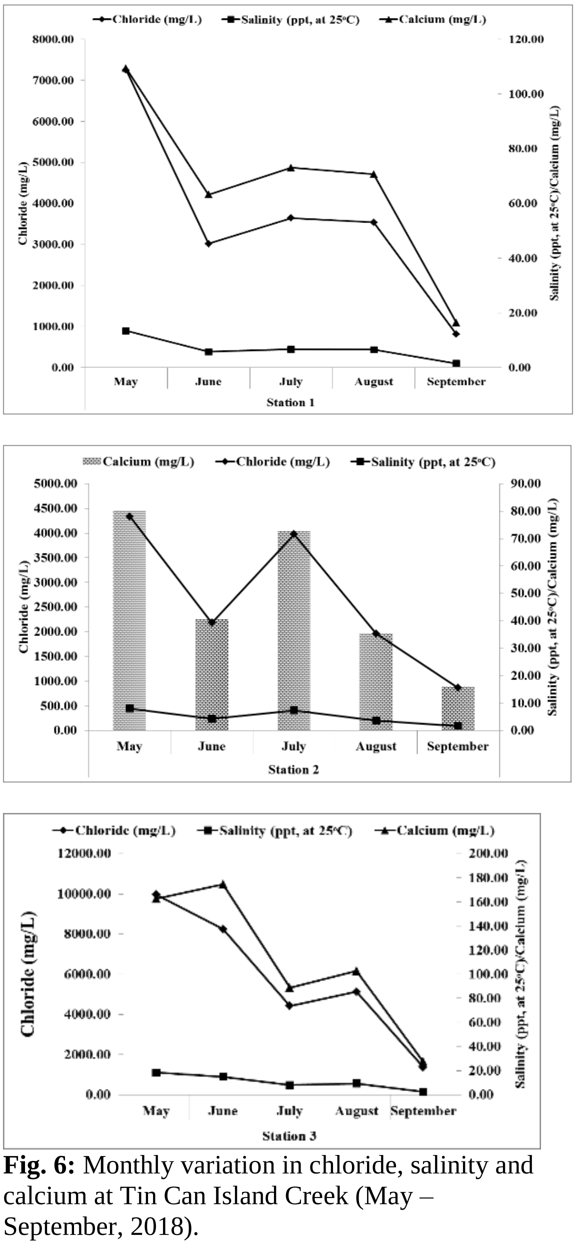


Fig. 6: Monthly variation in chloride, salinity and calcium at Tin Can Island Creek (May – September, 2018).

DISCUSSION

The changes observed in water quality parameters at the different stations along the creek may be attributed to weather conditions and may also suggest the dominance of a common forcing function; tidal dynamics. The proximity of the Tin Can Island Creek to the Lagos Habour may have accounted for the high brackish condition (13 – 18 ‰) and maritime influence across the study stations, corroborating an earlier report by Chukwu and Nwankwo (2004).

According to Hill and Webb (1958), in the tropics, rainfall and its distributive pattern is a more important factor than temperature in determining the terrestrial and aquatic environments. Floodwater introduction, associated with the rains may have caused dilution and possibly scouring and stirring up of detritus and organic matter which consequently increased the level of total dissolved solids. Rapid currents damaged phytoplankton, whereas moderate currents enhanced the development of benthic communities (Blum, 1956).

The high brackish condition (13.40 - 18.40 ‰) observed at the study area may be due to tidal sea water incursion from the Lagos Harbour as well as drastic reduction of flood water as rainfall ceased. Hill and Webb (1958), Nwankwo (1996) and Onyema *et al.*, (2007) reported seasonal salinity regimes in the Lagos Lagoon with high salinities between December and April and low salinities between May and November. Barnes (1980) reported considerable dilution of lagoons and creeks by freshwater from rain and river systems with evaporation being more prominent in the dry season. There were wide variations at the study site during the study period possibly due to its relative closeness to the Lagos Habour.

However, the sharp decline in June may possibly be linked with increase in flood water. Although this month corresponds with one of the ecological periods described by Nwankwo (1996) when salinity is decreasing, the unique situation of the area with respect to its proximity to the Lagos Harbour may have delayed any rapid dilution from flood water.

Total hardness, calcium and chloride ions significantly reflected a decline associated with increase in flood water during the peak of the rains. The low values of total hardness recorded at the creek may be due to effects of dilution of cations by flood waters subsequently resulting in higher conductivity as the creek tends towards a less brackish status. There was a corresponding low dissolved oxygen level in all stations throughout the 5 months of sampling, since oxygen is a by-product of photosynthesis, which was at its lowest during this period under study. This observation confirms earlier findings by Hill and Webb, 1958; Olaniyan, 1969; Nwankwo, 1993, 1996; Onyema and Nwankwo, 2009.

The relatively low air and water temperatures observed in this study are similar to those recorded by Adesalu and Nwankwo (2005) at Abule Eledu Creek, Emmanuel and Onyema (2007) at Abule-Agege Creek as well as Adedipe and Nwankwo (2016) at Ogudu Creek in Lagos.

CONCLUSIONS

The present study reveals the physical and chemical properties of the water. In summary, the water quality shows a polluted hydrological environment with degraded water conditions. High level of pollutants were observed. Consequently, great efforts and co-operation are needed by different authorities to protect the Tin Can Island Creek in Lagos and Nigeria from pollution and reduce environmental risk associated with the creek. This can be achieved by routine check and monitoring of the activities around the creek, treatment of domestic, industrial and agricultural waste deposed directly into Tin Can Island Creek to ensure the safety of the aquatic life.

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