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Water nutrients dynamics and use of chlorophyll ‘a’ in the determination of primary productivity of AMADI-AMA creek, upper bonny estuary, port Harcourt, Nigeria

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A B S T R A C T

Water nutrients dynamics and use of chlorophyll‘a’ in the determination of primary productivity of Amadi-Ama creeks were investigated for 2years(January 2009-December, 2010). Water samples collected were analyzed following the standard limnological methods of APHA. Data were analyzed using sample statistical method of mean and subjected to ANOVA for significant difference at p≤0.05.All the parameters investigated exhibited significant difference spatially,temporally and seasonally except nitrate. The estimation of the phytoplankton biomass by chlorophyll ‘a’ ranged from 0.0-4.50mg/l. The productivity of the creek measured by chlorophyll ‘a’ increased in the dry season than the wet season and also highest in station 3.The observed chlorophyll’a’ value of the creek placed it between mesotrophic to eutrophic status.It was observed that chlorophyll‘a’ value increased with increase in water nutrients especially phosphate.

1. Introduction

Amadi-Ama creek plays important roles in the lives of the surrounding inhabitants. Fishing, bathing, washing/laundry, car washing, refuse disposal, industrial wastes disposal and other human activities are constantly going on within and around the creek. The diversity of an aquatic system refers to the richness of biological variation in terms of the number of species found therein. The occurrence of algae in aquatic ecosystems cannot be considered alone but in relation to the prevailing environmental conditions particularly physicochemical parameters (Kadiri, 2000, 2006). Algae have an integrating response to their environment, fluctuation in water quality, which may be missed by intermittent chemical analysis.

Chlorophyll a is an essential plant pigment and its concentrations could be used to reflect algal biomass and hence the level of primary productivity. It is an effective measure of trophic status (Lee,1999). Elevated level of chlorophyll'a' concentrations often indicate poor water quality and low levels often suggest good condition(Ogamba *et al*., 2004).

The quantities of nitrogen, phosphorus, and other biologically useful nutrients are the primary determinants of a body of water's trophic state index (TSI). Nutrients such as nitrogen and phosphorus tend to be limiting resources in standing water bodies, so increased concentrations tend to result in increased plant growth, followed by corollary increases in subsequent trophic levels. Consequently, a body of water's trophic index may sometimes be used to make a rough estimate of its biological condition (USEPA,2007). Both natural and anthropogenic factors can influence a lake or other water body's Trophic Index. A water body situated in a nutrient-rich region with high Net Primary Productivity may be naturally eutrophic. Nutrients carried into water bodies from non-point sources such as agricultural runoff, residential fertilisers and sewage will all increase the algal biomass, and can easily cause an oligotrophic lake to become hypereutrophic (Carlson1977).

2. Materials and methods

2.1. Study area

Amadi-Ama creek is located in Port Harcourt Local Government Area of Rivers State and lies between longitude 5^0 60'E-6^0 60'E and latitude 6^0 06'N-6 07'. The creek is one of the tributories of the upper Bonny Estuary, brackish and tidal in nature with fresh waters intrusion from the surrounding inland waters and flood during the wet season(Fig. 1). It lies within the lowland area of the Niger Delta with dense and thick tropical rainforest vegetation. It is characterized by high atmospheric (ambient) temperature (27.5ºC) and high relative humidity fluctuating between 65% –90%. It has average rainfall of about 2500mm (Gobo1988).

2.2. Water sampling

Six sampling stations were established at least 500m apart through a reconnaissance survey undertaken using boat from the eastern by-pass through the Amadi axis and on foot along the creek banks from the Rumukalagbo to the Nkpogu axis through Woji to Abuloma jetty. Water sampling was always done between 9am and 12 noon each time, properly labeled and transported to the laboratory for preservation and further analysis.

