CHAPTER 14

A CASE STUDY OF EFFECTS OF INCESSANT OIL SPILLS FROM MOBIL PRODUCING NIGERIA UNLIMITED ON HUMAN HEALTH IN AKWA IBOM STATE

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Abstract

On 12th January 1998 the 24 inches Idoho Production Platform – Qua Iboe Terminal (QIT) high-pressure pipeline belonging to Mobil Producing Nigeria Unlimited (MPNU) ruptured, releasing about 40,000 barrels of Qua Iboe Light (QIL) crude oil into Akwa Ibom State coastal waters in the Atlantic Ocean. The crude oil spread fast on the surface of the water forming oil slicks on the sea and estuaries and on 25th January 1998, the crude oil was seen on the waters of Lagos Lagoon, thus traversing the entire Nigerian coastline. MPNU management reported this oil spill as the largest oil spill ever recorded by the company in all her years of crude oil exploration and production. At the end of December 1998, about 18 other oil spill cases were recorded to have occurred from MPNU facilities, representing about 3 oil spill cases every 2 months. According to residents of oil producing communities in Akwa Ibom State, oil spill cases occur from MPNU facilities almost weekly. There were reports of unprecedented increases in incidences of diseases, and residents of coastal communities expressed fears about possible health hazards arising from these incessant oil spills in the state. Studies carried out confirmed the fears of the coastal dwellers. Including biodiversity reduction unknown human infections, other Respiratory diseases and social disharmony.

Keywords: Crude oil, Oil spill, Qua Iboe light, Impacts on health, Diseases

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1.0 Introduction

The 1998 and 1999 annual medical reports submitted by Primary Health Care Co-ordinators from the LGAs showed increased incidences of diseases in Akwa Ibom State compared to previous years. Malnutrition and associated nutritional disorders were rampant. Skin diseases and complaints of general weakness, itchy eyes, stuffy nose and difficulty in urination persisted. From the experience, the symptoms listed above were feared to be due to hydrocarbon pollution. This fear was widely expressed by individuals and health workers in Akwa Ibom State to be due to the MPNU oil spill of 12th January, 1998.

On 12th January, 1998 the 24 inches Idoho Production Platform – Qua Iboe Terminal (QIT) high pressure pipeline belonging to Mobil Producing Nigeria Unlimited (MPNU) ruptured, releasing about 40,000 barrels of Qua Iboe Light (QIL) crude oil into Akwa Ibom State coastal waters in the Atlantic ocean. The crude oil spread fast on the surface of the water, forming oil slicks on the sea and estuaries and on 25th January, 1998 (about 14 days after the spill) it was reported that the crude oil was seen on the waters of Lagos Lagoon, thus traversing the entire Nigerian coastline. MPNU management therefore reported this oil spill as the largest oil spill ever recorded by the company in all her years of crude oil exploration and production (E & P) – activities.

MPNU (the spiller) among other things quickly activated its oil spill contingency plan (OSCP) to clean up the crude oil. Crude oil dispersants were used, among other technologies, to clean up the oil spill. This, according to Odiette (1999) caused the sinking of heavier particles of crude oil ("tar balls") to the seabed sediments thus leading to persistence of the crude oil in the marine environment. It is also known that the crude oil dispersants are toxic at varying levels.

At the end of December 1998, about 18 other oil spill cases were recorded to have occurred from MPNU facilities, representing about 3 oil spill cases every 2 months. According to residents of oil producing communities in Akwa Ibom State, oil spill cases occur from MPNU facilities almost weekly.

The toxicity of the dispersants coupled with the toxicity of the crude oil and its components to aquatic resources complicates the problems of incessant oil spill cases from MPNU facilities. This led to the pollution of our sensitive and fragile mangrove swamp ecosystems and the associated creeks and rivers and the consequent pollution of aquatic resources that are the cheap and easily available sources of protein to the coastal

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(rural) dwellers in Akwa Ibom State. This led to death of fish larvae and juveniles and other seafoods in particular, and reduction in fish and shellfish stock in general; thus leading to scarcity of aquatic resources. This problem led to protein energy malnutrition and associated nutritional disorders.

This poor nutritional status of the victims then predisposed them to infection and attack. Moreover, the sources of livelihood of the residents of not only the coastal communities but also all those that depend on the sales of aquatic resources, even in the hinterland, were destroyed. Anxiety and stress-related health problems became rampant in our communities.

In addition to the above, residents continuously come in contact with the spilled crude oil through the following avenues:

(a) Consumption of the contaminated aquatic resources, which have the capacity to bioaccumulate and biomagnify these pollutants in their lipophillic tissues.
(b) The crude oil coming in contact with their skin during boating, bathing or while fishing.
(c) The inhalation of volatile components of the crude oil.

Following the oil spill was a nationwide assessment of damages of nets and other fishing gears/implements caused by the said oil spill in May 1998 and payment of "compensations" to the "affected individuals" by MPNU in about August 1998. In the assessment team were medical personnel, who carried out Health Risk assessments of the MPNU oil spill of 12th January 1998 on human health. Efforts are not made by MPNU to mitigate the impacts of these incessant oil spills on human health.

