THE EFFECT OF OIL EXPLORATION AND EXPLOITATION ON SOME ENVIRONMENTAL RESOURCES IN A RAIN AND SWAMP-FOREST ECOSYSTEM: A CASE STUDY OF SAPELE, NIGERIA

J. ***A. Mogborukor***

Abstract

The oil industry in Nigeria is known to be as source of revenue and foreign exchange earning to the economy. However, while the industry is perceived as an engine of growth, it is regarded as a mixed blessing to the country. This is as a result of distortions in the environment as a result of oil spillages, contamination of agricultural lands. Based on these problems, the paper examined the quality of surface and well waters, bottom sediments, riverbanks soils and some species of plants. Samples of water, bottom sediments and riverbank soils were collected during (lie- month of June and September 2005. These samples were sent to the laboratory for physio-chemical analysis. The result shows that values of some samples in some locations were slightly higher than the WHO permissible level for potable water, the same was found in chemical parameters, indicating some level of pollution due to oil spillage. Kivcrbanks soil values were slightly higher than those of bottom sediments. Of the twenty-four species of plants evaluated, twenty were impacted slightly title to absorption of toxic nutrients from spilled oil and four non-impacted by oil pollution. To ensure the restoration of the ecosystem such preventive measures of regulating the activities of oil companies, checking pipe line vandalization, accidental discharge, pre and post-impact assessment by such oil companies should be carried out annually. Lastly, government should enforce pollution control measures and environmental friendly standards.

Key Words: Exploitation and Exploration, oil contamination, ecosystem.

Introduction

In the oil drilling areas of the Niger Delta, the environment is adversely affected as a result of oil exploration and drilling (Ayodele, 1983). It is agreed that oil is the main stay of the nation's economy, but however, little has been done to protect the environment where this vital actsvity is carried out from further deterioration. Pollution from oil wells, pipelines, ships and refineries are endemic in the Niger Delta area. The consequence includes contamination of surface and groundwater resources. Discharges also affect plants, marine organisms such as plankton, benthos and stresses terrestrial as well as wetland ecosystems.

Furthermore, the effect of gas Hares on vegetation, health and the microclimate arc equall disturbing. The free disposal of gas through flaring demonstrates the marginality of the interest of the oil producing communities. Apart from the deafening howl of the ranging tire at gas fare sites, the thick smoke which bellows into the sky fall back as acid rains which has poisoned most rivers and lakes in the Nigeria Della area (Alakpodia, 1989). Perhaps, more serious is the colossal waste on the environment by rendering cultivable land unsuitable, and also, the charring of the mangrove and rainforest vegetation with its associated loss of economic and medicinal plants.

Oil pollution in recent times in the petroleum producing area of the Niger Delta of Nigeria like in the case of Sapele, the study area, thousands of hectares of land have been rendered unproductive (See 'Table I).

Table 1: Volume of Oil Spill a nil Hectares of Land Affected in the Study Area

Years	No of Spills		Net Volume of Spills in (mb)		Hectares of land affected (Km^2)
	Crude oil	Products	Crude oil	Products	
1988	1	4	-	7.99.810	7
1992	1	14	5,240.00	19,679.29	10
1994	2	7	17,898.78	49.19	12

1995	-	5	-	5,027.46	9
1999	3	12	20,922.00	1,679.28	16
Total	**7**	**42**	**44,060.78**	**27,235.03**	**54**

Source: NNPC Bulletin (2004).

Some studies curried out on water pollution from oil spillage in Warri River at Opete Eborge (2001). Abe and Ayodele (1993), also looked at effect of oil exploration anti drilling on the general environment of the Niger Delta, while Akporido (2002), made a comparison on the quality characteristics of surface anti underground water in Sapele and Oghara oil producing areas of the Niger Delta, but their study did not extend to the soils, bottom sediment and plant species of the area.

It is against this background that the researcher has decided to go further by looking at soils, bottom sediment and plant species of the area with respect to oil pollution.

To achieve this aim, the following specific objectives are being pursued:

i) To asses the pollution status of surface and underground water (hand dug wells) around oil drilling locations.
ii) To determine the level of oil pollution on soil and bottom sediments along river banks
iii) To evaluate the number of plant species affected by such spills.

