ISSN: 2456-8473
International Journal of Chemistry, Pharmacy & Technology
Vol. 2, No.4, pp-169-177, 2017

TEMPORAL FLUXES IN THE PHYSICO-CHEMICAL PROPERTIES OF SOMBREIRO RIVER, SOUTHERN NIGERIA

[1*]O.A.F. Wokoma and [2]N.Umesi
[1]Department of Biology, Ignatius Ajuru University of Education, P. M. B. 5047, Rumuolumeni, Port Harcourt
[2]Dept. of Integrated Science, Federal College of Education (Technical), P. M. B. 002, Omoku, Rivers State
Corresponding Author: okoriwokoma@yahoo.com
Received 21-03-17; Revised & Accepted: 24-04-17

ABSTRACT

The quality of water is dependent on its intended use however it is influenced by Physico-chemical variables which in turn are affected by spatial and or temporal fluxes. A study was therefore carried out to determine the influence of seasonal variability on the physicochemical properties of Sombreiro River in Southern, Nigeria. Surface water samples were collected across 10 stations over a 24 – month period and analyzed in the laboratory following standard methods. The values obtained respectively for the wet and dry seasons varied from7.56±0.01–7.69±0.02 and 7.63±0.01 – 7.84±0.01 for pH, 4.52±0.07 – 5.44±0.06 and 3.69±0.12 – 5.34±0.08 for DO, 6.35±0.23 – 10.30±0.65 and 4.54±0.35 – 7.94±0.49 for BOD, 5.35±0.26 – 9.85±0.33 and 6.94±0.08 – 10.08±0.38 for THC, 8326.58±398.51 – 12338.17±546.38 and 10487.58±178.95 – 15681.33±399.83 for TDS, 8.40±0.18 – 13.95±0.82 and 6.36±0.22 – 11.12±0.28 for COD, 13687.92±546.48 – 20457.67±584.01 and 17037.58±275.67 – 30642.75±694.83 for EC, 0.28±0.02 – 0.46±0.04 and 0.31±0.03 – 2.38±0.93 for Turbidity, 372.83±13.89 – 801.42±25.68 and 565.50±26.32 – 897.83±22.09 for Sulphate, 5.25±1.01 – 7.24±0.16 and 0.52±0.09 – 3.64±0.80 for Nitrate, 0.21±0.03 – 0.50±0.02 and 0.42±0.02 – 0.74±0.02 for Phosphate and 0.018±0.0 – 0.202±0.05 and 0.024±0.0 – 0.484±0.03 for Ammonia. Two-way analysis of variance comparing the mean values obtained in both wet and dry seasons showed that there was significant difference between seasons in all the parameters investigated at $p < 0.05$, affirming that physicochemical quality of the study River is season dependent.

Keywords: seasonal variation, surface water, physico-chemical, water quality, wet season

INTRODUCTION

Water is an important natural resource that is facing pollution at the moment due to industrial /commercial activities of man as well as depletion as a result of increase in consumption by the ever growing human population [1]. This in recent years have led to increased anthropogenic impact on the aquatic systems resulting to a large extent in the deterioration of water quality and diminishing of water bodies leading to their quicker eutrophication [2]. Because aquatic organisms requires water for movement, support, feeding and for maintenance of their body functions, the physical and chemical conditions of the water can affect aquatic life directly or indirectly [3].

It has been reported by Yeng, *et al* [4], that the water quality of a river is influenced by natural processes namely, rate of precipitation, soil erosion, weathering and anthropogenic activities such as human exploitation of water resources, urban development, as well as industrial and agricultural activities, which often lead to the degradation of water quality [5].

Spatial and temporal variation determines water chemistry in rivers and streams and shows high heterogeneity at different spatial scales. Multivariate statistical techniques have been deployed in measuring spatial and temporal variations in surface water quality [6,7].

However, information on the spatial and temporal fluctuations of physicochemical parameters and how external factors such as rain, climate influences them in the study area is still lacking. This investigation is therefore designed to study the impact of season on the physicochemical parameters of the lower reaches of the Sombreiro River.

