SOURCE APPORTIONMENT AND HUMAN HEALTH RISK OF HEAVY METALS IN CONTAMINATED AGRICULTURAL SOIL FROM EGI COMMUNITY, NIGER DELTA.

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INTRODUCTION

- Diverse sources contribute to the contamination of the environment. Crude oil exploitation and production activities are seen as the leading source of related contaminant into the soil (Olajire *et al*., 2005); though, diffuse sources can also contribute to this contaminant in the soil. Gas flaring is also a major cause of contaminant into the soil.

AIM AND OBJECTIVES

The study was to identify the source and evaluate the human health risk of heavy metals in crude oil contaminated agricultural soil from Egi oil producing communities (Oboburu, Obagi and Ogbogu) in Ogba/Egbema/Ndoni local government Area of Rivers State, Niger Delta, Nigeria.

This was achieved by;

- Determination of the concentration of heavy metals in contaminated soil from Egi oil producing communities.
- Apportion the source of the contaminants into the environment using Principal Component Analysis.
- Assess the risk due to ingestion of the soil from the study area.

METHODOLOGY

Description of the Area of Study

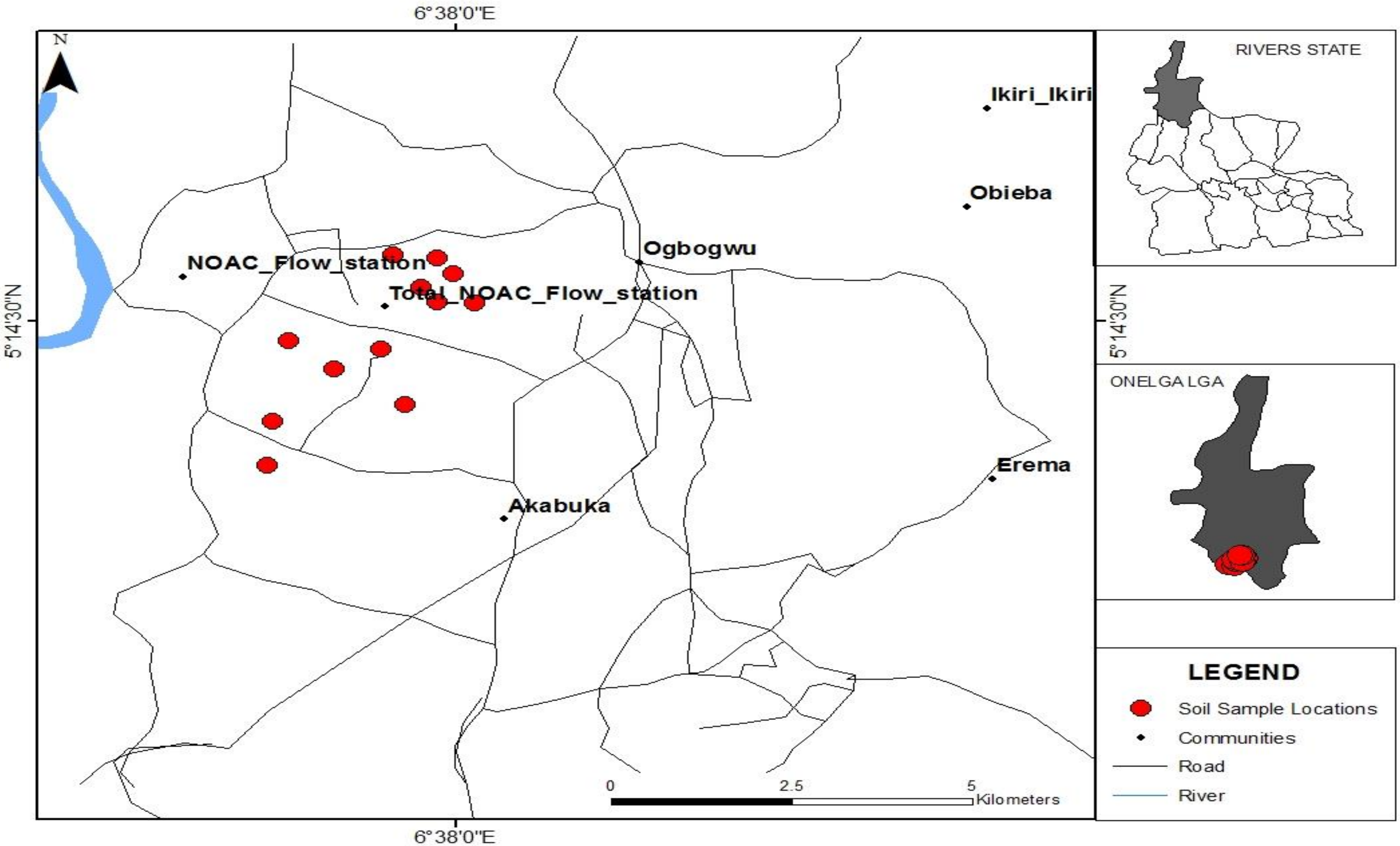

Figure 1. Sample Locations

SAMPLE COLLECTION AND PREPARATION/ANALYSIS

Four contaminated farm locations were chosen randomly from each community, making a total of twelve and in each location four quadrants were marked. In each quadrant, soil samples were collected at depth of 0-15 cm using a soil auger and homogenized to form a composite sample, from where was obtained a sub-samples. The samples were air and oven dried. They were then homogenized having been previously ground and sieved through sieves of stainless steel of 2mm mesh. The samples were digested with aqua regia and taken for atomic absorption spectroscopic analysis.

CONTAMINATION INDEXES

Geo-Accumulation Index/Contamination Factor/Enrichment Factor

The following equations were used to estimate the contamination index.

Geo-accumulation Index (Igeo) = $\log_2$ (Cn/Bn).........(i)

Contamination Factor = Cn/Bn...............................(ii)

Enrichment Factor = $(M/Fe)_{sample}/(M/Fe)_{background}$...............................(iii)

Where **M** stand for metal ion concentration, **Cn** for metal ion concentration and **Bn** for background concentration. (Turekian & Wedepohl, 1961; Zhang & Liu, 2002).

