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Human Induced Variations of Selected Physicochemical Parameters of Taylor Creek in the Niger Delta, Bayelsa State, Nigeria

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Abstract The physicochemistry of Taylor creek, Biseni, Bayelsa State was investigated in order to gauge the impact of human activities along the creek catchments on the creek integrity. Physicochemical parameters were investigated for one year, from November 2009 to October 2010. The creek was divided into six sampling zones located at Iturama, Tien and Kalama all in Biseni clan. Sampling was done monthly taking water samples. The physicochemical parameters investigated are pH, Electrical conductivity (EC), salinity, temperature, Alkalinity, Dissolved Oxygen (DO), Biochemical oxygen demand (BOD_5), turbidity, Hardness, sulphate (SO_4), phosphate (PO_4), and Nitrate (NO_3). Physico-chemical samples were collected using standard procedures and samples analyzed using standard techniques. Data were subjected to statistical analysis using the Microsoft Excel Descriptive Statistical Tool. Analysis of variance (ANOVA) was employed at 95% confidence limit to test for the variability of parameters between seasons and stations. Result from the investigation reveals that there was a significant seasonal difference ($p<0.05$) in physicochemical parameters of hardness, alkalinity, temperature, turbidity, pH, BOD_5, EC and NO_3 while there was no significant seasonal difference ($p>0.05$) in measured variables of salinity, DO, PO_4 and SO_4. There was no significant difference ($p>0.05$) across stations in all physicochemical variables except turbidity and pH which showed significant difference ($p<0.05$) from station to station. Also, pH, turbidity, temperature, BOD_5 and nitrate were generally higher downstream than upstream stations (Iturama stations > Kalama stations), while DO, hardness, alkalinity and EC were higher upstream than downstream of the creek (Kalama >Iturama). The mean EC, nitrate, BOD_5, DO, hardness and alkalinity levels in the creek were higher in the wet season than in the dry season, while temperature, turbidity and pH Levels were lower in the wet season than the dry season. The mean salinity, PO_4 and SO_4 levels were the same for both wet and dry seasons. All physicochemical parameters were either within or below ranges of international permissible levels in water. This implies a satisfactory physicochemical regime during the study period, suggesting the creek still has a positive integrity to support aquatic life.

Keywords Human, Induced, Physicochemical, Taylor Creek, Niger Delta

1. Introduction

The entire Niger Delta is characterized by nucleated human settlements occupying isolated dry sites within the delta swamps. Population surveys conducted in 1980 revealed that 20 percent of the estimated 100 million people then in Nigeria lived in coastal zones[1]. Further more, the discovery of fossil fuels with the attendant oil exploration and exploitation activities , coupled with the emergence of local and small scale industries like wood works, ceramics, weaving and boat building has given rise to increased population and sprawling coastal settlements[2].

Unfortunately, land use patterns in watershed influences the delivery of nutrients, sediments and contaminants intoreceiving waters through surface flow, ground water flow and atmospheric deposition ([3];[4];[5]).

The ecology and biodiversity of estuaries and coastal waters in many parts of the world are under serious threat from increasing human anthropogenic inputs of nutrients[6]. Many of these threats can be attributed directly to expansion of human population along riparian zones and coastal catchments.

Taylor creek situated strategically in the Niger Delta is an example of such threatened water bodies requiring urgent monitoring. Taylor creek possesses great importance vis- a-vis:

a.It provides the only source of drinking water for people in that catchment.

b.It supports a productive fishery.

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c. It is one of the important tributary for waters of the River Niger, the most extensive river network in West Africa.

The diversity of organisms that may survive in any water body is limited to the fluctuating conditions prevailing within it. This is consequent to the varying temperature, dissolved oxygen, salinity along the length of the estuary.

The objective of this paper is to study the varying levels of the physicochemical parameters of the creek along the identified current land uses upstream and downstream of the creek.

2. Materials and Methods

Description of Study Area:

Taylor creek is a lotic, non-tidal fresh water environmental unit. It is situated in the Biseni clan, although the creek stretches into Gbaran clan in Yenagoa local government area of Bayelsa State in the Niger Delta. The creek lies between longitude 006^0 17' to 006^0 21'E and latitude 05^0 01' to 05^0 05'N. The location of the sampling site is at Kalama, Tien and Iturama all in Biseni clan.