MATERIALS AND METHODS

Description of the study area

The study area- Sombreiro River is located in Rivers State in the Niger Delta region of Nigeria, and lies between Latitude 6^0 30^1 to 7^0 0^1 E and Longitude 4^0 12^1 to 6^0 17^1N [8]. It is a tidal dominated river, with possible fresh water input. The climate is classified as humid tropical of the semi hot equatorial type. The area experiences heavy rainfall from April to October with a mean rainfall estimated over 2000mm and mean annual temperature of about 29^OC [9]. Recently heavy rains tend to begin by May, and even in the dry season months of November to March, sporadic heavy downpours are not uncommon. The vegetation of the river is predominantly mangrove with *Rhizophora racemosa*, *Rhizophora mangle* Gaertin and *Rhizophora harosanii* Leechman, as the dominant species [10].

Sampling and Sampling Techniques

Prior to actual sampling, a reconnaissance survey of the stretch of River Sombreiro was carried out, during which, 10 sampling stations were established. Sampling stations were selected based on completely randomized block design to cover all the activity spots on both sides along the coastline, (see Fig. 1).

Initial sampling was carried out during the reconnaissance visit, this is with the view to master field methods, get used to the sampling stations as well as equipment's and above all eliminate likely sampling/ handling errors. Standard methods [11] were adopted for the collection of water samples which lasted for 24 months.

The geographic coordinates of the sampling stations were determined in-situ with hand- held GPS equipment – Garmin Extrex. The GPS was switched on at each station and allowed to stabilize for about 2 – 3 minutes, after which the readings were read off and recorded.

Surface water Temperature

Surface water temperature was measured in-situ using mercury -in -glass thermometer. The thermometer was tied with a rope to a floating cork and immersed in water at each Station, and reading was taken to the nearest 0.1^0C after about 2 minutes.

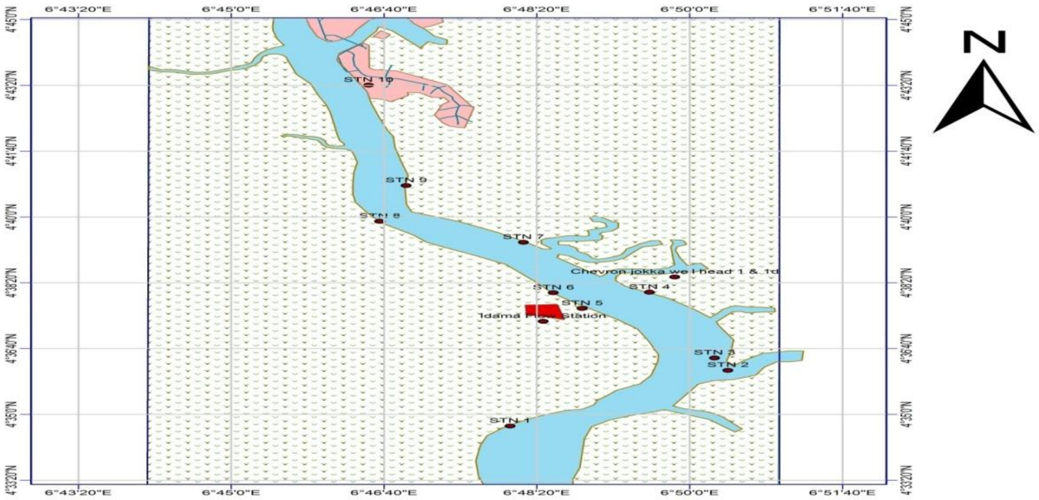

FIG 1: Map of Sombrerio River showing sampling stations

Legend
Road
River
Settlement
Flow Station
Mangrove Vegetation
stations

SCALE: 1:100,0000

Water samples for physicochemical analysis

Water samples were collected in 2 – litre plastic containers from the sub- surface (5- 10cm depth) in each Station. Two replicate samples were collected per Station and transported to the laboratory in an ice- chest container for analysis. Samples for Total Hydrocarbon Content (THC) and heavy metal analysis were collected in 1 litre glass bottle.

