ENVIRONMENTAL IMPACT OF BITUMEN ON SOIL, WATER AND PLANT IN LODASA AREA, ODE-IRELE, ONDO STATE, NIGERIA

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ABSTRACT
Six sites containing various plants with different indicator parts were analyzed for the environmental effects of bitumen on the plants and animals. From the location, which is in Lodasa, Ode-Irele Local Government Area of Ondo State, twelve soil samples, six plant and water samples were collected to study the effects of bitumen on them. Results show that the percentage composition of nitrogen in the plants ranged from 0.069-0.078, for phosphorous it ranged from 0.031-0.068, potassium from 0.16-0.23, calcium ranged from 0.212-0.288, for magnesium, 0.104-0.188. Constituents of Manganese ranges from 17.07-21.03 ppm, Zinc 13.25-16.20 ppm, Copper, 1.93-2.33 ppm and Iron ranges from 31.25-36.24 ppm all in plants analyzed. As for the composition of these constituents in soils, Nitrogen ranges from 1.058-3.61 ppm, Calcium, 0.66 – 0.88 ppm, Magnesium, 0.65-0.88 and organic matter ranges from 1.788-2.142 ppm. Evidently these show that the soils cannot support plant growth and their effects were manifested in visual signs of dying plants in the bitumen affected areas. The results for water samples have values below the standard recommended by the World Health organization (WHO) for safe drinking water while calcium and manganese values are above the WHO Standard. As for the results of waters samples analyzed, Manganese ranges from 1.63-2.94 ppm, Calcium, 3.22- 8.63 ppm, Iron 0.28-0.43ppm, Copper 0.19-0.38ppm while Magnesium ranges from 2.85-4.77 ppm. These show that the water was toxic and injurious to human, animals and aquatic lives. Statistical analysis shows a positive linear correlation between the presence of nutrients in plants and the soil, which is responsible for the retarded growth and yellow colouration of the leaves. The presence of bitumen in Lodasa soil is fast eroding soil fertility in the area and has contributed immensely to low yield of Agricultural products. The use of organic fertilizer to boost soil fertility, relocation and resettlement of farmers to areas with high soil fertility and appropriate legislation to protect the rights of the native settlers are some of the recommendations.

Keywords: *Bitumen, Elements, soil, plant, water, Lodasa*

INTRODUCTION

Bitumen is defined as a sticky substance obtained from crude oil and use for covering roads or roofs (Ekweozor and Unomah, 1989). It originated from fossil deposit, which represents the product of reservoir transformation of convectional oil by microorganism. The experience of tars and petroleum exploitation has created oil pollution and spillages on the communities, affecting land, crop, water and welfare of host communities (Ozumba, 1996). Local communities have raised their concern over health and quality of life the pollution has on their water and aquatic life, land are crops. In Nigeria, the residents of mineral resources exploitation areas are traditionally farmers. Due to the introduction of toxic chemicals into the sea by of companies in their quest for oil, massive migration of various fish species from coastal areas had taken place so also is the constant menace of gasses which are creating health problems. Added to these are numerous incidents of oil spillage, which scorched the soil and makes farming unprofitable (Eghagha, 2001). The overall effect of environmental degradation on the people especially the poor can be summarized in the word of Mink (1991) who stated that "environmental degradation decreases the production of those natural resources from which the poor wrest their livelihoods." There is therefore the need to address the problem especially as it affects agricultural productivity in such areas. No mineral resource is environmentally friendly when it comes to its exploitation. Whenever there is any exploitation, there must be an impact on the communities and in most cases, negatively. Several studies of the environmental impact of gas flaring on Izombe flow station in Imo State and carried out by Okeke and Okezie (1987) revealed staggering evidence of environmental damage resulting in low agricultural productivity of the affected area.

Mimiko (2000) argued that in as much as mineral resources exploitation would enhance the revenue outlay of Nigeria; the ecological consequences of it are grave, because these may not be manifested in the immediate more so that the Nigerian state has consistently refused to make the people the central part of crude oil economy. The need to arrest the environmental effects of bitumen in Lodasa becomes imperative due to the fact that the farmland can no longer support agricultural practices as a result of the chemical components of bitumen and its negative effect on, soil, water and plant growth.

The objective of this study therefore, is to investigate the environmental effect of bitumen deposits on soil, water and crop in Lodasa area of Ondo state. Also, to study the extent and degree of pollution of the 'black gold' within the study area as it affects its inhabitants.

