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The Environmental Impact of Etelebou Flow Station In Surface Water of Gbarain, Bayelsa State, Nigeria

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Abstract

Environmental impact of anthropogenic activities from industrial sources, have become a threat to biodiversity. Water samples were collected from rivers around the flow station, and analysed from some physicochemical parameters and hydrocarbon contents. Result of the physicochemistry was reported for: pH (6.58± 0.04 - 6.76±0.01), conductivity (168.30±13.98 - 194.57±3.78 µS/cm), conductivity 8.29±0.04 - 10.66±0.02 NTU, salinity (0.07±0.00 - 0.09± 0.00 mg/l), and Total Solids (83.96±1.49 - 103.66±0.60mg/l). Other elemental analysis includes: sulphates (2.43±0.01 - 4.28 ±0.02 mg/l), nitrates (0.19±0.01 - 0.28±0.01 mg/l), carbonates (1.14±0.07 - 2.06±0.07 mg/l), calcium (8.45±0.10 - 11.70±0.25 mg/l), magnesium (1.14±0.07 - 2.56±0.03 mg/l), and sodium (4.37±0.15 - 5.62±0.03 mg/l). The values of THC and TPH were 0.92±0.08 - 1.51±0.03, and 0.37±0.13 - 0.76±0.07 mg/l respectively. Generally, the result indicated mild level of contamination in terms of Hydrocarbon contents. However, diagnostic data emerging for physicochemistry and some elemental property indicates the water is unfit for consumption. Notwithstanding, the order on contamination were reported as; downstream > midstream > upstream. Therefore this study concludes that there should be frequent monitoring of the recipient water bodies associated with the flow station in order to check anthropogenic activities, and conserve biodiversity.

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Introduction

Over the past decades, the problems posed by Hydrocarbon contamination have become a source of concern. Environmental pollution have adversely affected all forms of biodiversity, infringing on the ambient quality of the abiotic environment such as; soil water and air [1]. As established in literature, consistent exploration of hydrocarbon have incured rapid decline of biodiversity [2]. Statistically, it was reported that Nigeria have recorded over 4000 hydrocarbon spill between 1976 and 1996. In Akwa Ibom, incident of oil spill was quantified to be over 1000000 barrel, posing grave consequences to the coastal environment [3].

Hydrocarbon or crude oil is a homogenous fluid substance with carbon as its massive substantial component. Notwithstanding, the origin of hydrocarbon dwells on two school of thought, being the abiotic theory and the biotic or biogenic theory. The formal believes crude oil originated from inorganic substances, while the latter adduce its origin to anaerobic decomposition of organic matter. As established by Obuasi [4], the biogenic theory was able to prove the presence of porphyrins as a biomarkers of chlorophyll, in samples isolated from hydrocarbon.

As a result of anthropogenic activities associated with the emission of hydrocarbons, including but not limited to; pipeline sabotage, accidental discharge and rupture of pipeline, large volumes of hydrocarbons contaminants are released into the environment. Such releases often pose immediate, or long term ecotoxicological and environmental degradation. The toxicity of hydrocarbon pollutants pose grave consequences to both terrestrial and aquatic environments, thereby affecting keystone biota of the ecosystem [1].

Hydrocarbons are common residual pollutant found in most organic waste around oil and gas exploration facilities [5]. These pollutant are usually transported through runoff, accidental vessels discharge, ruptured pipelines, and even by the act of sabotage [6]. The flow station is in Bayelsa state, which is a wetland with several river, creek and endangered species [1]. The impacts of hydrocarbon exploration and exploitation on biodiversity in the area needs to be quantified. As such, this research have become necessary in order to unravel the potential impact of possible hydrocarbon pollutant in the study area.