More than one year after the oil spill of 12th January 1998, there were reports of unprecedented increases in incidences of diseases, and fears were expressed by residents of coastal communities about possible health hazards arising from the oil spill in the state. Moreover, the poverty and literacy levels of the residents particularly in our coastal communities coupled with the general dearth of medical facilities in the state predisposed the residents to self-medication and quackery. This explains why the vast majority of health problems in the state occasioned by the oil spill go unreported and most illness are self-treated or treated by local herbalists (Moffat and Linden, 1995).

This book chapter documents the effects of incessant oil spills from MPNU facilities on the health of the people of Akwa Ibom State of Nigeria in particular and the impact of the said oil spill on the Akwa Ibom State environment in general.

2.0 Major Oil Spill Incidents in Nigeria

Major oil spill incidents in Nigeria between 1976 and 1998 are summarized in Table 1.0. However, the environmental components and impacted indicator employed in the determination of the impact of the said MPNU oil spill on the environment is presented in Table2.0.

3.0 Results

3.1 Field Observations and Findings

The following were the field observations and findings of the impact of MPNU oil spill of 12th January 1998 on the environment in general and human health in particular during the study visit to all the Local Government Areas of Akwa Ibom State, about 2 years after the spill.

(i) Wherever the team visited, the residents spoke overwhelmingly on the impacts of the MPNU oil spill on their environment in general and human health in particular. On the whole, the impacts of the MPNU oil spill were seen to be enormous on the residents.

Table 1.0: Oil Spill Incidents in Nigeria from 1976 – 1998.

Year of Spill	Number of Incidents	Volume of Spill (bbc)
1976	128	26.157
1977	104	32.879
1978	154	489.294
1979	157	694.117
1980	241	600.511
1981	238	42.722
1982	257	42.841
1983	173	48.351
1984	151	40.209
1985	187	11.877
1986	155	12.905
1987	129	31.866
1988	208	9.172
1989	195	7.628
1990	160	14.941
1991	201	106.828
1992	367	51.132
1993	428	9.752
1994	515	30.283
1995	417	63.677
1996	430	46.353
1997	339	59.272
1998	390	98.345
TOTAL	5724	

Source: Dublin – Green *et al*, 1998.

(ii) About two years after the MPNU oil spill, tar balls were seen along the entire stretch of the Akwa Ibom State shoreline. This is an indication of heavy pollution of the shoreline by the MPNU oil spill. The presence of tar balls on the beaches and shoreline is an indication of the fact that the MPNU oil spill on the shoreline will persist for some years.

(iii) Apart from the presence of tar balls, the continuous input of unpublicized oil spills into the AKS coastal waters will contribute to health risks on the residents.

(iv) There were clear evidences of the impact of the MPNU oil spill on the mangrove plants along the Akwa Ibom State shoreline. The oiling level indicated by scarcity of oysters on the mangrove plants is evident, about 2 years after the spill.

(v) Most individual victims of the MPNU oil spill were heard complaining of non-payment of adequate compensation for destruction or loss of fishing gears. These poor artisanal fishermen could not go back to fishing due to lack of capital base to acquire new fishing gears.

TABLE 2.0: Environmental Components and Impact Indicators

S/N	Environmental Components	Environmental Impact Indicators
1.	Air Quality	Particulate matter (SPM), NOx, SOx, CO_2, CO, VOC, etc.
2.	Water Quality (Surface Water)	Total solids (Dissolved solids, suspended solids); turbidity, other physico-chemical and microbiological characteristics. Aquatic toxicity tests, seabed sediment, physico-chemical / microbiological characteristics.
3.	Fisheries / Hydrobiology	Diversity, Abundance, productivity, catch/yield of fishes. Fish tissue analysis. Qualitative and quantitative information on benthos.
4.	Relief / Hydrology	Drainage / Discharge, Hydrologic balance, sedimentation, erosion, topography.
5.	Geology / Hydrogeology	Stratigraphical / Lithologic characteristics, ground water level and ground water quality (Physicochemical and microbiological characteristics).
6	Soil / Land Use	Soil type and structure, physico-chemical and microbiological characteristic land use types, recreational, industrial, agricultural, residential, institutional and commercial.
7.	Vegetation / Forestry	Species checklist, characterization of plant pollution, taxonomy, diversity and productivity load, locations and characteristics. Identification of types and economic importance of trees in the study area.
8.	Wildlife	Identification of wildlife types, parks, estimate population, behavioral pattern and habitat requirement; endangered species and ecological interactions.
9.	Noise / Vibration / Radiation	Ambient noise level, exposure limits of impulsive and persistent noise generated in the environment, the proximity of noise sources to human and ecological habitants; day and night disturbance, hearing loss communication interference.
10.	Health Risk Assessment	Health risks, public health and medical services, water supply and demand, analysis of medical records.
11.	Community/Socio-Economic Assessment	Needs and concern of host communities. Data on settlement, man-made features, socio-economic / historical sites, population, income, recreational facilities, social organizations and institutions, occupation and employment structure, culture, heritage, etc.

Source: FEPA, 1995

(vi) Owing to the loss of biodiversity and the subsequent reduction in catch per unit effort of the fishermen and partly due to non-payment of adequate compensation occasioned by the MPNU oil spill, most residents that hitherto were fishermen had abandoned fishing. This loss of source of livelihood had resulted in mental agony, stress and anxiety – related health problems.

