

Baseline Monitoring of Elemental Contamination Levels in Soil Samples in Elebele Community, Bayelsa State, Nigeria

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Abstract

This study evaluated the physico-chemical properties of the soil in Elebele Community in Ogbia Local Government Area of Bayelsa State, Nigeria. Standard sampling and analytical methods were employed. The predominant soils of the region are mainly sandy-loam and clayey-loamy. The soil physico-chemical properties were in good status as they were not toxic. Soil particle size distribution (sand silt and clay) was observed as follows: sand content ranged between 50.6%-86.2% with a mean of 64.5% at the surface soil while the subsurface soil ranged between 35%-80.2% with a mean of 60.2%. Silt on the other hand ranged between 7.8%-36% and a mean of 25.1% at the surface and ranged between 12.8-49.6% and mean of 25.4% at the subsurface while clay ranged between 3.4%-16% and mean of 9.4% at the surface and also ranged between 7%-16% and mean value of the soil. However, the soil physical properties were relatively good for sustainability. Also, the metals studied were detected in all the sites. Generally the concentrations of the metals were highest at the top soils. This is expected since the top soil is the point of contact. The metal levels in all the sites were significantly higher than the levels observed in the control sites. Sources of heavy metals in soils like inorganic fertilizers and pesticides need to be controlled.

Keywords: heavy metals, soil contamination, physico-chemical, heavy metals, elebele

1. Introduction

The soil formation is a constructive as well as destructive process; destructive process in the way that it predominates the physical and chemical disintegration of materials, plants and animal structures, which may lead to partial loss of more soluble and volatile products. Meanwhile, a constructive process because it develops new chemical compounds, both mineral and organic and provide new distribution or association characteristics, structural properties and chemical compositions (Samuel & Werner, 1975). The usefulness of soil which cannot be emphasized enough can be seen in human survival and existence, as well as plant and animal survival including micro-biological organisms hence the significance for a comprehensive study of the physical components and processes of soils has been greatly highlighted by Ukpong (2009).

Adelekan and Alawode, (2011) their examination opined that risky materials, for example, heavy metals, pesticides and hydrocarbons that are dissolved in this fluid regularly pollute soil. Anikwe and Nwobodo (2001) proposed that incessant discarding of city waste on soil may lead to proliferation these metals in the soil and surface water that would be hostile to deep rooted plants. These sorts of metals, for example, arsenic, cadmium, lead, chromium, nickel, cobalt and mercury are of concern fundamentally due to their capacity to hurt organisms in the soil, plants, animals and man.

An investigation by Begum et al. (2009) when he carried out an analysis on lead, iron, zinc, nickel and copper in soil and plants utilized the strategy for investigation. Also, Fong et al. (2008) in the investigation of copper, Cd, manganese, lead and zinc in urban roadside soils utilized atomic absorption spectroscopy in their examination. Many researchers have utilized atomic absorption spectroscopy in their examination of these metals. Mamtaz and Chowdhury (2006) considered iron, copper, manganese and zinc levels in urban strong waste, Awokunmi et al. (2010) investigated Cd, cobalt, chromium, copper, lead, manganese, nickel and zinc levels in soils from a

dumpsite, Mico et al. (2006) utilized atomic absorption spectroscopy technique in investigation of Cd, cobalt, chromium, copper, press, manganese, nickel, lead and zinc in the rural soils of Segura River Valley in Spain. Al-Weher (2008) examined dimensions of Cd, copper and zinc in three types of fish utilizing atomic absorption spectroscopy strategy while Wiczorek et al. (2005) utilized the equivalent.

Heavy metal contamination in soils refers to situations where the amounts of the components in soils are higher than greatest admissible limits and this is possibly destructive to natural life at such areas (Adeleken & Abegunde, 2011). These metals are found naturally in all ecosystems; in any case, anthropogenic discharges can result in higher concentrations of these metals. Heavy metals discharged from vehicular outflow can gather in surface soils and their deposition after some time can prompt unusual increase, hence causing metal defilement of the surface soils (Fong et al., 2008).