Study Area

This study is based on Sapele (Urban and rural). It is located at the co-ordinates of latitudes $5^{W}20'$ and $5^{H}50'$N and Longitude $5°15^1$ and $5°41^1$E. It has a total Landmass of about $291.37km^2$ (See Fig I.)

It has a population figure of 142,652 (1991 Census). The growth rate ofthe population was projected at 3.1% annually. This gave rise to (179,188) in 1999 and (184,766) in the year 2000,

Sapele is located within the Niger Delta region of Nigeria, which has the Agbada, Akata and Benin formation in terms of geology. The rock is made tip of the sedimentary type, which falls within the recent Holocene era. Buckle (1978), stated that, a large part of the sedimeutarx rock formation is very recent in age, having been laid down in the last 12,000 years.

It has a flat terrain with a Western part of the area being swampy and towards the Northeast is the undulating plain. Although the area is not hilly, the laud slopes towards the Benin and Ethiope rivers in the eastern part.

Generally, the soils ofthe area are acidic and non-saline in the freshwater swamps but in the mangrove swamps they are saline and usually near neutrality or slightly acidic, Udo (1984).

The area is drained by three major rivers namely, Ethiope, Jamieson and Benin. 11 rose rivers empty their waiters into the Atlantic Ocean.

The climate is warm and wet throughout the year, it is characterised by sub-equatorial type of climate marked by two dominant seasons, which are wet and dry. The wet season begins from March to October while the dry season spans from November to February. The area experiences almost uniform temperature but with a variation of l°C throughout the year and with a mean of 27^{L}C. The average monthly rainfall of about 2,277mm.

The vegetation consists ofthe rain and freshwater swamp forest. Species of tress include Iroko *{Chlorophera cxlcs.sa).* Mahogany *(Khava ivorensis).* Walnut *(/.ova trkhillo'uk's),* Sapele hardwood, 'flic Freshwater swamp forest is made up of Mangrove trees *(Rhizopcni raccmo.sa).* epiphytic plants and Raphia palms *(Klcusis vjiinccsis).*

However, as a result of anthropogenic activities, cultivated rubber tress and other secondary re-growth forest have replaced the natural vegetation. While few of the natural vegetation arc found only along the banks of river Ethiope, Jnmeison, Benin and in the heart ofthe swamps. Other secondary re-growth vegetation are found in the hinterlands. Elsewhere, most of the original forest have been cleared for settlement, for firewood and farming.