2.1. Description of Sample Stations

After a study of the peculiarities of the creek, 6 sampling zones were established to reflect the different forms of land uses in the catchments and reflect stations upstream and downstream of the catchments.

Station is located far most downstream of the creek at Kalama Biseni. The station is located at longitude 05^0 14' 29.4''N and latitude 006^0 32' 06.''E. The station has an elevation of 10.5. Station 1 is situated adjacent to a make-shift market facility adjacent to the creek.

Station 2 is also situated at kalama Biseni. It is located at longitude $05^0$14' 32.4'' and latitude 006^0 32' 09.1''. The station has an elevation of 0.8. This station is up stream relative to station 1. It has notable features as floating aquatic weeds and vegetation in the adjacent catchments.

Station 3 is situated at Tien Biseni at longitude 05^0 14' 36.7'' and latitude 006^0 32' 11.0''. This station lies at an elevation of 4.0. This station is characterized by relatively clearer water surface but with plentiful amounts of bathing and laundry activities going on there.

Station 4 is situated almost mid-way between all sampling stations. It is up stream of stations 1, 2 and 3. It is also located at Tien Biseni at longitude 05^0 14' 39,8'' and latitude 006^0 32' 15.6''. The station has an elevation of 14.9. The activities in station 4 are similar to those in station 3 with lots of bathing and washing activities. There are sparse distributions of aquatic plants in that area.

Station 5 is located upstream of Taylor creek at Iturama Biseni. The creek is widest at this point and has a display of aquatic plants. It is located at longitude 05^0 14' 3.4'' and latitude 006^0 32' 19.8''. It has an elevation of 15.0 and characterized by laundry activities.

Station 6 is situated uppermost upstream of all sampling points. It is also located at Iturama in Biseni clan. It sits on longitude 05^0 14' 40.4'' and latitude 006^0 32' 24.2'' with an elevation of 9.9. The overlying catchments are relatively uninhabited and coloured by aquatic macrophytes and dense vegetation. It is nearest of all sampling points to a portable water processing plant. This station serves as control in this study.

2.2. Collection of Samples

Dark labeled reagent bottles were used to collect water samples from the sampling stations. BOD and DO samples were collected by completely immersing the bottles into the water and then allowed to fill. 2mls each of Winkler I and Winkler II reagents were added to the DO sample bottles and then shaken to mix properly and then corked. BOD samples were stored in dark containers and then transported to the laboratory and kept for five days before fixing with Winkler I and Winkler II reagents. Water samples for all other physicochemical parameters were collected from the sampling stations using one litre plastic containers. The plastic containers were dipped into water to collect sub-surface water samples in each of the 6 sampling stations.

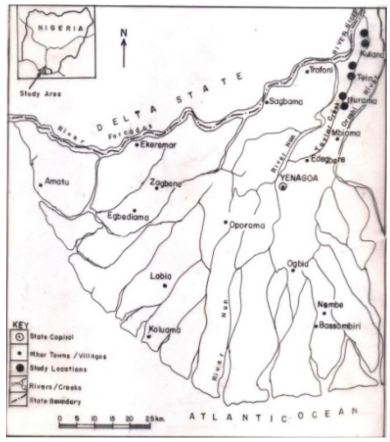

Figure 1. Drainage Map of the Niger Delta Sowing study stations

2.3. Analyses of Samples

Dissolved oxygen was measured by the use of the Winkler Iodometric method. This method is based on the oxidizing properties of oxygen. Biochemical Oxygen Demand (BOD_5) was determined after the samples were incubated in the dark for five days. The Dissolved Oxygen content of the samples was determined using the above Winkler Iodometric method.

The BOD_5 was then determined from the calculation: $BOD_5 = DO - DO_5$. Parameters of pH; Temperature; Electrical conductivity; Salinity; Turbidity were measured by the use of a U10 Horiba water checker. This was done by introducing water at each station into the metal container of the equipment. The probe of the U_{10} Horiba water checker was then put into the container and the water checker then switched on to measure each parameter one at a time. The readings of each parameter were displayed electronically on a display screen as bright red lights. The determination of total alkalinity involved the titration of 50ml of the water samples in the laboratory[7]. The EDTA titration method was used in determining hardness[7]. Sulphate determination was done using the turbidimetric method[7]. Phosphate was determined using the stannous chloride method[8]. Nitrate measurement was done by the brucine method[9].