2.3. Analytical methods

The physico-chemical analysis of the chlorophyll a' and water nutrients samples followed the standard limnological methods of APHA(1998). Chlorophyll '*a'* concentration of each sample was determined using a Fluorometer equipped with filters for light emission and excitation. Phosphate (PO_4^{2-}) was determined using stannous chloride method adopted for the estimation of phosphate-phosphorus. Nitrate (NO_3) was determined using Brucine method which was based on the reaction of nitrate with Brucine in an acidic medium to produce a yellow colour at moderate temperature. Sulphate ion was precipitated in a hydrochloric acid (HCl) medium with barium chloride ($BaCl_2$) so as to form barium sulphate ($BaSO_4$) crystals of uniform size.

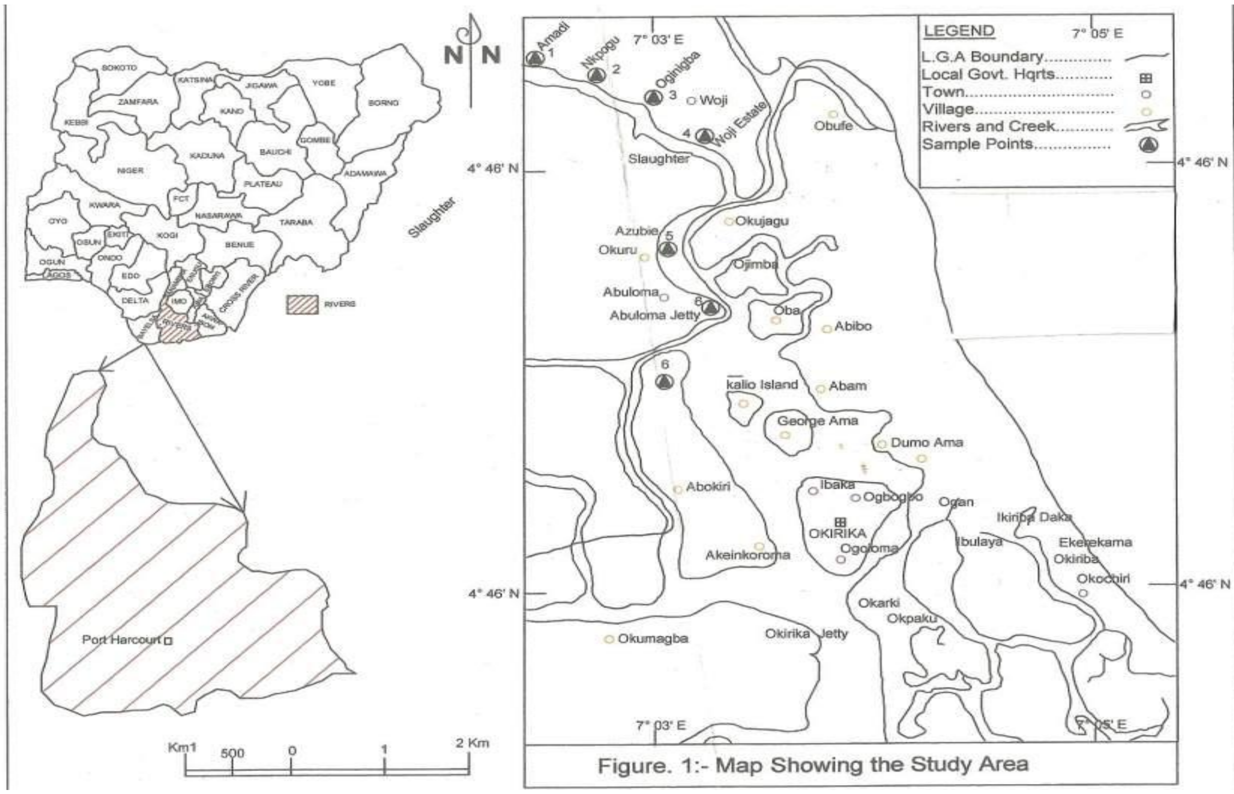

Fig. 1. Map showing the study area.