Water sample for Dissolved Oxygen (DO) was collected using narrow neck 250ml DO bottle, which was initially rinsed with the sample water and then dipped into the water column and allowed to fill to overflowing to remove trapped air bubbles. Samples were fixed immediately using 2ml each of prepared Winkler 1 and 2 reagents (Manganous Sulphate and Alkaline –Iodide azide), and the reagent bottles stoppered immediately so that no air is trapped in them. Those for Biochemical Oxygen Demand (BOD) were collected simultaneously using dark narrow neck 250ml DO bottles. Sample for BOD was not fixed but covered with aluminum foil and transported to the laboratory.

Laboratory Methods

Laboratory methods adopted for this study are based on the procedures prescribed by [11]. pH was determined in the laboratory using a digital sensor, Coleman pH meter, and TDS was determined by using the conductivity bridge, Lovibond µS meter type cm- 21. Horiba water checker, model 10 was used for the assessment of electrical conductivity, turbidity and salinity.

RESULTS AND DISCUSSION

Temperature fluctuations in the study area was shown to be season dependent, as dry season values were generally higher ranging from 26^{0}C to 32^{0}C than wet season values which varied from 25^{0}C to 30^{0}C. Such seasonal variations of temperature have been reported earlier [12,13,14,15].

Table 1: Two – way ANOVA comparing values of different parameters between Seasons

Source of Variation	*SS*	*Df*	*MS*	*F*	*F crit*
pH	0.52	1	0.52	148.53*	3.884
DO	2.66	1	2.66	13.82*	3.884

BOD	212.85	1	212.85	128.80*	3.884
THC	65.44	1	65.44	78.01*	3.884
TDS	3.77E+08	1	3.77E+08	175.21 *	3.884
COD	336.26	1	336.26	108.67*	3.884
EC	2.64E+09	1	2.64E+09	806.45*	3.884
TURBIDITY	6.32	1	6.32	7.91*	3.884
SULPHATE	470289.1	1	470289.07	129.93*	3.884
NITRATE	1018.75	1	1018.75	223.05*	3.884
PHOSPHATE	1.156482	1	1.156482	262.99*	3.884
AMMONIA	0.22	1	0.22	23.72*	3.884

* Sig. at $p < 0.05$

Mean pH of the study area showed significant spatial and temporal variation between the wet and dry seasons at $p < 0.05$ see Table 1. Similar variations have been reported [16,17,18,19]. Values of pH were generally higher in the dry season ranging from (7.63 – 7.84) and lower in the wet season (7.56 – 7.69), this observation is however at variance with the conclusions of [8,13]. Nevertheless, the pH of the study area is considered normal and the aquatic ecosystem said to be normal following the position of the US Public Health Association that pH balance in healthy aquatic ecosystem is maintained within the range of 5.5 - 8.5, while normal pH range is between 6 to 8.5 [20].

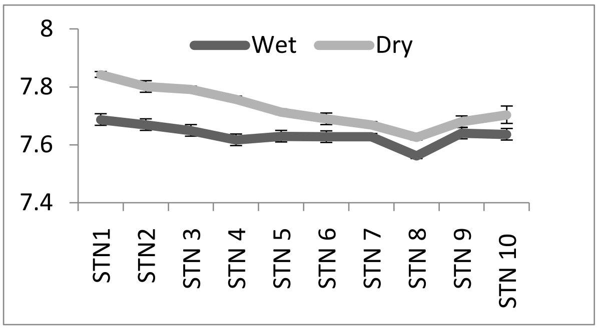

Figure 1: pH values at the Different stations

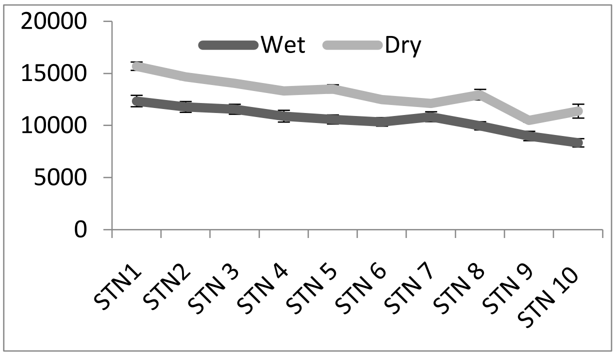

Figure 2: Total dissolved solids (mg/L)

