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Effects of anthropogenic activities on physicochemical properties of soils in Ezinihitte Mbaise L.G.A, Imo State

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ABSTRACT

The study was carried out to evaluate the effect of anthropogenic activities on physiochemical properties of soils in Ezinihitte Mbaise L.G.A. Imo State. 36 soil samples were collected randomly at the depth of 0-5cm, 5-15cm, and 15-30cm. The samples were collected from four different locations, farmland, market area, playground and forest. The samples were prepared and analyzed for physiochemical properties such as sand, silt, clay pH, conductivity, organic carbon, moisture content, available phosphate, calcium, magnesium, sodium, aluminum, nickel, cadmium, chromium and copper, using standard methods. The result of the analysis revealed that the soil pH was basic, ranging from 6.45-8.98; electrical conductivity ranged from 0.120-0.155µs/cm. The textual class was sandy-clay-loam, implying that the soil contain sand in a higher proportion. Moisture content, organic carbon, organic matter, available phosphate, calcium, magnesium, potassium, sodium, aluminum ranged from 6.56-16.70%, 0.32-1.52%, 0.55-2.61%, 5.53-58.52mg/kg, 0.4-6.7mg/kg, 1.0-8.5mg/kg, 424-624mg/kg, 224-392mg/kg, 0.001-2.8mg/kg respectively. Heavy metal concentration in the soil was Ni (0.099-0.416mg/kg), Cd (0.016-0.173mg/kg), Cr (0.004-0.216mg/kg), Cu (0.000-0.013mg/kg). From these results, it was found that there was a marked variation in parameters of various soil samples in different sampling points. These variations were as a result of different anthropogenic activities in the locations. The study recommends that efforts should be made to improve soil quality and its fertility status through continuous application of manure and compost, soil amendments, cropping pattern most especially in farmland.

Introduction

Environmental pollution arises majorly from human activities, which may be industrial or agricultural. Over the past few decades environmental quality of soil has been closely related to human health and so people have become more concerned about the potential pollution of soil around them (W.N, Annao *et al*.,2008, H.M, Zarki *et al., 2008*). Soil pollution arising from socioeconomic activities of man may threaten human health if not properly checked (J. Sheppard, 2013). Soil pollution is also caused by the industrial waste, agricultural waste, urban waste, biological pathogens, radioactive waste. The industrial pollution increases the toxicity levels of the soil. The soluble salt given out as pollutants damages the cultivated farms. The soil pollution due to sewage is also very high. Several diseases are inflicted in human beings due to pathogenic forms present in the soil. Human activities contribute a lot to the destruction, degradation and development of the immediate environment.

Soil is a mixture of minerals, organic matter, gases, liquid, and countless organisms that together supports life on earth. It is a natural body called pedosphere which has four important functions; as a medium for plant growth; as a means of water storage, supply and purification; as a modifier of earth's atmosphere; is a habitat for organism, all of which in turn modify the soil. As a natural phenomenon on the earth's surface, soil is as important as air and water for human survival and suitability of life at large.

A soil survey staff of the United States Department of agriculture made a wide definition of soil as a natural process for development or growth of plants with or without a specific layer of stratum of soil or subsoil in a vertical cross section of land (horizons). He focused more that individuals everywhere throughout the world have attached more significance to the soil for its support for a variety of highly important features on earth such as food supply, production of fibers and drugs, infiltration of surface water, purification of ground water, reuse of solid waste(especially organic waste) and other human wants (Eli,2012).

Knowledge of soil characteristics and heavy metal levels is important for safety policy formulation and awareness. Soil characteristics such as pH, exchangeable properties and base saturation are influenced by heavy metal contents. Solubility and percolation of heavy metals into deeper horizons are increased by low pH. Unlike most organic pollutants, heavy metals are elements which occur naturally in the earth's crust are influence by physicochemical characteristics of soil. They are therefore found naturally in soils and rocks with a subsequent range of natural background concentrations in soils, sediments, waters and organisms. Anthropogenic releases can give rise to higher concentrations of the metals relative to the normal background values, resulting to pollution. The most important anthropogenic release of heavy metals to the environment come from metalliferous mining

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and smelting, agricultural inputs (pesticides and fertilizers), irrigation and application of sewage water and sludge, fossil fuel combustion and metallurgical industries (A.O, Ano *et al*., 2007). This study is aimed at determining the effect of anthropogenic activities on the physicochemical parameters of soils found in Ezinihitte Mbaise LGA Imo State.