2.4. Statistical Analysis

Data were subjected analysis using the Microsoft Excel descriptive tool. Means and standard deviations were calculated for each physicochemical parameter. Analysis of Variance (ANOVA) was also employed at the 95% confidence limit, to check the degree of variability between the measured parameters. Duncan multiple range tests were then employed to separate means where variability exist.

3. Results and Discussion

The mean seasonal variations of the physicochemical parameters of Taylor creek; Temperature, Turbidity, pH, Salinity, Dissolved Oxygen (D.O), Biochemical Oxygen Demand (BOD_5), Nitrite (NO_3), Phosphate (PO_4), Sulphate (SO_4), Hardness, Alkalinity and Electrical Conductivity (EC) are presented in Table 1, and Table 2.

The result and analysis of the study demonstrates variations amongst the physicochemical attributes between stations and seasons (Tables 1 & 2). Some of the results obtained are in conformity with the works of previous scholars[10, 11], while others are in disagreement with the works of other scholars done in the Niger Delta and Diaspora.

In the creek, there was a higher amount of dissolved oxygen content in the wet season than in the dry season. The higher amounts of dissolved oxygen in the wet season can be attributed to the agitation of the surface water within the creek channel due to channel precipitation and run-off discharges as a result of rainfall. Also, the relative lower level of oxygen in the dry season could be partly due to increase in temperature of the creek and increase organic load during this season. Organic load encourages aerobic biodegration, resulting in oxygen depletion. Oxygen levels in the creek in all sample stations were relatively similar and relatively satisfactory. Alabaster and Lloyd[12] stipulated a minimum benchmark level of 5.0mg/l oxygen content for proper survival of aquatic life and the use of water for domestic purposes. The reason for the similarity in dissolved oxygen content across stations may be as a result of the fact that Taylor creek is a lotic water body with strong currents.

Table 1. Mean Physicochemical Parameters of Water in Dry season

	STATIONS					
PARAMETERS	ST1	ST2	ST3	ST4	ST5	ST6
Hardness (mg/l)	*6.72± 4.56	6.74± 4.60	6.78± 4.61	6.74± 4.60	6.70± 4.60	6.76 ±4.57
Alkalinity (mg/l)	28.80±3.03	28.60± 2.07	29.80 ±2.28	29.0± 2.24	31.60± 2.97	28.0 ±2.92
PO_4 (mg/l)	0.05	0.05	0.05	0.05	0.05	0.05
EC (us/cm)	29.80± 8.47	29.80 ±8.56	30.40 8±.14	30.40 ±8.47	30.20 ±8.58	30.0± 8.28
Turbidity (NTU)	8.0± 1.41^{a}	8.40± 1.34^{ab}	8.60 ±1.14^{b}	8.0± 1.22^{a}	8.0 ±1.22^{a}	8.0± 0.71^{a}
SO_4 (mg/l)	1.0	1.0	1.0	1.0	1.0	1.0
NO_3 (mg/l)	0.07± 0.01	0.08± 0.018	0.07± 0.011	0.07 ±0.010	0.07 ±0.014	0.07 ±0.013
BOD_5 (mg/l)	1.97± 0.31	1.15 ±0.34	1.02± 0.47	2.05± 0.51	`1.56 ±1.06	1.19 ±0.51
DO (mg/l)	2.31 ±0.53	2.65± 0.60	1.87± 0.49	3.04± 0.62	3.98 ±1.10	4.64± 1.35
Salinity (mg/l)	0	0	0	0	0	0
PH	6.8 ±0.35^{ab}	6.90± 0.25^{a}	6.8± 0.15^{ab}	6.9± 0.19^{a}	6.8 ±0.21^{ab}	6.6± 0.10^{b}
Temperature (^{o}C)	30.2 ±1.03	29.8 ±1.04	29.7± 1.04	29.7 ±0.92	29.5 ±0.84	29.9± 0.80

