Analysis of Physico-Chemical Parameters: An Empirical Study of Yewa River Ogun and Part of Badagry Creek Lagos, Southwest Nigeria

Abstract

The water quality was analysed for physicochemical parameters to ensure safe and continuous consumption by the citizens of Yewa Ogun State and Badagry, Lagos State southwestern Nigeria. In view of this, a detailed physical and chemical analysis of water samples was carried out across Yewa River and part of Badagry Creek. The physicochemical parameters studied are; pH, Salinity, EC, TDS, TS and TSS. Fifteen (15) samples each were taken across Yewa River and part of Badagry Creek making a total sample of thirty (30). Sterilized empty table bottle water was used to collect all the thirty (30) samples across the River and the Creek which was drawn from midstream at 0-10cm depth below the surface of the water. Physicochemical analysis on all sampled water was carried out in the Laboratory. From the result of the Laboratory test carried out, the mean, minimum and maximum value of Hydrogen ion concentration (pH), salinity (psu), Electrical conductivity (EC μScm⁻¹), total dissolved solid (TDS) mg/L total solid and total suspended solid (TSS) mg/L are (5.87, 5.35, 6.21), (0.499, 0.34, 0.65) psu, (970.40, 520, 1270) μScm⁻¹, (485.20, 260, 635) mg/L, (955.60, 920, 1115) mg/L, (470.40, 340.5, 815) mg/L for Yewa River and (4.72, 3.8, 5.8), (0.46, 0.28, 0.79) psu, (961, 678, 1574) μScm⁻¹, (480.5, 339, 787) mg/L, (982.62, 625, 1896) mg/L, (496.25, 153, 1109) mg/L for part of Badagry Creek. The Hydrogen ion concentration (pH) for both study area were found to be lower than World Health Organization (WHO) recommended limit of 6.5-8.5 in all samples. The T-test correlation analysis was conducted for the parameter studied for the River and the Creek as well as the correlation between the River and the Creek. The result was presented in form of statistical table showing the correlation between the water sampled in Yewa River and across part of Badagry Creek and the correlation that exists between the River and the Creek using Eviews 9 statistics software package. It was concluded that Yewa and part of Badagry Creek was a good source of portable drinking water as both meet the WHO recommended limit.

Keywords: Correlation; groundwater; Laboratory; Physiochemical parameters; Test

Abbreviations

PH: Hydrogen Ion Concentrate; EC: Electrical Conductivity; TDS: Total Dissolved Solids; TSS: Total Suspended Solids; TS: Total Solids; ds/m: Decisiemen per Meter; WHO: World Health Organisation

Introduction

Surface and Ground water is important source of water supply in the world which is needed for human survival and industrial development. The ground and surface water chemistry is controlled by the composition of its recharge components as well as geological and hydrological variations within the aquifers [1]. Khodapanah et al. [2] opined that polluted ground and surface water sources are the cause for the spread of epidemic and chronic disease in human beings. Industrialization and increase in population are responsible for depletion of our groundwater sources. Improved knowledge is required for understanding and evaluating the suitability of groundwater for different purposes. Groundwater quality comprises physical, chemical and biological qualities of groundwater [3]. A measure of the quantity of dissolved salts and other minerals in sea water is the term salinity. Normally, salinity can be defined as the total amount of dissolved solids in sea water in parts per thousand (ppt or ‰) by weight. Generally, salinity cannot be determined directly but can be computed from chlorinity, electrical conductivity, refractive index or some other property whose relationship to salinity is well established. In the Law of Constancy of Proportions, sample salinity can be established by the level of chlorinity in a sea water sample. The average salinity of sea water is around 35%. The rate of variation of sound velocity is approximately 1.3 m/s for a 1% alteration in salinity. Water is an invaluable resource to man and living things, essential for the sustenance of life [4] on earth as exemplified by its diversified uses (drinking, cooking, washing, irrigation, farming etc.) [5]. The quality of drinking water is a powerful environmental determinant of health [6]. In a recent survey by [7], it is estimated that 65 million Nigerians had no access to safe drinking water. Many human communities
around the world are increasingly turning to groundwater for their water needs. Groundwater is water that exists underground [8]. It represents all the water present in the soils’ voids and fissures within geological formations which come from natural precipitation either directly by infiltration or indirectly from rivers [9]. Without safe water near dwellings, the health and livelihood of families can be severely affected [10,11]. Concentrations of target substances in the groundwater increase or decrease along the flow path from the upstream to the downstream wells [12], human activities may consequently pollute this water source overtime and make it unsafe for use without prior treatment. More so, several research findings [6-13] have revealed a definite correlation between human socio-economic activities and industrialization to pollution patterns/trends of groundwater. Therefore, the evaluation of groundwater quantity and quality is essential for the development of civilization and to establish database for future water resources strategic planning and development [14]. However, human activities can alter the natural composition of groundwater through mining activities, disposal or dissemination of chemicals and microbial matter at the land surface and into soils or through injection of wastes directly into groundwater. High values of TDS in ground water are generally not harmful to human beings but high concentration of these may affect persons who are suffering from kidney and heart diseases [15,16]. Electrical conductivity (EC) of water is a direct function of its total dissolved salts [17]. Hence it is an index to represent the total concentration of soluble salts in water [18]. Therefore, this study aimed at analyzing physiochemical/sensitivity parameter present in the water based on pH, Salinity, EC, TDS, TS, and TSS across Yewa River and part of Badagry Creek and to show how they correlate to one another.

