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Oil Pollution and Its Impact on Water Quality in Ibeno Community

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Abstract

A comparative study on the impact of oil pollution on water quality in both the oil and non - oil bearing communities of Ibeno and Mbo respectively was conducted. The mean concentration of Pb, (0.20 mg/l) Cd (0.1 mg/l), Cr (0.10 mg/l) and Ni (<0.10 mg/l) were above the WHO recommended limits of 0.05 mg/l, (Pb) 0.005 mg/l (Cd), 0.05 mg/l (Cr) and 0.02 mg/l (Ni) for drinking and domestic water quality. The physicochemical properties in both oil (incident zone and non-oil (control zone) trialed below standards. The mean Ph (5.41) for incident zone and Ph (4.73) for control zone were below the recommended range of 6.5-8.5. BOD varied between 0.5 to 20 mg/l in the incident zone and 0.50 mg/l in the control zone. The Dø ranged from 2.7 mg/l to 11.6 mg/l in the incident zone and a mean concentration of 6.4mg/l in the control zone whereas WHO (1993) recommended level is 5 mg/l. Turbidity was higher in all samples above WHO recommended level of 5NTU. The mean values for hydrocarbons (range between <0.003-0.004 mg/l for BTEX were generally below some local and international standards (0.01 mg/l for benzene, 0.7 mg/l for toluene). The regulatory limits (0.0002 mg/l) are stipulated by Department of Petroleum Resources DPR.

Key words: Impact; Oil pollution; Water; Quality; Ibeno; Community

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INTRODUCTION

Environmental pollution arising from spilled crude oil is capable of degrading, altering or forming part of a process of degradation of the quality of any part of the environment.

Such degradation is usually detrimental to the use of that part of the environment by man, animal, fish or plant that is useful to man.

Over the years, activities of the oil industries including mining, oil spills and gas flaring; have impacted disastrously on the land and waters of the oil-bearing communities in particular.

In many villages near oil installations, even when there has been no recent spill, an oily sheen can be seen on the water, which in fresh water areas is usually the same water that the people living there use for drinking, cooking and washing. In April 1997, samples taken from water used for drinking and washing by local villagers were analyzed in the U.S. A sample from Luawii in Ogoni, where there had been no oil production for 4 years, had 18×10^{-6} of hydrocarbons in the water, 360 times the level allowed in drinking water in the European Union (EU). A sample from Ukpeleide, Ikwerre, contained 34×10^{-6}, 680 times the E.U. Standard (Nwilo & Badejo, 2005).

When there is an oil spill on water, spreading immediately takes place. The gaseous and liquid components evaporate. Some get dissolved in water and even oxidize, and yet some undergo bacterial changes and eventually sink to the bottom by gravitation. The soil is then contaminated with a gross effect upon the terrestrial life.

This work therefore sought to assess the impact of oil spill on the physicochemical properties of heavy metals and hydrocarbon concentrations in water in the oil bearing communities of Ibeno LGA of Akwa Ibom State.

1. OBJECTIVE OF THE STUDY

The specific objectives of this research work were:

(a) To investigate the effect of oil spill on the physicochemical properties of water.
(b) To assess the concentration of heavy metals and hydrocarbons in the spill environment.
(c) To compare results with international standards and make recommendations.

2. MATERIAL AND METHODS

2.1 Water Sampling

Water samples were collected from different sources within Ibeno LGA (i.e incident or oil spill zone) and Mbo LGA (i.e control or non oil spill zone) of Akwa Ibom State. The water sources were boreholes, well, pond and streams. Within the incident zone, samples were collected from 2 boreholes (marked B_1 & B_2), 2 wells (marked W_1 & W_2), 2 ponds (marked P_1 & P_2) and 2 streams (marked S_1 & S_2).

Within the control zone, samples were collected from 1 borehole (marked Wb), 1 well (marked Cb), 1 pond (marked Cp) and 1 stream (marked Cs).

Samples were collected into different glass or plastic containers and stored accordingly. Samples for various analyses were collected into appropriate containers and adequately labeled and preserved in accordance with standard practice. They were taken to the laboratory for analyses.