*Mean ± Standard deviation

Table 2. Mean Physicochemical Parameters of Water in wet season

	STATIONS					
PARAMETERS	ST1	ST2	ST3	ST4	ST5	ST6
Hardness (mg/l)	*12.66 ±4.26	12.81 ±4.36	12.70± 4.31	12.49 ±4.15	12.64 ±4.14	12.76± 4.30
Alkalinity (mg/l)	24.14 1.77	25.29 ±2.36	24.43 ±2.57	24.71 ±1.89	26.86 ±4.02	23.29 ±1.50
PO_4 (mg/l)	0.05	0.05	0.05	0.05	0.05	0.05
EC (µs/cm)	41.29± 6.58	42.43± 6.40	42.57± 6.29	42.57± 6.97	42.86 ±6.39	42.0± 6.81
Turbidity (NTU)	5.14± 1.46^{a}	5.86± 1.07^{b}	5.71± 1.98^{b}	5.43 ±1.51^{ab}	5.0 ±1.41^{a}	5.43± 1.62^{ab}
SO_4 (mg/l)	1.0	1.0	1.0	1.0	1.0	1.0
NO_3 (mg/l)	0.10± 0.001	0.10 ±0.012	0.10 ±0.011	0.09± 0.007	0.08 ±0.019	0.08± 0.001
BOD_5 (mg/l)	2.05 0.35	1.87 0.87	1.99 0.83	2.21 0.43	2.47 0.59	2.28 0.52
DO (mg/l)	3.56±0.66	3.16 ±0.53	3.09± 0.73	3.38± 0.43	3.82± 0.73	3.91± 0.85
Salinity (mg/l)	0	0	0	0	0	0
PH	6.1± 0.22^{a}	6.4± 0.43^{b}	6.1± 0.43^{a}	6.22± 0.19^{a}	6.11± 0.28^{a}	6.06 ±0.16^{a}
Temperature (^{o}C)	28.2 ±1.72	28.1± 1.48	27.7 ±1.62	27.63 ±1.55	27.46± 1.57	27.6 ±1.66

Mean ± Standard deviation

The biochemical oxygen demand (BOD_5) also showed similar seasonal trends as dissolved oxygen. This implies that BOD_5 levels were relatively higher in the wet season than in the dry season. This may be due to the fact that during the dry season, available oxygen is used for biodegradation of waste within the aquatic environment. Hence, very small amounts are left for biochemical (life processes) activities. This is also indicative of high organic content of the creek[13]. Also, the high concentration of BOD_5 seem to follow the depth profile theory, implying that water bodies of low depth are more disturbed, resulting in higher BOD_5 concentration[14].

Hynes[15] reported that BOD_5 values of 1 – 2mg/l or less represents clean water, 4 – 7mg/l represents slightly polluted water and more than 8mg/l represents severely polluted water.

FEPA[16] stipulated that BOD standard for fresh water of unpolluted rivers is less than 5mg/l. The high BOD_5 in this study may be attributed to the discharge of pollutants into the water through washing, sewage contamination, effluent discharge and the relative shallowness of the creek especially during the dry season.

High temperature ranges were observed in this study during the dry and wet seasons. Dry season temperatures ranged between 29.4℃ – 30.22℃ and wet season temperatures ranged from 27.63℃ – 28.20℃ (Tables 1 &2). The study also observed low between-station temperature ranges in both seasons. This may be due to the fact that Taylor creek is lotic water body with very fast moving currents causing easy dilution. Negligible temporal and spatial variations in temperature have also been observed by previous scholars[17]. Also, the limited variation in temperature and lack of seasonal variation in the areas studied, had been attributed to the limited changes associated with the equatorial tropical area[18, 19] against wider variation in the temperate environment. However the temperature ranges observed in this study disagrees with the submission of Obunwo[20] who observed much lower temperature trends (23 – 26℃) in the Niger Delta.

Temperature is an important characteristic that can vary widely and is influenced by a number of variables including geographic location, shading, water body size and depth. It can affect the amount of oxygen that can be dissolved in water, the rate of photosynthesis by algae and larger plants.

pH levels observed in this study ranged between 6.61 – 6.98 in the dry season and 6.08 – 6.42 in the wet season (Tables 1 &2). The pH values in the wet season were therefore more acidic than those obtained in the dry season. One reason for this observation may be due to the fact that during the wet season, more substances are leached into surface water through run-offs than in the dry season. Tannin from roots of plants growing in stream and creek catchments has been known to impact on water acidity by reducing PH. The seeming acidity is also suggestive of low biological productivity.