Objectives

To achieve the aim, the following objectives were pursued.

1. To determine some selected physicochemical parameters of the soil.
2. To analyse the texture of the soil in the study area
3. To determine the relationship between the soil parameters.
4. Suggest recommendation on how to improve the soil quality in the study area.

Materials and Methods

Study area

This study was conducted at Ezinihitte Mbaise LGA in Imo State Nigeria. It is located within the geographic coordinate's latitude 5º 27^{1}19.194^{11} N and 7º 19^1 24.444^{11}E longitude. The study area is within the Tropical region. There is early rainfall in January and February with full commencement of rainy-season in March and stopping in November of each year. The dry season lasts between four to five months. The highest rainfall is between July to October with little break in August.

The average highest annual rainfall range is about 2500mm-3000mm. The temperature pattern has mean daily and annual temperature as 26^{0}C to 30^{0}C respectively. The population as at 2006 was estimated to be 611,204 people (Agulanna, 2008). The soil of the area is derived from coastal plain sand. Tropical crops such as palm trees, raffia palms and other cash crops dominated the area (Onwudike, 2010). Farming and trading are the major socio-economic activities of the people in the area. (Onwudike *et al*, 2005, Onweremadu 2007).

Table 1. Soil Sample Sites and their Coordinates.

AMUMARA (play ground)1	Lat 5º 27^{1}19.788^{11} N	Long 7º 19^1 24.990^{11}E
2	Lat 5º 27^{1}19.194^{11} N	Long 7º 19^1 24.444^{11}E
3	Lat 5º 27^{1}19.55^{11} N	Long 7º 19^1 24.270^{11}E
EZIUDO (farm land) 1	Lat 5º29^{1}15.612^{11}N	Long 7º19^{1}32.304^{11}E
2	Lat 5º29^{1}15.990^{11}N	Long 7º19^{1}32.058^{11}E
3	Lat 5º29^{1}15.696^{11}N	Long 7º19^{1}31.644^{11}E
OKPOFE (market)1	Lat 5º28^{1}5.484^{11}N	Long 7º19^{1}3.996^{11}E
2	Lat 5º28^{1}4.698^{11}N	Long 7º19^{1}3.750^{11}E
3	Lat 5º28^{1}4.632^{11}N	Long 7º19^{1}4.170^{11}E
ITU (forest)1	Lat 5.45844º	Long 7.32987
2	Lat 5.45859	Long 7.32970º
3	Lat 5.45844	Long 7.32970