Study Area

The study area is Yewa River and Part of Badagry Creek. The study stretch from Yewa River to Part of Badagry Creek precisely from Badagry to Ajido (Right) and the boundary between Nigeria and Benin Republic (Left). The Badagry creek and Yewa river is a major sea transportation route for transporting Badagry and Yewa residents and their goods from the ancient city of Badagry and Yewa to the other coastal areas of Lagos as Lagos Island, Apapa and Epe. For this reason, the navigable passage is often very busy with several private and commercial vessels plying the route. Yewa River is a stream (class H - Hydrographic) in Lagos (Nigeria (general), Nigeria (Africa) with the region font code of Africa/Middle East. It is located at an elevation of 36 meters above sea level and its population amounts to 174,152. Yewa River is a trans-boundary (international) river between the republic of Benin (source) and Nigeria and it lies approximately within longitude 2.70°E and 3.00°E of the Greenwich meridian and Latitude 6.25°N and 6.75°N of the equator. Badagry Creek is located in Lagos, Lagos State, Nigeria. The Creek separate the mainland sedimentary basin from the Atlantic Coastline. It lies within Longitude 2° 42’E and 3° 42’E and stretches between Latitude 6° 22’N and 6° 42’N, sharing boundary with Republic of Benin. Badagry Creek is approximately 177km long [19] (Figure 1), and directly connects with Nigeria 960km of coastline bordering the Atlantic Ocean in the Gulf of Guinea, a marine area of 46,500km² with depth of up to 50m and an Exclusive Zone of 210,900km². There is a harbor which is constructed in the form of a channel. The water in Badagry Creek is not shallow. The Creek is important for both artisanal and commercial fisheries, and as well as transportation, recreation and domestic purposes. Also serve as means of livelihood for fishermen and women. Below show the maps of the study area by image credit [20] and Google earth satellite imagery 2015 (Figure 2). There are two main methods of determining the salt content in water: The Total Dissolved Solts (or Solids) and Electrical Conductivity. Total Dissolved Solts (TDS) is measured by evaporating a known volume of water to dryness, then weighing the solid residue remaining while Electrical conductivity (EC) is measured by passing an electric current between two metal plates (electrodes) in the water sample and measuring how readily current flows (i.e. conducted) between the plates. The more dissolved salt in the water, the stronger the current flow and the higher the EC. Table 1 shows the water recommendation and use for different EC rates.

