Water-Soil, Biological Environment and Energy (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/wsbee.2022.010101
ISSN 2616-3764 Vol. 1 Num. 1

ANALYSIS OF PHYSICOCHEMICAL PARAMETERS AND HEAVY METALS IN CRUDE OIL SPILLED CREEKES AND LAKES IN BISENI BAYELSA STATE NIGERIA

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Keywords: Physicochemical Parameters, Crude Oil Spill, Biseni

Abstract: Experimental survey has been advanced on the impact of oil spillage in Greeks and Lakes in Biseni community in Bayelsa State, Nigeria. The analysis which involves the evaluation of physico-chemical parameters and heavy metals was conducted using Atomic Absorption Spectrophotometer and other standard methods, shows that Pb, Cr, Cd and Mn as analyzed trace metals were mostly deposited in Fudonbazuno (Fu) lake at values which exceeded their respective permissible limits when compared with international standards (WHO, US-EPA, NIS and ATSDR). BOD was equally high as it ranges from 195mg/l in AM to 108mg/l in FR. For DO, it was 2.05mg/l in FR to 0.72mg/l in AM, indicating pollution and its trend. Other parameters were also estimated. In general assessment, the Greeks and lake were polluted and should be remediated.

INTRODUCTION

Oil spillage constitute an important environmental problem as it can pollute streams and rivers with a devastating effect on the aquatic environment since the water environment is a delicate one. When spillage occur, the hydrologic force of the river tides, force the spilled crude oil on water to move up into the area of the vegetation with the volatile and quick penetrating viscous properties of crude oil, large areas of vegetation are wiped out (Oteiva 2018). A greater majority of the spilt oil

from on shore usually find its way into the rivers, ocean and stream directly or indirectly where a reasonable fraction mix with water or sink into the sediment causing severe damage to benthic feeders (Partin, 1999). In Dambo (1992) opinion, the resulting hydrocarbon became a pollutant as it impairs the growth and development of marine organism causing fish, crustaceans and others to acquire objectionable odour, sometime leading to the death of flora and fauna. Crude oil is considered to be the most frequent organic pollutant of an aquatic ecosystem (Saadoum 2005). It is noteworthy to mention that this form of incidence is regular in Niger Delta Since the inception of oil exploration and exploitation.

As a marine ecosystem fused in a delicate and complex relationship between organisms and their environment, Niger Delta has a wet land with diverse ecosystem with extensive and impressive fresh water swamp forest, mangrove swamp, rain forest, an ecosystem with rich biological diversity (UNDP 2006, Kadata 2012). It is in this region that Nigeria's largest oil deposit is found making it the main stay of the country's economy as a monolithically structured economy. It is in this environment and region that Biseni Community is located in Bayelsa State, Nigeria. The Biseni Tribe (Biseni) lives in central Bayelsa State, Nigeria. It is a small tribe bordered by the Gbaran to the north and the Zarama and Okordia clans to the north east (Alagoa 2005). Its forest is a fresh water swamp forest located in the north-west of Ahoada and the west of upper Orashi in the Taylor Greek flood plain of the Niger Delta.Located in Biseni is a stretch of water body consisting of four Greeks; Ambisumo, Frazuno, Isigberigbe and Adawarisumo and two Lakes; Nwanba and Fudonbazumo with ponds. In Biseni, both shell petroleum development company (SPDC), and Nigerian Agip Oil Company (NAOC) have producing oil facilities within surblock (OML 27) in Biseni oil field. SPDC has four oil well bores of; Biseni 001, Biseni 002, Biseni 003 and Biseni 004. Biseni – 004-Bis with unique well identifier (UW1) of; 17600200002780 belongs to NAOC as operator within Surblock (OML27) in Biseni oil field. The oil that spilled from Biseni-004-Bis well bore facility into the listed Greeks and Lakes in February 2020 formed the basis of this current research. Researchers have undertaken several works in area of oil spillage and its impact on the water bodies. Oteiva *etal* (2018) studied the effect of crude oil spill on the surface water of the lower Niger Delta (Sombriero River). Examining the impact on physicochemical properties and heavy metals speciation, the work opined that there was effect as some parameters were lighter than the initial conditions of the river. Contributing, Ifelebuegu *etal* (2017), evaluated environmental effects of crude oil spill on the physicochemical and hydro biological characteristics of the Nun Rivers, Niger Delta. The research results of the physicochemical parameters indicated a significant deterioration of the river quality as most were in breach of national and international limit for drinking water. In a general submission, Ayuba (2012) in a study captioned "Environmental impacts of oil exploration and exploitation in the Niger Delta of Nigeria", posited that oil exploration and exploitation has been ongoing for several decades in the Niger Delta and has had disastrous impacts on the environment in the region and has adversely affected people inhabiting that region. Vincent-Akpu *etal* (2015) carried out assessment of physicochemical properties and metal contents of water and sediment of Bodo Greek, Niger Delta, Nigeria. Their findings shows that the parameters were within permissible limits except the mean values of BOD, COD, TH, and Sulfate that exceeded levels permissible for domestic use.