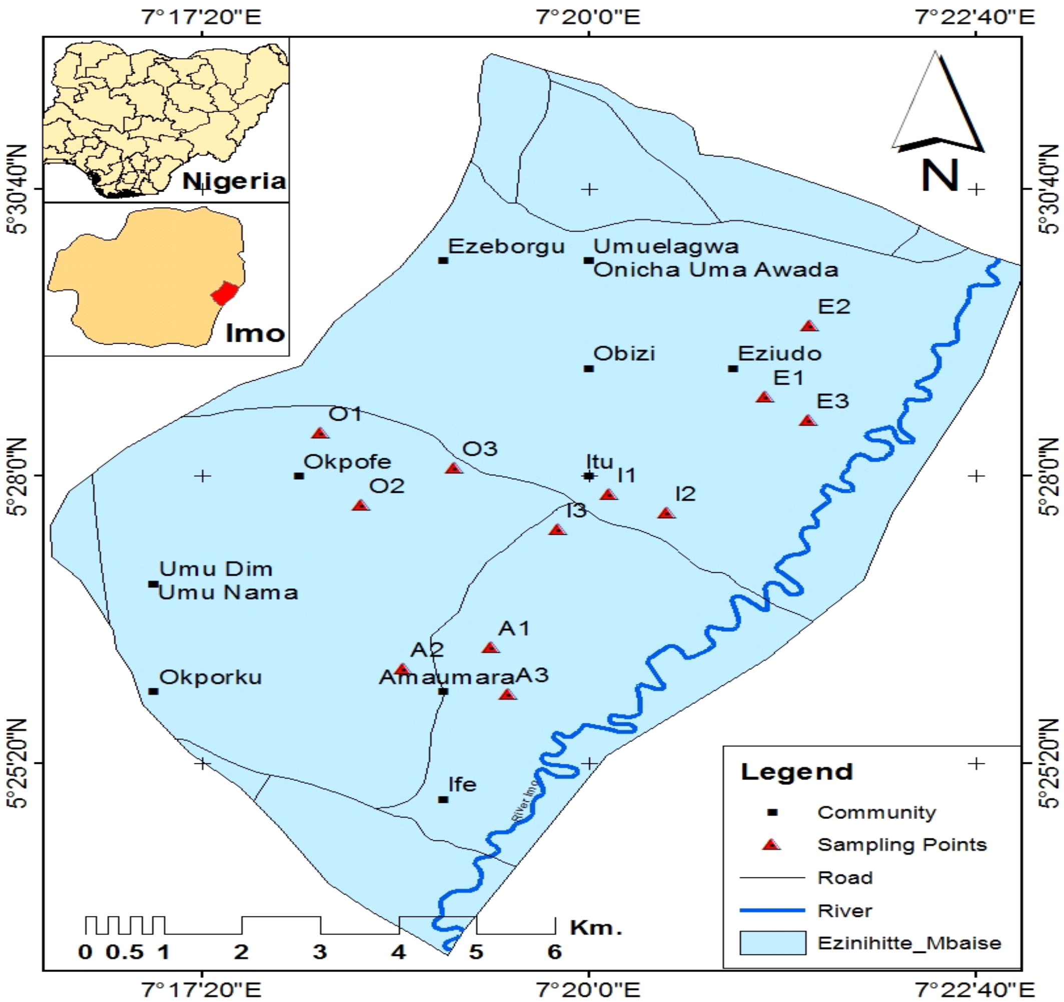

Figure 1. Map of the study area (sampling locations) in Ezinihitte Mbaise.

Sample collection: To investigate the effect of anthropogenic activities on the soil physicochemical parameters in Ezinihitte mbaise, three (3) basic materials were taken to the field, viz; polythene bags for the collection of soil samples, a GPS for recording of coordinates of the soil samples and a soil auger. With the use of soil auger, composite soil samples were taken randomly at three depths i.e. 0-5cm, 5-15cm and15 30cm respectively from Amumara (playground), Eziudo (farmland), Okpofe (market) and Itu (forest). The collected samples were sent to the laboratory for analysis of physicochemical properties.

Determination of parameters: The samples were air-dried at room temperature for seven days in aluminum dishes before they were sieved through a 2mm sieve. Then each soil sample was divided into two portions or sub samples to yield a laboratory sub sample and an original sub sample.

Results

Table 2. Mean Values of Physicochemical Parameters of Soil from Ezinihitte Mbaise

Location	Dept Cm	MC %	OC%	OM%	P ppm	pH	Mgmg/kg	Ca mg/kg	K mg/kg	Na mg/kg	Al mg/kg	EC μs	Sand %	Silt %	Clay %	TC
Playground	0-5	16.28	0.34	0.59	5.53	6.9	8.5	0.7	576	248	2.0	0.126	72.63	4.95	22.43	SL
	5-15	13.09	0.66	1.14	6.3	6.59	4.2	0.5	600	368	1.6	0.127	82.63	3.28	14.09	SL
	15-30	13.72	0.94	1.62	5.25	7.02	7.9	1.2	512	232	1.2	0.127	74.96	6.28	18.76	SL
Farmland	0-5	13.48	0.74	1.27	18.55	6.47	4.9	1.3	624	392	1.6	0.145	74.63	7.28	18.09	SL
	5-15	16.09	1.26	2.17	58.52	7.38	4.8	2.0	552	328	0.001	0.145	87.96	4.16	7.43	S
	15-30	16.59	0.68	1.17	28.35	6.45	4.9	2.5	600	336	1.6	0.154	79.29	5.95	14.76	SL
Market	0-5	12.17	1.14	1.96	4.55	7.40	1.0	0.9	488	296	2.8	0.`154	82.29	7.28	10.42	SL
	5-15	16.70	1.52	2.61	8.12	6.46	2.9	0.5	424	264	1.6	0.121	74.63	7.95	17.43	SL
	15-30	11.94	0.84	1.45	3.78	6.52	1.3	0.4	496	304	2.0	0.120	75.63	6.28	18.09	SL
Forest (control)	0-5	10.90	1.08	1.86	38.64	7.88	4.4	9.0	536	224	0.001	0.134	83.63	7.28	9.09	S
	5-15	6.56	0.32	0.55	20.44	8.15	4.5	3.2	528	240	0.001	0.155	90.96	3.61	5.43	S
	15-30	7.63	0.32	0.55	27.3	8.98	4.9	6.7	520	256	0.001	0.138	88.96	3.95	7.09	S

