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# Physico-Chemical and Heavy Metal Content of Tidal-Polluted Creek, Ijora, Lagos, Nigeria

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***Abstract***

*To assess the water pollution within Ijora Creek situated in Lagos, Nigeria, the physico-chemical parameters and total concentrations of four (4) heavy metals: lead (Pb), Copper (Cu), Management (Mn) and Nickel (Ni) were determined in the surface water of the Creek using standard methods. Water samples were collected for a period of three (3) consecutive months bi-weekly from two sampling locations within the Creek at high tide. The ranges of the parameters measured were as follows: temperature (30.5 – 34$^0$C), turbidity (3.0 – 99.0NTU), Nitrate (26 – 63.5mg/L), Phosphate (7.0 – 24.6mg/L) Sulphate (12.0 – 49.0mg/L), Dissolved Oxygen (1.2 – 4.2mg/L) Chemical Oxygen Demand (4.5 – 840mg/L), Biochemical Oxygen Demand (4.0 – 460mg/L). Concentrations of Heavy metals in water samples were: Lead (Pb) (0.3 – 7.2mg/L), Copper (Cu) (1.07 – 12.72mg/L,) and Manganese (Mn) (0.14 – 4.10mg/L). The high level of heavy metals reflected the impact of domestic and industrial wastes on the creek. The level of organic pollution were suspected to have arisen due to daily human activities around the creek as observed and this will not only threaten the aquatic life of the Creek but will also affect the aesthetic beauty of Ijora Creek and environs.*

***Keywords:*** *Polluted water, Physico-chemical Parameters, Heavy metals and Creek.*

## Introduction

Water has been described as one of the most important compounds of the biosphere which encompasses all ecosystems. According to Richman (1997), water pollution occurs when a body of water is adversely affected due to addition to large amount of toxic materials to the water, which makes it is unfit for its intended use, water is considered polluted.

Many causes of pollution including sewage and fertilizers contain nutrients such as Nitrates and Phosphates. When in excess levels, nutrient stimulate the growth of aquatic plants and algae (Poppe *et al*, 1997). The discharge of heavy metals into aquatic ecosystem has become a matter of concern. These pollutants are introduced into aquatic systems significantly as a result of various industrial and domestic operations which may contain elements such as: lead, chromium, mercury, uranium, selenium, zinc, arsenic, cadmium, gold, silver, copper and nickel. These toxic materials can be derived from mining operations, refining, ores, sludge disposal, fly ash from incinerators, the processing of radioactive materials, metal plotting, or the manufacture of electrical equipment, points alloys, dry and wet cells, pesticides or preservatives (Trivedi 1989).

In Africa, most industrial developments occur along the littoral zone of aquatic ecosystem. Numerous ecosystems are threatened with heavy metal pollution from mining and petrochemical industries (Oyewo 1998, Chukwu, 2006b). Nigeria as a developing nation and Lagos metropolis which is located along the coastal region is experiencing rapid industrial growth. Rapid growth in population and massive industrialization in recent years have resulted in pollution of the biosphere; a situation which pose major hazard and human health problems worldwide (Uttinger, 2005).

The rapid urbanization and industrialization of cities and improper environmental planning has resulted in the discharge of sewage and industrial wastes, thereby affecting the physico-chemical properties of water. The importance of physico-chemical studies cannot be overemphasized as it helps to get vital information about the quality of water bodies. In doing this, values of different physico-chemical parameters obtained are compared with standard values. Patil *et al*., 2012 in their review, indicated the necessity of taking detailed measurements about different physico-chemical parameters such as colour, temperature acidity,

hardness, pH, Sulphate, Chloride, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), alkalinity used for testing of water quality. Heavy metals such as Pb, Cr, Fe, Hg etc are of special concern because they tend to cause poisoning in water bodies and hence, aquatic animals.

Lagos metropolis which is situated along the coastal line has become an important city in Nigerian because of the harbor and commercial activities available around it. The Ijora Creek is one of the major creeks in Lagos adjoining the Lagos harbour. There are various existing industries, homes and industrial estates in the region, which generate both industrial and domestic wastes.