Concentration of dissolved oxygen in the wet and dry seasons in this investigation were significantly different at $p < 0.05$, with the wet season values (4.52 – 5.44mg/l) higher than that of the dry season (3.69 – 5.34mg/l). This trend of variation is consistent with the findings of [17,21]. Nkwoji *et al.*, [22] also reported higher wet season values of DO and attributed it to flood water dilution and reduced resident time of polluted waters. On the contrary [12], reported lower wet season DO values compared to dry season values in Elechi Creek. This was attributed to flood and municipal drains depositing wastes (organic, inorganic and debris) into the estuary leading to degradation. Similarly, [23] observed high dissolved oxygen values in the dry months. However, [18] did not observe any seasonal or annual variations in the concentration of dissolved oxygen in the Okpoka Creek.

The relatively lower DO values and higher BOD_5 in the dry months may be due to elevation of water temperature in the dry season and increased rate of bacterial decomposition of organic matter.

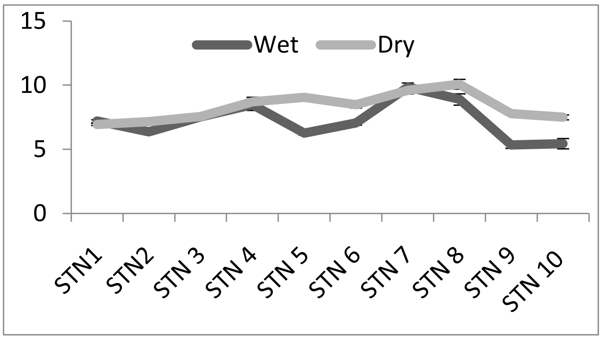

Figure 3: Dissolved oxygen (mg/L)

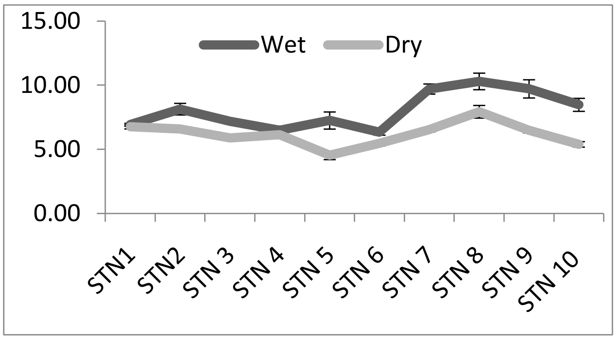

Figure 4: Biochemical oxygen demand (mg/L)

Hynes [24] reported that BOD_5 values between 1mg/L – 2 mg/L or less represent clean water, 4 mg/L –7 mg/L represent slightly polluted water and more than 8 mg/L represent severe pollution. Based on the above criteria, the Sombreiro River (water) is slightly polluted, since mean BOD is 7.08mg/l (with a range from 2.38 – 13.64mg/l), however stations 7 – 9 during the wet season with pooled average BOD values of 8.12, 9.12 and 8.10 respectively can be said to be severely polluted. According to Ademoroti 1996, cited in [25], the concentration of BOD in surface waters is dependent upon the oxygen demand which in turn is contingent upon the decomposable matter present.

Concentrations of THC in the wet and dry seasons were significantly different in both seasons and period of sampling. Values of THC were generally higher in the dry season months and lower in the wet season. However, on the contrary no significant difference (at $p < 0.05$) was recorded by Howard *et al.*, [26] between seasons.

The study further revealed significant seasonal variations of Conductivity at ($p < 0.05$); between the dry and wet seasons, which is supported by the findings of previous workers in the Niger Delta [14,18,27]. The conclusion of this study is however contrary to the non- seasonality of conductivity reached by [3,8]. The conductivity values gotten for the dry season were higher than that of the wet season agreeing with a similar position expressed earlier by [18]. This can be attributed to the concentration of ions by evaporation, coupled with increased mineralization of organic matter [28].