MATERIALS AND METHODS

Study area

Lodasa area is part of the bitumen deposit zone within Ondo state, South Western Nigeria. It is located between latitudes $4^0 45^1$E to $5^0\ 0^1$E and longitudes $6^0 15^1$N to $6^0 47^1$N with a climate of tropical wet and dry with well defined rain and dry seasons. The predominant occupation of the inhabitants is farming (crop and livestock). Agricultural technology has remained relatively unchanged over the years and over 90% of the farmers practiced subsistent farming using simple tools. The discovery and subsequent exploration of bitumen ordinarily should have brought about development in the area but the adverse environmental impact of it had brought untold hardship on the human, plant, animals, water and soil of Lodasa area of Ondo State, Nigeria

Twelve soil samples were taken at depth of 0-30cm (using auger) within Lodasa area of Ode-Irele. The samples were taken within the distance of between 5 and 10m. Six plant samples, taken at a distance of 3m from six different locations within a farm in Lodasa were also analyzed. The plant indicator parts taken for analysis were, Cocoa, plantain, cassava, yam, maize and kola nut leaves. Six water samples taken at a distance of 3m in six different locations along river Opa were taken to the International Institute of Tropical

Agriculture (IITA) laboratory for analysis in line with AOAC (1990) procedures. The samples analysis covered mineral compositions such as Nitrogen, Phosphorus, Potassium, Calcium, Manganese, Magnesium, Zinc, Copper and Iron. Statistical analyses was carried out using correlation coefficients, coefficient of determination and other related packages to determine variation and level of significance at P>0.05.

RESULTS AND DISCUSSION

The analyses of both plant and soil samples at different locations in Lodasa area strongly indicate adverse impact of bitumen exploration on the farm. Adopting J.B Robinson's standards (as used by Ozumba, 1996) for nutrient concentration in the plant and soil, the results are as shown in Tables 1 and 2.

Table 1: Nutrient Concentration in Plants

Nutrient	Deficient	Marginal	Critical	Adequate	High/Toxic
N (%)	-	-	-	3.5-5.0	-
P (%)	0.15	-	0.25	0.25-0.4	0.5
K (%)	1.25	-	-	1.71-2.25	2.5
S (%)	-	-	0.24	0.2-0.3	-
Ca (%)	0.1	-	0.4	0.4-0.5	-
Mg (%)	0.12	-	0.3	0.3-0.46	-
Mn(ppm)	10	-	25	100-2200	4000-6000
Zn(ppm)	14	14-20	18	21-35	>35
Fe(ppm)	-	-	80	80-200	-
Cu(ppm)	-	3-7	9	9-20	-

Source: Ozumba (1996)

Table 2: Nutrients Concentrations in Soil

Nutrient	Deficient	Marginal	Critical	Adequate	High/Toxic
N (%)	2.6	2.6-2.8	-	2.8-4.0	-
P (%)	0.13	0.13-0.19	0-2	0.2-0.25	-
C (%)	0.5	0.5-1.5	1.5-3.0	-	>3.5
Ca (%)	0.5	0.5-0.7	-	0.8-1.2	1.25
Mg (%)	0.2	0.2-0.3	-	0.3-0.46	-
K (%)	0.5	2.5-3.0	-	3.1-4.0	-
Na (%)	-	-	0.005	0.01-0.10	-
Mn(ppm)	10	10-20	25	100-220	-
Fe(ppm)	-	-	80	70-200	-
B(ppm)	10	10-20	11	20-80	80-300
Cu(ppm)	-	3-7	9	9-20	-
Zn	14	14-20	-	21-35	>35

Source: Ozumba (1996)

From Table 3, only Iron was found to be at adequate levels in soil among the micro nutrients in all the six sampling points. Major element such as Potassium and Carbon were found at deficient and marginal levels respectively. Nitrogen (N) and calcium (Ca) were found to be adequate while zinc (Zn) and copper (Cu) were found to be at right levels (Table 3). The indication of all these are that the soils in these areas cannot support plant growth. These effects were also manifested in the visual signs of dying Cocoa plants in bitumen deposit areas. The pH of the soil ranged from 3.78 - 4.41 (Table 3) i.e. acidic in nature. This shows that the soil cannot support plant growth rather; retardation in growth and development of plants as a result of acidic nature of the soil were experienced. This agreed with Fayemi (1975) that plants growing in oil polluted soil will suffer retardation and chlorisis of leaves as well as dehydration of plants indicating water deficiency.

The results of plant analysis (as shown in Table 4) show that major elements (N, P, K, Mg) were found at deficient levels in all the six locations while Ca was at toxic level. Also from the table micro elements (Mn, Fe, Zn, andCu) were found at deficient and marginal levels. This indicate that due to the continuous contact of the chemical contents of the bitumen with soil and plant roots, nutrients and water absorption from the soil for plant development becomes difficult. It was inferred that the plant nutrients status in both the plants and soil tend to have similar pattern in all the six locations investigated.