### Table 1: Water recommendation and use.

| µS/cm | Use                                                                 |
|-------|----------------------------------------------------------------------|
| 0 - 800 | Generally good for irrigation, though above 300µS/cm some care must be, particularly with overhead sprinklers, which may cause leaf, scorch on some salt sensitive plants. |
| 800 - 2500 | Can be consumed by humans, although most would prefer water in the lower half of this range if available |
| 2500 - 10,000 | Not recommended for human consumption, although water up to 3000 µS/cm can be consumed |
| Over 10,000 | Not suitable for human consumption or irrigation |
|         | Good drinking water for humans (provided there is no organic pollution and not too much suspended clay material) |
|         | When used for irrigation, requires special management including suitable soils, good drainage and consideration of salt tolerance of plants |
|         | When used for drinking water by poultry and pigs, the salinity should be limited to about 6000 µS/cm. Most other livestock can use water up to 10000 µS/cm |

Source: [21].

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Materials and Methods

Equipment used

i. Empty Bottles of Table water 30
ii. Handheld GPS (Garmin) 1
iii. Boat (used in movement on water) 1

Methods/Procedures of sampling

Analysis of Chemical composition and salt content in water samples make available the facts about changes that has occurred in groundwater systems which will help in understanding the water conditions and causes of its changes. For this study, water salinity was done by collecting a water sample from different point along Yewa River and Badagry Creek. The coordinates x, y of each sample point was determined with handheld GPS as at the time the sample is taking. Fifteen (15) samples along Yewa River and Fifteen (15) samples were taken along Badagry Creek, all to a total of twenty four (24) samples from both the River and the Creek drawn from midstream at 0 to 10 cm depth below the surface of the water. The water sample collected were tightly sealed with cover bottle as quick as possible to avoid exposure to air and took to the laboratory for immediately analysis for some sensitive parameters like pH, electrical conductivity (EC) and total dissolved solids (TDS), total suspended solid (TSS) and total solid (TS) respectively. The sampling period was during the dry season (November 18th, 2015). The techniques of water sampling come after as defined by [22,23]. The chemical analyses were conducted at the Lagos University Teaching Hospital (LUTH). The significance of the correlation between parameters was calculated for Yewa River and part of Badagry Creek as well as correlation that exist between the both using the critical value of Pearson’s r for a two-tailed test as follows; The degree of freedom for both the river and the Creek = total sampled -2, since the total sample is fifteen (15) for each, then the degree of freedom (df) = 15 – 2 = 13 and from the Pearson ‘r’ statistical table, the degree of freedom for 13 at 1% (0.01), 5% (0.05) and 10% (0.1) were (0.641, 0.541 and 0.441) and was used to compare the result of the ‘r’ statistics from the correlation coefficient matrix table which was used to show the level of significance between parameters. Table 2 shows the sampled locations/name for both the river and the Creek. Table 3 below shows the x, y coordinates of each sample point with their locations.

Table 2: Shows the sampled area across Yewa River and part of Badagry Creek.

| Sampled Location Across Yewa River | Sample |
|-----------------------------------|--------|
| Aghonyedo Agbajedo               | 1      |
| Ere                               | 2      |
| Itire Itere                       | 3      |
| Seje                              | 4      |
| Ipokia                            | 5      |
| Ibawe Kararemunao                 | 6      |
| Itohun                            | 7      |
| Iyafin Isalu                      | 8      |
| Between Itohun and Iyafin Isalu  | 9      |
| Igbo – Pipe                       | 10     |
| Igoro                             | 11     |
| Iregon                            | 12     |
| Bamin Glohangingbe                | 13     |
| Odan Popo Afami                   | 14     |
| Onfo                              | 15     |

Table 3: Shows the sampled area across Yewa River and part of Badagry Creek.

| Sampled Location of Part of Badagry Creek | Sample |
|------------------------------------------|--------|
| Badagri Badagy                          | 1      |
| Towpo Topo                              | 2      |
| Akarakumo                                | 3      |
| Between Akarakumo and Ajido             | 4      |
| Ajido Wuru                               | 5      |
| Ojogun                                   | 6      |
| Epe                                      | 7      |
| Appa Apa                                 | 8      |
| Between Appa Apa and Akere              | 9      |
| Igbaji                                   | 10     |
| Between Igbaji and Ganyingbo            | 11     |
| Ganyingbo                                | 12     |
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Table 3: Coordinates of points sampled during water sampling.