Several Nigerian workers have investigated the physico-chemical analyses of water bodies in Creeks. Akintola *et al* (2011) carried out study of some physio-chemical characteristics of Badagry Creek, Nigeria, and they revealed that variations in the water quality of the Creek are largely influenced by seasonal changes and various intrusions from the ocean at different levels. Saliu *et al* (2006) in their preliminary chemical and Biological Assessment of Ogbe Creek, Lagos, recorded the hydrochemistry of the Creek as being strongly influenced by seasonal flood. The surface water of the Creek was characterized by high total dissolved solids, Biological, alkalinity and low values of Dissolved Oxygen. Similarly, Hill and Webb (1958), Olaniyan (1975) and Nwankwo (2004) implicated two physiographic factors namely, rainfall and salinity as determining factors of the hydro-climate of coastal lagoons in South-Western Nigeria. Major ecological parameters (physico-chemical parameters) of the Ijora creek water body have not been documented in literature before now. Therefore, this work aimed at determining the level of pollution in Ijora creek so as to establish its level of suitability for agricultural and various other purposes.

## Materials and Methods

### *The Study Area*

The study area is Ijora Creek in Lagos; (figure 1) The Creek is located at the Central Business District of the Lagos Metropolis. The Creek is located at the Upper part of Lagos harbor, which is open all year round to the sea (Onyema 2007). The Creek is shallow and experiences semi-diurnal tidal oscillations (Olaniyan 1975, Onyema 2007). It is situated very close to the National Theater Iganmu and is surrounded by a number of industries. Among them are: Nigerian Breweries, Igunmu, Apex Paper Mill, Nigerian Flour Mills Apapa. Some of the oil marketers have their Oil Depots very close to the Creek. Similarly there are artisans such as battery chargers auto-mechanics, panel beaters and motor mechanics. All the above mentioned industries discharge their effluent into Ijora Creek. The effluent discharged from these sources are either treated or not treated. The Creek is polluted through deposition of atmospheric particulates. Hence, the transfer of air-borne particles of the water surfaces by dry deposition constitutes the first stage of accumulation of atmospheric heavy metals.

Furthermore, during the rainy season, especially when the rainfall of high intensity for a longer duration, larger volume of water enter the Creek carrying all kinds of toxic chemicals, oils and grease, heavy metals from motor vehicles, animal wastes and sewage. The pollution is significant in the Creek where large areas of paved surface result in increase run-off from roads, industrial sites and residential areas. The Creek has a characteristic main feature of being linked to the Lagos harbour. At high tide water from the Atlantic Ocean flows through the canal into the Creek. The high tides that alternates with the low tides makes the Creek to be very dynamic in nature. However, the Creek is not navigable at both High and Low tide periods. According to Onyema (2007), the flora at the creek include, *Paspalum vaginatum, Paspalum orbiquilare, Philoxerus vermicularis, Typha* sp., *Marisus alteriforlus*, *Rhynchospora* sp. and few white (*Avecennia nitida*) and red mangroves (*Rhizophora* racemosa). The fauna of the creek include *PeripthalamusBalanus pallidus, Chthamalus* and *Gryphea gasar* (Onyema, 2007).


**Fig. 1:** Part of Lagos showing Ijora creek and the sampling site

*Collection of water samples*

Samples for the physico-chemical parameters were collected in 2-litre (screw capped) plastic bottles that have been previously soaked in 10% nitric acid for 48 hours, and rinsed with distilled water. The containers were rinsed three times each with the water sample before samples of water were collected from principally two locations 3-4km apart. Water samples were collected at high tide bi-weekly for three consecutive months (Feb–April, 2012). All samples were filtered with cellulose acetate filter and were transported to the Laboratory where they were stored in the refrigerator at a preset temperature of $4^0$C prior to analysis.

*Physico-chemical analyses of water*

Analyses were carried out on the water samples for such parameters such as, Temperature, Turbidity, Total Soluble Solids (TSS), Total Dissolved Solids (TDS), pH, Alkalinity, Salinity, Nitrate, Phosphate, Sulphate, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen using standard method prescribed by APHA (1995) and ASTM (2003). Reagents produced by AnalaR (BDH, England) were used for the various analyses and also, distilled water was used for the preparation of the solutions. The visual appearance, colour and odour of water samples from the creek were also recorded.

*Digestion of water samples for heavy metal determination*

A 50ml of water sample from each sampling point was taken into Teflon beaker and 5ml of concentrated Nitric acid was added. This was boiled gently on a hot plate in a fume cupboard for about 45 minutes. The digested samples were transferred into a 25ml volumetric flask and diluted to mark with distilled water. The digest was taken for heavy metal analyses using Atomic Absorption Spectrophotometer (AAS).