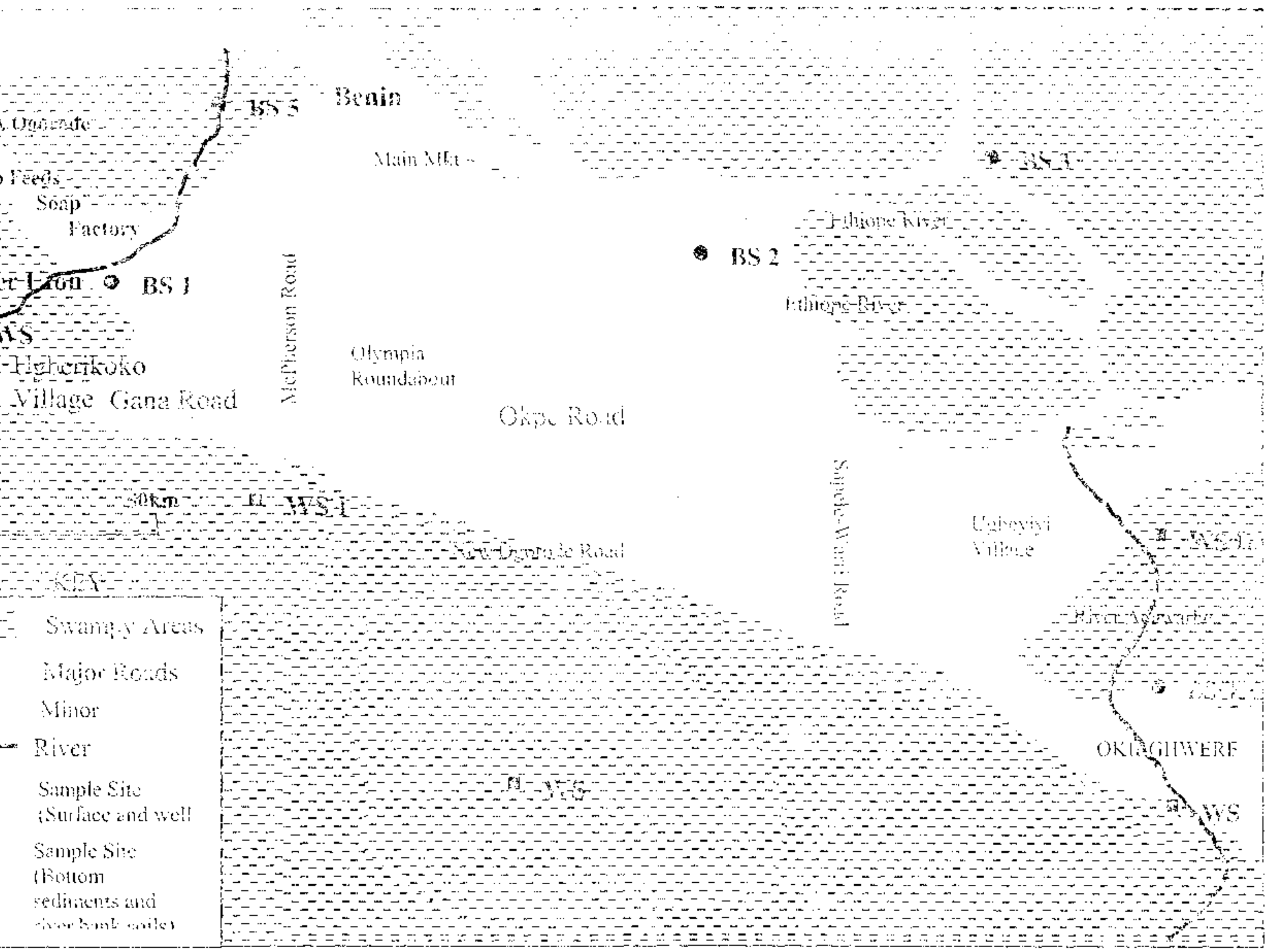

Fig 2: Map of Sapele Showing Sample Collection Sites

$5^0 41'$

Analysis of Water and Soil Samples

Samples taken from surface and hand dug wells on 25$^{'''}$ June and I O$^{'1'}$ September, 2005 were analyzed for physiochemical variables in the laboratory using different standard analytical equipment recommended by W1K) (1078), American Society for Jesting Materials (ASI'M), (1982), American Public Health Association (APHA) (1976), Department of Petroleum Resources (DPR) (1997) and Federal Ministry of Environment standard for testing water and soil samples **(** 1991**).**

The physical parameters determined were colours, temperature, dissolved solids and turbidity while the chemical factors were pH, total hardness, total alkalinity, conductivity, sulphate, and nitrate-nitrogen. Also determined were heavy metals like Cadmium (Cd). Copper (Cu), Iron (Ie), and total hydrocarbon content.

Water samples used for analysis were collected using 2 litre sterilized plastic bottle on the 25^{lh} June and 10^{lh} September 2005. These were preserved in accordance with recommended preservation methods and holding period as prescribed by (Schorlield, 1980). The mean of the two samples were calculated and used for the study.

Bottom sediments and riverbank soils were collected from five locations on 25^{lh} June and September 10^{11}', 2005. The samples were labelled BS1-BS5 and taken to the laboratory for analysis (see figure 2 for collection sites).

At the laboratory, sediment aliquots were dried at 60°C and homogenized by grinding. 5.00g of the sediment sample were weighed and digested in acid mixture of equal ratios (5m/FINCf), 5ml HCIO4 and 5ml I IF), d'he beakers containing the samples were kept on hot plates for 30 minutes before they were transferred to the fume cupboard where they remained overnight (UNEP, 1985).

Heavy metals were determined with atomic absorption spectrophotometry, using a Perkm-Elmcr.

Result and Discussion

The data collected for the research are presented and discussed in Figs 3-8.

Colour, Total Dissolved Solid and Turbidity

The colours of the hand dug well close to Shell Petroleum Development Company (SPDC) location WSI with value of 8.5 pt. co and WSII (12.5 pi. co) were above (WHO) maximum acceptable limit of 5 pt. co, while WSill (3.5 pt. co) WS1V (3.5 pt. co) and WSV (3.8 pt. co) all conform to maximum permissible level. Turbidity of all samples in all locations were above permissible level of (10NTU) except for WSV (4NTU). TDS of both wells and surface water were generally low, below the acceptable limit of WHO (500mg/l) (See Fig. 3).