Key: OC= organic carbon, P= phosphate, MC= moisture content, OM= organic matter, EC= electrical conductivity, Al= aluminium, Ca= calcium, K=potassium, Na= sodium, SL= sandy loam, S= sand

Table 3. correlation matrix for linear relationships between soil physicochemical parameters obtained from ezinihitte mbaise.

	MC	OC	OM	P	pH	Mg	Ca	K	Na	Al	BC	Sand	Silt	Clay
MC %		0.10784	0.10705	0.97201*	0.0035423	0.52581	0.074053	0.71287	0.28888	0.12781	0.42103	0.023335	0.27982	0.028316
OC %	0.48759				0.27047	0.17264	0.62892	0.08691	0.87921	0.63334	0.57157	0.5182	0.027907	0.89756
OM %	0.48855	0.99999*		0.64928	0.2692	0.17361	0.6277	0.087416	0.87991	0.63259	0.56707	0.51696	0.028319	0.89505
P Ppm	-0.011375	0.14671	0.14664		0.20607	0.78352	0.056209	0.45063	0.86079	0.0055177	0.16925	0.043231	0.48232	0.030045
pH	-0.76784	-0.34609	-0.34695	0.39319		0.85738	0.0061819	0.57222	0.068778	0.013508	0.3074	0.0029414	0.20081	0.0033415
Mg mg/kg	0.20352	-0.42124	-0.42038	0.088897	0.058214		0.81808	0.15879	0.4159	0.4105	0.6871	0.54458	0.34433	0.32729
Ca mg/kg	-0.53349	-0.15571	-0.15626	0.56384	0.73759	0.074471		0.95385*	0.1496	0.0083155	0.54277	0.068708	0.87561	0.038326
K mg/kg	0.11889	-0.51462	-0.51392	0.24094	-0.18158	0.43386	0.018762		0.045827	0.89504	0.31938	0.98578*	0.23925	0.75692
Na mg/kg	0.33386	0.049241	0.048954	0.056813	-0.54188	-0.25921	-0.44263	0.58475		0.27778	0.50884	0.70346	0.8587	0.63714
Al mg/kg	0.46489	0.15373	0.15407	-0.74411	-0.68738	-0.26212	-0.71971	-0.042755	0.34118		0.58735	0.011138	0.15426	0.015223
EC μs/cm	-0.25647	-0.18188	-0.18398	0.42428	0.322	-0.13003	0.19541	0.31453	0.21174	-0.17458		0.06202	0.67713	0.040768
Sand %	-0.64568	-0.20719	-0.20779	0.59049	0.77707	-0.19455	0.54199	0.0057791	-0.12294	-0.70072	0.55331		0.039073	1.3004E-07
Silt %	0.33982	0.63064	0.62937	-0.22484	-0.39741	-0.29947	-0.050718	-0.36798	-0.05767	0.43814	-0.13438	-0.12601		0.20238
Clay %	0.62938	0.041722	0.04275	-0.62421	-0.77078	0.30969	-0.60204	0.1001	0.15204	0.67877	-0.59617	-0.59882	-0.97197*	

OC= organic carbon, P= phosphate, MC= moisture content, OM= organic matter, EC= electrical conductivity, Al= aluminium, Ca= calcium, K=potassium, Na= sodium, The laboratory sub samples were placed in labeled plastic bags. Analysis of all soil samples described below was carried out on these laboratory sub samples.