2.2 Parameters Analyzed and Methods Used

Various analytical methods were employed for the following parameters: physicochemical (pH, TDS, BOD, TSS, Turbidity, EC, colour), Heavy metals (Fe, Cd, Pb, Ni, Cr, V) and Hydrocarbons (i.e BTEX and Polycyclic aromatic hydrocarbon (PAH))

Either of these methods was used for each analysis.

ASTM = American society for testing and materials (1999 edition).

APHA = American Public Health Association (20th edition, 1998)

USEPA = United State Environmental Protection Agency

3. RESULTS AND DISCUSSION

The physicochemical, heavy metals and hydrocarbon contents of water samples from different sources are presented in Table 1, 2 and 3 respectively. The standards including World Health Organizing (WHO, 1993), Environmental Guidelines and Standard for Petroleum Industry in Nigeria (EGASPIN, 2002, USEPA (2001), EEC (1998), FEPA (1991), World Average (Turekian, 1977) and concentrations in fresh water (Pais & Jones Jnr, 1977) are also included.

Table 1
The Physicochemical Concentration on Water Sources in Oil Polluted Zones of Akwa Ibom State

Parameter	Incident zone								Mean	Control zone				Mean
	B_1	B_2	W_1	W_2	P_1	P_2	S_1	S_2		Cb	Cw	Cs	Cp	
Physicochemical														
pH	6.81	7.3	6.83	6.19	4.42	4.6	3.26	3.84	5.41	7.1	4.24	3.26	4.32	4.73
BOD (mg/l)	20	<0.50	20	20	<0.50	<0.50	<0.50	20	10.25	<0.50	<0.50	<0.5	<0.50	0.50
COD (mg/l)	31.6	<0.80	30.7	31.1	<0.80	<0.80	<0.80	28.5	15.64	<0.80	<0.80	<0.50	<0.80	0.73
DO (mg/l)	3.1	11.6	4.0	2.7	5.2	6.1	0.8	1.9	4.43	5.2	6.7	4.1	6.2	5.55
TSS (mg/l)	52	15	11	81	35	47	29	12	35.25	16	17	16	32	20.23
Turbidity (NTU)	21	12	11	62	21	10	23	11	21.24	12	11	10	36	17.25
Colour (Pt-co unit)	138	89	97	521	116	115	200	141	177.13	62	34	80	277	100.75

Table 2
Heavy Metal Concentration in Water Sources From Oil Polluted Zones of Akwa Ibom State

Parameter	Incident zone								Mean	Control zone				Mean
Heavy metals	B_1	B_2	W_1	W_2	P_1	P_2	S_1	S_2		Cb	Cw	Cs	Cp	
Lead (mg/l)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20
Calmium (mg/l)	0.16	0.13	<0.02	0.10	0.23	<0.02	<0.02	0.19	0.12	0.14	0.02	<0.20	<0.20	0.14
Total Iron (mg/l)	<0.05	<0.05	0.75	<0.05	0.18	0.14	0.13	0.07	0.18	<0.05	0.05	0.19	<0.02	0.05
Total Cromium (mg/l)	<0.10	0.11	<0.10	0.13	0.11	<0.10	0.10	0.13	0.11	0.11	0.11	0.13	<0.10	0.11
Nickel (mg/l)	<0.10	<0.10	<0.10	0.10	0.16	<0.10	0.2	0.19	0.13	<0.10	<0.10	0.07	0.41	0.20
Vanadium (mg/l)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Table 3
Hydrocarbon Concentrations in Water Sources From Oil Polluted

