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Impacts Assessment of Coastal Activities on Water Quality of Upper Segment of Qua Iboe River, Akwa Ibom State, South-South, Nigeria

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ABSTRACT: A study was carried out at the supper segment of Qua Iboe River from November, 2018 to August, 2019 in four sampling stations to assess the impacts of coastal activities on water quality. Water samples were collected monthly and analyzed using standard procedures of Associations of Official Analytical Chemist and American Public Health Association. The stations comparisons and location of significant differences were carried out using ANOVA and Least Significant Difference (LSD) test, while paired sample t-test were employed to compare the seasonal difference. The mean ranged values of water temperature were (25.03 – 25.33^{0}C), pH (5.8 – 6.6 mg/l), DO(3.11 - 5.45 mg/l), TDS (18.63 – 32.53mg/l), EC (8.33-13.16μs/cm), Turbidity (7.61 – 18.32 NTU), TSS (90.80 - 165.63 mg/L), NO_3^{-1}(33.02 – 78.33mg/l), $P0_4^{3-}$(4.44 – 7.39mg/l), Cl^-(43.60 – 63.21mg/l), COD(35.96 – 113.05mg/l), NH_3(0.33 – 0.62 mg/l). Mean values of TSS, EC, TSS, NO_3, PO_4^{3-}, NH_3 and turbidity were higher in wet season, while water temperature, pH, DO, Cl^- and COD values obtained were higher in dry season. Spatial variations in parameters were ascribed to levels of anthropogenic activities and wastes discharged within the stations; the seasonal variations were emanated from influx of wastes, and dilution as result of surface run-offs during wet season. Based on the findings, the WQI values were poor for human consumption; especially from station 2 to 4.These calls for urgent attention by Federal / State Ministry Health and Environment regards to its effects on human health and consistent water quality monitoring should be put into consideration.

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Pollution indeed is a global problem affecting aquatic ecosystems. Aquatic ecosystem contains diverse habitats which supported myriads of species of organisms; served as important sources of water for human consumption (Adeogun and Fafioye, 2011) and as a medium for survival, reproduction, growth of aquatic biota and recycling of nutrients (Jonah *et al*., 2019). Unluckily, the available water quality have been impacted negatively upon by both natural and drastic anthropogenic activities leading to scarcity of good water quality and often impede its ecologically functioning and primary productivity. According to George and Atakpa (2015), water quality may describe based on the physical and chemical characteristics. Continuous dumping of wastes, run-offs from agricultural land-used, municipal run-offs and domestic wastes discharged will keep on deteriorating the water system. However, research had been embarked in Nigeria and identified anthropogenic activities outside and within the coastal areas as a threat to aquatic ecosystems (Obasi and Balogun, 2001; Ekiye and Zejioa, 2010; Irfan and Shakil, 2012; Ayobaham *et al*., 2014; Wanjala *et al.*, 2018 and Jonah *et al*., 2019), thus rendered the water unsuitable for aquatic life. Qua Iboe River is one of the major tropical rainforest river exposed to various anthropogenic activities, which there is need for continuous monitoring of the river in order to report the level of degradation for effective management. Therefore, the objective of this paper is to assessment the effect of coastal activities on water quality of the upper segment of Qua Iboe River, Akwa Ibom State, Nigeria.

MATERIALS AND METHODS

Study area and Sampling stations: The study area was at the Upper Coastal zone of Qua Iboe River, Akwa Ibom State Southern Nigeria. The studied sections of the river, lie within Latitude 05^{0}43' - 05^{0}13'North and Longitude 07^{0}34' - 07^{0}40' East (Figure 1). The river flows in South – Eastern direction towards Atlantic Ocean from Ikwuano Local Government Area of Abia State into Usaka community in Obot Akara Local Government Area, Akwa Ibom State. The study stations were selected according to ecological setting

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and the level of anthropogenic activities. Station 1 (Ikot Amba) is located in Obot Akara Local Government Area; the observed human activities here were bathing and laundry. Station 2 (Ikot Usurua) is located in Ikot Ekpene Local Government Area, 6km away from station 1, the anthropogenic activities here were farming, dredging, washing of motor cycle and laundry. The river at this station also received wastes from municipal through surface run-off. Station 3 (Afaha Ikot Ebak) and station 4 (Ekpenyong Attai) were located in Essien Udim Local Government Area; station 3 is about 4km away from station 2, while station 4 about 3km in a distance away from station 3. The anthropogenic activities observed in these stations include extensive farming, sand dredging, bathing, laundry, loading of sand and other domestic activities.