The findings were made through the use of standard methods (APHA 1998) in analytical process. As a closing literature review, Anyalebechi *etal* (2018) carried out a physico-chemical analysis of water from different sources in the Greater Port Harcourt City Development Area (GPHCDA) of Rivers State, Nigeria. using standard method to evaluate eleven (11) parameters of physico-chemical qualities from twenty (20) water samples randomly collected from twenty different points from five (5) different water sources of; pond, borehole, well, water, stream and river, distributed in the (3) different towns of; Igwuruta, Omagwa and Isiokpo. Their findings showed comparatively that the borehole samples expressed values which makes them more desirable than others in the face of poor

water management regime. In this current study efforts were made to investigate the nature of crude oil spill on the physico-chemical parameters and metal load of water bodies of four (4) Greeks and two (2) lakes in Biseni Community in Bayelsa State, Nigeria.

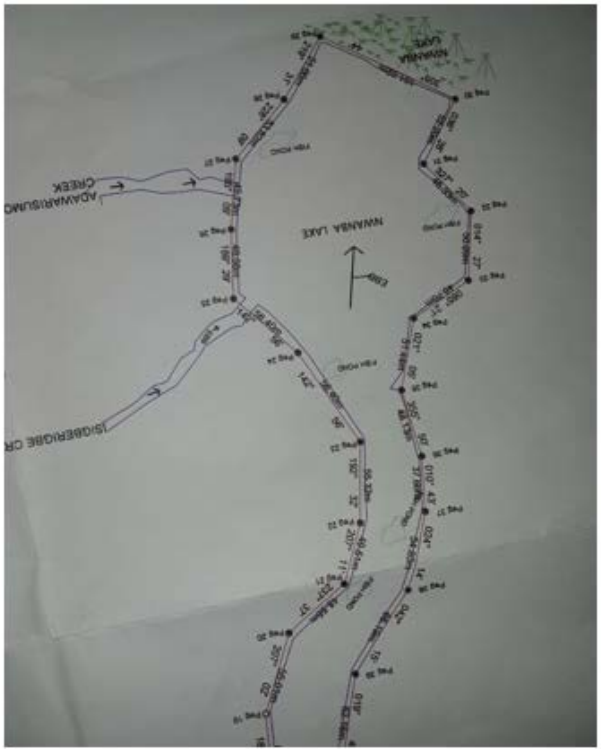
Figures 1 and 2. The crude oil spill on the water in Biseni Creeks and Lakes

MATERIALS AND METHOD

Biseni community in Yenegoa Local Government Area of Bayelsa State, Nigeria is located within $5^{0}14^{1}37$ 1796" Ns and $6^{0}32^{1}3.0834$" EW. The exact concern of this study which was carried out in Feb. 2020 is the behavior of some of the physicochemical parameters and heavy metal load of the four Greeks and two lakes after the impact of oil spillage on the water body from Asambiri Biseni cluster flowing line, lying and situated within the area presented in survey plan no. RV/TMS/2020/SPL001, in origin of; UTM Zone 32N, covering an area of 10, 2762,720 square meters (10,2762,720 hectare) or 25,313 acres. The area span across body of water which encompassed four Greeks and two lakes with several ponds. The Greeks and lakes are; AMBISUMO (AM), FRAZUNO(FR), ISIGBERIGBE(IS) and ADAWARISUMO (AD) (Greeks) and FUDONBAZUNO(FU) and NWANBA (NW) (lakes).