3. Results

The chlorophyll'a'(chl'a') values ranged from 0.0-4.1mg/l with the mean value of 2.52±1.06mg/l in the first year(2009) while the second year (2010) values ranged from 2.00-4.50 mg/l with a mean 3.18±0.56 mg/l(Table1).Spatially, mean values were consistently high in station 3 and low in station 6 with observed significant difference. Other stations fluctuate in value within the period. Chlorophyll'a' values were consistently low in the month of August throughout the period with the highest value (3.40±0.40mg/l) recorded in March (Fig.3). Chorophyll 'a' values were consistently higher in the dry season than the wet season values throughout the study period with observed significant difference ($p<0.05$)(Fig.4).

The nitrate values recorded ranged from 0.5-2.8mg/l with a mean of 1.10±0.44 mg/l in the first year while the second year(2010) values ranged from 0.3-3.5mg/l with a mean of 0.97±0.47mg/l(Table1). Spatially, the lowest mean value (0.87±0.30mg/l) was recorded in Station 5 and the highest value (1.63±0.66mg/l) was recorded in Station 1 in the first year(Fig.2 4.7). In the second year(2010), the lowest mean value (0.73±0.17mg/l) was recorded in Station 5 while the highest value (1.48±0.60mg/l) was recorded in Station 1 (Fig.2).Nitrate values showed no significant difference spatially, temporally nor seasonally. Temporal values fluctuate within the period of study.

The sulphate-sulphur values observed ranged from 30.0-920mg/l with a mean of 268.25±149.93mg/l in the first year(2009) while the second year(2010) value ranged between 79.2-950mg/l with a mean of 268.25±149.93mg/l)(Table 1). Spatially, Station 4 had the lowest mean value (236.72±64.83mg/l) and the highest mean value (310.33±36.66mg/l) was recorded in Station 3 in the first year(Fig.2). In the second year(2010), the lowest mean value of sulphate (225.41±238.06mg/l) was recorded in Station 1 and the highest mean value (290.96±121.98mg/l) was recorded in Station 5 (Fig.2).It showed significant difference spatially and seasonally. Temporal values were consistently high in April and consistently low in January within the period of study(Fig.7).

The phosphate value ranged from 0.9-1.95mg/l with a mean of 1.56±0.21mg/l in the first year (2009) 1.1-2.1mg/l with a mean of 1.59±0.19mg/l in 2010 (Table1). Spatial mean value was consistently high in station 3 throughout the period but the lowest mean value fluctuate between stations 4 and 5 in 2009 and 2010(Fig.2).Values showed significant difference spatially and seasonally. Temporal values fluctuate within the period (Fig.6).

Table1
Chlorophyll 'a' and water nutrients of Amadi-Ama Creek(JAN.2009-DEC.2010)

January –Decembe	Jan-Dec2009 Overall Mean	Range	Jan-Dec 2010 Overall Mean	Range
Chlorophyll 'a'()mg/l	2.52±1.06	0.00-4.10	3.18±0.56	2.00-4.50
Nitrate($NO^2{}_3$)()Mg/l	0.55±0.24	0.05-1.12	0.71±1.02	0.05-8.89
Sulphate($SO^{-2}{}_4$) (mg/l)	230.33±14.4	57.50-820.90	227.29±141.90	19.80-842
Phosphate($PO^{-2}{}_4$)	0.05±0.03	0.00-0.10	0.07±0.02	0.00-0.10