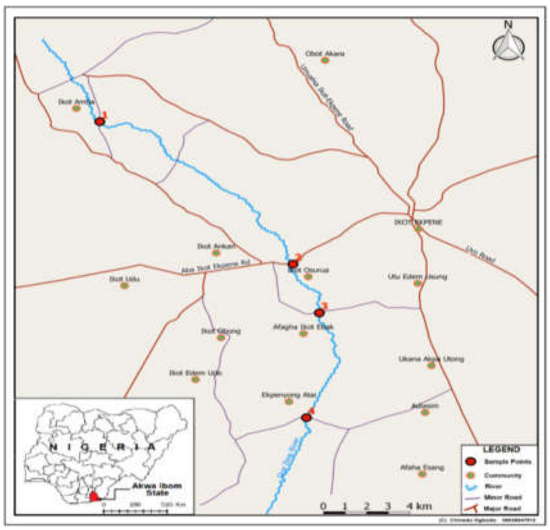

Fig 1: Map of Qua Iboe River showing the sampling stations

Sample collection and Analysis: Water samples were collected from each sampling stations using washed and sterilized plastic bottles. The samples were collected in monthly bases between November, 2018 and August, 2019. Physical parameters (water temperature, dissolved oxygen, electrical conductivity, total dissolved solids, turbidity and hydrogen ion concentration) were determined *in-situ* using Extech Meter Probes (Exstick 11).Other parameters were analyzed *ex-situ*, according to Standard Methods of AOAC (2000) and APHA (2005). Statistical Package for Social Science (SPSS) version 20 was employed to compute the mean and standard error in the data obtained, while test for significant difference ($p<0.05$) among the stations was carried out using one- way analysis of variance (ANOVA), and significant variations were isolated among the stations using Least Significant Difference (LSD) test, while paired sample t-test were used to compare the seasonal difference.

Water Quality Index (WQI) for surface water: Water quality index (WQI) was employed to assess the pollution status of the river per stations for drinking. WQI was calculated by using the Weighted Arithmetic Index method as described by Brown *et al.* (1972) (Table 1). Different water quality concentrations are multiplied by a weighting factor and then aggregated using arithmetic mean. Calculation of quality of water was group into three (3) steps: The first step was to assign each parameteranalyzed a weight (W_i) according to its relative important in the overall quality of water for drinking purpose. In the second step, the relative weight (W_r) was computed using the following equations;

$$W_r = \frac{W_i}{n} \quad (1)$$

Where; Wr = relative weight; Wi = weight of each parameter and n = number of parameters

In step three, a quality rating scale (qi) for each parameter was assigned by dividing its concentration in each water sampled by its respective standard according to the permissible limits of WHO (2011), then multiplied by 100.

$$q_I = \frac{C_1}{S_I}(2)$$

Where; qi = quality rating; Ci = concentration of each parameter; Si = WHO drinking water standards for each parameter. For computing the WQI, the Si is first determined for each parameter, which was then used to determine the WQI sing the following equations;

$$S_I = W_I q_I$$

$$\sum Si = \text{WQI} \ (3)$$

Where; Si =Sub-index of each parameter; qi = rating based on the concentration of each parameter.

Table 1: Classification of water quality based on Weighted Arithmetic WQI method

Water Quality Index value	Water quality status
0 – 25	Excellent
26 – 50	Good
51 – 75	Poor
76 – 100	Very poor
>100	Unsuitable for drinking

***Source**: Brown et al. (1972)*

RESULTS AND DISCUSSION

The summary of spatial mean values of physicochemical parameters obtained during the study period were presented in Table 2, while seasonal variations in range and mean values were presented in