| Sample | Location Name         | Easting (mE) | Northing (mN) |
|--------|-----------------------|--------------|---------------|
| 1      | Agbonyedo Agbajedo    | 483174.7     | 712265.4      |
| 2      | Ere                   | 484111.8     | 713202.4      |
| 3      | Itire Itere           | 484793.3     | 714182.1      |
| 4      | Seje                  | 485176.6     | 715204.3      |
| 5      | Ipokia                | 487135.9     | 715246.9      |
| 6      | Ibawe Kararemunao     | 488039.6     | 717035.8      |
| 7      | Iyafin Isalu          | 488797      | 719847        |
| 8      | Between Iyafin Isalu  | 487306.3     | 722402.6      |
| 9      | Between Iyafin Isalu  | 487774.8     | 724276.7      |
| 10     | Igbo - Pipe           | 489623.1     | 716101.6      |
| 11     | Igero                 | 489938.3     | 717520        |
| 12     | Iregun                | 489938.3     | 718947.4      |
| 13     | Bamin Gbobamingbe    | 492672.6     | 720417.6      |
| 14     | Odan Popo Afami       | 483911.8     | 717447.4      |
| 15     | Onfo                  | 483851.8     | 723747.9      |

Source: Authors field Survey 2015.

Methods used for chemical analyses

Salinity is not measured directly for this study but is derived from the conductivity measurement [24]. This is known as practical salinity. Salinity measurements based on conductivity values are unitless, but are often followed by the notation of practical salinity units (psu) [25]. Digital pH and digital conductivity meter were used to determine the pH and electrical conductivity (EC) values [26]. Residual sodium carbonate (RSC) and adjusted residuals sodium were calculated using standard equation procedures. Total dissolved solids (TDSs) were estimated by weighing the solid residue obtained by the evaporation of a measured volume of water samples to dryness [27]. TSS were measured for this study by filtering a water sample, dried, and weighed. This method is the most accurate technique for measuring total suspended solids, however it is also more difficult and time-consuming [28]. The amount of solids present in a known volume of sample was weighed to determine the Total Solid.

Statistical Analysis

The statistical analysis was done using EVIEW software package (9.0 version). All sampled data were tested for correlation analysis to determine associations among various parameters measured for Yewa River, part of Badagry Creek and between both the river and the Creek. The Pearson ‘r’ statistics analysis showed coefficient of their correlation and their significance. Correlation coefficient is a common tool used to assess the relationship between two variables and how well one predicts the other [29].

Results

The result presented here was as a result of the test carried out from the Laboratory as well as the Pearson correlation coefficient analysis. The mean, minimum and maximum values obtained for the estimates of the Laboratory test for pH are 5.87, 5.35, and 6.21 across Yewa and 4.72, 3.8, and 5.8 across Badagry Creek, for Salinity are (0.499, 0.34, and 0.65)psu across Yewa and (0.46, 0.28 and 0.29)psu across Badagry Creek, for EC are (970.40, 520, and 1270)µs/cm across Yewa River and (961, 678, and 1574)µs/cm across Badagry Creek, for TDS are (955.60, 920, and 1896)mg/l across Yewa River and (982.62, 625, and 14896)mg/l across Badagry Creek, for TDS are (982.62, 625, and 1896)mg/l across part of Badagry Creek and (970.40, 520, and 1270)µs/cm across part of Badagry Creek, for TS are (485.20, 260, and 635)mg/l across Yewa River and (480.5, 339, and 787)mg/l across Badagry Creek, for Salinity value were between 0.65 and 0.28 and 0.29)psu across Badagry Creek, for EC are (970.40, 520, and 1270)µs/cm across part of Badagry Creek, for TDS are (955.60, 920, and 1896)mg/l across Yewa River and (982.62, 625, and 1896)mg/l across Badagry Creek, for TS are (485.20, 260, and 635)mg/l across Yewa River and (480.5, 339, and 787)mg/l across Badagry Creek, for Salinity value were between 0.65 and 0.28 and 0.29)psu across Badagry Creek, for EC are (970.40, 520, and 1270)µs/cm across part of Badagry Creek, for TDS are (955.60, 920, and 1896)mg/l across Yewa River and (982.62, 625, and 1896)mg/l across Badagry Creek, for TS are (485.20, 260, and 635)mg/l across Yewa River and (480.5, 339, and 787)mg/l across Badagry Creek, for Salinity value were between 0.65 and 0.28 and 0.29)psu across Badagry Creek, for EC are (970.40, 520, and 1270)µs/cm across part of Badagry Creek, for TDS are (955.60, 920, and 1896)mg/l across Yewa River and (982.62, 625, and 1896)mg/l across Badagry Creek, for TS are (485.20, 260, and 635)mg/l across Yewa River and (480.5, 339, and 787)mg/l across Badagry Creek, for Salinity value were between 0.65 and 0.28 and 0.29)psu across Badagry Creek, for EC are (970.40, 520, and 1270)µs/cm across part of Badagry Creek, for TDS are (955.60, 920, and 1896)mg/l across Yewa River and (982.62, 625, and 1896)mg/l across Badagry Creek, for TS are (485.20, 260, and 635)mg/l across Yewa River and (480.5, 339, and 787)mg/l across Badagry Creek.