High concentrations usually occur in soils below or near landfills and agricultural lands usually irrigated with contaminated water (Mamtaz & Chowdhury, 2006). Researches have demonstrated that both long term and short term pollution of soils have impacts on microbial movement and chemical activities of the soil (Adeleken & Abegunde, 2011). The poisonous quality and movement of these metals in soils depend on the accumulative concentration, specific chemical form, bonding state, metal properties, ecological variables, soil properties and organic matter content (Osu & Okoro, 2011). Exposure of children is generally seen as the most susceptible and vulnerable group who have a higher adsorption rate of heavy metals as a result of the effectiveness of their digestive system and affectability of hemoglobin, to heavy metals, can incredibly expand ingestion of metal loaded soil particles by means of hand – to-mouth exercises. Likewise, grown-ups might be presented to danger since inward breath is a less demanding pathway for poisonous metals to enter their body (Fong et al., 2008).

The area of study, Elebele a rural community of 8000 persons from the onset has been an agriculture-based settlement comprised mainly farmers and fishermen but now predominant in civil service and oil and gas operations resulting to an notable hike in population influx and expansion of settlement size on daily basis. Consequently, there is observable increase in population influx and physical expansion of settlement size on daily basis. With this, there is high demand for food and accommodation, and scarcity of available land is beginning to be experienced. This study goes a long way in opening many windows for further research on various aspects of the area's physical and chemical properties especially, as it concerns soil and

2. Study Area Description

The area of study, Elebele is located in the North-East part of Bayelsa State in Ogbia Local Government Area. Geographically, the area lies between latitudes 40 51'21"N and longitudes 60 20'32"E (Figure 1). The annual rainfall distribution begins with the early rains in March, which ceases in November. In general, there should be only two seasons, but in climatology four seasons are actually discernible for the entire region. These seasons too are differentiated by rainfall and they are the early rainy season (March-July), little dry season (also called August break), late rainy season (September-November) and dry season (December-February). The most important role of rainfall to air pollution studies is that it acts as a scavenger by washing pollutants off the atmosphere. The amount and distribution of rainfall in the study area is such that it plays an salient role in moving pollutants from the atmosphere to other spheres of the environment. The mean annual rainfall for the study area is above 3000 mm. Highest rainfall values were obtained in July (424.6 mm), August (444.6 mm) and September (552.3 mm). Lowest rainfall values were obtained in January (42.7 mm) and December (51.1 mm). It is fundamental to highlight that rainfall is very important in road construction projects because of its power to cause erosion and erode soil particles from ground level surfaces.

The study area lies in the coastal Niger Delta sedimentary basin. The Niger Delta is one of the World's largest Tertiary delta systems and an extremely prolific hydrocarbon province. It is situated on the West African continental margin at the apex of the Gulf of Guinea, which formed the site of a triple junction during continental break-up in the cretaceous. Throughout its history the delta has been fed by the Niger, Benue and Cross rivers, which between them drain more than 106 km² of continental lowland savannah.