Table 3.The spatial mean values of surface water temperature were observed to be slightly difference across the sampling stations, with no significant difference. High value was recorded during dry season (29.34^{o}C) while wet season value was 25.16^{o}C. The seasonal differences could be attributed to the time and weather conditions during sampling. The rising of atmospheric temperature during the dry season could lead to rising of water temperature values as obtained in this study. This affirms the reports of Sowmyashree *et al.* (2012) that the heat generated during the dry season normally resulted in rising of surface water temperature. The mean values of water temperature obtained were within the permissible limits (24-30^{o}C) of WHO (2011). One-way ANOVA showed significant difference between the seasons ($p<0.05$). The low pH values in station 2 and 4 could be attributed to constant deposition of organic pollutants and dredging activities at the stations. Studies of (Seiyaboh *et al.,* 2013 and Amah-jerry *et al*., 2017) have reported that human activities like dredging and mining of sand could lower the pH levels of water bodies. High value recorded in dry season (8.5 mg/l) could be ascribed to low volume of water to dilute its concentration. In this study, the values obtained in station 2 and 4 were below the acceptable limit (6.5-9.0 mg/l) of WHO (2011) suitable for aquatic life.

Table 2: Spatial mean values of physico-chemical parameters of Upper Qua IboeRiver obtained during the sampling period.

Param.	STN.1	STN. 2	STN. 3	STN. 4	P-value	WHO std
Temp ^{0}C	25.33±0.35	25.26±0.33	25.12±0.45	25.03±0.38	P>0.05	24 - 30^{0}C
pH mg/l	6.6±0.44	5.8±0.15	6.5±0 .11	5.8±0.34	P>0.05	6.5-9.0mg/l
DO mg/l	5.45±0.64a	3.52±0.93^b	3.11±0.31^b	4.6±0.49^a	P<0.05	≥4 mg/l
TDS mg/l	18.63 ±0.43^a	25.33±0.72^b	32.53±0.40^b	28.43±0.68^b	P<0.05	250 mg/l
EC µs/cm	8.33±0.28^a	7.15±0.20^a	11.32±0.54^b	13.16±0.38^b	P<0.05	1500 µs/cm
Tub.NTU	7.61±0.16^a	18.32±0.49^b	12.33±0.70^c	16.38±0.37^b	P<0.05	<5NTU
TSS m/l	90.80±1.33^a	165.63±1.37^b	153.15±1.51^b	158.33±1.12^b	P<0.05	500mg/l
NO_3^{-1}mg/l	33.02±0.13^a	78.33±0.19^b	58.52±0.26^b	62.65±0.31^b	P<0.05	50mg/l
PO_4^{3-}mg/l	4.44±0.83^a	7.39±0.63^b	6.74±0.33^b	7.33±0.68^b	P<0.05	<5mg/l
Cl^-mg/l	55.93±5.80	43.60±6.63	57.79±5.74	63.21±5.11	P>0.05	50mg/l
COD mg/l	35.96±5.63^a	53.28±5.03^a	98.35±6.34^b	113.05±5.36^b	P<0.05	250mg/l
NH_3 mg/l	0.33±0.12^a	0.17±0.28^b	0.53±0.18^b	0.62±0.13^b	P<0.05	0.5mg/l

±=Standard error; mean with different superscript on the same row are significantly difference at p<0.05

Table 3: Seasonal variations in mean values of physico-chemical parameters obtained during the study period

Param.	Wet season range	Dry season range	Wet season	Dry season	t- value
Temp ^{0}C	21.18-23.4	26.3-31.8	25.16 ±0.33	29.34±0 .41	2.913*
pH mg/l	6.2-7.3	6.4 – 8.2	6.0 ± 0.27	8.5±0.36	-2.440*
DO mg/l	3.01 – 5.6	5.33 – 11.4	4.87 ±0.63	8.31±0.42	-4.416*
TDS mg/l	46.18– 53.43	39.33-61.06	46.18±1.13	31.13±1.12	-2.753
EC µs/cm	4.43-18.2	8.72-13.6	16.10±0.46	13.30±0.53	-2.163
Tub. NTU	12.34-17.34	5.8-14.8	17.03± 1.53	6.49±1.02	-4.474*
TSS mg/l	243-300	137-264	360.18±2.13	201.13±2.23	-2.753*
NO_3^{-1}mg/l	55.39– 78.10	41.16-53.12	58.45±0.53	31.39±0.02	-2.782
PO_4^{3-} mg/l	4.10 -24.15	3.9-13.37	12.03±0.39	7.10±0.23	-6.310*
Cl^- mg/l	48.01-88.43	45.16-173.16	89.31±5.64	111.1±5.31	-3.121
COD mg/l	89.39-129.01	137.15-151.14	83.16±4.39	136.41±5.65	-5.319*
NH_3 mg/l	1.62-19.03	1.32-10.46	4.01±0.43	1.10±0.13	-2.339*