The pH of soil was measured on saturated paste using pH meter. Walkely Black method was used to determine the percentage organic matter and organic carbon in all samples of soil (Nelson & Sommers,1982). Mg**,** K and Ca were measured using Optical Emission Spectrometer. Available phosphate was measured using Electrophotometer. Heavy metals were analysed using Atomic Absorptions Spectrophotometer (AAS). Electrical Conductivity was determined using conductivity meter. Particle size distribution was determined by hydrometer method according to Gee and Or (2002).

Discussion

Table 2 showed the physicochemical properties of the soils affected by human activities. Moisture content of the soil from all the locations ranged from (6.56% - 16.70%). The highest value (16.70%) was recorded in the soil from market at the depth of 5-15cm and the lowest (6.56%) was recorded in forest (control) at the depth of 5-15cm. These values were high compared to values obtained from the control site. Soil moisture content were found to vary with depths, which was similar to the report of Wakene (2001) and this may be due to the amount of clay (Andrade *et al*.,2011) and nature of the activities on the sites. Organic carbon from all location ranged from (0.32% - 1.52%). The highest organic carbon content (1.52%) at 5-15cm depth was recorded in the market area and the lowest (0.32%) (5-15cm depth) was recorded in forest (control). These values differed significantly ($p<0.05$) from each other in all the sites. The values obtained from different land use type were higher than that of forest (control). This observation is in line with Onyedele *et al*. (2008) who reported that polluted sites has significant higher soil organic matter and organic carbon compare to the control site. Ayolagha and Onwugbuta (2001) also reported that organic carbon greater than 1.2% creates a conducive medium for heavy metal chelation formation. Soil organic matter ranged from (0.55%-2.61%). The highest value (2.61%) at 5-15cm depth was recorded in the market area while the least value (0.55%) at 5-15cm depth was recorded in forest (control). Soil organic matter identifies the humus content in the soil from decomposition of crop and microbial residues. Increase in organic matter in soil increases the amount of carbon in soil, which makes up approximately 60% of soil organic matter with the remaining 40% containing other important elements such as calcium, hydrogen, oxygen and nitrogen. It increases soil stability, assist in cycling nutrients, provides habitat and erosion control. Organic matter content in soil is as a result of the activities going on at the different locations. Available phosphate concentration in soil ranged from (3.7 ppm – 58.53 ppm). The highest value (58.53 ppm) at depth of 5-15cm was recorded in farmland and the least value (3.78 ppm) (15-30cm depth) in market area. The difference in soil available phosphate may have resulted from changes in biological and geochemical processes at different depths after human disturbance (Gong *et al*.,2005). The high amount of phosphate maybe due to the increased use of fertilizer in farming activities. Soil pH significantly ($p<0.05$) differed among the soils. Highest value of soil pH (8.98) at depth of 15-30cm was observed in forest (control) while the lowest value (6.45) (15-30cm depth) was observed in farmland. Soil pH ranged between slightly acidic and slightly basic as indicated by Benton (2002).

The average pH values for all sites were lower than the control sites. Low pH from these anthropogenic sites could be as a result of decomposition of organic matter that releases carbon (iv) oxide which reacts with water to form carbonic acid which eventually reduces soil pH. Magnesium content in the soil from all locations ranged from (1.0 - 8.5mg/kg). The highest value (8.5mg/kg) at depth of 0-5cm was recorded in play ground while the least value (1.0mg/kg) at depth 0-5cm was recorded in market area. Magnesium is very important for plant life. It is the most abundant mineral in the soil.