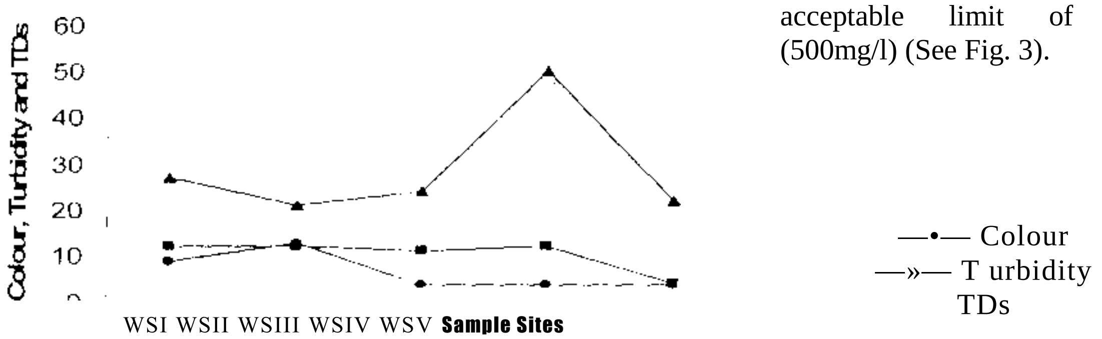

Figure 3: Variation in Colour, Turbidity and TDS in Surface and Well Water Samples.

Temperature

The temperature of water samples from all locations ranges from 27.2°C – 29°C. All values falls within WHO desirable unit of 30°C and maximum permissible Unit of 34°C (see Fig 4).

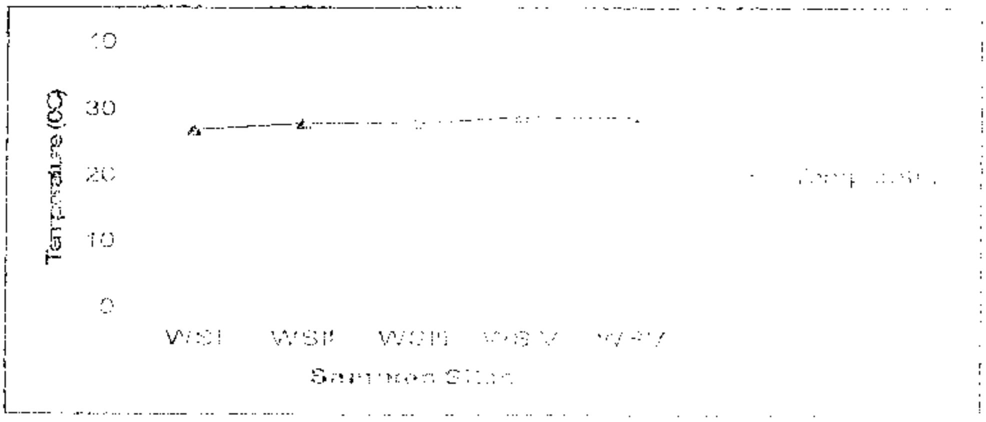

Figure 4: Temperature Variation from Location to Location

pH

The WHO/FEPA maximum permissible limit for pH is (6.5-9.2). WSI, which is located in the oil drilling area, has a pH value of 5.2, which is below the recommended standard. The implication is that, the water from the hand dug well is acidic. WSII has a value of (5.6), WSIII (5.4) indicating also acidity. WSIV (6.9) and WSV (6.8) both indicating non-acidity (alkaline) (See Fig. 5). The Acidity may be as a result of acid rain, which occurs in the area as a result of the flaring of natural gas, which is a common feature of the oil drilling areas of Nigeria.