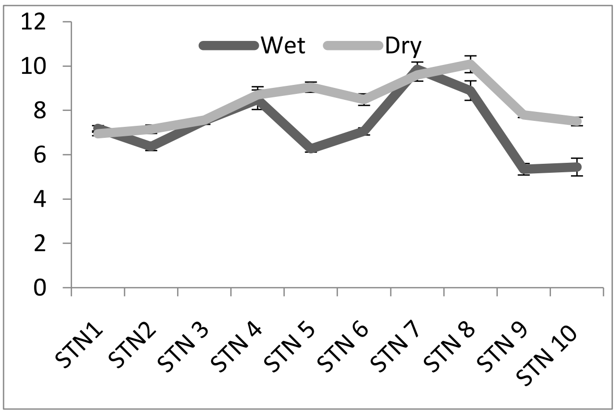

Figure 5: THC (mg/L)

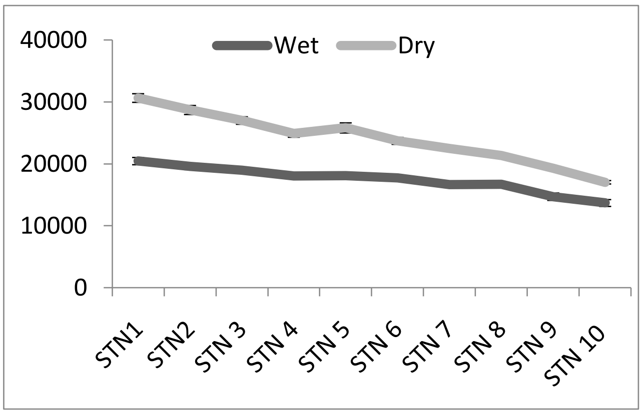

Figure 6: Conductivity (μS/cm)

The study of [12] showed significant seasonal variation in the values of turbidity with the wet season accounting for the higher values, but on the contrary this study showed the dry season values to be significantly higher than the wet seasons. Similar dry season dominance of turbidity value (in all the sampling Stations) was recorded by [3], though statistically insignificant.

The study further revealed that there was a significant difference between the wet and dry season concentration of phosphate, with the latter enjoying a higher concentration than the former. This position is strengthened by the earlier findings [12] concerning the seasonality of phosphate concentration in Elechi Creek. Nevertheless, it is opposed to other views [13] that there is no significant seasonal difference and [29] that wet season months had higher concentration values than dry season. As noted by [13], phosphate concentration in this study is thought to be limiting as all observed values were below 1mg/l.

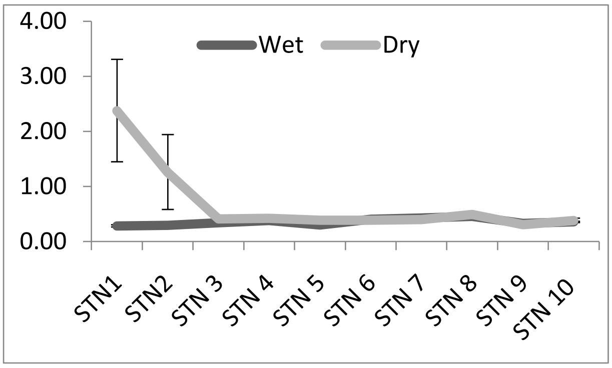

Figure 7: Turbidity (NTU Units)

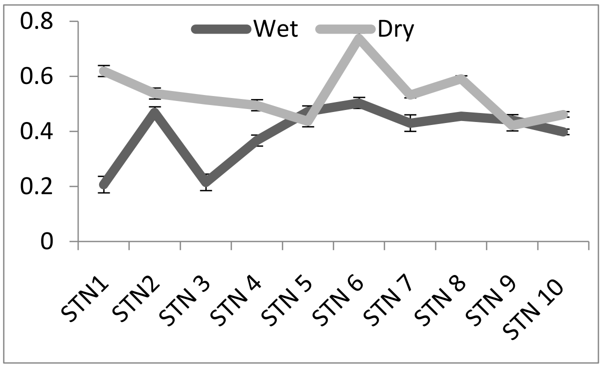

Figure 8: Phosphate (mg/L)