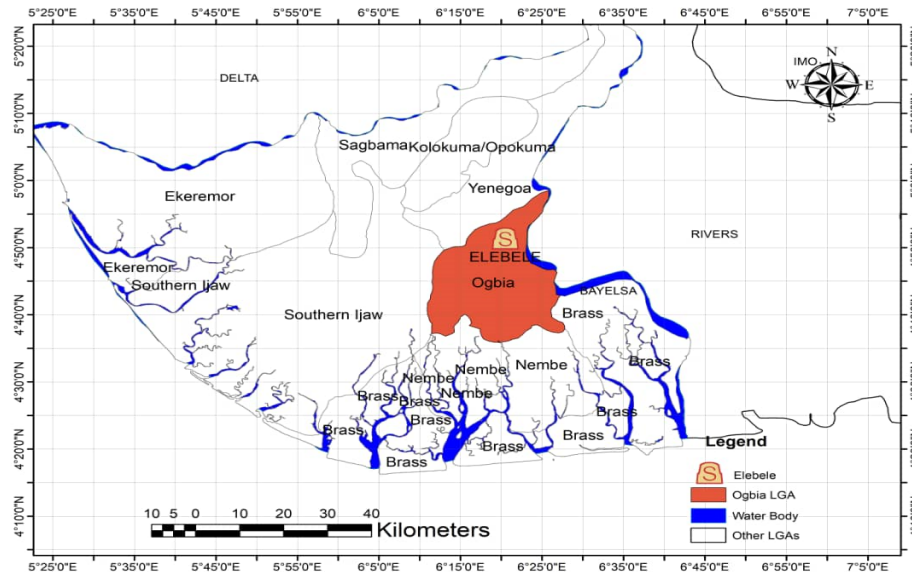


Figure 1. Map showing study area

The Niger Delta comprises of three (3) diachronous units, specifically Akata (most established), Agbada and Benin (most youthful) developments. The Benin Formation (Oligocene to Recent) is about 2100 m thick at the basin focus and comprises of medium to coarse grained sandstones, thin shales and rock (Weber et al., 1975). The Niger Delta has spread over various natural zones including sandy seaside obstructions, salty or saline mangrove, freshwater and occasional marsh timberlands. The Niger Delta has two most critical aquifers, Deltaic and Benin Formations. With a regularly dendritic waste system, this very penetrable sands of the Benin Formation enables simple penetration of water to revive the shallow aquifers. Nwankwoala et al. (2014) depicted the aquifers here as an arrangement of various aquifer frameworks stacked on one another with the unconfined upper aquifers happening at the best (Ngerebara et al., 2008).

The recharge of aquifers is immediate from invasion of precipitation, the yearly aggregate of which shifts between 5000mm at the drift to about 2540mm landwards. Groundwater in the zone happens in shallow aquifers of overwhelmingly mainland deposits experienced at penetrations of somewhere in the range of 45m and 60m. The lithology contains a blend of sand in a fining up arrangement, rock and mud. Well yield is phenomenal, with generation rates of 20,000 liters/hour normal and borehole achievement rate is typically high (Amadi et al., 2012). Surface water event incorporates various systems of streams, rivulets and waterways.

3. Methods of study

The methods employed in this study was carried out in line with the objectives of the heavy metals composition of the soil of the study area.

3.1 Physical and Chemical Properties of the Soil

The physical properties of the soil studied include sand, silt and clay while the chemical properties; Total Organic Carbon (TOC), Total Hydrocarbons (THC), Available Phosphorus (Av.P), Exchangeable Acidity (H+Al₃), Exchangeable bases (Ca, Mg, K and Na), pH and Total Nitrogen (TN).

3.2 Soil Sampling

Anthropogenic sources of heavy metals influenced the choice of sampling locations. At each sampling point, approximately 0.5 kg of soil was collected 0-10 cm in depth using a stainless steel sampler. Soil samples along the roads were taken at a distance of one metre away from the road and within an area of one square metre. Three (3) samples were collected from each point, thoroughly mixed in a clean plastic container to obtain a representative sample dried, crushed and sieved with 2 mm mesh before being stored in labeled polythene bags prior to the analysis. The soil samples were labeled in line with the regions from which they were obtained.

3.3 Soil Tests

The Soil pH was estimated in water suspension (1:2.5) utilizing the glass cathode coupled pH meter. The

potential acidity was estimated in a 1:10 (w/v) apportion of soil to arrangement of 1M KCl. The cation exchange limit (CEC) was dictated by extracting the cations with 1 M ammonium acetic acid derivation cradled at pH 7. 30 ml of 1 M $\text{CH}_3\text{COONH}_4$ was added to 5 g of soil. The suspension was shaken for 2 hours and after that centrifuged (15 min, 6000 rpm). After centrifugation and filtration, the filtrate was moved into a 100 ml container and two different volumes of 30 ml ammonium acetic acid derivation were included progressively after 30 min of unsetting and centrifugation. The last filtrates were finished to 100 ml with ammonium acetic acid derivation arrangement.

Calcium (Ca) and magnesium (Mg) were dictated by EDTA titration while potassium (K) and sodium (Na) were controlled by flame photometry. Exchangeable acidity (EA) was dictated by titration technique (Juo, 1979). The effective cation exchange limit (ECEC) was ascertained as the aggregate exchangeable bases in addition to exchangeable acidity. Percentage based saturation (BS%) was ascertained as the percentage (%) of the sum of exchangeable bases over the ECEC. Available phosphorous (Av. P) was separated with Bray solution and the phosphorous controlled by the molybdenum technique (Udo and Ogunwale, 1978). The organic matter percentage (%OM) was ascertained from the percentage of organic carbon (OC%) estimated utilizing Walker-Black (1934) wet oxidation strategy. Total nitrogen (TN) was resolved utilizing the modified Kjeldahl distillation strategies (Juo, 1979).

The heavy metals were determined using the atomic absorption spectroscopy. The heavy metals elements determined were Cadmium (Cd), Nickel (Ni), Cobalt (Co), Chromium (Cr), Copper (Cu) and Lead (Pb).