**Results**

The physico-chemical parameter of water samples at Ijora Creek in the Lagos metropolis during the study period are presented in Table 1.

**Table 1:** Mean Physico-chemical Parameters of water in Ijora Creek

| Parameters | Mean value | | FME/ LASEPA LIMIT |
|---|---|---|---|
| | A | B | |
| Air Temp. ($^0$C) | 34.08±0.74 | 32.42±0.80 | <35$^0$C |
| Water Temp ($^0$C) | 31.83±1.25 | 0.6871±0.003 | 25-35$^0$C |
| TDS (mg/L) | 19060.00±3543.11 | 2465.00±1110.87 | 2000.00 mg/l |
| TSS (mg/L) | 24.92±14.57 | 0.00±0.00 | 30mg/l NTU:10 |
| Appearance | Clear | Clear | |
| Colour | Colour-less | Colour-less | |
| Odour | Odou-rless | Odour-less | |
| Turbidity (FTU) | 20.83±38.84 | 3.45±0.4637 | 30mg/l, NTU 10 |
| Alkalinity | 250.00±132.66 | 126.67±7.53 | |
| Salinity | 23.50±5.16 | 30.72±1.21 | NS |
| pH | 7.21±0.24 | 7.60±0.25 | 6-8 |
| Nitrate ($NO_3$) (mg/L) | 48.93±16.16 | 46.83±4.17 | 10.00mg/l |
| Phosphate ($PO_4$) (mg/L) | 16.15±6.28 | 13.03±.90 | 5.00mg/l |
| Sulphate ($SO_4$) (mg/L) | | | 1.00mg/l |
| Oil and Grease ((mg/L)) | 6.80±8.45 | 0.34±0.48 | 10.00mg/l |
| DO (mg/L) | 2.82±1.38 | 3.82±0.51 | >5mg/l |
| COD (mg/L) | 386.67±418.11 | 5.58±2.60 | 200mg/l |
| BOD (mg/L) | 208.67±223.36 | 5.68±1.65 | 50mg/l |

Data collected in replicates of 6 as mean±standard deviation

**Table 2:** Selected Heavy Metal content of water in Ijora creek

| Parameters | Mean Value | | FME/ LASEPA LIMIT |
|---|---|---|---|
| | A | B | |
| Pb (mg/L) | 3.09±2.72 | 0.37±6.06E-02 | <1.00mg/l |
| Ni (mg/L) | 0.44±.37 | 0.00±0.00 | NS |
| Cu (mg/L) | 8.37±3.49 | 1.59±.38 | <1.00mg/l |
| Mn (mg/L) | 2.05±1.77 | 0.51±8.05E-02 | <1.00mg/l |