Material and Method

Study Area

The Etelebou creek lies along the Gbarain/ Ekpetiama (Central Niger Delta) area of Bayelsa State, Nigeria. The study area is a wetland have two major seasons (dry and wet seasons). It has an elevation of 4 meters above sea level. It is located around the Taylor creek, with geographical coordinates of; latitude 5^{o} 1′ 36.44″, and longitude 6^{o} 16′53″. Gbarain settlement have several communities which includes: Ikpetiama, Agbia, Koroama, Polaku, Obinagha, Nedugo and Ogboloma. Specifically, the Flow Station is located at Ogboloma in Gbarain/Ekpetiama Clan of Yenagoa Local Government Area of Bayelsa State, Nigeria (Figure, 1). The Etelebou Flow Station belongs to Shell Petroleum Development Company of Nigeria (SPDC) is one of the oil fields feeding the Nigeria Liquefied Natural Gas (NLNG), Bonny Island, River State, Nigeria.

Sampling Techniques and Analysis

The triplicate sampling of the surface water from the study area was carried out in 4 stations. Sampling was carried out; upstream, midstream and downstream, including the control station. Physicochemical parameters like; pH and Total dissolved Solid (TDS) were measured *insitu* using portable digital multi-probe meter (EXTECH-DO700). In the same vein, Salinity and conductivity were measured *insitu* using EXTECH-EC400 multi-probe meter, while turbidity and Total Suspended Solid (TSS) were assessed with the EXTECH-TB400 Turbidity meter and Envco-1500 TSS Meter respectively. Other element and nutrients associated with the water were analyzed *ex-situ* in the laboratory.

Analysis of ionic elements were carried out based on the protocol of APHA, [7]. This includes; sulphate, carbonate, calcium, and magnesium by the volumetric titration methods; nitrate was analysed based on the spectrophotometric methods. In addition, sodium and potassium concentrations were quantified by flame photometry methods (Perkin Elmer 5100 PC AA Spectrometer).