Results of Statistical Analysis

The results of the correlation analysis of the nine elements determined and their co- variability index relating their presence in plant and soil as shown in Table 5. For nitrogen, there is a positive linear correlation in its contents in plant and soil. The Pearson correlation coefficient was 0.02 while its coefficient of determination (R) is 0.06%. This indicates that there is deficiency in the quantity of nitrogen in the soil. Also, the indi-

Table 3: Soil Samples Analysis from Lodasa Area

S/N	pH H_2O	pHKCI	N%	P%	K%	Ca%	Mg%	Mn ppm	Zn ppm	Cu ppm	Fe ppm	C%	OM%
1	4.04AC	3.98AC	1.93D	0.060D	0.143D	0.78C	0.86H	250.07A	159.09H	46.59H	215.91H	1.075M	1.902C
2	3.78AC	3.50AC	3.61A	0.149M	O.185D	0.66M	0.69H	382.79A	123.85H	42.78H	236.43H	1.025M	1.813C
3	4.21AC	4.05AC	3.60A	0.187M	0.136D	0.82A	0.71H	333.33A	154.76H	54.76H	190.48A	1.011M	1.788C
4	4.43AC	4.25AC	2.53D	0.012D	0.125D	0.69M	0.74H	353.41A	164.32H	53.21H	252.54H	1.024M	1.811C
5	3.95AC	3.81AC	2.83A	0.52M	0.177D	0.75C	0.88H	322.54A	158.35H	44.85H	188.34A	1.068M	1.889C
6	3.80AC	3.63AC	3.37A	0.135M	0.160D	0.72C	0.82H	288.35A	135.44H	52.12H	199.53A	1.083M	1.916C
7	4.03AC	3.88AC	1.065D	0.069D	0.21D	0.63M	0.65H	219.35A	140.32H	33.32H	133.21A	1.033M	1.827C
8	3.82AC	3.25AC	1.058D	0.058D	0.23D	0.54M	0.72H	200.35A	150.21H	32.21H	134.25A	1.123M	1.987C
9	3.95AC	3.67AC	1.082D	0.44D	0.19D	0.88A	0.85H	200.21A	149.23H	21.98H	133.32A	1.034M	1.829C
10	4.41AC	4.00AC	1.053D	0.036D	0.18D	0.71C	0.81H	210.82A	140.23H	22.32H	134.38A	1.021M	1.806C
11	4.20AC	4.21AC	1.032D	0.065D	0.22D	0.81A	0.77H	199.44A	130.21H	20.11A	134.21A	1.033M	1.827C
12	3.92AC	4.12AC	1.058D	0.054D	0.24D	0.84A	0.75H	188.21A	160.22H	22.23H	130.33A	1.211M	2.142C

Key: AC-Acid, H-High, A-Adequate, C-Critical, D-Deficient, M-Marginal

Table 4: Plant Samples Analysis from Lodasa Area Ode-Irele

S/N	N%	P%	K%	Ca%	Mg (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Fe (ppm)
1	0.075D	0.068D	0.20D	0.232C	0.132D	21.01M	16.14M	2.34D	36.24M
2	0.078D	0.031D	0.16D	0.212C	0.104D	17.07M	12.23D	1.93D	30.17M
3	0.073D	0.045D	0.18D	0.295C	0.162D	18.21M	14.32M	1.97D	35.33M
4	0.077D	0.052D	0.18D	0.234C	0.123D	20.25M	14.67M	2.030D	37.20M
5	0.069D	0.039D	0.21D	0.288C	0.115D	21.03M	13.03D	2.15D	31.25M
6	0.074D	0.054D	0.23D	0.255C	0.188C	20.58M	16.20M	2.33D	32.33M

KEY **INDICATIVE PART**

1= Cocoa leaves → Shoot leaf
2= Plantain leaves → Top leaf
3= Cassava leaves → 3rd lead
4= Yam leaves → Petiole leaf
5= Maize leaves → Maize leaf
6= Kolanut leave → Kolanut leaves

D= Deficient
C= Critical
M= Marginal
H= High
T= Toxic

Table 5: Pearson's Correlation Coefficients /Prob>/R/ Under H.O Rho=P/M=6

Elements	Correlation coefficient (r)	Coefficients of determination (r) %	Probability correlation for both soil and plant
N	0.02	0.06	0.97
P	-0.59	3.51	0.22
Ca	-0.56	31	0.22
K	0.04	0.17	0.94
Mg	0.09	0.93	0.86
Mn	-0.72	52.5	0.11
Fe	0.16	2.78	0.75
Zn	0.32	10.5	0.53
Cu	0.30	9.22	0.56

cation that the plant roots find it difficult to obtain nutrients from bitumen dominated soil was evident. This led to retarded growth, thin stem and sprouting of yellow leaves at the lower parts. The same could be said of calcium with correlation coefficient of 0.56 and coefficient of determination (R) is 31%. Low calcium content in the soil is inadequate for plant use. Similar comments can be made for elements such as phosphorous, potassium, zinc, copper magnesium, manganese and Iron. Positive linear relationship in correlation coefficients and high correlation determination are indications of their low presence in soil which makes it even harder for plants to survive on them.