Data collected in replicates of 6 as mean±standard deviation

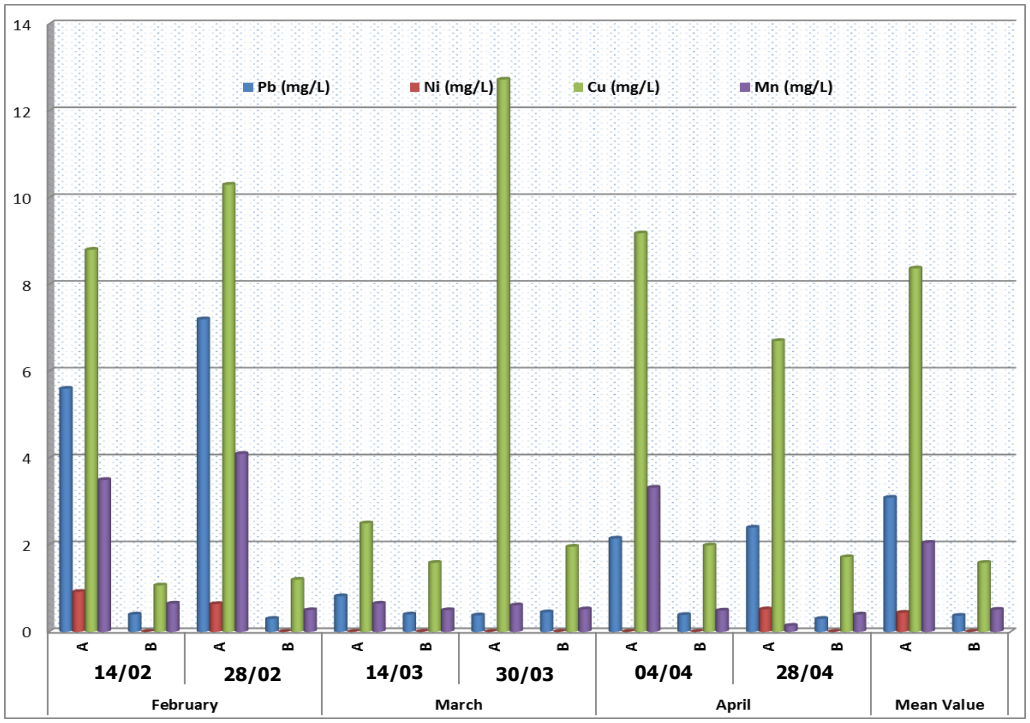


**Fig. 2:** Heavy metal levels at the Ijora creek as compared to mean values

**Discussion and Conclusion**

The air temperature ranged between 33.5 and 35°C at station A. The mean value at station A was 34.08°C. Station B temperature ranged between 32°C and 34°C with a mean value of 32.42°C. The highest air temperature was recorded in station A in the month of March (35°C) (Table 1). The highest turbidity value recorded was in the month of April at station A as 99mg/L. The mean value of turbidity in stations A and B were 20.88mg/L and 3.45mg/L respectively. The statistical t-test analysis revealed that there was no significant difference between the values obtained from the two stations (P>0.05). The range recorded for total suspended solids (TSS) in station A was between 10.0 mg/l and 48.0mg/l. Recorded values of total suspended solids were the highest in February and lowest in March. No TSS values were recorded for station B. The t-test analysis conducted showed a significant difference between the values of suspended solids in the two stations. The Total Dissolved Solids (TDS) values at the two stations ranged between 200 to 24,100mg/L. The highest TDS was recorded in station A in the month of April. The lowest TDS 200mg/L was recorded in February in station B. The mean values of TDS were 19060.0 and 2465.0mg/L between station A and B respectively.

The pH values obtained generally showed alkalinity of the water samples, ranging from 6.8 in station A to 7.8 in station B. Salinity was lowest in station A (16.2%o) while the highest value (of 32.5%) was recorded in station B for April. The mean values of Salinity at station A was 23.50% while station B showed a mean value of 30.7167%o. There was a significant difference between the readings from the two stations. Alkalinity values ranged, between 110 and 420mg/l with mean values of 250.0 and 126.67mg/L at both stations A and B respectively. T-test analysis of the two stations showed significant differences for both stations. The Dissolved oxygen concentration of the samples ranged between 1.2 and 4.6mg/L. The highest value of DO was recorded in April (from station A) and the lowest was also recorded in station A (in February). There was no significant difference in levels of dissolved oxygen between stations A and B. The Chemical Oxygen Demand values ranged between 5mg/L in April and 840mg/L in February.

In station A, values obtained were generally above Lagos State Environmental Protection Agency (LASEPA) limits, having a mean value of 386.67mg/L. Chemical Oxygen Demand values in station B were generally low. The ranges recorded in station B were 3.0rng/L to 9.5mg/L in February. Mean values of 386.6667mg/L were recorded in station A and 5.5833mg/L were recorded in B. There was significant difference in values for both station as revealed by a t-test statistical analysis. The Biological Oxygen Demand values ranged from a maximum of 4 and 450 mg/L. Biological oxygen Demand values, in station B were generally low. The mean values for Biological Oxygen Demand water samples were 298.6667mg/L in station A and 5.6833mg/L in station B. t-test analysis showed a non-significant difference in the two stations. The values were highest in; April with a value of 63.5mg/L in station A and the lowest value of 26.0m^/L were recorded in March in station A

The mean values of nitrate recorded at station A and B were 48.9333mg/L and 46.8333mg/L respectively. The t-test analysis showed that there was no significant

difference in the value for the two stations. The measurement lot $PO_4$ in water samples ranged between 7mg/L and 24.6mg/L in station A and 12.0mg/L and 14.0mg/L. Generally the values of the phosphate variation of the water Creek exceeds the LASEPA limits. Phosphate revealed mean value of 161500 in station A and 13.033 in station B. The t-test analysis showed no significant difference in values from both stations. The values for sulphate ranged between 41.0 and 47.5mg/L. The mean values of sulphate in the water sample showed mean values of 29.3333mg/L in station A and 44.1167mg/L in station B. The t-test analysis showed no significant difference in stations A and B. The highest value for oil and grease was obtained in February in station A (19mg/L). Oil and grease in station B ranged between 0.0lmg/L in April and 1.02mg/L in the month of February . Oil and Grease values had mean values of 6.8000mg/L in station A and 0.333mg/L in station. The t-test analysis showed no significant difference between values for station A and station B.