4. Results and Discussion

Table 1 revealed that the physical properties of soil that was studied varied in texture along the sampled stations (Station A- D). The texture varied from sandy, clay, loam and clayey texture due to the inherent environmental condition as at the time of sample collection.

The concentration of sand, silt and clay in Elebele community at both surface and subsurface include: sand, 67.6% at the surface and 67% at the sub surface; silt was 23.05 at the surface and 19% at the subsurface while clay was 9.4% at the surface and 13.4% at the subsurface in Station B, sand concentration was 86.2% (surface) and 80.2 (sub-surface) silt had 7.8% (surface) and 12.8% (surface) while clay concentration was 6.5 (surface) and 7% at the subsurface level of the soil. In the same vein Station C had percentage values of sand at 55.6% at both the surface and subsurface level of the soil, silt also had a twin value of 32.5% at the surface and subsurface level and clay also had the same value of 12% for both the surface and subsurface level of the soil. Furthermore, Station D had sandy content of 68.85 (surface) and 35% (subsurface), silt had percentage value of 21.2% (surface) and 49.6% (subsurface) while clay had 10% at the surface and 15.4% at the subsurface level.

Table 1. Physical properties of the soil in elebele community

Sample Stations	Physical Properties					
	Sand (%)		Silt (%)		Clay (%)	
	Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface
A	67.6	67	23.05	19	9.4	13.4
B	86.2	80.2	7.8	12.8	6.5	7
C	55.6	55.6	32.5	32.5	12	12
D	68.85	35	21.2	49.6	10	15.4

4.1 Chemical Properties

4.1.1 Total Organic Carbon (TOC)

Organic carbon is a major soil component that is a principal content of organic matter and it is very important and it is a major some of CO_2 and atmospheric CO_2 organic carbon is made up of the cells of micro-organisms, plants and animals residues at various stages of decomposition. Therefore plants and animals need carbon for their growth and production. Hence, the level of organic carbon in the area varied in the area at both surface and sub-surface soils. Organic carbon level in *Station A* surface soil was 0.156% and 0.254% at the sub-surface. In *Station B*, TOC was 1.131% (surface) and 0.273% (sub-surface) while *Station C* had 0.254% (surface) and 0.195% (subsurface). For *Station D*, surface TOC was 0.098% and subsurface Toc was 0.136%.

4.1.2 Total Hydrocarbons (THC)

This is a very important component of the soil as it shows the amount of heat energy availability in any given unit of soil. Thus this also shows the level of soil toxicity of contamination in the soil and they varied with space and depth in a given region of soil. *Station A* had the values of 0.50mg/kg and < 0.01 mg/kg at the surface and subsurface soil. *Station B* had <0.01 mg/kg (surface) and < 0.01 mg/kg (sub surface). *Station C* had 1.25 mg/kg (surface) and 0.25 mg/kg (sub surface) *Station D* had < 0.01mg/kg (surface) and 1.55 mg/kg (sub surface)

4.1.3 Available phosphorus (AV.P)

This is very important to plant growth, protein synthesis and promotion tissue development both plant and animals based on this, the soils AV.p were seen to occur as follows *Station A* 0.33 mg/kg (surface) and 0.33 mg/kg (sub surface) *Station B* = 0.33mg/kg (surface) and 1.00 mg/kg (sub surface) *Station C* = 0.66mg/kg (surface) and 1.00 mg/kg (sub surface). *Station D* = 30.66mg/kg (surface) and 1.00mg/kg (subsurface)

4.1.4 Exchangeable Acidity ($H^+ Al_3^+$)

This indicates the availability of hydrogen and aluminum compounds in the soil. The excess concentration of exchangeable acidity in the soil which is caused by the loss or reduction in exchangeable bases (Mg, Ca, Na and K) can increase in toxicity of the soil thereby causing poor plant and animal's health. However the *Station A* surface had a value of 0.48 cmol/kg and 0.88 cmol/kg went for the subsurface *Station B* had 0.48 cmol for both the surface and subsurface layer while *Station C* was 0.80 cmol/kg surface and 2.12 cmol/kg (subsurface) for *Station D*, the surface and subsurface value were 1.56 cmol/kg and 2.12 cmol/kg respectively

4.1.5 Exchangeable Bases

Exchangeable bases (Ca, Mg, K and Na) are positively charged ions absorbed by electrostatic or coulombic attraction to soils surface colloids. Thus, cation relates information on soils ability to sustain plant growth, retain nutrients and buffer acid deposition of requester toxic heavy metals.