The examination of the physicochemical qualities involved the analysis of sixteen (16) parameters from the four (4) Greeks and two (2) lakes listed above. From each of the six sources, three (3) samples were also randomly taken. Generally, the water samples were taken at a depth of 1.0meter directly in to a clean 2liter bottle. The polypropylene bottles that were rinsed before with deionized water were re-rinsed with the stream water at the site before they were used for collection. Grab samples were collected following guidelines from USGS inter agency field manual for the collection of water quality data. The samples were collected before any other work could be performed at the site to prevent risk of disturbance. Collected samples were taken to the laboratory and analyzed for each of the reported parameters respectively. Protective eyewear and laboratory quality latex gloves were use during collection and preservation of samples.

The metals; Fe, Mn, Pb, Cd and Cr were analyzed using AAS (atomic absorption spectrophotometer) after been prepared by digestion of water (reagent of water – free of analytes) and Nitric acid (ultra-high purity grade) 1.1 dilution and mineralization performed using a Berghof NWS-2 microwave digester. Salinity, Dissolved Oxygen (DO), Biological Oxygen demand (BOD), Nitrate (NO_3), Sulphate (SO_4) and chloride were determined using standard method (APHA, 1998, 2005). In all, parameters were analyzed using standard methods, results obtained in triplicate and reported in mean value. The results were compared with known standards and discussed.



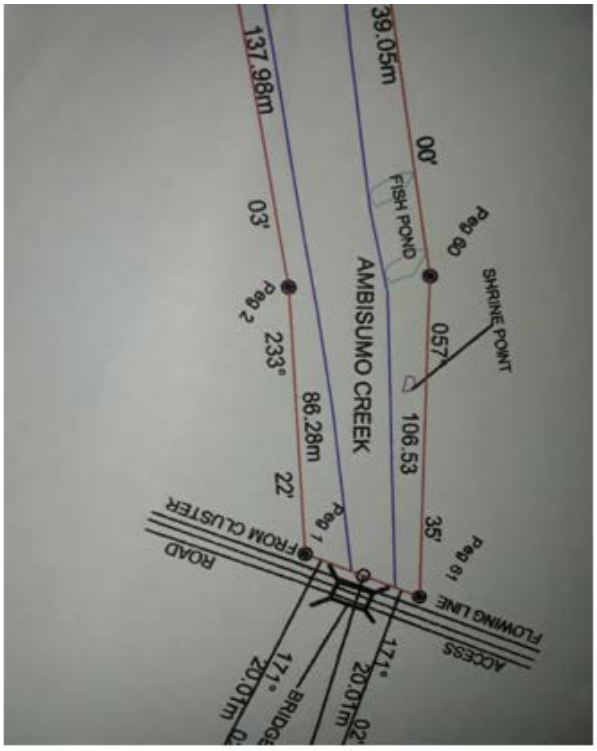


Figure 3 and 4. The survey of the area

RESULT

Table 1: Mean Analysis of Physiochemical Parameters and Heavy Metal of Oil Spilled Lakes and Creeks in Biseni