Variations in the levels of selected heavy metals (Pb, Ni, Cu, and Mn) in Ijora Creek between the months of February to April of two stations are shown in Table 2 and Fig. 2. Pb estimates ranged between 0.38 and 7.2mg/L in station A. The highest value of 7.2mg/L was recorded in February and the lowest value recorded was recorded in March (0.38mg/L). In station B the range was between 0.30 and 0.45mg/L. The lowest value was in station B (0.30mg/L) obtained in April while the highest value recorded was 0.45mg/L and recorded in March. Man values for lead in water were 3.0917mg/L and 0.3733mg/L in both stations. The t-test value showed a significant difference in the two stations. Nickel values ranged between 0.52 and 0.92mg/L in station A. The highest value of 0.92mg/L was recorded in February while the lowest value of 0.52mg/L was recorded in April. Nickel was not detected in station A in water sample in March, In station B, Nickel was not detected in the samples of water.

Mean values for Nickel in water samples were 0.4383 in station A, and 0 (zero) in station B. The t-test analysis gave a significant difference in the two stations. In station A copper levels ranged between 2.5 and 10.3mg/L. The lowest value of 2.5mg/L occurred in March and the highest value 10.3mg/L was recorded in March. In station B the levels of copper ranged between 1.07 and 1.99mg/L and recorded in April while the lowest value 1.07 mg/L was recorded in February. The mean value of 8.37 mg/L for station A and mean value of I.59mg/L in station B.

Mean values of Copper in station A was 8.3667 and 1.5883 in station B. There was significant difference in the two stations. The manganese values in station A ranged between 0.14 and 4.1mg/L. The highest value of 4.1mg/L was recorded in February and the lowest value 0.14 mg/L was recorded in April. The Manganese values in station B ranged between -0.40 and 0.65/mg/L. The lowest value 0.40mg/L was obtained in April, while the highest value 0.65mg/L was recorded in February. The Manganese mean values in stations A and B were 2.0533 and 0.5100 respectively. The t-test analysis showed no significant difference in stations A and B.

Air temperatures at both sides were high throughout the period of study (32 – $35^0$C). This probably is a reflection of the fact that the region is located within the tropics. The appearance, colour, odour at the site especially Station A clearly points to high levels of pollution. The level of putrescent odour observed at the site clearly points to high levels of biodegradable matter and microbial activities. The salinity of the sites showed that the area is a marine environment. Salinity and total values showed a positive relationship and were high. This is similar to findings by Ajao (1996).

The pH of the site was alkaline for most sampled period and could also point to the influence of bicarbonate rich water of the sea to which the site is exposed (Oyenekan, 1988). Additionally high levels of Phosphates, nitrates, and sulphate also point to the Ijora Creek as a sink for the disposal of wastes water from a number of industries from the area. The very high levels of chemical and biological oxygen demands recorded at one time or the other also clearly points to high level of pollution to which the area is exposed (Nwankwo, 2004). Low levels of dissolved oxygen also signify stress in the Creek for life forms. The high levels of heavy metal species are a reflection of pollution from industrial wastes waters (Nwankwo, 2004; Chukwu, 2006b).

The pH of the Creek environment under study was about 7. This confirms the findings of Ansari *et. al*. (2004). In their study they found that solubility of heavy metal pollutants in seawater is controlled by several factors such as pH, temperature, salinity and nature of anions. The authors also found that heavy metal pollutants introduced into the marine environment ultimately settle on to the seabed. The Soluble metal cations are precipitated by the anions such as sulphate bicarbonate and carbonates in sea water.

In conclusion, the results from this study goes to show that human activities around Ijora creek in the Lagos metropolis has inevitably increased the levels of heavy metals contamination of the Creek. Over the years, industrial effluent discharge from pesticides, paints, leather, textile, fertilizer, pharmaceutical, domestic effluent, agricultural run-off from the highly industrialized and populated region have contributed to the heavy metal load in the Creek. Earlier studies carried out by Oyewo (1998), Chukwu (2006a) and Oyewo and Don-Pedro (2003) have implicated coastal waters of South Western Nigeria as waste dump sites. The results from the study have revealed that the Ijora Creek is significantly polluted and this may affect the lives which directly or indirectly depend on this source of water.