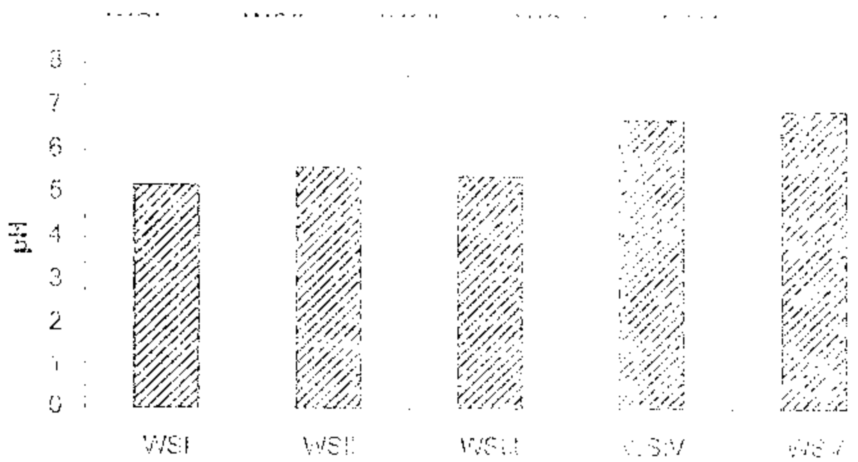

Figure 5: Variation in pH from Location to Location

Total Hardness, Total Alkalinity and Conductivity

Total Alkalinity had values of (12.7mg/l) in WSIII, which was the highest, followed by WSII (10 mg/l), WSIV (9.00mg/l), WSV (5.95 mg/l) and WSI (5.9 mg/l). All values fall within WHO Standard of (10 mg/l) except for location WSIII. Total Hardness ($CaCO_3$) level in surface and well water samples were generally low, lower than the 100mg/l maximum acceptable threshold of WHO. The values spans from 30-45mg/l. Thus, all waters in the study area are soft.

Water samples taken from the five locations indicate that the level of conductivity recorded was below 500 US/cm. The highest value is 54 and the lowest 22 US/cm. (See Fig. 6).

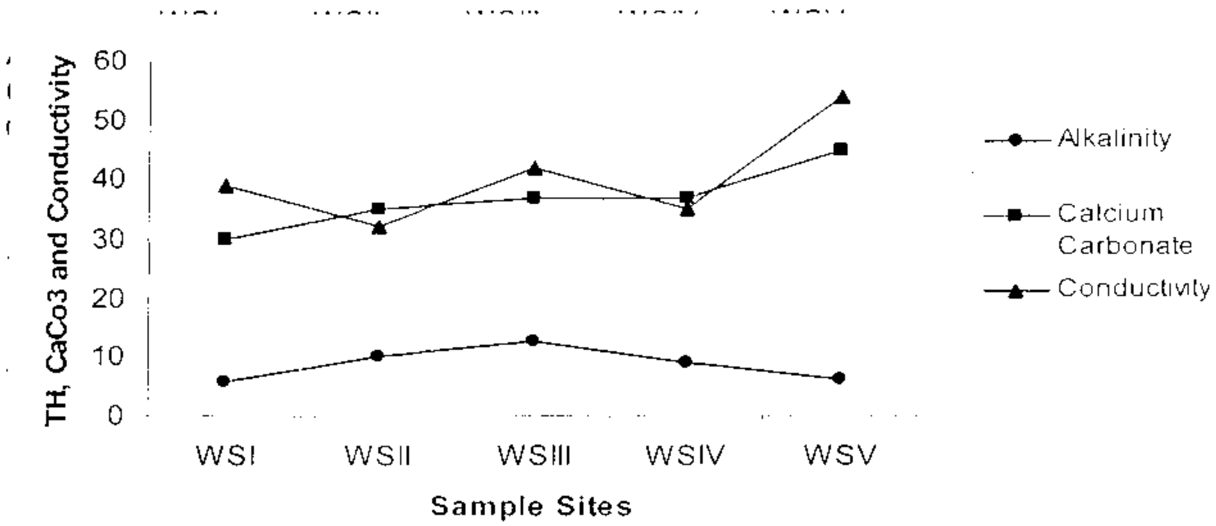

Figure 6: Variation in Total hardness, Total Alkalinity and Conductivity in the Five Locations.

Sulphate and Nitrate

Sulphate levels in all samples were within the WHO limits of 200mg/l. SO_4^2 level, which ranged from (4.0mg/l) in WSIV to 7.0mg/l in WSI.