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River and (678 and 1574) µs/cm across Badagry Creek, TDS value were between (260 and 635)mg/l across Yewa River and (339 and 787)mg/l across Badagry Creek, TS value ranged between (876 and 1115)mg/l across Yewa River and (153 and 1109)mg/l across Badagry Creek (Table 4). The percentage of pH ranged between (6-7)%, Salinity were between (5-9)%, EC (3-9)%, TDS (3-9)%, TS (6-8)% and TSS (5-12)% across Yewa River and percentage of pH ranged between (5-8)%, Salinity (4-11)%, EC (5-11)%, TDS (5-11)%, TS (4-13)% and TSS (2-15)%. (Table 5-7) showed the result of the Pearson correlation coefficient analysis carried out on all samples. pH showed a positive and strong significant relationship with EC (r = .543), Salinity with EC and pH (r = .513, .826) TDS with EC and pH, and Salinity (r = 1.000, .543 and .513) TS showed weak relationship with EC, pH, Salinity and TDS (r = .054, .037, .086 and .054) and not significant, with TSS with positive and strong significant relationship with TS (r = .671) and negative with no relationship with EC, pH, Salinity and TDS (r = -.704, -.376, -.320 and - .704) across Yewa River and across Badagry Creek. pH showed a positive and no significant correlation with EC (r = .050) , Salinity with positive and strong correlation with EC (r = .796) and pH (r = .218) which showed a weak correlation, Salinity showed positive and strong relationship with EC (r = .796) and positive but weak correlation with Ph (r = .218), TDS showed positive and strong relationship with EC and Salinity (r = .999,.796) and with positive but weak correlation with pH (r = .050), TS showed a positive and strong correlation with EC, Salinity and TDS (r = .708, .575 and .708) and positive and weak correlation with pH. TSS showed a positive and strong correlation with TS (r = .911) and weak correlation with EC, pH, Salinity and TDS across part of Badagry Creek. Also, TS in Badagry showed positive and strong correlation with TS in Yewa (r = .530) (Table 5-7). (Figure 3) presents the percentage (%) for each sample, (Figure 4) presents trend across both the River and Creek, (Figure 5) presents parameter variation to a total in 3D across category for both the River and Creek, (Figure 6) shows Bar graph of Yewa and part of Badagry Creek and (Figure 7 & 8) presents the quantiles scatter plot for both the River and the Creek which showed how the correlation relates to the strength of the linear association. Therefore, it can be perceived from the scatter plot that the points are reasonably closely scattered about an underlying straight lines as opposed to a curves, so it can be said that there is a strong linear relationship between the parameter. The scattered plot showed that as the quantiles of normal increases so the quantiles of the parameter increases.