Based on these the exchangeable calcium (Ca) in *Station A* was 2.382 cmol/kg (surface) and 2.522 cmol/kg (subsurface), *Station B* has 1.837 cmol/kg at the surface and 1.927 cmol/kg at the subsurface. In *Station C*, the surface and subsurface calcium values were 1.095 cmol/kg and 6.721cmol/kg respectively *Station D* has 1.672 cmol/kg (surface) and 1.451 cmol/kg (subsurface).

4.1.6 Exchangeable Magnesium (Mg)

The content in the soils was 1.668 cmol/kg and 1.774 cmol/kg respectively at both surface and subsurface soils of *Station A*. *Station B* had mg content of 1.599 cmol/kg (surface) and 1.768 cmol/kg (Subsurface) and *Station C* 1.578 cmol/kg respectively at both the surface and subsurface. For *Station D*, the mg value of surface and subsurface soils were 1.441 cmol/kg and 1.422 cmol/kg respectively

4.1.7 Exchangeable Potassium (K)

The K content in the soils was 0.468 cmol/kg and 0.262 cmol/kg respectively at both surface and subsurface soils was 0.468 cmol/kg and 0.262 cmol/kg respectively at both surface and subsurface soils of *Station A*. *Station B* had K content of 0.113 cmol/kg (surface) and 0.092 cmol/kg (subsurface). *Station C* had 0.085 cmol/kg at the surface and 0.155 cmol/kg at the subsurface layer. For *Station D*, the K content for both the surface and subsurface layer were 0.090 cmol/kg, respectively.

4.1.8 Exchangeable Sodium (Na)

The exchangeable Na in *Station A* was 1.084 cmol/kg (surface) and 0.804 cmol/kg (subsurface) *Station B* had 1.246 cmol/kg (surface) and 2.431 cmol/kg (subsurface), *Station C*, 0.746 cmol/kg (surface) and 0.928cmol/kg (subsurface) while that of *Station D* was 1.438 cmol/kg (surface) and 1.211 cmol/kg (subsurface).

4.1.9 pH

For pH, *Station A* PH value of 3.53 and 4.95 were obtained at the surface and subsurface of the soils layer. In *Station B* the pH value of surface and sub-surface layer were 4.83 and 4.95 respectively. *Station C* had a pH value of 4.32 for the surface layer and 4.82 for the subsurface layer *Station D* has a pH value of 4.66 (surface) and 4.27 (subsurface)

4.1.10 The Exchangeable Cation (EC)

The EC value of *Station A* at the surface and subsurface layer of the soil were 335 us/cm and 91.8 us/cm respectively *Station B* has EC values of 105.1 us/cm and 76.5 us/cm at both the surface and subsurface layer of the soils *Station C* had EC value of 108.8 us/cm at the surface layer and 67.4 us/cm at the subsurface level

Station D had 77.4 us/cm (surface) and 68.2us/cm (subsurface).

Table 2. Chemical properties of the soil in elebele community

Sample Stations	TOC (%)		THC (mg/kg)		AV.P (mg/kg)		Acidity (cmol/kg)		Bases (cmol/kg)		Magnesium (cmol/kg)		Potassium (cmol/kg)		Sodium (cmol/kg)		pH		EC (µs/cm)	
	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub	Surf	Sub
A	0.156	0.254	0.50	0.01	0.33	0.33	0.48	0.88	2.382	2.522	1.668	1.774	0.468	0.262	1.804	0.804	3.53	4.95	335	91.8
B	1.131	0.273	0.01	0.01	0.33	1.00	0.48	0.48	1.837	1.927	1.599	1.768	0.113	0.092	1.246	2.431	4.83	4.95	105.1	76.5
C	0.254	0.195	1.25	0.25	0.66	1.00	0.80	2.12	1.095	6.721	1.578	1.578	0.085	0.155	0.746	0.928	4.32	4.82	108.8	67.4
D	0.098	0.136	0.01	1.55	30.66	1.00	1.56	2.12	1.672	1.451	1.441	1.422	0.090	0.090	1.438	1.211	4.66	4.27	77.4	68.2
Mean	0.41	0.21	0.44	0.45	7.99	0.83	0.83	1.4	1.74	3.15	1.57	1.63	0.18	0.14	1.31	1.34	4.33	4.75	156.57	75.97
P-Value	0.774	.997	0.774	.997	0.774	.997	0.774	.997	0.774	.997	0.774	.997	0.774	.997	0.774	.997	0.774	.997	0.774	.997

Note. Surf = Surface; Sub Surf = Sub Surface.