Sample code	PH Unit	Sal (mg/L)	EC (ms/cm^3)	TSS (mg/L)	TDS (mg/L)	NO_3 (mg/L)	SO_4 (mg/L)	Fe (mg/L)	Mn (mg/L)	Col (mg/L)	Pb (mg/L)	Cr (mg/L)	mg/L DO	(mg/L) BOD	(mg/L) CL	Temp. (^oc)
AD	6.87 ± 0.07	0.04 ± 0.01	87.4 ± 0.08	37.65 ± 0.01	43.7 ± 0.04	1.64 ± 0.00	9.47 ± 0.01	1.60 ± 0.0	0.36 ± 0.00	0.12 ± 0.00	0.21 ± 0.00	0.33 ± 0.00	1.82 ± 0.01	175.0 ± 0.82	63.0 ± 0.82	27.00 ± 0.05
AM	6.78 ± 0.01	0.05 ± 0.01	124.7 ± 0.08	21.48 ± 0.00	62.35 ± 0.04	1.42 ± 0.00	10.53 ± 0.01	1.63 ± 0.00	0.25 ± 0.00	0.11 ± 0.00	0.23 ± 0.00	0.31 ± 0.00	0.72 ± 0.02	195.0 ± 0.82	75.0 ± 0.82	29 ± 0.30
FR	7.61 ± 0.01	0.09 ± 0.01	155.3 ± 0.08	46.27 ± 0.01	77.6 ± 0.08	1.74 ± 0.00	7.54 ± 0.01	1.52 ± 0.00	0.38 ± 0.00	0.17 ± 0.00	1.3 ± 0.00	0.14 ± 0.00	2.05 ± 0.01	108.0 ± 1.63	113.0 ± 0.82	28.00 ± 0.28
IS	6.51 ± 0.09	0.04 ± 0.01	146.42 ± 0.02	48.47 ± 0.01	73.21 ± 0.01	2.62 ± 0.00	5.76 ± 0.01	0.82 ± 0.00	0.42 ± 0.00	0.11 ± 0.00	1.31 ± 0.00	0.19 ± 0.00	0.81 ± 0.00	188.0 ± 1.63	73.0 ± 0.82	28.0 ± 0.27
NW	6.68 ± 0.01	0.03 ± 0.01	159.5 ± 0.02	28.84 ± 0.01	79.75 ± 0.01	1.64 ± 0.00	12.42 ± 0.01	0.68 ± 0.00	0.38 ± 0.00	0.1 ± 0.0	0.83 ± 0.00	0.15 ± 0.00	1.22 ± 0.00	183.0 ± 0.82	93.0 ± 0.82	27.04 ± 0.28
FU	6.46 ± 0.01	0.01 ± 0.01	55.4 ± 0.22	47.3 ± 0.08	27.7 ± 0.11	1.88 ± 0.02	7.48 ± 0.02	3.47 ± 0.02	0.42 ± 0.00	0.37 ± 0.00	1.34 ± 0.00	0.42 ± 0.00	1.46 ± 0.01	185.0 ± 0.82	92.0 ± 0.82	29.7 ± 0.27

Where; AD - ADAWARISUMO, AM - AMBISUMO, FR - FRAZUNO, IS – ISIGBERIGBE, NW – NWANBA, FU - FUNDOBAZUNO

DISCUSSION

In water body analysis, Fudonbazuno (Fu) Lake recorded the highest value in Temperature column with a value of 29.7^{oc} as shown in Table 1. In P^H column it has the lowest value with P^H value of 6.46. For Trace metal, all parameters analyzed were at their optimum value in Fu. We have Chromium (Cr) 0.47 mg/L, Cadmium (Cd) 0.37 mg/L, Lead (Pb) 1.34 mg/L and Manganese (Mn) 0.42 mg/L. Iron (Fe) 3.47 mg/L, was its highest in the Fe parameter column. From the same Fu Lake, some parameters were relatively at the lowest in their column. These are Electrical conductivity (Ec) 55.4 ms/cm^3, Total dissolved solid (TDS) 22.7 mg/L, Sulphate (SO_4) 7.48 mg/L, and salinity (Sal) (0.01PPM).

Nwamba (Nw) Lake had the highest electrical conductivity (EC) of 159.5 mg/cm^3. Highest also in TDS 79.75 mg/L and SO_4 12.42 mg/L. Analyzed parameters which were extreme low in their columns are; Fe 0.68 mg/L, Pb 0.83 mg/L and Cd 0.1 mg/L. In the water body of Frazuno (FR) Creek the P^H was at its highest at 7.01. Also, Sal. 0.09PPM, Chloride (Cl) at a deposit of 113 mg/L and dissolved oxygen (DO) 2.05 mg/L.