*±= standard error; *indicate significant difference at P<0.05*

Dissolved oxygen (DO) had its spatial mean values ranging between 3.11 to 5.45 mg/l. Station 3 had the lowest value of 3.11 mg/l, while station 1 had the highest (5.45 mg/l) followed by station 4 (4.6 mg/l). Seasonal regime recorded higher mean value of 8.31 mg/l in dry season when compare to wet season value (4.87 mg/l). The low means values obtained in station 2 and 3 could be ascribed to high accumulation of organic and inorganic pollutants in the water sample originated from anthropogenic activities. Similar trend were reports by Fakayode (2005) and Adeogun and Fafioye (2011). These authors reported decline of dissolved oxygen concentration from a water sample at a point of organic effluent discharged into water body. The high DO value obtained during dry season may be attributed to low accumulation of organic pollutants, high photoperiod and high intensity of sunlight used by sub-merged green plants for photosynthesis which released dissolved oxygen as a by-product into water body. In this study, ANOVA showed significant difference between the values across the sampling stations; LSD test indicate significant difference between in both seasons ($p<0.05$); the values recorded in station 2 and 3 were below the recommended range (>4) of WHO (2011).

Total dissolved solids (TDS) mean value were higher in station 3 (32.53mg/l); seasonally, higher value were observed in wet season 46.18mg/l when compare to 31.13 mg/l value of dry season. This could be attributed to impact of precipitation which transported dissolved materials from the nearby community and surrounding farmland into the river. The values obtained spatial and seasonal were within the range of WHO (2011). There was no significant difference observed within the stations and in seasons. Electrical conductivity (EC) had its means values range between 8.33µs/cm to 13.32µs/cm. Higher value were recorded in wet season 16.10µs/cm, while the lowest were obtained in dry season 13.30µs/cm.The high value recorded in station 3 could be attributed to dredging activities in the water body. Dredging contributes to the increase in EC value as observed in station 3; similar observations were made by Seiyaboh *et al*. (2013) and Rehman *et al*. (2016).The significant increase during wet season is probably owned to high surface run-off of inorganic dissolved salts into the river. Turbidity had its range between 7.61 NTU and 18.32 NTU, while total suspended solids (TSS) had its range between 90.80 mg/l to 165.63 mg/l. Highest mean value of turbidity was recorded in station 2 (18.32 NTU), while the lowest value of TSS was recorded in station 1 (90.80 mg/l).Higher values of these parameters were recorded in wet season, which maybe traceable to impact of surface run-offs from the immediate environment into the water. Ajibade (2004) and Wakawa *et al*. (2008) reported significant increase in turbidity value in Nigerian rivers. According to the authors, this could be linked to run-offs effects as well as domestic and industrial discharge on the rivers. The finding in this study is deviate from the report of Jonah *et al*. (2019). The authors reported low value of TSS in wet season due to increase in water level resulted in reduction organic debris and allochthonous materials in the water body. Studies have been reported that high values in TSS and turbidity may be attributed to anthropogenic activities like dredging, car wash and abattoir effluents (Ohimain *et al*., 2008; Eni *et al.,* 2014; Aikins and Boakye, 2015 and Amah-jerry *et al*., 2017). The high mean values of turbidity and TSS recorded in station 2 was traceable to anthropogenic activities like dredging and loading of sand in this station. Turbidity values recorded in this study were above the recommended range (<5NTU), while TSS values falls within the range (500 mg/L) of WHO (2011).The mean values of nitrate, phosphate and ammonia were higher in station 2, 3 and 4. These may be traceable to extensive agricultural activities at the banks of the river at these stations. The application of organic and inorganic fertilizer in the farmlands near the river contributed significantly to high value of these parameters as observed in this study. Similar finding was reported by Jonah *et al*. (2019) where nitrate ($N0_3$-) and phosphate ($P04^3$-) values were high from water samples of a river dominated with agricultural activities at the banks. Mandal *et al.* (2012) observed that phosphate contamination emanated from anthropogenic activities including runoffs laden with fertilizer and pesticides. The highest values of these parameters recorded in wet season may be ascribed to surface run-offs from farmlands and waste from the nearby community brought into the river. This trend is in accordance with those reported by Clement *et al*. (2010), but dissonant with the findings of Ibrahim *et al*. (2009).The mean values of these parameters falls above the range acceptable by WHO (2011) exception of $P04^{3-}$ and NH_3 values in station 1. ANOVA showed spatial significant difference between the values of $N0^-_3$, PO_4^{3-} and NH_3 ($p<0.05$) respectively.