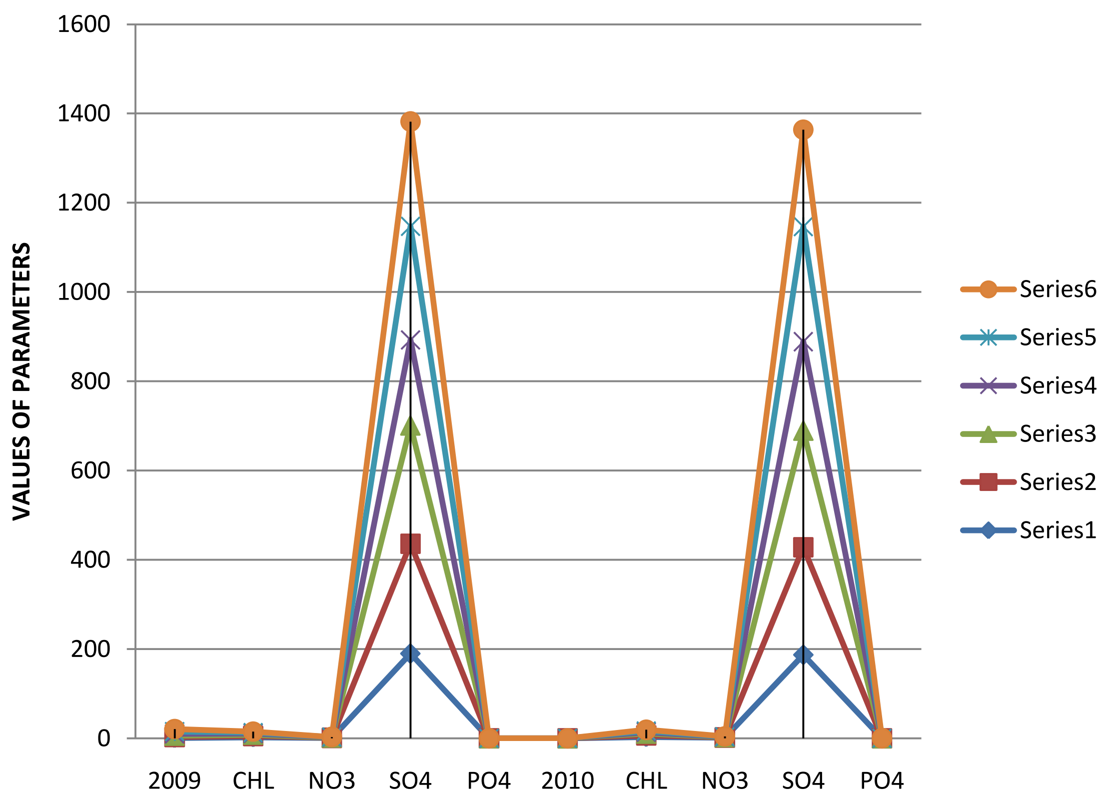

Fig. 2. Spatial values of chl 'a' and water nutrients in the area between Jan 2009-Dec 2010.