Multivariate Analysis (PCA) was used to apportion the sources of the contaminant.

RISK ANALYSIS OF HEAVY METAL

$$CDIm = \frac{\text{Msoil x IR x EF x ED x CF}}{\text{BW x AT}} \quad \text{...(iv)}$$

where **CDIm** = metal daily intake (mg/kg/day); **Msoil** = metal concentration in soil (mg/kg); **IR** = the ingestion rate of soil (mg/day); **EF** = exposure frequency (day/year); **ED** = the exposure duration (year); **BW** = the body weight (kg); **AT** = the averaging time (days); and **CF** = the conversion factor (10^{-6}kg/mg).

Risk = CDIm x SF...(v)

where **Risk** = probability of carcinogenic effect (unitless) and SF= cancer slope factor(mg/kg/day)$^{-1}$.

Hazard Quotient = CDIm/RfD...(vi)

where **RfD** = reference dose (mg/kg/day). (US Environmental Protection Agency 2004)

RESULT

The result of the heavy metals concentration in soil is shown in the table below.

Table 3.1: Mean of heavy metals (mg/kg) in Agricultural soil samples of studied communities

H M	Oboburu	Obagi	Ogbogu	Ase-Azaga	WHO Limits
Manganese (Mn)	27.92±23.80	80.46±12.40	42.90±16.82	ND	2000
Iron (Fe)	271.0±156.6	248.4±175.9	160.9±150.3	2.769	50000
Chromium (Cr)	17.27±10.31	11.51±8.385	3.820±3.886	ND	100
Zinc (Zn)	6.980±2.800	8.728±5.845	1.630±0.724	0.346	300
Lead (Pb)	111.2±94.97	64.75±59.94	10.63±10.65	0.745	10
Nickel (Ni)	5.853±2.190	3.973±2.843	1.458±1.547	ND	50
Cadmium (Cd)	5.650±5.749	0.770±0.830	ND	ND	3
Copper (Cu)	23.30±18.56	34.15±29.57	2.495±2.516	0.045	100
Cobalt (Co)	11.28±16.33	116.3±193.7	240.1±412.1	ND	3

CONTAMINATION INDEXES

Table 3.2: Contamination Indexes of heavy metals of the study area.

	Contaminated Soil Samples		
	Oboburu	Obagi	Ogbogu
Mn	-5.422	-3.986	-4.893
Fe	-8.029	-8.155	-8.781
Cr	-2.967	-3.552	-5.143
Zn	-4.352	-4.029	-6.450
Pb	1.890	1.110	-0.451
Ni	-1.241	-1.409	-6.128
Cd	3.650	0.775	-
Cu	-1.534	-0.983	-4.758
Co	-1.259	2.107	3.153
	Contamination Factor		
Mn	0.033	0.095	0.050
Fe	0.006	0.055	0.003
Cr	0.192	0.128	0.042
Zn	0.155	0.092	0.017
Pb	5.560	3.277	0.531
Ni	0.086	0.058	0.021
Cd	18.83	2.567	-
Cu	0.513	0.759	0.055
Co	0.627	6.461	13.34
	Enrichment Factor		
Mn	5.724	17.99	14.81
Fe	1	1	1
Cr	31.86	23.17	11.87
Zn	12.888	17.57	5.065
Pb	1026	651.7	165.2
Ni	21.60	15.99	9.061
Cd	3228	487.4	1425
Cu	85.98	137.5	155.1
Co	104.1	1170	3292

SOURCES OF THE CONTAMINANTS

Table 3.3: Principal component loadings of heavy metals in contaminated soil sample from the study area.