	Incident zone								Mean	Control zone			
Parameter	B_1	B_2	W_1	W_2	P_1	P_2	S_1	S_2		Cb	Cw	Cs	Cp
Hydrocarbon (Btex)													
Benzene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003		<0.003	<0.003	<0.003	<0.003
Toluene	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004		<0.004	<0.004	<0.004	<0.004
Ethybenzene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003		<0.003	<0.003	<0.003	<0.003
Xylene	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004		<0.004	<0.004	<0.004	<0.004
(PAHs)													
Acenaphthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Acenathylene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Anthracene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Benzo(a) anthracene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Benzo(a) pyrene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Benzo(b) fluoranthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Benzo(k) fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
Chrysene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Benzo(ghi) perylene	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03		<0.03	<0.03	<0.03	<0.03
Naphthalene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Pyene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Dibenzo(ah) anthracene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Fluoranthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
Indeno(1,2,3-cd)pyrene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02
TOTAL	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

In Table 1, a comparison shows that the mean concentration of pH (5.4) for the incident zone and pH (4.73) for the control zone was not within the range of 6.5-8.5 recommended by WHO (1993) for drinking water. This acidic nature is attributed to decompose vegetative materials and the resulting humic acid in such environment (Hems, 1992; Offiong & Edet, 1998; DeZuane, 1997). The decomposed vegetative materials were responsible for the enhance concentration of colour in all the samples (incident) and Cb and Cp (control zone).

The mean dissolve oxygen (DO) values for the incident (4.43) are not within the recommended WHO (1993) limit of 5min and FMENV (1991) limit of 7.5min for drinking water. The low DO level could be attributed to decompose materials.

Within the control zone, the mean dissolved oxygen value (5.55) was also slightly not within the recommended FMEN (1991) and WHO (1993) limits.

The mean concentrations of other physicochemical parameters including turbidity (21.3 NTU) for the incident and (17.2 NTU) for the control). BOD (10.25 mg/l) (for the incident and (0.50 mg/l for control) etc.; are not within WHO (1993) limit for drinking water.

The concentration of heavy metals is as shown in Table 2. The mean concentrations of Pb, Cd, Cr and Ni were above the WHO recommended limits of 0.05 mg/l, 0.005 mg/l, 0.05 mg/l and 0.02 mg/l respectively for Pb , Cd, Cr and Ni for drinking water and domestic water quality. The concentration of Pb is within the range of concentration in fresh water of 0.01-5.6 for Pb.

The concentration of Fe at two locations (W_1 and P_2) was higher than the WHO (1993) recommended limits of 0.03 mg/l for drinking water quality.

The sources of these heavy metals (Pb, Cd, Cr, Ni) were attributed to the fact that the aquifer is very shallow and hence proximity to the land surface and couple with the fact that the ground water flow direction is generally from hinterland in the North to the coastal area in the South, thus making the groundwater vulnerable to heavy metal pollution (Longe & Enekwechi, 2007; Nouri et al., 2006). In addition, the enhanced concentration may also be attributed to metal leaching from garbage and solid waste dumps (Bubb and Lester, 1991, Ntekim et al., 1993) into the groundwater system in the hinterlands before being transported to the coastal areas.

It may also be attributed to metal from domestics, industrial and port waste (Valdes, 2011).

In Table 3, the mean concentrations between BTEX including benzene, toluene, ethylbenzene, and Xylene, ranged from 0.003 to 0.004 mg/l. the concentrations of polycyclic Aromatic Hydrocarbons (PAHs) and ∑ PAHs averaged <0.02 mg/l and <0.36 mg/l for the incident and control zones. These values of hydrocarbons were below the regulatory limits of 0.002 mg/l stipulated by DPR (EGASPIN, 2002).

CONCLUSION

Environmental pollution arising from spilled crude oil is capable of degrading, altering or forming part of a process of degrading of quality of nay part of the environment.

In respect of the groundwater environment, the present study has shown that the mean colour and turbidity concentration values for the incident and control zones are not within the recommended WHO (1993) limits of 50 Pt-Co unit for colour and 5NTU for turbidity for drinking water.

The concentration of Pb, Cd, Cr, and Ni, were higher than the target and intervention values set for petroleum industries in Nigeria (EGASPIN, 2002). Sources of these heavy metals may be attributed to indiscriminate waste disposal, abandoned boats etc and metal leaching from garbage and solid waste dumps (Bubb & Lester, 1991; Ntekim et al., 1993).

The hydrocarbons were not within the detection limits of the equipment.

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