Table 4: Water Quality Index (WQI) values of Upper Qua Iboe River

Param.	WHO std	Wi	wr	Relative Rating (qi) stn.1	stn.2	stn.3	stn.4	Sub-index value (S.1=wi X qi) stn.1	stn.2	stn.3	stn.4
Temp.	24-30	4	0.08	101.3	101.04	104.5	100.2	8.1	8.08	8.4	8.0016
pH	6.5-90	4	0.08	85.7	75.3	84.4	75.3	6.8	6.03	6.7	6.02
DO	≥ 4	4	0.08	136.3	88	77.7	115	10.9	7.04	6.22	9.2
TDS	250	4	0.08	7.5	10.2	13	11.4	0.6	0.8	1.04	0.909
EC	1500	4	0.08	0.56	0.47	0.75	0.87	0.045	0.037	0.060	0.070
Tub.	<5	3	0.06	152.2	366.2	246.6	327.6	9.2	21.9	14.8	19.6
TSS	500	4	0.08	18.16	33.1	30.6	31.7	1.45	2.65	2.45	2.53
NO_3^-	50	5	0.10	66.04	156.7	117.04	125.3	6.604	15.7	11.704	12.5
PO_4^{3-}	<5	4	0.08	88.8	147.8	134.8	146.6	7.104	11.8	10.78	11.7
Cl	50	3	0.06	111.8	87.2	115.5	126.4	6.708	5.23	6.93	7.58
COD	250	3	0.06	14.4	21.3	39.3	45.2	0.86	1.27	2.36	2.71
NH_3	0.5	4	0.08	66	114	106	124	5.28	9.12	8.48	9.92
		∑46						WQI 63.6	WQI 89.6	WQI 79.9	WOI = 90.7

The low mean value of chemical oxygen demand (COD) was recorded in station 1 (35.64 mg/l), while the highest value of 113.05 mg/l was obtained in station 4; this is attributed car wash activities in the station. ANOVA showed significant difference between the stations ($p<0.05$). Remarkable high value of this parameter was recorded in dry season is probably due to low volume of water to dilute organicrich wastes concentration. Statistical analysis showed significant difference between the seasons ($p<0.05$). Osibanjo *et al.* (2011) reported high COD values from water sample of Ona and Alaro due to run-offs from dumping sites and farmland. The present finding is in agreement with the reports of Jonah *et al.* (2015) and contradicts with the reports of Jonah *et al.* (2019).

Water Quality Index of Sampling Stations: The range value of WQI is presented in Table 4. Going by the classification of water quality based on weighted arithmetic WQI method, water quality recorded in all the stations are poor which is not fit for drinking purpose. The poor water quality status reflects the pollutants concentration in the water body arising from human indiscriminate dumping of refuse materials, sewage and industrial wastes into the water body. Insecticides and detergent pollutants are basically toxic to water including chemical fertilizers; they have more obvious and severe affects in the constituted waters of river.

Conclusion: The study has shown that the anthropogenic activities and municipal run-off significantly influenced the water quality parameters negatively.The continued discharge of wastes and unlawful activities in the water will keep on deteriorating the water body, making it unsuitable for drinking and for survival of aquatic life; these calls for urgent attention by the Federal Ministry of Environment regarding to its effects on human health. Consistent monitoring of Qua Iboe River to ascertain its portability for drinking and for aquatic life sustainability is recommended.

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