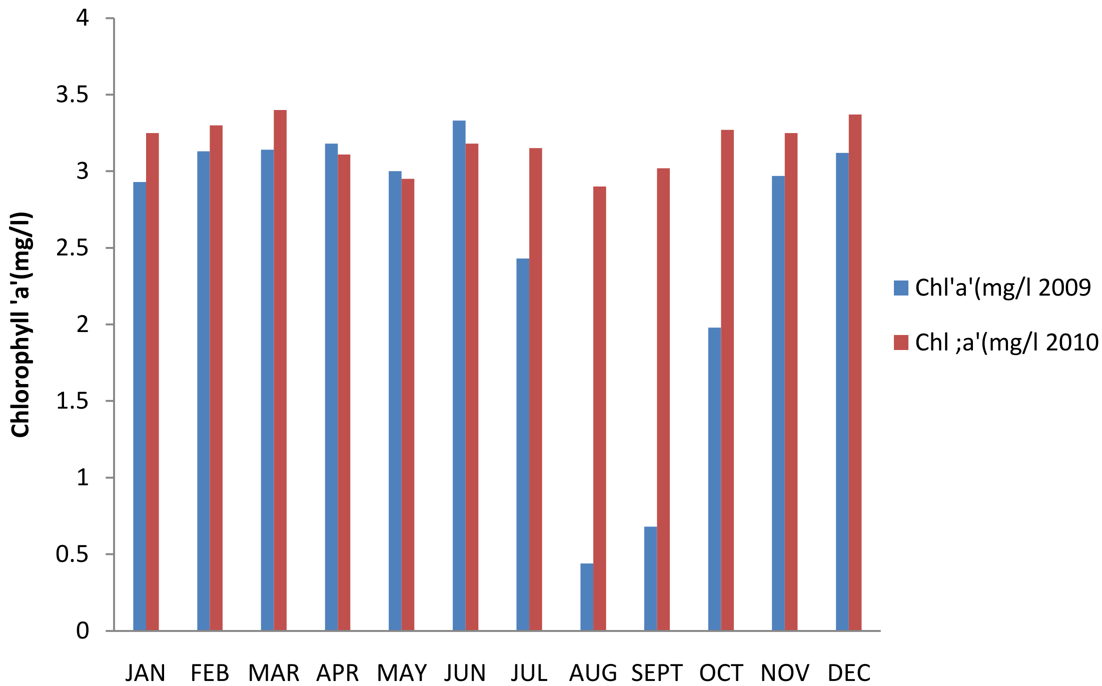

Fig. 3. Monthly values of chlorophyll 'a' in water.

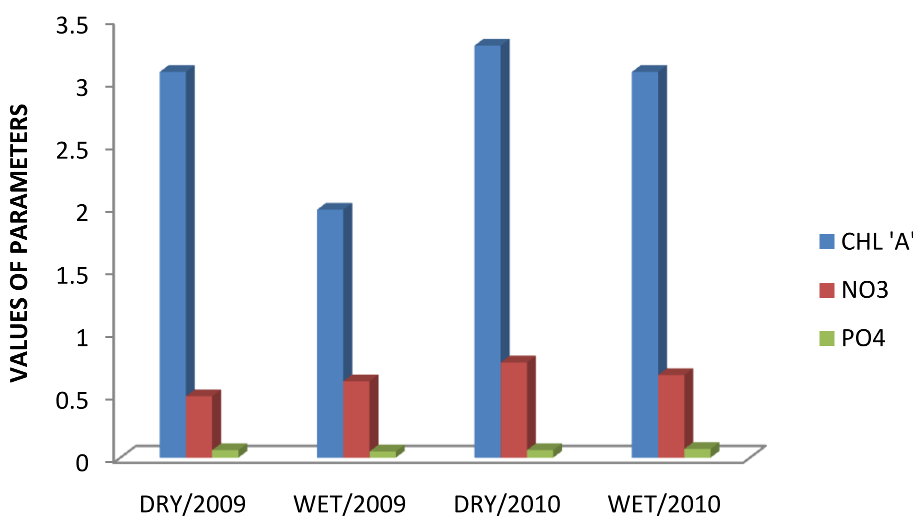

Fig. 4. Seasonal values of chl 'a' , NO_3 and Po_4 in the study area between Jan 2009 Dec 2010.