(vii) Loss of biodiversity due to the high mortality of the fish and aquatic resources were evident by sizes of fish caught in the inland waters of the AKS shoreline. The drastic decline in catch per units effort reported by the fishermen is also clear indication of the adverse impact of the MPNU oil spill on fisheries in Akwa Ibom State in particular and Nigeria in general.

(viii) The eating habit of the residents of Akwa Ibom State is such that no one can do without eating substantial quantities of food aquatic sources every day. Every one in Akwa Ibom State eats crayfish and fish on a daily basis. Most others (especially from the low income class) eat in addition periwinkle and other shellfishes like water snails, whelk, oysters, etc.

(ix) Shellfishes (e.g. periwinkles, oysters, whelk, etc.) are filter feeders and can bioaccumulate toxic substances in their lipophilic tissues.

(x) Residents of coastal communities and most other consumers of aquatic resources complained of fish tainting due to the MPNU oil spill. Also, there has been a growing fear of contamination of the aquatic resources and the likely subsequent causation of sicknesses by the consumption of these contaminated aquatic resources. These led to loss of market confidence in fishes and aquatic resources from Akwa Ibom State coastal waters. A few people restrained themselves from further consumption of aquatic resources from the coastal waters.

(xi) An unprecedented level of malnutrition especially among children of school age was observed in the state generally and coastal communities in particular. This may have informed the launching of the Child Nutrition Programme by the wife of the Executive Governor, Her Excellency, Mrs. Allison Attah in Akwa Ibom State.

(xii) Apart from malnutrition, skin diseases were found to be prevalent in Akwa Ibom State, mostly on the exploiters of aquatic resources and divers in the coastal waters.

(xiii) In addition to malnutrition and skin diseases, unprecedented increases in some disease conditions like persistent cough, weakness, stuffy nose, itchy eyes and difficulty in urination were observed in victims. These are related to impact of oil spills.

(xiv) All environmental components including human health, namely: Air quality, water quality, fisheries/hydrobiology, soil/land use, vegetation/forestry, wildlife, socio-economics, etc were found to be grossly impacted by the MPNU oil spill of 12th January 1998, as against MPNU reports of no impact on any environmental component.

3.2 Tar Balls Accumulation at the Beaches

About years after the MPNU oil spill of 12th January 1998, tar balls density on the beaches were found to be quite high. Generally, tar balls accumulation along the Akwa Ibom State shoreline ranged from 360 – 520 grams per square meter.

3.3 Results of Total Hydrocarbon and Heavy Metals Content of Water and Aquatic Resources

3.3.1 Total Hydrocarbon Content (THC) and Heavy Metals in Water Samples

The results of analysis of water samples for THC and heavy metals are as presented in Table 3.0

The THC and heavy metals analyzed except Iron (Fe) were below detectable limits. Iron content of water samples ranged from 0.65mg/L to 3.01mg/L depending on sampling locations.

3.3.2 THC and Heavy Metals in Sediment Samples

The THC and heavy metals in seabed sediment samples from various designated sampling locations along the Akwa Ibom State shoreline are as presented on Table 4.0

The THC was found to be highest in seabed sediment from Ibeno beach (212.3 mg/kg), followed by Oron (157.9 mg/kg) and Mbo (107.4 mg/kg). The heavy metals content of seabed sediments from Akwa Ibom State shoreline were found to be highest in samples from Ibeno beach followed by Mbo beach samples.

3.3.3 THC and Heavy Metals in Tilapia Fish Samples.

The Table below (Table 5.0) presents the results of THC and heavy metals in Tilapia fish samples taken from the designated sampling locations along the Akwa Ibom State shoreline.

The THC content was highest in fish sampled from Ibeno shoreline followed closely by samples obtained from Eastern Obolo and Mbo shorelines. The heavy metals content did not follow any specific trend.

3.3.4 THC and Heavy Metals Content in Periwinkle Samples from Akwa Ibom State Shoreline.

The THC and heavy metals content in periwinkle samples from mangrove swamps along the Akwa Ibom State shoreline at the different sampling stations are as shown on Table 6.0

THC was found to be highest in periwinkle samples from Eastern Obolo mangrove swamp followed by periwinkle from Ibeno mangrove swamp. The heavy metals content of periwinkles was found to follow the same trend as the THC: Eastern Obolo > Ibeno > Mbo > Oron.

Table 3.0: THC and Heavy Metals Content of Water Samples from Akwa State Shoreline

Parameter	Results			
	A*	B*	C*	D*
THC (mg/L)	<1.00	<1.00	<1.00	<1.00
Lead (mg/L)	<0.20	<0.20	<0.20	<0.20
Nickel (mg/L)	<0.10	<0.10	<0.10	<0.10
Copper (mg/L)	<0.05	<0.05	<0.05	<0.05
Iron (mg/L)	0.65 ± 0.02	2.90 ± 0.21	3.01 ± 0.40	0.82 ± 0.03
Vanadium (mg/L)	<0.20	<0.20	<0.20	<0.20
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02

*Source: Field Survey, 2000; *A, B, C, D were samples from the four designated sampling stations.*

Table 4.0: THC and Heavy Metals Content of Seabed Sediments Along Akwa Ibom State Shoreline.