	Principal Components		
Heavy metals	PC1	PC2	PC3
Mn	-0.253	0.886	0.079
Fe	0.129	0.751	0.271
Cr	0.921	0.066	-0.028
Zn	0.786	0.415	-0.406
Pb	0.966	-0.133	-0.086
Ni	0.941	0.111	-0.192
Cd	0.839	-0.522	0.007
Cu	0.513	0.656	-0.443
Co	-0.124	0.232	0.902
Eigen value	4.348	2.312	1.300
Loading %	48.316	25.692	14.44
Cumulative %	48.316	74.008	88.448

CARCINOGENIC RISK

Table 3.4: Carcinogenic risk of heavy metals in soil samples of Egi study area

		Children	
Heavy Metals	Oboburu	Obagi	Ogbogu
Cr	2.84E-5	1.85E-4	3.70E-5
Pb	3.10E-6	1.81E-6	1.80E-6
Ni	3.26E-5	2.23E-5	4.90E-5
Cd	7.07E-6	9.61E-7	-
		Adult	
Cr	2.36E-6	4.73E-6	1.57E-6
Pb	7.77E-7	4.52E-7	7.43E-8
Ni	8.18E-6	5.54E-6	2.04E-6
Cd	1.76E-6	2.41E-7	-

NON-CARCINOGENIC RISK

Table 3.5: Hazard Quotients of heavy metals in contaminated soil samples for children and adults of Egi study area.

Heavy Metals	Oboburu	Obagi	Ogbogu	Total Hazard Quotient
	Children			
Mn	6.56E-5	2.64E-4	1.01E-3	1.34E-3
Fe	5.24E-2	4.81E-2	3.11E-2	1.32E-1
Cr	1.89E-2	1.20E-2	4.17E-3	3.51E-2
Zn	7.63E-5	9.57E-5	1.79E-5	1.90E-4
Pb	1.01E-1	5.92E-2	9.69E-3	1.70E-1
Ni	9.60E-4	6.55E-5	2.48E-3	3.50E-3
Cd	1.86E-2	2.53E-3	-	2.11E-2
Cu	2.05E-3	3.03E-3	2.22E-4	5.30E-3
Co	1.24E-1	1.27E-3	2.63000	2.75527
		Adults		
Mn	1.63E-3	4.72E-4	2.52E-4	2.35E-3
Fe	1.31E-2	1.20E-2	7.76E-3	3.29E-2
Cr	1.58E-3	3.15E-3	1.05E-3	5.78E-3
Zn	1.91E-5	2.39E-5	4.47E-6	4.66E-5
Pb	2.54E-2	1.48E-2	2.43E-3	4.26E-2
Ni	2.40E-4	1.63E-4	6.00E-5	4.63E-4
Cd	4.64E-3	6.35E-4	-	4.70E-3
Cu	5.19E-4	7.59E-4	5.54E-5	1.33E-3
Co	3.09E-2	3.19E-1	6.57E-1	1.0069

THQ >1 the population is considered unsafe, THQ < 1 the population is considered safe.

DISCUSSIONS

- The result show high level of contamination for Co, Cd, and Pb which were above WHO limit.
- The geo-accumulation index and contamination factor indicated that Co, Cd and Pb were of high concentration while the enrichment factor indicated anthropogenic sources for the heavy metals.
- The sources were anthropogenic for Cr, Zn, Pb, Ni, Cd, and Cu. Fe and Mn were of biogenic sources while Co was of mixed origin.
- The risk due to cancer was high for Cr, and Ni in children while other metals were within the level of management decision.
- Cobalt was of the greatest risk for the non-carcinogenic element.

CONCLUSION

- The findings suggest that the levels of these elements in the study area are high and can be of danger for those that may come in contact with these media.
- There is a need for immediate action as to ameliorate the possible negative effect.

RECOMMENDATION

- It is therefore recommended that usage of the contaminated soil should be limited or invariably avoided.

RELEVANCE OF THE STUDY

This study will:

(a) bring about boost in agricultural production as more lands will be available for agricultural purposes (b) it will help to give accurate data on health related illness due to the ingestion of these contaminants (c) it will lead to more research on the effect of these chemicals on both living and non-living components of the environment. (d) help the multinational oil companies to regulate their production and as such reduce spill into the environment (e) there will be diversification into other areas by the oil industry; like electricity generation through gas turbines to reduce gas flaring (f) more refineries will be built as to manage the volume of oil produced and as well reduce unnecessary spills.

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