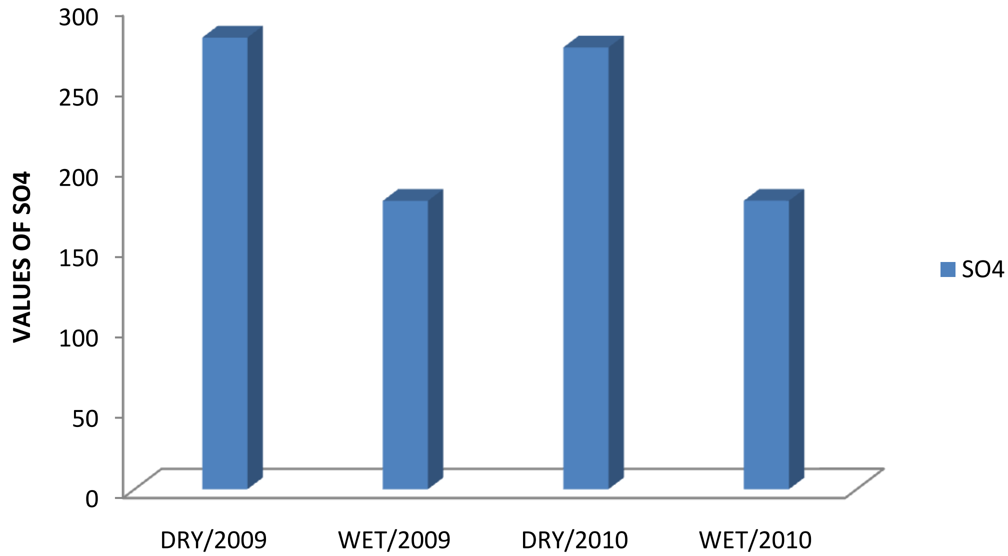

Fig. 5. Seasonal mean values of sulphate in the area.

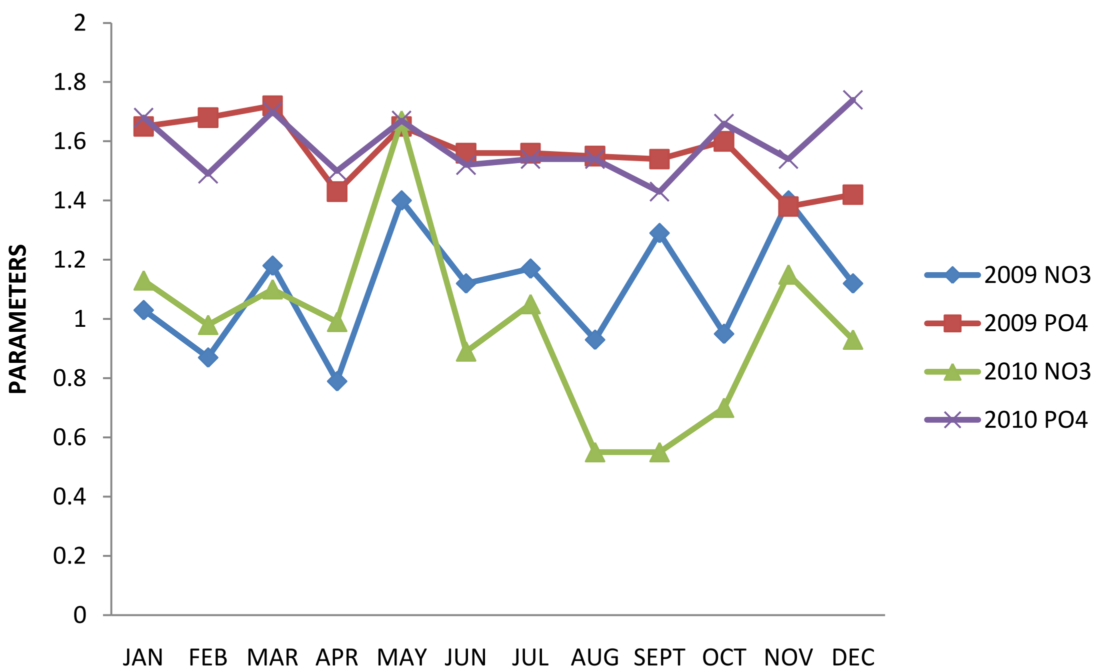

Fig. 6. Monthly mean values of nitrate and phosphate in the study area(2009-2010).