In terms of seasonality, wet season concentration of nitrate was significantly higher at all Stations (5.24 – 7.24mg/l) and lower in the dry season (0.52 – 3.64mg/l). This is in agreement with the conclusion of [12] but is at variance with the higher dry season concentration values of nitrate recorded by [30]. The higher wet season values obtained in this investigation can be attributed to storm water run-off from agricultural land and other urban centres/ human settlements. Ammonia had the lowest concentrations among all the dissolved nutrients, a position earlier asserted by [31], whose conclusion of a partial higher wet season concentration is in sharp contrast to the generally higher dry season values culminating into a significant seasonal variation as observed in this investigation.

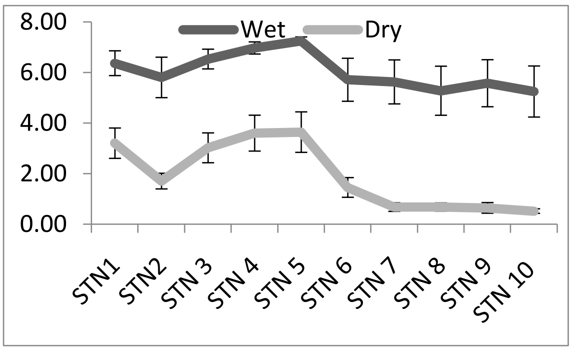

Figure 9: Nitrate (mg/L)

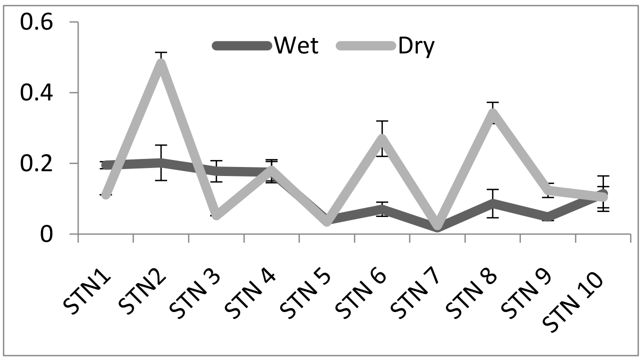

Figure 10: Ammonia (mg/L)

There was a significant difference between sulphate concentration values in the wet and dry seasons with the dry season values generally higher than the wet season values, this position is affirmed by [13], who also arrived at a similar conclusion.

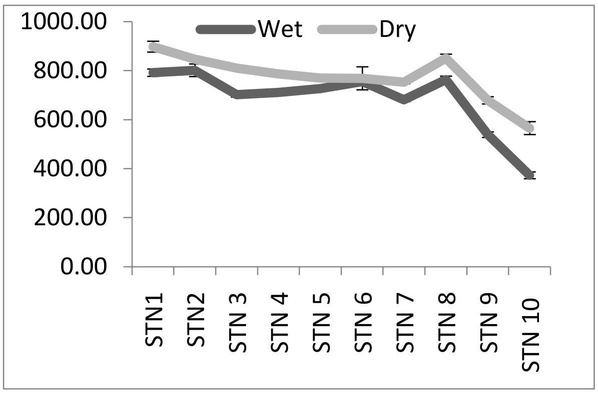

Figure 11: Sulphate (mg/L)

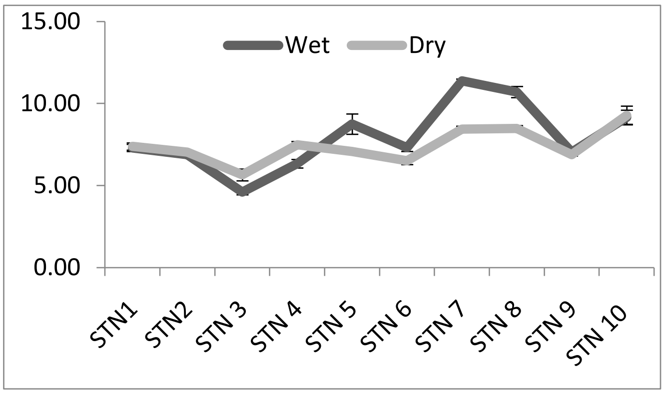

Figure 12: Chemical oxygen demand (mg/L)

Figure 1-12: Mean Seasonal Concentration of the different parameters in the surface waters of Sombreiro River.