Table 4: Salinity variation across yewa and part of badagry creek and their concentration in percentages (%).

| Sample Location/ Station Name | Sample | PH  | Salinity(‰) | Conductivity EC(µs/cm) | (ds/m) | TDS(mg/L) | TS(mg/L) | TSS(mg/L) |
|-------------------------------|--------|-----|-------------|------------------------|--------|-----------|----------|----------|
| Agbonyedo Aghajedo            | 1      | 6.2 (7%) | 0.65 (9%)  | 926 (6%) | 0.926 | 463 (6%) | 965 (7%) | 502 (7%) |
| Stat Isaru                   | 2      | 6.1 (7%)  | 0.54 (7%)  | 1270 (9%) | 1.27  | 635 (9%) | 1115 (8%) | 480 (7%)  |
| Itire Itere                   | 3      | 5.5 (6%)  | 0.38 (5%)  | 520 (3%)  | 0.52  | 260 (3%) | 1075 (8%) | 815 (12%) |
| Seje                         | 4      | 5.7 (6%)  | 0.46 (6%)  | 982 (7%)  | 0.982 | 491 (7%) | 946 (7%)  | 455 (6%)  |
| Ipokia                       | 5      | 5.8 (7%)  | 0.48 (6%)  | 974 (7%)  | 0.974 | 487 (7%) | 920 (6%)  | 433 (6%)  |
| Kararemunao                  | 6      | 6.21 (7%) | 0.62 (8%)  | 1123 (8%) | 1.123 | 561.5 (8%) | 1033 (7%)| 471.5 (7%) |
| Itohun                       | 7      | 5.64 (6%) | 0.45 (6%)  | 962 (6%)  | 0.962 | 481 (6%) | 1072 (8%) | 591 (8%)  |
| Iyafin Isalu                 | 8      | 5.35 (6%) | 0.34 (5%)  | 938 (6%)  | 0.938 | 469 (6%) | 885 (6%)  | 416 (6%)  |
| Between Itohun and Iyafin Isalu | 9      | 6.18 (7%) | 0.57 (8%)  | 1165 (8%) | 1.165 | 582.5 (8%) | 923 (7%)  | 340.5 (5%) |
| Igbo-Fipe                    | 10     | 6.15 (7%) | 0.47 (6%)  | 856 (6%)  | 0.856 | 428 (6%) | 876 (6%)  | 448 (6%)  |
| Igoro                        | 11     | 5.90 (7%) | 0.52 (7%)  | 978 (7%)  | 0.978 | 489 (7%) | 889 (6%)  | 400 (6%)  |
| Iregon                       | 12     | 5.60 (6%) | 0.51 (7%)  | 899 (6%)  | 0.899 | 449.5 (6%) | 906 (6%)  | 456.5 (6%) |
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#### Salinity Variation of Part of Badagry Creek

| Location                        | Mean Salinity | Standard Deviation | Minimum | Maximum | WHO Standard
|---------------------------------|---------------|--------------------|---------|---------|---------------|
|                                 | 5.87          | 0.499              | 970.4   | 1270    | 918 (6%)      |
| **Minimum**                     | 5.35          | 0.34               | 520     | 1.27    | 470.4 (7%)    |
| **Maximum**                     | 6.21          | 0.65               | 1270    | 635     | 340.5 (6%)    |

Source: Authors computation.

Note: To convert from µS/cm to dS/m, divide by 1000. To approximately convert from µS/cm to mg/l, multiply by 0.5.
Table 5: Pearson Correlation matrix of parameter studied for Yewa.

| Parameters | Conductivity (µs/cm) | pH | Salinity(‰) | TDS (mg/l) | TS (mg/l) | TSS (mg/l) |
|------------|----------------------|----|-------------|------------|-----------|------------|
| Conductivity EC | 1 | | | | | |
| pH | 0.543** | 1 | | | | |
| Salinity | 0.513*** | 0.826* | 1 | | | |
| TDS | 1.000* | 0.543** | 0.513*** | 1 | | |
| TS | 0.054 | 0.037 | 0.086 | 0.054 | 1 | |
| TSS | -0.704 | -0.376 | -0.32 | -0.704 | 0.671* | 1 |

*, ** and *** represent 1% (0.01), 5% (0.05) and 10% (0.1) levels of significance respectively for 2 tailed Test
Source: Authors Computation.

Table 6: Pearson Correlation matrix of parameter studied for part of Badagry Creek.

| Parameters | Conductivity (µs/cm) | pH | Salinity (psu) | TDS (mg/l) | TS (mg/l) | TSS (mg/l) |
|------------|----------------------|----|---------------|------------|-----------|------------|
| Conductivity EC | 1 | | | | | |
| pH | 0.05 | 1 | | | | |
| Salinity | 0.796* | 0.218 | 1 | | | |
| TDS | 0.999* | 0.05 | 0.796* | 1 | | |
| TS | 0.708* | 0.176 | 0.575* | 0.708* | 1 | |
| TSS | 0.362 | 0.245 | 0.331 | 0.362 | 0.911* | 1 |

*represents 1% (0.01) level of significance for 2 tailed test;
Source: Authors Computation.