Nitrate values of samples were generally low, within l()mg/l recommended acceptable Unit of WHO. Values in samples ranged from 5mg/l - 8mg/l in five locations (See Fig 7).

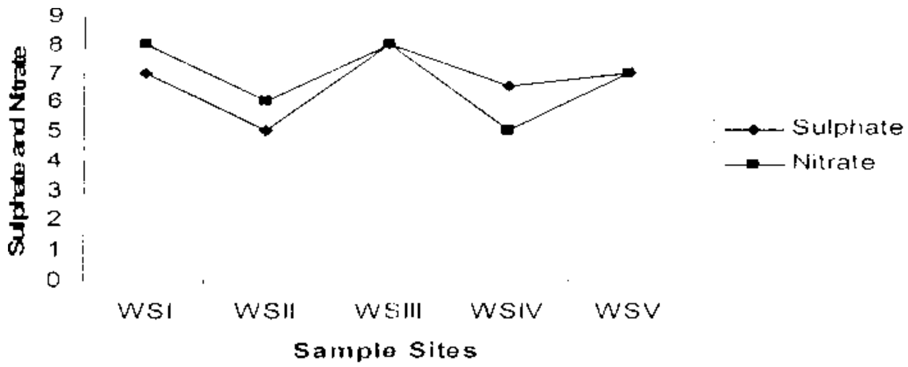

Figure 7: Variation in Sulphate and Nitrate in all Locations.

Heavy Metals (Cd, Cu, Fe)

Cadmium permissible value is 0.015. Sample values range from (0.003 - 0.005) in WSI, (0.002) WSII, (0.005) WSIII, (0.003) WSIV and (0.004) WSV. All are below the recommended value of (WHO, 1979). Copper permissible level is (1.5mg/l). All values of Copper were below 1,5mg/l. WSI (0.19), WSII (0.1), WSIII (0.15), WSIV (0.11) and WSV (0.14). Iron permissible level is (0. lmg/l). All values were below this value. Its span from 0.06 - 0.2.

Total Hydrocarbon Content (THC)

The maximum permissible level for THC in water is 0.5tng/l (DPR 2000). But study shows that all sample in the live locations were above this value which indicate that all water bodies are slightly contaminated with hydrocarbons (See Fig. 8).

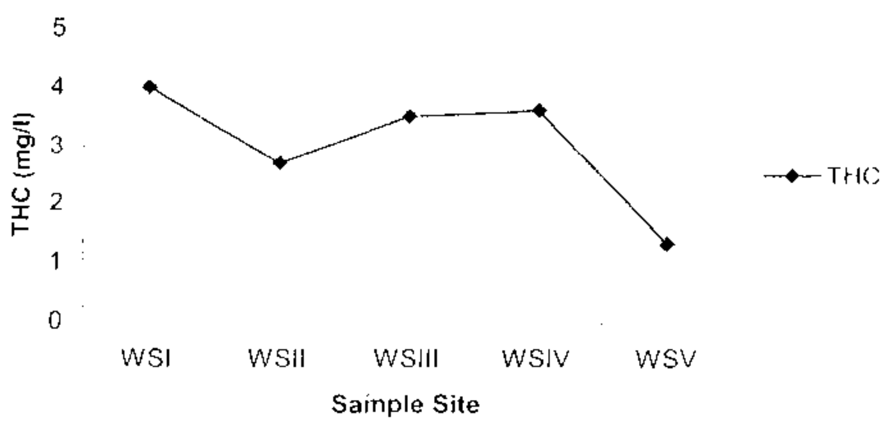

Figure 8: Variation in Total Hydrocarbon Content from Location to Location.

Bottom Sediments and River Bank Soils

Botlom-^edimcnts and river bank soils collected from live locations named BSI - BSV (See Fig. 2) were analyzed lor heavy metals and total hydrocarbon Content (THC) as shown in Table 2.

fable 2: Heavy Metals, I I 1C (pg/g) in Bottom Sediments and Bank Soils

S/N	Factors	Bottom Sediments					River Bank Soil
		BS 1	BS2	BS3	BS4	BS5	
1.	Cadmium (Cd)	0 120	0 132	0 143	0 125	0 145	1 226
2	Copper (Cu)	0 03	0 01	0 25	0 06	0 03	3 354
3	Iron (Fe)	0 56	2 30	3 35	0 67	0 42	5 770
4.	Lead(Pb)	0.310	0.220	1.380	0.230	1.310	1.750
5.	Manganese (Mn)	1.990	1.950	1.190	1.825	1.170	4.866
6.	FI 1C	226.2	1 10.3	1 15.4	205.5	104.2	334.0

Source: Authors Field Study, 2005.