CONCLUSION

Season based variations in the physicochemical quality of the Study River as revealed by this study may be as a result of anthropogenic perturbations and or storm water. The result of this investigation has clearly shown that seasonal fluctuations do influence physicochemical variables of surface waters and affirms the position earlier proposed by [31] that the precipitation received during long and short rainy seasons had considerable impact on the characteristics of the coastal water.

REFERENCES

1. Bhateria, R. and Abdullah A. Analyzing uncertainties in lake water: A review, 2015, *5*(6), 155–168.
2. Abdar, M. R. Physico-chemical characteristics and phytoplankton of Morna lake, Shirala (M.S.) India,"Biolife., 2013, 1(2):1-7.
3. Sikoki, F. D. and Anyanwu, I. N. Spatial and Temporal Variations of Physicochemical Variables in a Small Pristine Stream in Niger Delta, Nigeria. .*Journal of Fisheries and Aquatic Science,* 2013, 8, 129-135.
4. Yang, L., Song, X., Zhang, Y., Yuan, R., Ma, Y., Han, D. and Bu, H. A hydrochemical framework and water quality assessment of river water in the upper reaches of the Huai River Basin, China. Environ Earth Sci., 2012, 67(7):2141–2153
5. Varol M, and Sen, B. Assessment of surface water quality using multivariate statistical techniques: a case study of BehrimazStream, Turkey. Environ Monit Assess., 2009, 159(1): 543-553
6. Varol, M., Go¨kot, B., Bekleyen, A. and Sen, B. Spatial and temporalvariations in surface water quality of the dam reservoirs in theTigris River basin, Turkey. Catena, 2012, 92:11–21
7. Mustapha, A., Aris, A. Z., Juahir, H., Ramli, M. F. and Kura, N. U. River water quality assessment using environmentric techniques: case study of Jakara River Basin. Environ Sci. Pollut. Res., 2013, 1–15