In their lowest deposit were Cr, 0.14 mg/l and Biological Oxygen Demand (BOD) 108 mg/l. Ambisumo (AM) Greek is the part of the entire water body that made contact with the flowing line from cluster along the bridge at access road, the oil spill point of entry. Here BOD from the table 1 was highest at 195 mg/l. Other parameters such as Nitrate (NO_3) 1.42 mg/l, Mn 0.25 mg/l, DO 0.72 mg/l and Total Suspended Solid (TSS) 21.48 mg/l were at their lowest. In Isigberigbe (IS) Greek, parameters such as TSS and NO_3 recorded highest values of 48.47 mg/l and 2.62 mg/l in their respective columns. Finally, Adawarisumo (Ad) Greek is one of the Greeks joining the entire river network at Lake Nwanba. Two parameters from table1were at the lowest units in their column. These are temperature (T) 27°C and Chloride (CL) 63 mg/l respectively.

Trace metals analyzed in this work are; Mn, Pb, Cr and Cd. These listed transition metals are classified in US-EPA list as “Hazardous” they have high toxicity with potential for bio-accumulation hence constituting priority pollutants, their solubility tend to increase with the decrease in P^H from the result, they were visibly present in fudonbazuno (Fu) Lake where P^H was lowest at 6.46 P^H unit. Cadnium (Cd) [0.37mg/l - 0.1mg/L] from both the high and low reported concentrations Cd exceed its maximum contaminant level goal of 0.005 mg/l or Allowable limit of 0.003mg/l (ATSDR 1999 and NIS 2015) respectively. At concentration beyond 0.003mg/l Cd is suspected to be toxic to the kidney causing renal dysfunction (NIS). US-EPA (2000b) classified Cd as a probable human carcinogen (group B1), International Agency for Research on Cancer (IARC) classifies Cd as a known human carcinogen. National Toxicology Program (NTP 2004), stated that Cd is known to be a human carcinogen. Chromium (Cr); (0.42mg/l - 0.14mg/l) At both values, Cr, critically exceeded its limit of 0.05mg/L (NIS, BIS and US-EPA). Chromium poisoning is recognized in areas of; gastrointestinal bleeding, hemolysis, coagulopathy, seizures and pulmonary dysfunction (Geller 2001).

Lead (Pb) (1.34mg/l - 0.83mg/l) This range of concentrations of Pb in the river beyond its limits of 0.01mg/l and 0.05mg/l violate the Biological exposure indices (BEI) of American Conference of Industrial Hygienists, (ACGIH), Permissible exposure limit (PEL) of US Occupational safety and health Administration (OSHA 2012a/2012b), US-EPA Lead and Copper rule (2000b) including NIS – 2015, Above the recommended exposure level of 0.01mg/l is said to be carcinogenic and toxic to central and peripheral nervous system and possibly interference with vitamin D metabolism (NIS 2015).

Manganese (Mn): [0.42mg/l - 0.25mg/l], the maximum permissible limit of Mn is 0.2mg/l above which it can cause a neurological disorder (NIS). Maximum Acceptable Concentration (MAC) of Mn is fixed at 0.12mg/l ($120\mu g/l$) in water by Health Canada. At 0.02mg/l Mn in water may affect the

colour or appearance, causing stains on laundry and plumbing fixture. A limit of 0.4 $\mu g/l$ – 10 $\mu g/l$ magnitude was equally established by (ATDR 2000, WHO). Beyond these limits, Mn can cause neurotoxicity, muscular weakness, Parkinson like syndrome, lower limb rigidity, testosterone effect, anorexia and apathy. Effects which are irreversible (Roel H.A. *etal* 1992).