Table 7: Pearson Correlation matrix of the same parameter between Yewa River and Part of Badagry Creek.

| Parameters | EC (Y) | EC (B) | pH (B) | pH (Y) | Salinity(B) | Salinity (Y) | TDS (B) | TDS (Y) | TS (B) | TS (Y) | TSS (B) | TSS (Y) |
|------------|--------|--------|--------|--------|-------------|-------------|---------|---------|--------|--------|--------|--------|
| EC (Y) | 1 | | | | | | | | | | | |
| EC (B) | 0.167 | 1 | | | | | | | | | | |
| pH (B) | 0.339 | 0.05 | 1 | | | | | | | | | |
| pH (Y) | 0.543 | -0.238 | -0.044 | 1 | | | | | | | | |
| Salinity (B) | 0.211 | 0.796 | 0.218 | -0.196 | 1 | | | | | | | |
| Salinity (Y) | 0.512 | -0.471 | -0.103 | 0.826 | -0.282 | 1 | | | | | | |
| TDS (B) | 0.999 | 0.167 | 0.339 | 0.543 | 0.211 | 0.512 | 1 | | | | | |
| TDS (Y) | 0.167 | 0.999 | 0.05 | -0.238 | 0.796 | -0.471 | 0.167 | 1 | | | | |
| TS (B) | 0.054 | 0.268 | 0.172 | 0.037 | 0.263 | 0.085 | 0.054 | 0.268 | 1 | | | |
| TS (Y) | 0.400 | 0.708 | 0.176 | 0.045 | 0.575 | 0.016 | 0.400 | 0.708 | 0.530** | 1 | | |
| TSS (B) | 0.429 | 0.362 | 0.245 | 0.199 | 0.331 | 0.287 | 0.429 | 0.362 | 0.565 | 0.911 | 0.083 | 1 |
| TSS (Y) | -0.704 | 0.067 | -0.129 | -0.376 | 0.030 | -0.320 | -0.704 | 0.067 | 0.671 | 0.079 | 1 | |

*represents 5% (0.05) level of significance for 2 tailed test;
Y: Yewa; B: Badagry.
Source: Authors Computation.
Discussion of Results

The physical and chemical analysis on water samples across Yewa River and Part of Badagry Creek has been assessed based on pH, Salinity, EC, TDS, TS and TSS. Moreover, the average pH of 6.21 and 5.8 were recorded across Yewa River and part of Badagry Creek which are below WHO Standard limit of 6.5 - 6.8 and this is compatible with results obtained by [30] and usually indicate good water quality and this range is typical of most drainage basins of the world [31]. It can then be said that Yewa River and Badagry Creek is a source of portable drinking water.

It also shows that the impact of salt intrusion from the Atlantic Ocean into the Lagoon is minimum at the Yewa River and as well as Badagry creek. Only on Three (4) sampling points 2, 6, 9 and 13 with high EC (1270, 1123, 1165 and 1006)µs/cm across Yewa River and sampling points 2, 3, 8 and 11 with EC (1574, 1061, 1398 and 1021)µs/cm across Badagry Creek and the amount by which EC rises depends on increase in temperature [32]. Also, with high TDS (635, 561.5, 582.5 and 503)mg/l across Yewa and (737, 530.5, 699 510.5)mg/l across Badagry Creek and these high in TDS value can be attributed to the presence of salt and metals that occurred naturally and also can be as a result of domestic
human beings from diseases like typhoid and diseases. There is need for Lagos State water boards to carry out research to study the rate of salt intrusion from the Atlantic into the Lagos state inland water ways as a quick measure to ensuring sustainable availability of portable drinking water to the citizenry. Further studies on the River and Creek with reference to microbial and chemical analyses will give detailed information on the water quality.

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Conflict of Interest

None.

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