The study also observed zero salinity throughout the study period (dry and wet seasons) in all study stations. Fresh water habitats are defined as having salinities of less than 1ppt (parts per thousand) or 1gram of total dissolved solids per litre of water. Indeed most are usually considerably less than 1ppt. Zero salinity is therefore indicative of a typical fresh water condition. Salinity over the years has been identified as the key factor in coastal waters in determining the absence and availability or density of endemic species[21, 22, 23].

Mclusky[24] confirmed that the absence of species such as *Nereis virens* in his study area may be due to the low salinity he recorded.

The study also observed higher levels of turbidity in the dry season compared to the wet season. This is also in agreement with the findings of previous scholars. The high turbidity concentration in the dry season is an indication of the presence of suspended organic and inorganic particulate matter in the water column which leads to the interaction of ions and the large load of charged inorganic sediment particles which have been washed down into the creek.

The nutrient parameters of phosphate (PO_4), nitrate (NO_3), and sulphate (SO_4) were generally low. Low nutrient levels of this nature have been reported for the Niger Delta region by other researchers[10, 19]. This low nutrient level in the water column can be attributed to high activity rate of organisms and their ability to quickly use up the nutrient in the water column as soon as it is released, and the poor nutrient status of the substratum. The super abundance of aquatic macrophytes in the creek substantiates the quick usage of nutrients by aquatic organisms. Although the nutrient parameters in the water column showed no specific trend across stations, nutrient parameters were slightly higher in the down stream stations than those upstream. This implies that although Taylor creek is a lotic water body, that waste from human inputs contribute a considerable extent of waste inputs into the creek. In conclusion, Taylor creek displayed physicochemical parameters that were fairly within acceptable limits (Appendices 1 & 2). However, the use of the creek as the only source of water for washing and alimentation may compound a rising problem. Despite the window of life the creek possesses there is an urgent need to regulate land uses along the creek catchments.

This may preserve its use as drinking water and conserve its fisheries.

4. Conclusions

The objective of this research is to investigate the relationship between human inputs and physicochemical variability of Taylor Creek. The result has shown that most of the measured variables were still within stipulated normal ranges. Variability between stations was low, limited to just a few stations and parameters. It may be concluded that lotic waters are hardly impacted by human inputs and Taylor Creek is not under any immediate threat. It is suggested that biological analysis be also carried out to determined ecosystem integrity.

Appendix 1

Natural Water Quality Standard for Human Consumption.

Parameter	Permissible Limit
pH	6.5 – 8.5
Colour (TCU)	15 (Colourless)
Odour (TNU)	3.5 (Odourless)
Taste	Tasteless
Turbidity	1mg/l
Dissolved Oxygen	7.5mg/l

Source: FEPA, 1991

Appendix 2

Suggested permissible physicochemical parameters of water.

S/N	Parameter	International permissible limit
1	pH	7.0 – 8.5
2	Conductivity (us/cm)	400 – 1250
3	TDS (mg/L)	500
4	Turbidity	NS
5	DO (mg/L)	3 – 7
6	BOD5 (mg/L)	4
7	Chloride (mg/L)	200 – 600
8	Alkalinity (mg/L)	100
9	Total Hardness (mg/L)	100 – 500
10	Calcium (mg/L)	75 – 200
11	Magnesium (mg/L)	50 – 150
12	Potassium (mg/L)	10
13	Sodium (mg/L)	120 – 400
14	Phosphate (mg/L)	0.5
15	Sulphate (mg/L)	200 – 400
16	Nitrate (mg/L)	45
17	Amonia (mg/L)	0.5
18	Temperature (0C)	NS

FEPA, 1991. NS – Not stated

REFERENCES

[1] Barbour, K.M; Oguntoyinbo, J.S; Onyemelukwe, J.O.C; Nwafor, J.C. (1982) Nigeria in Maps. London: Hodder and Stoughton.

[2] Ibe, A.C. (1990) Global climate change and the vulnerability of the Nigerian Coastal Zone to Accelerated Sea Level Rise: Impact of response measures. Technical Paper No. 52, Nigeria Institute for Oceanography and Marine Research, Lagos, Nigeria.

[3] Correll, D.L. (1983) N and P in soils and run-offs of three coastal plain land uses. P. 207-224. In R. Lawrence, R. Todd, L. Asmussen and R. Leonard (eds) Nutrient Cycling in Agricultural Ecosystems.