Parameter	Results			
	A	B	C	D
THC (mg/kg)	157.9	107.4	212.3	78.5
Lead (mg/kg)	0.32	0.51	0.73	0.40
Nickel (mg/kg)	0.87	1.53	2.64	1.03
Copper (mg/kg)	0.18	0.25	0.38	0.21
Iron (mg/kg)	327.36	533.57	704.08	411.42
Vanadium (mg/kg)	0.30	0.55	0.79	0.42
Cadmium (mg/kg)	0.06	0.11	0.15	0.08

Source: Field Survey, 2000

Table 5.0: THC and Heavy Metals in Tilapia Fish from Designated Sampling Locations Along Akwa Ibom State Shoreline.

Parameter	Results			
	A	B	C	D
THC (mg/kg)	17835.6	18228.5	19,989.0	18371.3
Lead (mg/kg)	<0.20	<0.20	<0.20	<0.20
Nickel (mg/kg)	<0.10	<0.10	<0.10	<0.10
Copper (mg/kg)	2.27	2.63	3.00	2.76
Iron (mg/kg)	41.36	40.56	46.00	52.20
Vanadium (mg/kg)	<0.20	<0.20	<0.20	<0.20
Cadmium (mg/kg)	<0.02	<0.02	<0.02	<0.02

Source: Field Survey, 2000

Table 6.0: THC and Heavy Metals Content of Periwinkle Samples from Akwa Ibom State Mangrove Swamps.

Parameter	Results			
	A	B	C	D
THC (mg/kg)	2763.4	3010.7	3,121.0	4137.3
Lead (mg/kg)	<0.20	<0.20	<0.20	<0.20
Nickel (mg/kg)	<0.10	<0.10	<0.10	<0.10
Copper (mg/kg)	118.3	123.6	137.0	142.0
Iron (mg/kg)	455.8	461.5	487.0	499.2
Vanadium (mg/kg)	<0.20	<0.20	<0.20	<0.20
Cadmium (mg/kg)	<0.02	<0.02	<0.02	<0.02

Source: Field Survey, 2000

3.3.5 THC and Heavy Metals Content of Oyster Samples from Akwa Ibom State Shoreline.

The results of the THC and heavy metals content of oyster samples collected from mangrove plants at the 4 designated sampling stations along the Akwa Ibom State shoreline are as presented on Table 7.0

The results of microbial counts of Tilapia fish from Akwa Ibom State coastal waters showed that there is a significant input of petroleum hydrocarbon into our coastal waters.

3.4.4 Microbial Counts of Periwinkle from Akwa Ibom State Mangrove Swamps.
Table 11.0 shows the results of microbial counts of periwinkle from the sampling stations along the Akwa Ibom State mangrove swamps.

Table 10.0: Microbial Counts of Tilapia Fish from Akwa Ibom State Coastal Waters

Sample Location	Microbial Count (cfu/g)[a]		
	THBC ($\times 10^5$)	TFC ($\times 10^3$)	CUB ($\times 10^3$)
A	4.9 ± 0.3	1.3 ± 0.4	5.4 ± 0.7
B	6.7 ± 0.5	5.0 ± 0.3	8.7 ± 0.4
C	6.7 ± 1.0	4.7 ± 0.6	11.4 ± 0.2
D	5.5 ± 0.6	3.3 ± 0.5	8.3 ± 0.3

Source: Field Survey, 2000; a) Values are mean of three replications ± SD

Table 11.0: Microbial Counts of Periwinkle from Akwa Ibom State Mangrove Swamps

Sample Location	Microbial Count (cfu/g)[a]		
	THBC ($\times 10^6$)	TFC ($\times 10^3$)	CUB ($\times 10^4$)
A	3.8 ± 0.8	7 ± 0.3	4.9 ± 1.3
B	4.3 ± 1.0	3.6 ± 1.1	6.0 ± 0.8
C	7.5 ± 1.3	5.9 ± 0.5	13.5 ± 0.3
D	4.6 ± 0.8	4.1 ± 0.4	6.9 ± 0.7

Source: Field Survey, 2000; a) Values are mean of three replications ± SD

The microbial counts of periwinkle samples from Akwa Ibom State mangrove swamps are consistent with results of microbial counts of other aquatic food resources: the variation follow the same trend as Ibeno > Eastern Obolo > Mbo > Oron apart from the results of total fungal count (TFC). However, the ratio of total heterotrophic bacterial count (THBC) to crude oil utilizing bacteria (CUB) gives an indication of significant crude oil input into the coastal waters.

3.4.5 Microbial Counts of Oyster Samples from Akwa Ibom State Shoreline
The results of the microbial counts of oyster samples from the Akwa Ibom State shoreline are as shown on Table 12.0

Table 12.0: Microbial Counts of Oyster Samples from Akwa Ibom State Shoreline

Sample Location	Microbial Count (cfu/g)[a]		
	THBC ($\times 10^6$)	TFC ($\times 10^3$)	CUB ($\times 10^4$)
A	3.7 ± 0.6	5.0 ± 0.7	4.1 ± 0.5
B	4.3 ± 0.3	5.5 ± 0.4	5.6 ± 0.8
C	6.4 ± 0.4	8.3 ± 0.2	10.9 ± 1.3
D	5.1 ± 1.0	6.6 ± 0.5	7.7 ± 0.7

Source: Field Survey, 2000; a) Values are mean of three replications ± SD

The total heterotrophic bacterial count was found to be highest in oyster samples from Ibeno coastal waters followed by samples from Eastern Obolo coastal waters. The ratio of crude oil utilizing bacteria to total heterotrophic bacteria in oyster samples ranged from 1.1% to 1.7%, indicating a significant input of petroleum hydrocarbon in Akwa Ibom State coastal waters.