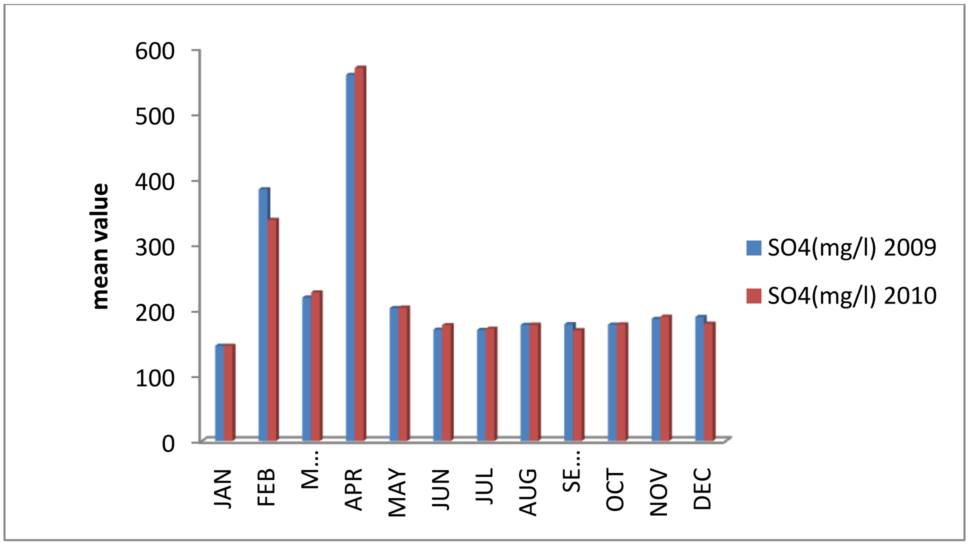

Fig. 7. Monthly mean values of so_4 in the area(2009-2010).

4. Discussion

The study showed that chlorophyll"a"concentration exhibited spatial, temporal, seasonal and yearly variations. The range observed in this study showed that Amadi-Ama creek is between mesotrophic and eutrophic productivity status(Suzuki et al.,2002, APHA,1998).Spatial variation among stations with the highest concentrations (3.17±1.10mg/l and 4.06±0.25) in 2009 and 2010 respectively in station 3 could be due to increased nutrients like Phosphate and Nitrate in the station. Temporally, the lowest chlorophyll'a' concentration (0.44±0.35mg/l) observed in August when water nutrients were generally low especially in the first year could be due to the dredging activity that was observed during the period which must have caused impairment in light penetration for photosynthetic activities. In addition, the lowest abundance and species of phytoplankton and epipelic algae observed in this month of August confirms the observations by Ward et al; (1998) which stated that increased primary productivity is a function of chlorophyll 'a' which is in turn the function of essential nutrient such as nitrate phosphate and silica. Seasonally, chlorophyll 'a' concentrations were generally higher in the dry season than the wet season in this study. This is in line with the observations by Ogamba et al; (2004) who reported a chlorophyll 'a' range of 0.15 – 37.4mgl/l for the wet season and 0.10 – 40.28mgl/l for the dry season in Elechi creek in the Niger Delta and Suzuki et al, (2002) who also reported higher chlorophyll 'a' concentration in the dry season than the wet season Coastal lagoon in the Northern region of Rio. Onyema et al; (2009) also observed higher chlorophyll 'a' concentration in the dry season than the wet season in Badagry creek, Lagos and attributed it to clarity of water permitting adequate light penetration. The seasonal difference observed in this study is in line with the report of Amy (2003) in Florida who attributed it to several factors such as nutrient flow and hydrogen-chemical characteristics and amount of light energy impinging on the water body.The non seasonality in chlorophyll "a"concentration in the second year (2010) could be attributed to environmental factors which is contrary to most of the researches carried out in the Niger Delta water system.

The increased mean value of Nitrate in the second year in this study could be attributed to higher biological oxygen demand in the periods. Spatial values of Nitrate fluctuating across the stations with the highest value observed in station 1 might be attributed to high human excrement and industrial discharges. The highest nitrate concentrations (0.61±0.21mg/l) in wet season than dry season (0.49±0.27mg/l) in the first year could be attributed to anthropogenic inputs while the decreased value(0.66±0.26) in the wet season in the second year could be attributed to uptake of Nitrate by phytoplankton and epipelic algae during photosynthesis.