**References**

[1]. Ajao, E.A. (1996). Review of the State of Pollution of the Lagos Lagoon. *NIOMR Tech.* 106: 19

[2]. Akintola, S.L. Anetekhai, M.A. and Lawson, E.O. (2011). Some Physico-Chemical characteristics of Badagry Creek, Nigeria. *West African Journal of Applied* Ecology 18: 95 – 107.

[3]. Ansari T.M., Marr, I.L. and Tariq, N. (2004). Heavy metals in Marine Pollution Perspective – A Mini Review. *Journal of Applied Sciences* 4(1): 1-20.

[4]. APHA, (1995). Standard Methods of Examination of Water and Wastewater, 20th Edition, American Public Health Association D.C.

[5]. ASTM International (2003). Annual Book of ASTM Standards. Water and Environmental Technology V. 11.01, West Conshohocken, Pennsylvania pp. 6-7.

[6]. Chukwu, L.O (2006a). Physico-chemical characteristics of Pollutant load of treated industrial effluents in Lagos metropolis. *Journal of Industrial Pollution Control* 22(1): 147 – 153

[7]. Chukwu, L.O. (2006b). The Impact of Industrial Effluents on the Water Chemistry of an Urban River in Southern Nigeria. *Ekologia* 5(1): 8-16.

[8]. Don-Pedro, K.N. Oyewo, E.O. and Otitoloju, A.A. (2009). Trend of Heavy Metal Concentration in Lagos Lagoon Ecosystem, Nigeria. *West African Journal of Applied Ecology*, 5: 103 – 114

[9]. Hill, M.B. Webb, J.E. (1958). The Ecology of Lagos Lagoon II. The Topography and Physical Features of Lagos Harbour and Lagos Lagoon. *Phil Trans R. Soc. Lond.* 241(B): 317 – 417.

[10]. Kodarkar, M.S. (1992). Methodology for Water Analysis, Physico-Chemical. Biological and Microbiological Indian Association of Aquatic Biologist Hyderabad Pub 2: pp 50.

[11]. Nwankwo, D.I. (2004). Studies on the Environmental Preference of Blue-green algae (cyanophyta) in Nigeria Coastal Waters. *The Nigeria Environmental Society Journal*. 2(1): 44 – 51.

[12]. Olaniyan, C.I.O (1975). An introduction to West African Ecology. Hienemann Education Books Ltd London 170 pp.

[13]. Onyema I.C. (2007). The Phytoplankton Composition, Abundance and Temporal Variation of a Polluted Estuarine Creek in Lagos Nigeria. *Turkish Journal of Fisheries and Aquatic Sciences* 7: 89 – 96.

[14]. Oyenekan J.A. (1988). Benthic macrofauna Communities of Lagos Lagoon, Nigeria. *Nig J. Sci* 21: 45-51.

[15]. Oyewo, E.O. (1998). Industrial Sources and Distribution of Heavy Metals in Lagos Lagoon and their Biological Effects on Estuarine Animals. Ph.D. Thesis. University of Lagos 274 pp.

[16]. Oyewo, E.O. and Don Pedro, K.N. (2003). Influence of Salinity Variability in Heavy Metal toxicity of those tropical estuarine organisms. J. Nig. Environ Soc. 1(2): 145 – 155.

[17]. Patil, P.N. Sawant D.V, Deshmukh R.N (2012). Physico-Chemical Parameters for Testing of Water – A review. *International Journal of Environmental Sciences* 3(3): 1194-1207.

[18]. Poppe, W. and Hurst, R. (1997): Water Pollution. *Water Qual Int.* pp 39 – 43

[19]. Richman M. (1997). IND Water Pollution, *Wastewater* 5(2): 24-29.

[20]. Saliu, J.K. and Ekpo M.P. (2006): Preliminary Chemical and Biological Assessment of Ogbe Creek, Lagos, Nigeria. *West African Journal of Applied Ecology* (WAJAE) 9: 22. www.wajae.org.

[21]. Trivedi, R.K. (1989): Pollution Management Industries, Environmental Publication Karad.