The exchangeable basic cations (Ca, Mg, K, Na) of the soil differed significantly ($p<0.05$) among the soils. Calcium content in the soils ranged from (0.4 - 9.0mg/kg) with forest (control) having the highest value (9.0mg/kg) at 0-5cm depth and market the least value (0.4mg/kg) at 15-30cm depth. Calcium in soil increased with depth in farmland and decreased with depth in market area. From all the locations it was observed that the potassium content in the soils ranged from (424 – 624kg/mg). The highest value (624mg/kg) at 0-5cm depth was recorded in farmland while the least (424mg/kg) at the depth of 5-15cm was recorded in market area. Potassium is an essential nutrient for crop production. As the level of potassium increases, the level of soil fertility also increases. Sodium content in the soils ranged from (224 – 392mg/kg). The highest value (392mg/kg) (15-30cm depth) was recorded in farmland while the least value (224mg/kg) at 0-5cm depth was recorded in forest (control). Sodium plays a role in soil health but is not a plant nutrient. High amount of sodium indicates salinity problem such as poor soil structure. It can be remediated immediately by watering frequently and applying gypsum. Aluminum content in soils ranged from (0.001–2.8mg/kg). The highest value (2.8mg/kg) (0-5cm depth) was recorded in the market area while the least value (0.001mg/kg) at depth of 0-5cm was recorded in forest (control). EC in the soils ranged from (0.120 – 0.155µs/cm). Electrical conductivity increased with depths in playground and farmland, but decreased with depth in market area. The highest value (0.155µs/cm) (5-15cm depth) was recorded in forest (control) while the least value (0.120µs/cm) (15-30cm depth) was recorded in market area. Conductivity measures the current that gives a clear idea of soluble salt present in the soil suspension.

More acidic soil shows high electrical conductivity value. The high electrical conductivity was as a result of different anthropogenic activities going on in the locations.

The sand fraction was highest followed by clay and silt. This proportion showed that the soils were coarse textured and as such, have low supply of nutrients and moisture unlike fine textured soils that have sufficient water holding capacity, good aeration and high supply of nutrients (Wilde et al., 1972). The percentage of sand, clay and silt are categorized as textural class. The soil texture was sandy-loamy (sand>clay>silt). This soil therefore has the potential to hold more water within the particles due to the presence of a relatively high percentage of clay (Brandy.1996).

The result of the correlation analysis (Table 3) revealed both positive and negative correlation of diverse magnitudes. There were high positive correlation between OC and OM (0.99999), P and MC (0.97201), P and Ni (0.82315), pH and Cr (0.85381), Mg and pH (0.85738), Ca and Mg (0.81808), k and Ca (0.95385), Na and OC (0.87921), Na and OM (0.87991), Na and P (0.86079), Al and K (0.89504), Ni and OC (0.82867), Ni and OM (0.83134). Cd and K (0.94559), Cr and Mg (0.80654), Cr and K (0.82829), Cu and OC

(0.98614), Cu and OM (0.98548), Cu and Na (0.86171), Sand and K (0.98614), Sand and OM (0.98578), Silt and Ca(0.87561), Silt and Na (0.8587), Silt and Cu (0.81666), Clay and OC (0.89756), and between Clay and OM (0.89505).

The result also showed high negative correlation between sand and silt (-0.97179), MC and pH (-0.76784), P and Al (-0.74411), pH and clay (-0.77078), Ca and Al (-0.71971), Al and sand (-0.70072). The correlations were positively significant ($p<0.05$) between OC and OM (0.99999), P and MC (0.97201), K and Ca (0.95385), Cd and K (0.94559), Cu and OC, OM (0.98614), (0.98548), Sand and K, (0.98578). The result of the correlation analysis indicates causal relationship among the variables.

Conclusion

The study on the effect of anthropogenic activities on soil physicochemical properties in Ezinihitte Mbaise LGA., Imo State, showed significant variations ($p<0.05$) in soil properties. This is as a result of the different land use (playground, market, farmland and forest) and the anthropogenic activities in the study area. The soils of the study area were slightly acidic and basic depending on land use. The findings revealed that the soils were mostly sandy-loam. Organic carbon was reduced by human activities. Available phosphate was on the increase in farmland compared to other land use type. Calcium increased especially in the forest area (control). Potassium and sodium were greatly increased in soils from playground as compare to other land use type. The concentration of Al was high at the market area compared to other sites.