4.0 Discussion

After an oil spill, three major aspects constitute serious health problems. They are:

(i) The physical presence and toxicity of the crude oil in the environment
(ii) The toxicity of the chemical dispersants used in the oil spill containment clean-up,
(iii) Associated socio-economic effects of the spill on the residents

The physical presence of crude oil will create aesthetic problems leading to human exposure to the pollutant. Three major human exposure pathways/routes to the crude oil exist. They are:

(i) Oral (ingestion) route
(ii) Inhalation route, and
(iii) Physical contact

All of these routes have been shown to contribute significantly to health problems but the "Critical Pathway" of human exposure to oil pollutant during a marine oil spill is the oral (ingestion) route.

Crude oil can be ingested during a spill directly by drinking the crude oil/components with water (surface or underground water contaminated with the oil) knowingly or unknowingly. An indirect way of ingesting the crude oil has always been by consumption of contaminated aquatic resources.

In a developing country like Nigeria and in the face of global economic recession with low economic/purchasing power, residents depend on cheap sources of nutrients to complement conventional sources. The dependence on aquatic resources like crayfish, periwinkle, oyster, and fish as cheap and available sources of protein cannot be over-emphasized. Crayfish is consumed by every household that can afford it while the majority of residents in Akwa Ibom State consume other aquatic resources.

Total hydrocarbon, copper, Iron and Cadmium were found to be significantly high in commonly consumable aquatic resources like periwinkle, tilapia and oyster samples from different locations along the Akwa Ibom State coastal waters. The human health implications of these pollutants are enormous. Udoette (1997) reported that ingestion of hydrocarbon (directly or indirectly through contaminated food) results in poisoning. Mutagenic, carcinogenic, genotoxic, immunotoxic, haematotoxic and neutrotoxicological effects of exposures to hydrocarbon products have been well documented (Kanoh et al, 1990; Ohnishi et al, 1990; Dellarco et al., 1990; Zhang and Jensen, 1991; Takeuchi, 1993; Bastlova et al., 1993; Nygren et al., 1994; CIIT, 1994; Vergnes and Pritts, 1994; d'Azevedo et al., 1996; Rabble and Wong, 1996; Ross, 1996; Rthman et al., 1996; Snyder and Hedli, 1996).

Apart from the possible neurotoxicity effect of the high hydrocarbon content of the aquatic resources from the coastal waters, polyneuropathy has been reported on workers exposed to hydrocarbon substances (Environmental Health Criteria 20, 1982). Many of the cases of polyneuropathy have been associated with prolonged exposure to high concentrations of n-Hexane, n-Decane, n-Pentadecane and other aliphatic hydrocarbon components detected in fish and periwinkle samples from our coastal waters (Table 8.0). The most serious adverse neurological effect of hydrocarbon toxicity in man has been reported to be the production of peripheral neuropathy (Takeuchi, 1993).

Most constituents of hydrocarbon e.g. benzene, Xylene and the alkanes have been reported to be haematoxins, hence they are haematotoxic. This may have partly led to the manifestation of anaemia and malnutrition symptoms in the residents consuming aquatic resources with such high concentrations of THC ranging from 17, 834.3 to 20, 143.2mg/kg. All haematologic parameters (total white blood cells, absolute lymphocyte count, platelets, red blood cells, and haematocrit) were low in subjects analyzed as compared to normal values. According to Rabble et al (1996) and Synder and Hedli (1996), the toxicity of some of hydrocarbon constituents like benzene involves both bone marrow depression and leukaemogenesis caused by damage to multiple classes of haematopoietic cell and a variety of haematopoietic cell functions. Moreover, through

the myelotoxic actions of some of the hydrocarbon constituents, some haematologic changes ranging from Pancytopaenia to total bone marrow aplasia, leukocytosis and leukocytopaenia have been reported (d'Azevedo et al; 1996).

It is important to mention that above a defined level, all the mineral elements (essential and non-essential elements) are toxic to man (Ewers and Brockhaus, 1991; Mallinckrodt, 1991). According to Jorhem and Sundstrom (1993) diet/nutritional sources are the main sources of human exposure to toxic heavy metals; and so the levels of these heavy metals in aquatic resources are of great interest from toxicological and nutritional points of view.

Copper (Cu) and Zinc (Zn) are essential elements in man. However, Cu has been known to exhibit an antagonistic effect with Zn in humans. Ingestion of Zn in excess of 1-2mg/day may cause lung disturbances. Also, haematological parameters, particularly erythrocyte sedimentation rate (ESR) are affected.