[4] Correll, D.L; Miklas, J.J; Hines, A.H; Schafer, J.J. (1987) Chemical and Biological trends associated with acidic atmospheric deposition in Rhode River watershed and estuary (Maryland, U.S.A.). Water Air and Soil Pollution. 35. 63-86. University of Georgia press. Athens. Georgia.

[5] Jordan, T.E; Correll, D.L; Weller, D.E. (1997c) Relating water discharges from watersheds to land use and stream flow variability. Water Resource Research 33: 2579- 2590.

[6] Nixon, S.W. (1995) Coastal Marine eutrophication: A definition. Social causes and future consequences. Ophedia, 41: 199- 219.

[7] American Public Health Association (APHA, 1985) Standard method for the Examination of water and waste water 16th ed. American Public.

[8] American Public Health Association (APHA, 1998) Standard methods for the examination of water and waste water. 17th edition. American Public Health Association, Washington. D.C.Health Association Washington D.C.

[9] American Public Health Association (APHA, 1995) Standard methods for the examination of water and waste water. 19th edition. Method 5210. American Works Association, Washington. D.C.

[10] Chindah, A.C.; Hart, A.I.; Uzoma, A. (1999) Periphyton associated with submerged macrophytes (Crinium natans) in the upper reaches of the New Calabar River, Niger Delta. J. Agric Biotech. Environ. 1(2): 37 – 46.

[11] Edogbotu, A.J. (1998) The ecological quotient (EQ) of point sources of pollution along Okpoko creek, Port Harcourt. Msc. Thesis. RSUST, Port Harcourt.

[12] Alabaster, J.S; Lloyd, R. (1980) Water quality criteria for fresh water fish. Butterworths, London.297pp.

[13] Clerk, R.B (1986) Marine Pollution. Clarandon Press, Oxford. 210pp.

[14] Chindah, A. C. and Braide, S. A. (2003) Epipelic algal of tropical estuary: Case of stable and invariable seasonal community. *Polish J. of Ecology,* v. 51, n. 1, p. 91-99.

[15] Hynes, H.B.N (1960) The biology of polluted waters. Liverpool University press, Liverpool. 1 – 22.

[16] Federal Environmental Protection Agency (FEPA) (1991) National Interim Guidelines and Standards for Environmental Pollution in Nigeria. Pp 54 – 58

[17] Edokpayi, C.A.; Nkwoji, J.A. (2007) Annual changes in the physicochemical and macrobenthic invertebrates' characteristics of the Lagos lagoon sewage dump site at Iddo, southern, Nigeria. Ecol. Env. And Cons. 13(1): 13 – 18.

[18] Gobo, A. E. (1988) Relationship between rainfall trends and flooding in the Niger Delta- Benue River basin – *J. Meterology* Uk. v. 13, No. 132, p. 220-224, 1988.

[19] Chindah, A. C. and Pudo, J. (1991) A preliminary checklist of algae found in plankton of Bonny River in Niger Delta, Nigeria. *Fragm. flor. Geobot,* v. 36, No. 1, p. 112-126, 1991.

[20] Obunwo, C.C.; Braide, S.A.; Izonfuo, W.A.L.; Chindah, A.C. (2004) Influence of urban activities on the water quality of a fresh water stream in the Niger Delta. Journal of Nigeria Environmental Society 2(2): pp 196 – 209.

[21] Sandison, E.E and Hill, M.B (1966) The distribution of Balamus pallidus (Darwin), Gryphaea gasar Dautzenberg, Mercierella enigmatica (fauvel) and Hydroides uncinata

(Phillipii) in relation to salinity in lagos habour and adjacent creeks. J. Animal Ecology, 35: 235 – 250.

[22] Oyenekan, J.A (1988) Benthic macrofaunal community of lagos lagoon, Nigeria. Nig. J. Sci 21: 45 – 51.

[23] Brown, C.A and Oyenekan, J.A (1998) Temperal variability in the structure of benthic macrofauna community of the lagos lagoon and habour, Nigeria. Pol. Arch. Hydrobio. 45 (1): 45 – 54

[24] Mclusky, D.S. (1989) The estuarine ecosystem 2nd ed. Chapman and Hall, New York.