Recommendation

Based on the above conclusion, the following recommendations were made:

- Efforts should be made to improve soil quality and its fertility status through continuous application of manure and compost, soil amendments, cropping pattern most especially in farmland.
- The level of heavy metals in the soil should be maintained especially where direct or indirect contacts may occur.
- There should be reduction in unsuitable land use practices.
- Proper documentation of guidelines and regulations governing soil contamination should be made to aid further research in the subject matter.

References

Agulanna, E.C. (2008). “The Mbaiseness of Mbaise (2^{nd} ed), Owerri: Carrier publishers.

Andrade, F.A.,Al-Qureshi, H.A., Hotza, D. (2011). Measuring the plasticity of clays.Applied Clay Science, Elsevier,51(1):1-7

Annao, W.L., K.Nurdans, D.A.K., Cheung, C.C., Mingh, W. (2008). “Heavy Metals Concentrations of Surface Dust from e-Waste Recycling and Its Human Health Implications in Southeast China.”Environmental science and technology, vol. 42, no. 7, 2671- 2680,

Ano, A.O, Odoekelem, A.S and P.O. Ekwueme.(2007). “Lead and Cadmium Levels in Soils and Cassava (Manihot Esculenta Gnantz) Along Enugu Port Harcourt Expressively In Nigeria” Electronic, Journal of Environment, Agriculture and Food Chemistry, vol. 6 no. 5, pp. 2024 - 2031.

Ayolagha, G.A., Onwugbata, G.C.(2001).Suitability comparison of waste disposal site.27^{th} Proceedings of the Annual Conference of the Soil Science of Nigeria.November 5-9, University of calaba.

Dauda, M.S., Odoh, R. (2012). Heavy metal assessment of soil in the vicinity of fuel filling station in some selected Local government areas of Benue State, Nigeria. *Pelagia research library, Der chemical sinica*, 3(5): 1329-1336.

Eli, H.D. (2012).Analysis of flooding on farmland along the kolo Creek of Bayelsa State, Nigeria.Unplublished Ph.D thesis, University of Calabar, Calabar Nigeria. PP 20-67.

Gee, G.W and Or, D. (2002) Particle Size Analysis. In Methods of Soil Analysis.Dan, D.J and G.C.Topps (eds), part 4.Physical methods.Soil Science Society of American Book Series No 5, ASA and SSSA Madison, W.I. pp 225-293.

Gong, J.L., Chen, N.F.U., Huang, Y., Haung, Z.and H. Peng.(2005).Effect of Land Use on soil Nutrients in the Loess Hilly Area of the loess plateau China. John Wiley and sons, Ltd.

Nelson, D.W., and Sommers, L. E. (1982).Methods of soil analysis part 2: Total carbon, organic carbon and organic matter. American Society of Agronomy, 9, 539-579

Onweremadu, E.U. (2007). Lithosequential Variability in phosphorous (P) forms in the humid tropics. *International journal of soil science*, 2 (3): 182 -187.

Onwudike, S.U. (2010). “Effectiveness of cow Dung and Mineral fertilizer on soil properties, Nutrient uptake and yield of sweet potato (ipomoea batatas) in Southern eastern Nigeria” *Asian journal of Agricultural Research*. 148-154.

Onyedele, D.J., Gasu, M.B., Awotoye, O.O. (2008). Changes in soil properties and plant uptake of heavy metals on selected municioal solid waste dump sites in Ile-Ife, Nigeria. *African Journal of Environmental Science and Technology* 3(5): 107-115.Sheppard, J.(2013). Environmental Toxic: Growing up on chemical- Our children’s Toxic Environmental.2005 http//www.healthychild.com.5thMay.

Wakene, N. (2001).Assessment of important physicochemical properties of Dystric Udalf (Dystric Nitosols) under different management systems in Bak area, Western Ethiopia.M.Sc. Thesis submitted to school of Graduate Studies, Alemaya University, Ethopia.

Zakir, H.M., Shhikazono, N and Otomo,K. (2008). “Geochemical Distribution of Trace metalsand Assessment of Anthropogenic Pollution in Sediments of Old Nakargawa River, Tokyo, Japan.”American Journal of Environmental Sciences, vol. 4, no. 6, pp. 654-665.