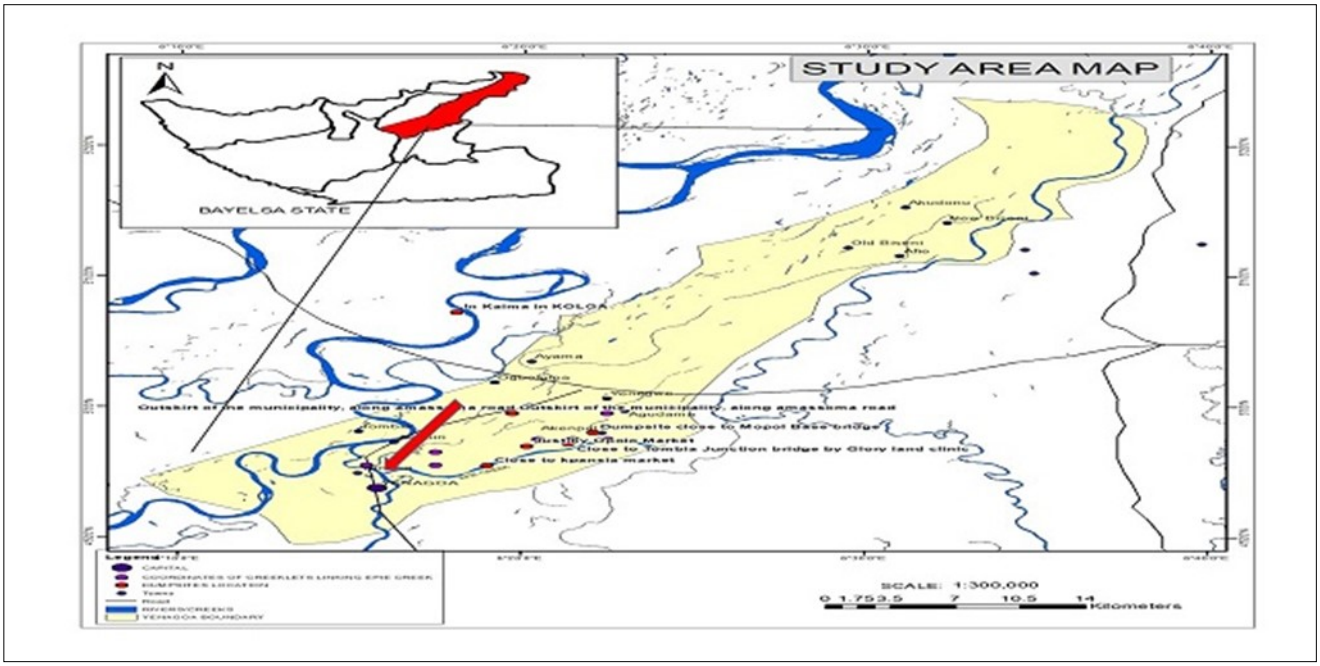

Figure 1. Map of the study area

Table 1. Physicochemical Properties of Surface water from the Study area

	pH	Conductivity (µS/cm)	Turbidity (NTU)	Salinity (mg/l)	TSS (mg/l)	TDS (mg/l)	TS (mg/l)
Upstream	6.70 ± 0.09	168. 30 ± 13.98	8.29 ± 0.04	0.07 ± 0.00	11.29 ± 0.04	72.67 ± 1.45	83.96± 1.49
Midstream	6.76 ± 0.01	176.67 ± 6.49	9.49 ± 0.01	0.07 ± 0.00	12.49 ± 0.01	87.00 ± 0.58	100.94± 0.59
Downstream	6.58 ± 0.04	194.57 ± 3.78	10.66 ± 0.02	0.09 ± 0.00	13.66 ± 0.02	90.00 ± 0.58	103.66± 0.60
Control	6.77 ± 0.02	180.67 ± 0.33	18.68 ± 0.07	0.08 ± 0.00	17.53 ± 0.02	104.00 ± 2.08	221.66± 2.08
WHO Limits	6.50 – 8.50	NS	5.00	600	NS	NS	1500

Data expressed as mean ± standard deviation, NS means not specified limits.

Statistical Analysis

Version 20 of SPSS was the applied statistical tool. One-way Analysis of Variance (ANOVA) was used for the statistical analysis of all emerging data, which graph chart were plotted using 2013 version of Microsoft excel package.

Results and Discussion

Results of the physicochemical properties of the recipient surface water in the study area is presented in Table 1. Results showed that the pH values ranges from 6.58 ± 0.04 - 6.76 ± 0.01, with a slightly higher value of 6.77 ± 0.02 in the control station. The highest pH value was indicated midstream, while the lowest value was downstream. In water quality assessment, lower pH values indicates acidity, compared to higher pH value which reflects alkalinic water. Notwithstanding, the WHO threshold values stipulates pH value 6.50 - 8.50 for safe and potable water. Notwithstanding, the pH values of the water from the study area was almost neutral. Thereby falling within the safe range (6.50 – 8.50), stipulated by World Health Organisation. Result on the conductivity of the water ranges from 168. 30 ± 13.98 - 194.57 ± 3.78 µS/cm (Table 1). The highest conductivity value was indicated downstream compared to upstream which had the lowest conductivity value (Table 1). There is no stated regulatory limit for conductivity. However result of the control had value (180.67 ± 0.33 µS/cm) that was in similar trend with the study area (Table 1).

Result on turbidity of the water sample was in the range of 8.29 ± 0.04 - 10.66 ± 0.02 NTU (Table 1). Comparatively, the control station had higher turbidity value (18.68 ± 0.07 NTU). Meanwhile the highest and lowest turbidity values were indicated downstream and upstream respectively. The World Health Organisation stipulates that the turbidity of potable water should not exceed 5 NTU, as such result indicates that the water is not suitable for drinking purpose. Since water is a universal resource, tolerable limits varies depending on the affected species, therefore the intended use of the water must be put into consideration.

As presented in Table 1, the level of salinity of the water ranges from 0.07 ± 0.00 - 0.09 ± 0.00 mg/l, with control value of 0.08 ± 0.00 mg/l. Furthermore, the highest and lowest values downstream and upstream respectively. The salinity level of the study area was relatively low and within stipulated threshold limit of 600 mg/l (Table 1). The results of Total Suspended Solid (TSS) ranges from 11.29 ± 0.04 - 13.66 ± 0.02 mg/l, with a higher control value of 17.53 ± 0.02 mg/l (Table 1). Results also indicated that highest TSS value was recorded downstream, which lowest TSS value was upstream (Table 1).