Moreover, excess Cu could lead to mucosal irritation, vomiting, diarrhea, intestinal cramps, severe gastrointestinal irritation, widespread capillary damage, hepatic and renal damage and nervous system irritation followed by depression. Possible necrotic changes in the liver and kidneys have also been known to occur (Grant, 1980; WHO, 1984).

Although iron (Fe) is an essential dietary element, ingestion of large quantities have been shown to result in haemochromatosis. Siderosis, pneumoconiosis due to Fe inhalation has been reported (Udosen, 1991).

Cadmium (Cd) is a cumulative poison and can be bioconcentrated to highly toxic levels. Some of the adverse human health effects of Cd include emphysema, liver and kidney damage, and cardiovascular diseases. Hyperglycemia and reduced glucose tolerance as a result of Cd poisoning will therefore result in hypertension. This is because Cd accumulates in the pancreas and could therefore affect insulin production (Sastry and Subhadra, 1982). The classical renal effect of cadmium poisoning is associated with proteinuria and glucosuria (WHO, 1984). Other effects of acute Cd poisoning include bronchitis, Pneumonitis, destruction of testicular tissue and anaemia.

The notorious Itai-Itai disease of Japan was reported to have been caused by chronic Cd intoxication. The Cd exposure was caused by pollution of the irrigation water by the Kamioke mine effluent upstream of the Jintsu River. Rice grown on the paddy soil irrigated by the polluted Jintsu river water accumulated the Cadmium. The Japanese Ministry of Health then reported itai-Itai disease and Welfare (Udosen, 1991) to be a Cd–induced disease due to contaminated rice supplies in Japan (Goldsmith and Hildyard, 1988). The Japanese Ministry of Health and Welfare further reported that Itai-Itai disease resulted when there was tubular impairment caused by Cd poisoning, followed by the development of osteomalacia. This led to kidney and heart damage. Inductive factors were reported to include pregnancy, lactation, aging and nutritional deficiencies.

Other heavy metals like lead, nickel and vanadium were found in the aquatic resources to be below detectable limits. However, these heavy metals may accumulate to toxic concentrations with time (Udosen, 1991). Results of toxicological studies on Pb have shown that the metal is not only a neurotoxin that has been linked up with several symptoms such as fatigue, loss of appetite, constipation, colic anaemia, neuritis, seizures, general weakness, insomnia, hypertension, renal dysfunction, sperm suppression and death, but is also found to be responsible for the decline in intelligence of children exposed to quite low concentrations. According to (Moore, 1991), chronic neuropathy in children is evident at a blood level of 70 to 100µg/dl while colic and other gastrointestinal symptoms are evident at 60µg/dl. Similarly, it has been reported that anaemia may appear at Pb of 70µg/dl and reduced haemoglobin synthesis at 40µg/dl. There is also an evidence that Pb < 30µg/dl induce cognitive and behavioural disorders in children (Ernhart, 1988). These values are said to be lower than those reported for adults. Moreover, since children generally have higher relative food intake capacity than the adults, they are more prone to poisoning from this metal than the adults.

Some trace elements are highly toxic to biological systems; an example of such is lead. No evidence of its essentiality to man has been found. Its toxic effect is cumulative and long-term exposure to lead has been recognized as constituting a serious health hazard; lead absorbance is higher in young animals and children.

The increasing discharge of wastes of petroleum origin illustrates well the serious biological consequences of liquid waste disposal on the terrestrial, atmospheric and aquatic environment. Petroleum contaminates ground water and the soil – a problem facing oil-producing areas today.

On spillage the more volatile fractions escape leaving the less volatile fractions for biodegradation and leaving the unused recalcitrant components of the petroleum in the soil. Oil in the soil has adverse effects on plants, their nutrients and the microbial population of the soil ecosystem because of the physiochemical and microbial changes in the properties of the soil. Apart from these petroleum chemicals being toxic to plants, they are also toxic to aquatic life. The latter adversely affects the livelihood of fishermen in coastal areas.

Petroleum chemicals also have toxic effects on most systems of the human body as well as organs like the heart, liver, lungs, kidneys and skin, thereby causing respiratory diseases, cardiac diseases, bronchial asthma, nephropathy, neuropathy, lung cancer etc. Petrol and kerosine ingestion also results in intoxication causing symptoms such as restlessness, excitement and confusion (Tables 1.3 and 1.4).

More than 30 poly-aromatic hydrocarbons (PAHs) and their derivatives have been identified since 1976 to have mutagenic and carcinogenic effects making them the largest known single class of carcinogens. Polyaromatic hydrocarbons, organochlorine pesticides and polychlorinated biphenyls are environmental micro-pollutants, which accumulate to high concentrations in organisms in relation to the concentration present in the abiotic environment.

The presence of metal compounds such as copper in excess is dangerous to aquatic life in that it becomes toxic to the larvae of oysters. Sometimes wastes migrate away form the actual sites of discharge. Some volatilize into the air or are carried as dust, some are transported as liquid and dissolved solids on the surface of the soil while others are transported on or through open waters. Bioaccumulated wastes through the food chain show high levels of toxicity in tissues of aquatic organisms e.g. fish, mammals etc.

The petroleum wastes earlier mentioned i.e. OGPs, PCBs etc. can cause liver enlargement, gastric disorders, failures in the reproductive system function, lesions of the skin, nausea, tumors, neurological disorders, anorexia, impotence and low complications in a developing foetus as a result of placental transfer of PCBs.