8. Ezekiel, E. N., Hart, A. I. and Abowei, J.F.N. Benthic Macro- Fauna Composition and Abundance in Sombreiro River, Niger Delta, Nigeria. *Research Journal of Applied Science and Engineering Technology,* 2011, 3(4), 257 – 263.
9. UNEP. *Environmental Assessment of Ogoni Land*. Nairobi: United Nations Environment Programme. 2011.
10. Abowei, J.F.N. Davies, O.A. and Tawari, C.C. Phytoplankton in the lower Sombreiro River, Niger Delta, Nigeria. *Research Journal of Biological Sciences*, 2008, 3(12), 1430 – 1436.
11. APHA, AWWA & WEF. *Standard Methods for Examination of water and waste water* Washington DC, American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). 2005.
12. Ogamba, E.N., Chinda, A.C., Ekweozor, I.K.E. and Onwuteaka, J.N. Water quality and Phytoplankton distribution in Elechi Creek Complex of the Niger Delta.*Journal of Nigerian Environmental Society*,2004, 1(2), 121- 130.
13. Chindah, A.C and Braide, A. S. The Physicochemical Quality and Phytoplankton Community of Tropical Waters: A case of 4 Biotopes in the Lower Bonny River, Niger Delta, Nigeria. Caderno de Pesquisa Ser. Bio., Santa Cruz do Sul, 2004, 16 (2), 7- 35.
14. Ekeh, I.B. and Sikoki, F.D. The state and seasonal variability of some physicochemical parameters in the New Calabar River, Nigeria. S*upp. Ad. Acta Hydrobiologica.* 2003, 5: 45 – 60.
15. Ajao, S.K. and Fagade, S.O. The benthic macro – fauna of Lagos Lagoon.*The Zoologist,* 2002, 1(2), 1 – 15.
16. Ezekiel, E.N., Ogamba, E.N. and Abowei, J.F.N. The Distribution and Seasonality of Zooplankton in Sombreiro River, Niger Delta, Nigeria. *Current Research Journal of Biological Science*, 2011, 3(3), 234 – 239.
17. Deekae, S.N., Abowei, J.F.N. and Chinda, A.C. Some physic-chemical parameters of Luubara Creek, Ogoni Land, Niger Delta, Nigeria.*Research Journal of Environmental and Earth Sciences*, 2010, 2(4), 199 – 207.
18. Abowei, J.F.N. and George, A.D.I. Some Physicochemical Characteristics of Okpoka Creek, Niger Delta, Nigeria. *Research Journal of Environmental and Earth Science*, 2009, 1 (2), 45 – 53.
19. Allison, M.E. The ecology and fisheries of *Paraila Pellucida* (Boulenger, 1901) (SCHILRELDAE) in the lower Nun River of the Niger Delta, Nigeria. Ph. D. Thesis, University of Port Harcourt, Nigeria, 2006, pp. 267.
20. Patil, J. H., Raj, M. A., Gavimath, C. C. and Hooli, V. R. A comparative study on anaerobic co-digestion of water hyacinth with poultry litter and cow dung. *Int. J Chem Sci Appl.,* 2011, 2(2), 148 – 155.
21. Onyema, I.C. and Nwankwo, D. I. Chlorophyll a' dynamic and environmental factors in a tropical estuarine Lagoon. *Acad. Arena.,* 2009, 1(1), 18 – 30.
22. Nkwoji, J.A., Yakubu, A., Ajani, G.F., Balogun, K.J., Renner, K.O., Igbo, J.K., Ariyo, A.A. and Bello, B.O. Seasonal Variations in water chemistry and benthic macro invertebrates of a South Western Lagoon, Lagos, Nigeria.*Journal of American Science*, 2010, 6(3), 85 – 92.
23. Edoghotu, A. J. and Aleleye-Wokoma I.P. Seasonal variations in Phytoplankton composition and Physicochemical properties of Ntawoba Creek, Port Harcourt, Nigeria. *International Journal of Natural and Applied Sciences,* 2007, 3(3), 344 – 348.
24. Hynes, H.B.N. *The Biology of Polluted Waters*. Liverpool, Liverpool University Press.1960

25. Puri, P. J., Yankie, M. K. N., Battalwer, D. G., Gandhare, N. V. and Dhanokar, D. B. Study and interpretation of physic-chemical characteristics of Lake water in Negpur City (India). *RASAYAN J. Chem*. 2010, 3(4): 800 – 810.
26. Howard, I.C., Gabriel, U. U. and Onyekwere, B.C. Bioconcentration patterns of some trace metals in *Tympanotonus fuscatus* (var Radula) and *Crasso streagasar* from the tidal flats of the Sombreiro River, Niger Delta. *Journal of Nigerian Environmental Society,* 2012, 7 (3), 114 – 123.
27. Zabbey, N. An ecological survey of benthic macro-invertebrates of Woji Creek, off the Bonny River System Rivers State.M. Sc. Thesis, University of Port Harcourt, Port Harcourt. 2002, pp. 102.
28. Petr, T. (1983). The Purari- Tropical Environment of a High Rainfall River Basin. Dr. W. Junk. The Hague. 1983.
29. Obire, O., Tamuno, D.C. and Wemedo, S.A. (2003).Physico-Chemical Quality of Elechi Creek in Port Harcourt, Nigeria.*Journal of Applied Science and Environmental Management,* 2003, 7(1), 41 – 49.
30. Obunwo, C.C., Braide, S.A, Izonfuo, W. A. L. and Chindah, A.C. Influence of urban activities on the water quality of a fresh water stream in the Niger Delta, Nigeria. *Journal of Nigerian Environmental Society*, 2004, 2(2), 196 – 209.
31. Marthe, Y. K, Lancine, G. D., Bamory, K., Aristide, D. G. and Ardjouma, D. Seasonal and spatial variations in water physicochemical quality of coastal Potou Lagoon (Cote d’ Ivore, Western Africa). *Journal of Water Resource and Protection*, 2015, 7: 741 – 748.