The results of Total Dissolved Solids (TDS) ranges from 72.67 ± 1.45 - 90.00 ± 0.58 mg/l, with a higher value of 104.00 ± 2.08 mg/l in the control station (Table 1). Based on spatial distribution, the highest TDS value was recorded downstream. On the other hand, he lower TDS value was recorded upstream (Table 1). Results of Total Solid (TS) ranges from 83.96 ± 1.4 9 - 103.66 ± 0.60mg/l, with a higher value of 221.66± 2.08mg/l in the control station. Also the highest level of total solid was recorded downstream as opposed to a lower value upstream (Table 1). The tolerable limit of total solid in water is 1600mg/l, therefore total solid in the water is in conformance with regulatory limit.

Result of the ionic assessment of the water samples is presented in Table 2. The level of sulphate ranges from 2.43 ± 0.01 - 4.28 ± 0.02 mg/l. Meanwhile the value of sulphate in the control station was 4.66 ± 0.02 mg/l. The reported level of sulphate in this study complied with the regulatory limit (100 mg/l). The highest level of sulphate was recorded downstream, compared to result upstream that recorded the lowest value of sulphate (Table 2). Compared to values of the control station (0.33 ± 0.01 mg/l), the level of nitrate in the study area ranged from 0.19 ± 0.01 - 0.28 ± 0.01 mg/l (Table 2). Also, the highest and lowest values of nitrates were recorded downstream and upstream respectively (Table 2). There is no stated regulatory limit for nitrate, but comparison of spatial values to values of the control station indicate similar trending.

Carbonate ion level ranges from 1.14 ± 0.07 - 2.06 ± 0.07 mg/l with higher value (2.56 ± 0.03 mg/l) in the control station. Notwithstanding, the highest and lowest level of carbonate ion were recorded downstream and upstream respectively. In addition, the regulatory limit of

Table 2. Elemental Properties of Surface water from the Study area

	SO_4 (mg/l)	NO_3 (mg/l)	HCO_3 (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)
Upstream	2.43 ± 0.01	0.19 ± 0.01	1.14 ± 0.07	8.45 ± 0.10	1.14 ± 0.07	4.37 ± 0.15	1.76 ± 0.01
Midstream	3.86 ± 0.02	0.20 ± 0.01	1.43 ± 0.01	9.48 ± 0.10	1.43 ± 0.01	4.63 ± 0.01	1.81 ± 0.01
Downstream	4.28 ± 0.02	0.28 ± 0.01	2.06 ± 0.07	11.70 ± 0.25	2.56 ± 0.03	5.62 ± 0.03	2.21 ± 0.01
Control	4.66 ± 0.02	0.33 ± 0.01	2.56 ± 0.03	12.03 ± 0.37	2.66 ± 0.07	5.66 ± 0.03	2.45 ± 0.03
WHO Limit	100	NS	NS	200	150	NS	NS