The table reveals that all the metals had concentration slightly higher in soils and bottom sediments than in the open water and wells indicating that cations and anions sink to the bottom and remain bound to sediment particles.

The Macrophytes

The list of macrophytes either on the banks floating or submerged in water are provided below. Approximately thirty three percent (33%) of species were evaluated. The full list reveals number of impacted plants as provided in 'fable 3. Twenty (20) taxa were slightly impacted and four (4) non-impacted.

fable 3: Inventory of Plant Species Impacted by Crude Oil Spillage

S/N	T axa	Slight Impact	No Impact
1	Aeschynomene Indica	+	-
2	Alchornea Cordifolia	-	a-
3.	Bambusa Bambusa	+	-
4.	Brachiaria dellexa	-t-	
5.	Coslus afer	+	-
6.	Chromolaenaodoranta	-	+
7.	Canna Indica	+	-
8.	Elaesis guineensis	+	-

9	IZichhorncd crassipes | i		-
10	1 larimgena Madagascaniensis	+	-
II.	Uevea brasi 1 iensis	-	+
12	Heterotis crecta	+	
13.	Musanga Ccrcropioidcs	+	=
14	Ncwbonldra Laevis	+	
15	Pennisetum Pedicel latum	-i-	-
16	Penni setum Purpureum	+	-
17	Persia gralissima	—	4-
18	Raphia hookcri	+	-
19	Sacchanim ofllcinarum	+	-
20	Selenia Vcnrucosa	t	-
21	Synedrella nudillora	t	-
22	Smilax Krausiana	+	-
23	Vitex doniana	+	-
Total		20	4

Economic Value of Some of The Plants

Timber is of great economic value to the inhabitants of this ecosystem. It becomes more serious when crude oil spillage affects some species of timber such as *Harmgena madagascariensis* and *Mnsangema Cereropioides.*

In a similar study by Egborge (1999), in the wetlands of Udu-Ughievwen communities of the Niger Delta, it was discovered that a number of plants, which are of high medicinal value, were affected by crude oil spillage. In this study, such plants with medicinal value imparted include *Alchornca cordijoHa* used in controlling stomachaches. *Anthocleista vopc/li* used for traditional treatment of impotency and *Costas afar,* which removes skin rashes, and worms from the alimentary system were also affected.

Kccommcmlations and Conclusion

The drive to lap natural resources to the advantage of man has translated into a number of environmental problems, Jimoh (1997).

This study has looked at the consequences of oil exploration and drilling on an ecosystem using Sapele as a ease study. The work was able to reveal that, pollution from oil spillage to some extent have rendered water in rivers, streams and wells unlit for human consumption. Also, some medicinal plants species have been rendered impotent in their value. Most farmlands that are close to river courses have their soils rendered unproductive due to contamination from oil spill.

In order to avert the aforementioned consequences, preventive measures such as ensuring that the law of the land adequately protects the fundamental rights of the inhabitants of the oil producing areas of the country who depends solely on the land and water resources as means of livelihood. 'I'his may require the revision of the existing legislation in the oil industries so that the welfare aspect of oil exploration may be properly addressed. There may be need for government to take appropriate regulatory measures to ensure the restoration of the ecosystem of the producing areas. In this regard, the government should enforce possible pollution control measures and impose environmental friendly standards.

The concentration of efforts on checking oil pollution either through sabotage, accidental discharge or pipeline vandalization should be carried out. The oil companies operating in such communities should be compelled from time to time to carry out environmental surveillance, pre and post - impact assessment and auditing of area of exploitation and exploration. This will help to stem the tide of pipeline vandalization and create quick response to cases of oil spillages.

All oil companies should pul in place measures at prohibiting gas flaring. Such gas should be piped and distributed for domestic and industrial use as it is done inmost developed countries.

Finally, it is also imperative for government to introduce a system that would make all the oil companies operating in the country to constitute an ecological insurance policy for the purpose of compensation to the affected people.

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