Heavy metals bioaccumulate (are concentrated, accumulated and magnified) in tissues of organisms due to their hydrophobicity and low biodegradability. The metals could have been obtained from the surrounding medium or indirectly through the food chain. Organometallic complexes are formed by heavy metals, which also cause bioaccumulation. These organometallic compounds are toxic hence they inflict severe environmental damage. A clear example was seen in 1956 in Japan where hundreds of people died or gave birth to deformed children on consuming fish that ingested methylated mercury. Mercury and selenium also bioaccumulate in the marine food chain. Many metals accumulate in plants and animal tissues to high levels causing a hazard to the organism or to humans consuming them.

Methyl and dimethyl mercury poisoning may lead to severe disturbance of the central nervous system, impairment of speech and coordination, impairment of vision, tremors etc. Muscle weakness, brain injury, paralysis, coma and perhaps death also result from this type of poisoning. Inorganic mercurial compounds are also poisonous. Chlorides of mercury and cadmium attack the kidney. Higher exposures to cadmium may cause crippling bone and joint disease.

Ingestion of about 0.1g arsenic can result in arsenic poisoning. Arsenic is carcinogenic. It can contaminate the environment through pesticides: chemical wastes, mining by – products and coal combustion. It poisons individuals on reaching natural water used for drinking and contaminating it. Arsenic also contaminates the fishes, which are consumed by humans. Compounds of arsenic have been shown to be extremely poisonous and hazardous to health. They can cause irritation of the skin, eyes and respiratory system. On ingestion, these compounds irritate the stomach: affect the kidneys, liver and the heart. Arsenic poisoning manifests in symptoms of thirst, nervousness, vomiting, diarrhea, cyanosis and collapse. In severe cases, the vomitus and stool could be bloody, the patient could go into collapse and shock with weak rapid pulses, cold sweat and coma and even death. The inhalation of arsine (AsH_3) a colourless gas with garlic odour causes anorexia, weakness, nausea and death.

Some non-metals and anions also pose pollution hazards. Nitrogenous anions such as NO_3^- and NH_4^+, which are not reused by living organisms, can be permanently incorporated into sediments. Their high solubility tendency causes them to dissolve easily and percolate through the soil. In the process, they are carried through ground water into and other bodies of water streams.

Excess nitrogen in soil water and streams is toxic and causes problems in areas where leguminous plants are widely grown or areas where fertilizers are freely spread. High levels of nitrogen compounds are found to be responsible for infantile methaemoglobinaemia and death.

Petroleum fumes are sources of air pollution, and are dangerous to human health. Petroleum fumes are vapours obtained from the evaporation of such fractions as petrol, diesel and kerosine as well as the smoke from automobile and other engine exhausts (Uboh, 1999). Reports indicate that carbon monoxide, carbon disulphide, sulphur dioxide, methane, n-hexane propylene, tetraethyl lead (an antiknock agent), acrolein, pyrene, 1 – nitropyrene, benzene (which is a possible carcinogen) and their oxides are known to be the most hazardous petroleum products (Uboh, 1999).
Research has shown that repeated exposure to petroleum fumes can cause the following clinical conditions:

(a) Anaemia, evidenced by decrease in total weight, haemoglobin level, haematocrit as well as total serum protein.

(b) Hepatotoxicity and hepatitis as evidenced by raised serum AST, ALT and ALP concentrations, increased liver weight as well as the mild degenerative changes observed in liver histological integrity.

(c) Coronary heart disease as evidenced by increased total serum chloesterol and triglyceride concentrations. Several literature reports elevated serum cholesterol and triglycerides as an indication of atherosclerosis, which is implicated in coronary heart disease.

Some constituents of these fumes are both gaseous and particulate. These compounds when inhaled pass through the trachea and lodge in the lungs. Sneezing and cough may result from these particles choking the nostrils. Particulates like phosphates, and nitrates often undergo bioaccumulation within humans, plants and animals such that a high concentration of these chemicals have been determined in wild life such as sea birds, snails, fish, penguins and other vertebrates (Davies, 1998).

The red blood cells (and consequently haemoglobin) are attacked by carbon monoxide, which diffuse into the blood stream from where they again diffuse into other body tissues (Davies, 1998).

Tables 13.0 and 14.0 present the components of petroleum, the target organs affected by them and the injuries caused and toxicological and clinical effects of some hazardous components of petroleum fumes, respectively.

Table 13.0: Components of Petroleum and Injuries Caused in Target Organs

Component	Target Organ	Injuries Caused
Carbon Monoxide	Respiratory Organs Digestive Organs Circulatory Organs Sensory Organs	Itching, suffocation, Hypoxia, lung defects Hypertension, peptic ulcer, Myocardial Infarction
Poly Aromatic Hydrocarbons	Respiratory Organs Sensory Organs	Headache, Emphysema Asthma, cancer, bronchitis Trachial Aberration
Organo Halogen compounds	Respiratory, Sensory Organs	Neurological damage
Heavy Metals	Respiratory, Sensory Organs	Anorexia, Coma, Brain damage
Organic Solvents	Respiratory Sensory Organs	Anaemia, weak pulse, irritation of mucus membrane and eyes.