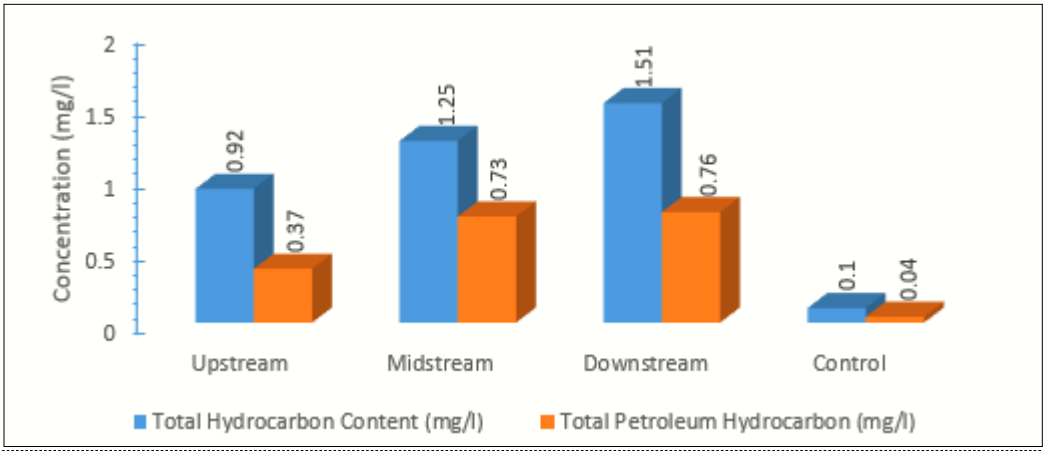

Figure 2. Levels of Total Hydrocarbon and Petroleum Content

carbonate was not specified, but the higher level of carbonate reported in the control station indicates lesser impact of carbonate in the study area (Table 2). The level of calcium (Ca) ranges from 8.45 ± 0.10 - 11.70 ± 0.25 mg/l. In addition, the control station recorded higher value of 12.03 ± 0.37. Notwithstanding, calcium level complied with the allowable limit of WHO (Table 2). The values of calcium was extremely low and conform to the threshold value of WHO (Table 2). Similarly, highest level of calcium was recorded downstream, while the lowest value was reported upstream (Table 2).

The level of magnesium ranges from 1.14 ± 0.07 - 2.56 ± 0.03 mg/l. Meanwhile a higher value (2.66 ± 0.07mg/l) was recorded in the control station. While all values of magnesium complied with regulatory limit of WHO, the highest and lowest levels of magnesium were similarly recorded downstream and upstream respectively. Furthermore the levels of sodium ranged from 4.37 ± 0.15 - 5.62 ± 0.03 mg/l, while the control station had higher value of 5.66 ± 0.03 mg/l. Meanwhile the highest and lowest levels of sodium were recorded downstream and upstream respectively. The levels of potassium was highest downstream and lowest upstream. Notwithstanding, spatial potassium level ranges from 1.76 ± 0.01 - 2.21 ± 0.01 mg/l. No regulatory limit, but potassium level was higher in the control station 2.45 ± 0.03 (Table 2).

Generally the measured concentration of TPH in the study area were low, compared to THC. Notwithstanding, the values of THC ranges from 0.92± 0.08 - 1.51±0.03 mg/l, with a lower value in the control station 0.10 ± 0.00 mg/l (Figure 2). In addition, the levels of Total Hydrocarbon content (THC) was highest downstream and lowest upstream (Figure 2). The levels of Total Petroleum Hydrocarbon ranged from 0.37± 0.13 - 0.76±0.07 mg/l, while the reported value of the control was lower (0.04± 0.00 mg/l). Furthermore, the highest level of TPH was indicated downstream, while the lowest level was upstream (Figure 2). As established, the Nigerian regulatory limit states that the residual concentration of THC in the environment should not exceed 50 mg/l, therefore values reported in this study were quite low and complied with regulatory limit.

As established in literature, Hydrocarbon pollutant in surface water can adversely affect aquatic biota [3, 8, 9], by disrupting their productivity and metabolic rate [10]. Although the extent of adverse effect is largely dependent on the affected specie [11, 12]. The adverse effect can be either directly or indirectly. For instance, when the physicochemical properties of surface water is beyond tolerable limit, biota that depends on such water body are adversely affected. Biota have the ability to directly accumulate hydrocarbon toxicant into their tissues. Fortunately, results of this study generally indicated low degree of contamination, in terms of physicochemical properties of the recipient water body around the flow station.

Result of TPH in our study is very low and in tandem with to values of 0.045 to 0.307 mg/l in the water samples from Algoa Bay showing as reported by Adeniji et al. [13]. On the other hand, higher levels of TPH have been reported by several authors in Africa and other countries around the world. They include Ceuta harbour in North Africa [14], and Musa Bay [15], as well as the Barnegat-Bay-Little Egg Harbor Estuary, located in the United States [16]. Hydrocarbon contaminant sink down to affect sediment as abyssal sink [12].