The observed spatial variations and fluctuations in Sulphate level with the highest value in station 3 might be attributed to the various amounts of organic materials in the station. Ekeh (2005) attributed increases in Sulphate level in Amadi creek to leachates from dumpsites, runoff and plant materials partly decomposed by the action of water that was characteristically rich in sulphate.

Spatial variation with the highest value in station 3 could be due to increased human faeces and high level of utilization of detergent by the teaming population in the area. The observed higher values of phosphate in the dry season in the first year with slight variation in the second year could be responsible for increased chlorophyll'a' concentration in the dry season than the wet season. This observation is in line with the results of Horsley *et al* .,(2000) who disclosed that chlorophyll 'a' increases with increases in phosphate and nitrate in the aquatic environment which consequently lead to increase in primary productivity.

References

Amy, C., 2003.The incredible glowing algae.Oregon State university press. Pp51.GSFC EARTH Sciences DAAC MODIS Web.

APHA, 1998. Standard methods for the examination of water and waste water 20th(ed), Washington D.C1213pp

Carlson,R.E.(1977)A trophic state index for lakes. *Limnology and* Oceanography. *22, 2 361--369.*

Ekeh, C.A., 2005.The study of planton in Amadi and Nwaja creeks of the upper Bonny Estuary. MSc thesis, Rivers State University of Science and Technology, Port Harcourt, Nigeria.254pp.

Gobo, A.E., 1988. Relationship between Rainfall Trends and flooding in the Niger Delta- Benue River Basin.*Journal of meterology of UK. 13(132), 220- 224*.

Horsley, C., Witten, B., 2000. Ashmet Plame Nitrogen offset propram Tasks 5 and 8 Report" Detailed Analysis of All Feasible Corrective Measures and Identification of Alternative strategies that can be accomplished within a capital Budget of 8.5 million. Report prepared for the town of Falmouth, 52Town Halls square, Falmouth.02540.

Kadiri, M.O., 2000. Limnological studies of two contrasting but closely linked springs in Nigeria, West Africa. Plant Biosyst., 134, 123-131.

Kadiri, M.O., 2006. Phytoplankton flora and Physicochemical attributes of some waters in the Eastern Niger Delta Area of Nigeria. Nig. J. Bot., 19, 188-200.

Lee, R.E., 1999. *Phycology.* Cambridge University Press, New York. 614pp.

Ogamba, E.N., Chindah, A.C., Ekweozor, I.K.E., Onwuteaka, J.N., 2004. Water quality of phytoplankton distribution in Elechi Creek Complex of the Niger Delta. *Journal of Nigerian Environmental Society.* 2(2), 121-130.

Onyema, I.C., Okpara, C.U., Ogbebor, C.I., Otudeko, Nwankwo, D.I., 2007. Lagoon, NigeriaEcology. *Environment and conservation 200/13(1), 1-12.*

Suzuki, M.S., Figueiredo, R.O., Castro, S.C., Silva, C.F., Pereira, E.A., Silva, J.A., Aragon, G.T., 2002. Sand bar opening in a castal lagoon (Iquipari) in the Northern regon of Rio De Janeiro State: Hydrological and hydrochemical changes. *Braz. J. Biol., 62(1), 51-62.*

United States Environmental Protection Agency (2007) Carlson's Trophic State Index. *Aquatic Biodiversity*.http://www.epa.gov/bioindicators/aquatic/carlson.html*accessed17 February, 2008*.

Ward, T., Butler, E., Hill, B., 1998. Environmental Indicators for National State of the Environment Reporting,Estuaries and the Sea, Commonwealth of Australia, pp. 81.