Iron (Fe) range [3.47mg/l –0.68mg/l] the observed range of Iron is above its permitted level of 0.3mg/l (NIS) also, it violates the acceptable concentration of 0.2mg/l recommended by EU Standard 1998 and Romanian Law No. 311/2004. It forms part of many organic and inorganic chelation in water beyond the permissible limit, Fe may cause colouration and Stain in water pipelines and laundry respectively. It is suspected to be harmful to the eye causing conjunctivitis and retinitis.

BOD; The value ranges from [195mg/l - 108mg/l]. Biological oxygen demand (BOD) is a measure of the oxygen used by microorganism to decompose waste. High BOD leads to low dissolved oxygen (DO). This is confirmed from table 1 where in AM; BOD was highest at 195mg/l and DO lowest at 0.72 mg/L and in FR, BOD was lowest with value of 108mg/l and DO highest at 2.05mg/l respectively. At BOD value of 100mg/L and above the water is considered very polluted. Fish and other aquatic lives are at risk and may not survive as BOD will be beyond permissible pollutant level. This was the situation in both the Lakes and creeks in this study.

Close examination of the deposition pattern of trace metals and some other species shows that there was proportionality among the rate of chemical disintegration, physical transport and rate of disappearance. This was in line with the submission of April and parker (2002). Anyalebechi *etal* (2007) explained the above submission through the relation

$$R = \frac{\partial c}{\partial t} + \frac{\cup \partial \cup}{\cup \partial x} \qquad [1]$$

Where U is the drift velocity of the given pollutant (chemical parameters) and R, its rate of disappearance. The disappearance can be via; bio –degradation, evaporation, chelation, complexation, or sedimentation or all. At a constant flow rate of the spilling oil into the river, the above equation is coming to steady state form;

$$R = \frac{udc}{dx} \qquad [2]$$

Where change in concentration of the involved chemical as a function of river distance is proportional to its rate of disappearance. To that end the rate (R) of disappearance becomes more dependent on chemical speciation (Johnson et al 1989) reaffirming Anyalebechi et al (2007) position that “the flow and spread of composite pollutants in rivers is governed by complex physical and chemical process”. The physical factors affect the advection of ambient water in the area of oil discharge given rise to vertical variable in the case of dilution water mixing with the effluent.

The dispersion and transport likely involved centerline concentration which emphasized maximum concentration from the cross section of the plume at a particular time in the flow regime. It is from these perspectives that we will appreciate the pattern of deposition of these analyzed chemical parameters like trace metal from Fundanbazuno (Fu) Lake to Nwanba (NW) Lake and Greeks such as Adawarisumo (Ad).

CONCLUSION

In this study, Biseni lakes; Fudonbazuno and Nwanba and Greeks; Ambisumo, Frazuno, Isigberigbe and Adawarisumo were examined for sixteen (16) parameters in physico-chemical analysis. The electrical conductivity (EC) values lie in the range of 159.5ms/cm^3 in NW to 55.4m/cm^3 in FU. TSS was 48.47mg/l in IS to 21.48mg/l in AM and TDS, 79.75mg/l in NW to 27.70mg/l in FU. It was equally observed in the study that priority pollutants like the analyzed trace metals (Pb, Mn, Cr and Cd) which have high toxicity with potential for bioaccumulation, likely exhibited increases in solubility with decreases in P^H from surface to depth. This probably account for their result in FU

where all the trace metals showed their highest concentrations of; Pb 1.34mg/l, Cr 0.42mg/l, Cd 0.37mg/l, Mn 0.42 mg/l, while the P^H was lowest at 6.46 P^H unit. Again, the dispersion to and at FU could be explained in terms of centerline concentration given its position in the Creeks and Lakes interconnectivity and water flow regime. Similar attention can be paid to the vertical non-uniformity probably exhibited by DO in Frazuno Creek.

Finally with BOD range of 195mg/l in AM to 108mg/l in FR which exceeded permissible limits of all known international standard and those of trace metals which are also above maximum contaminant level, the examined Greeks and Lakes are polluted. Therefore, remediation is required to restore the utility value of the Creeks and Lakes.

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