Conclusion

This study investigated the impact of Etelebou Flow Station on surface water on the Gbarain, axis of Bayelsa State, Nigeria. Fortunately, results indicated very low level of contamination on recipient water bodies around the flow station. The assessed physicochemical parameters were within regulatory limit. The assessed ionic content of the water was low as well. Similarly, the levels of TPH and THC were very low and tolerable. In most cases, physicochemical properties of samples from the control station were even higher. Generally, the order of contamination were reported as; Downstream > Midstream > Upstream. This study concludes that emissions from the flow station should be monitored regularly, in order to avert potential adverse Impacts.

References

1. Angaye, T.C.N., and Abowei J.F.N. (2017). Review on the Environmental Impacts of Municipal Solid Waste in Nigeria: Challenges and Prospects. Greener Journal of Environmental Management and Public

Safety, 6(2), 18 – 33.

2. McOrist, S., and Lenghaus, C. (1992). Mortalities of little penguins (*Eudiptuta minor)* following exposure to crude oil. Vet. Rec., 130, 161.
3. Eze, C. N. (2010). Ecological impact of petroleum hydrocarbon pollution and efficacy of some bioremediation techniques for contaminated arable lands. Ph.D Thesis. University Of Nigeria Nsukka.
4. Obuasi, P. A. (2002). The origin of petroleum, natural gas and coal. Lecture Monograph, Chemistry Department, University of Nigeria Nsukka.
5. Commendatore, M. G., Esteves, J. L. (2004). Natural and anthropogenic hydrocarbons in sediments from the Chubut River (Patagonia, Argentina). Mar. Poll. Bull., 48, 910 –918.
6. Lucas, Z., and Macgregor, C. (2006). Characterization and source of Oil contamination on the Beaches and Seabird Corpses, Sable Island, Nova Scotia, 1996 – 2005. Marine Pollutant Bulletin, 52, 778 - 781.
7. APHA-AWWA-WPCF. Standard methods for the examination of water and waste water (19th ed.). (1995) New York, USA.
8. Long, S. C., Aelion, C. M., Dobbins, D. C., and Ptaender, F. K. (1995). A comparison of microbial community characteristics among petroleum-contaminated and uncontaminated sub-surface soil samples. Journal of Microbial Ecollogy, 30, 297 - 307.
9. Sicilliano, S. D., Germida, J. J, Banks, K. and Greer, C. W. (2003). Changes in microbial community composition and function during a polyaromatic hydrocarbon phytoremediation field trial. Appl. Environ. Microbiol., 69(1), 483 - 489.
10. Kurylenko, V., and Izosimova, O. (2016). Study of the impact of petroleum hydrocarbons on sea organisms. Journal of Ecological Engineering 17(1), 26 – 29.
11. Patin, S. A. (1994). Dobycha oil and gas offshore, eco-logical and fishery analysis. Ryb. Hoz., 5, 16 - 18.
12. Kryuchkov, V. I. (2000). Eksperimentalnye data on the effect of oil pollution on vegetation function sturgeon. Hooks Ekologiya, 1, 1040–1044.
13. Adeniji, A. O., Okoh, O. O., and Okoh, A. I. (2017). Petroleum Hydrocarbon Profiles of Water and Sediment of Algoa Bay, Eastern Cape, South Africa. International Journal of Environmental Research and Public Health.
14. Guerra-Garcia, J. M., and Garcia-Gomez, J. C. (2005). Assessing pollution levels in sediments of a harbor with two opposing entrances. Environmental implications. J. Environ. Manag., 77: 1 – 11.
15. Tehrani, G. M., Hashim, R, Sulaiman, A. H., Sany, B. T., Salleh, A., Jazani, K., Savari, A., and Barandoust, R. F. (2013). Distribution of total petroleum hydrocarbons and polycyclic aromatic hydrocarbons in Musa Bay Sediments (Northwest of the Persian Gulf). Environ. Prot. Eng., 39, 115 – 128.
16. Vane, C. H., Harrison, I., Kim, A. W., Moss-Hayes, V., Vickers, B. P., and Horton, B.P. (2008). Status of organic pollutants in surface sediments of Barnegat Bay-Little Egg Harbor Estuary, New Jersey, USA. Mar. Pollut. Bull., 56, 1802 – 1808.