Effect of Bitumen on Water Base Chemical Parameters

Six water samples taken from six different locations along river Opa were analyzed to determine the effects of bitumen on its chemical parameters. The parameters determined are pH, PO_4, NO_3, Ca, Mg, Na, Mn, Fe, Zn and Cu the results are as presented in Table 6.

For pH, the values ranged from 4.9-5.5, 0.08-0.23ppm for NO_3, 0.08-0,21ppm for NH_4. Others are 3.22-8- 6.3ppm (Ca), 2.85-4.77ppm (Mg), 2.15-3.20ppm (Na) and 1.63-2.94ppm (Mn). The rest are Zn (0.15-0.29 ppm), Fe (0.28-0.43 ppm) and Cu (0.19-0.38 ppm). All these were compared with the WHO Standard minimum permissible level for drinking water. On the account of this, Mg,Fe,Zn,Cu, Na and NO_3 concentration in all the water samples fall below the WHO standard while Ca and Mn were above the WHO standard.

As a result of the concentration of these constituents in the stream, water in this area is not palatable for human and domestic uses. This may be responsible for death of aquatic animals in the river. High content of Ca in water leads to excessive scale formation, high Fe content makes the water objectionable to sight high contents of Na and Mn leads to bitter taste, discoloration and turbidity. The cumulative effect of these high concentrations is injurious to health of the consumers (Akinbile 2004)

On the whole, the effect of bitumen deposits on soil, plant and water in Lodasa community of Ode -Irele local Government area of Ondo State is degrading not only to the environment but also to the inhabitants. It does not allow the soil to support plant growth and therefore does not sustain healthy living of the dwellers and the environment of Lodasa community.

CONCLUSIONS AND RECOMMENDATIONS

An attempt has been made to assess the environmental impact of bitumen on soil, water and plant in Lodasa, area of Ode Irele in Ondo State, Nigeria

Based on our findings it was confirmed that bitumen affected farm land cannot support plant growth, but rather caused harmful impact to the

Table 6: Water Samples from Lodasa Area, Ode-Irele, Ondo State

Water samples	pH (H_20)	NO_3 (ppm)	NH_4 (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	Cu (ppm)
1	5.50	0.15	0.09	3.41	2.85	2.15	1.63	0.28	0.15	0.19
2	5.30	0.23	0.13	8.63	4,77	3.20	2.94	0.43	0.29	0.36
3	5.20	0.21	0.21	3.22	3.20	2.84	1.85	0.23	0.17	0.23
4	5.00	0,19	0.08	5.32	3.11	2.33	2.43	0.32	0.19	0.25
5	4.90	0.08	0.11	4.21	2.91	2.41	2.88	0.41	2.60	0.32
6	5.60	0.16	0.13	6.12	2.88	2.62	2.63	0.38	0.28	0.38

environment and farm land making it unproductive for Agriculture. Furthermore, results showed that water from the area was toxic to human, plant and aquatic lives (Going by the values of pH range 4.9 and 55, Fe, 0.28 – 0.43 and other ions determined). Its consumption by inhabitants may likely cause water related diseases and death for animals. The adverse effects observed on plants were the unfavourable conditions created in the soil resulting in non-availability of nutrients and destruction of plants by toxic substances contained in the bitumen deposits. It can therefore be inferred that the presence of bitumen in this location has adversely affected soil fertility and cause great harm to farmers, most of whom have been displaced due to the barrenness of their farmlands.

The recommendations are as follows:

1. Planting of arable crops such as Palm tree, Cashew, Guava trees that can thrive well on acidic soil should be encouraged.
2. Usage of organic fertilizer to boost soil fertility should be encouraged to minimize problems arising from acidity since results show that soils in bitumen dominated areas are acidic.
3. In extreme cases, farmers should be relocated and resettled to areas where they can earn living by farming and adequate compensation be paid to them both by Government and prospecting companies.
4. Finally, appropriate legislation and policy must be put in place to preserve and protect the rights of the inhabitants of mineral deposits areas to prevent incessant clashes between the host communities, the prospecting companies and the Government

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