Source: Davies (1998)

Apart from the effect of the physical presence and toxicity of crude oil and its components on aquatic resources and subsequent toxicity to humans, some chemical dispersants have been shown to be toxic with associated human health hazards (Wells et al, 1995). Chemical dispersants were widely employed during the clean up of the MPNU oil spill of 12th January 1998.

Table 14.0: Toxicological and Clinical Effects of Some Hazardous Components of Petroleum Fumes

Substance	Mechanism of Action	Toxicological & Clinical Effects
Carbon Monoxide	Combine with haemoglobin and cytochromes of respiratory enzymes. It induces lipid peroxidation	The symptoms include headache, nausea, dizziness, dimness of vision, ataxia, possible cell collapse, convulsion, coma and death from shock. Respiratory as well as cardiovascular failure Hemorrhagic lesions. The heart and brain are the most effected times.
Carbon Disulphide (CS_2)	Cross linking of Proteins covalently	The symptoms include behavioural neurological hepatic and cardiovascular changes. Under occupational exposures, blistering of the skin and coronary heart disease have been reported.

Benzene (Bz)	Active Oxidation products bind to proteins and DNA covalently.	The symptoms include dizziness, weakness, euphoria, headache, nausea, vomiting, chest congestion and staggering, blurred vision, tremors, shallow and rapid respiration, ventricular irregularities, paralysis and unconsciousness, loss of appetite, drowsiness, nervousness and pallor and aplastic anaemia have been reported in chronic exposures.
Aldehyde (Acrolein)	Congugation non-enzymatically with -SH groups in glutathione and membrane bound proteins (P-SH).	The symptoms include running nose, sore throat, headache, cough and skin reactions, epithelial damage
Sulphur dioxide (SO_2)	Combustion products of fossil fuel, forms acid in contact with moist membrane hence irritant effect. Reacts with haemoglobin to form sulphur –Hb causing oxidative damage may induce lipid peroxidation in the erythrocytes.	Irritation of the eye, nose and throat as well as reflex broncho-constriction, headache, ischaemic heart diseases and other cardiovascular disorders as well as death Erythrocite damage resulting in haemolytic anaemia.
Ethylene and Propylene	Metabolized in the liver to their oxidized forms which are active mutagens	Occupational exposure to ethylene and propylene oxides produce increased absolute lungs weight and congestion, haemorhage and necrosis. Cell toxicity occurs as shown by increased lactate dehydrogenase release showing damage to plasma membrane. Occupational exposure to ethylene results in increased Hb–H2 fraction and hyperglobinaemia.
I- nitropyrene	This is common in diesel particles. It is nitrosubstituted hydrocarbon and it is a direct acting mutagen. The dinitropyrene is the active form.	It can cause tumor by causing mutation thus it is mutagenic and carcinogenic

The MPNU oil spill of 12th January 1998 caused some socio-economic problems on the residents of the state. Some of the socio-economic problems include loss of sources of livelihood to fishermen, fish and shellfish traders. These problems may lead to anxiety and stress-related (health) problems. Moreover, loss of sources of livelihood may also lead to poor/inadequate feeding with resultant malnutrition and associated symptoms. It may also result in habits that can predispose the residents to health hazards. For example, prostitution due to loss of sources of livelihood may expose victims to AIDS and other sexually transmitted diseases (STDs).

5.0 Recommendations

Based on the findings of the study, the following recommendations are made:

(i) In view of the enormous health risks associated with Petroleum Exploration and production (E & P) operations, a participatory approach to solving problems in the Health sector should be adopted. Mobil Producing Nigeria Unlimited should therefore show interest in solving health problems in the state as their operations contribute substantially to health risks in the state.

(ii) Since petroleum E & P activities will continue until oil reserves are depleted, efficient Health statistics Databank should be maintained by Ministry of Health. This will serve as baseline data for health risks/impact prediction in the event of oil spills.

(iii) A specialist unit for the treatment of cases suspected to be associated with oil spill/hydrocarbon pollution should be established in the Federal Medial Centre, Uyo for referral cases.

(iv) A detailed impact assessment / study of crude oil spills on human health should be carried out.

(v) Detailed survey, enumeration, references, verification and valuation of the impacted individuals should be conducted for a fair and adequate compensation payment for health risks associated with crude oil spills.

(vi) Special medical centres where specialist treatment for oil spill associated health problems can be received should be established by MPNU.

(vii) A substantial annual budgetary input into AKS Healthcare delivery system by Mobil Producing Nigeria Unlimited and other oil companies operating in AKS coastal waters

will be necessary to mitigate / ameliorate the devastating impacts on human health in the state.

(viii) A continuous surveillance of the diseases pattern in AKS in general and coastal communities in particular will give a picture of the health status of the areas under review.

(ix) Sponsorship of regular health campaigns in all the LGAs in the state will create health awareness in the local communities in the state.

(x) Adequate health facilities should be provided in the local communities by both the oil producing companies as community development effort and government.

(xi) Training and re–training of health workers to be relevant in solving the problems of crude oil associated health problems in the state should be vigorously embarked upon.

(xii) Sponsorship and training of specialist medical personnel in occupational and community health and related areas is necessary.

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