4.2 Heavy Metals Concentrations in Soil

Heavy metals were detected in all the sites. Generally the concentrations of the metals were highest at the top soils. This is expected since the top soil is the point of contact. The metal levels in all the sites were significantly higher than the levels observed in the control sites.

Iron has the highest mean concentration among all the metals studied and its levels ranged from (mg kg^{-1}) 62.32 to 204.32 with mean value of 142.93 ± 42.16 . High concentrations of iron in soils relative to other metals have been reported in various studies, confirming that natural soils contain significant levels of iron (Dara, 1993; Ademoroti, 1996; Aluko & Oluwande, 2003). The mean value of iron obtained in this study is lower than those reported by Osakwe, (2010); Nwachukwu et al. (2011); Idugboe et al. (2014), but higher than the values reported by Okorie and Egila (2012), Suleman, (2014).

Zinc concentrations (mgkg^{-1}) vary from 30.34 to 105.78 with mean value of 59.34 ± 25.21 . Similar range of values was reported by Iwegbue et al. (2013). The range of values obtained in this study is lower than those reported by Zakir et al. (2014), Ojo et al. (2015); but higher than the levels reported by Nwachukwu et al. (2013), Ubwa et al. (2013). Zinc is also the second most abundant metal obtained in this study. This high level of zinc in roadside soil could be attributed to the wear and tear of vehicle bodies with galvanized steel surfaces (Zakir et al., 2014). Zinc is used in brake linings of vehicles because of its heat conducting properties and can be released during mechanical abrasion of vehicles and from combustion of engine oil and also from vehicle tyres (El-Gamal, 2000, Akbar et al., 2006; Manno et al., 2006, Matthews – Amune & Kakulu, 2013). Elik, (2003) reported that high concentration of Zinc in heavy traffic zones indicate that fragmentation of car tyres is a likely sources of the metal. Other possible sources of zinc in relation to automobile traffic in addition to wearing of brake lining are losses of oil and cooling liquid of vehicles and wearing of road paved surface (Saedi et al., 2009).

Chromium concentrations ranged from (mgkg^{-1}) 8.52 to 28.52 with a mean value of 14.27 ± 5.39 . These values are higher than those reported by Okoye and Egila (2012); Iwegbue et al. (2013); Ubwa et al. (2013), Idugboe et al. (2014); but lower than the values reported by Ferronato et al. (2013); Zakir et al. (2014). According to Al-Rhashman (2007), chromium level in road side soil is associated with the chromic plating of some vehicle parts used for preservation of corrosion. Chromium is carcinogenic resulting in cancer of respiratory organs in workers exposed to chromium containing dust (Langard, 1980).

Lead levels in all the sites were in the range of (mgkg^{-1}) 6.82 to 26.67 with mean value of 13.63 ± 5.41 . Similar range of values for lead has been reported (Zakir et al., 2014; Das et al., 2015). However the lead levels observed in this study are significantly higher than those reported by Matthews-Amune (2013), Ubwa et al. (2013) and lower than those of other similar studies (Nwachukwu et al., 2011; Najib et al., 2012; Pam et al., 2013). The concentration of lead in the soil is likely to have derived from vehicle exhaust fumes containing some lead-rich aerosols. (Zakir et al., 2014). Studies have shown that the use of tetraethyl lead as an anti-knocking agent in gasoline gives rise to its release during emissions from automobiles and fossil fuel combustion (Oztas & Ata,

2002, Akbar et al., 2006, Onder et al., 2007, Sharma & Parasade, 2010). Sherene (2010) reported that major sources of lead pollution are exhaust gases of petrol engines, which account for nearly 80% of the total lead in the air. Kakulu, (2003) also reported that lead content of leaded gasoline in Nigeria ranges from 0.60 to 0.80g/l. In addition, lead levels in roadside can also be attributed to wearing down of vehicle breaklinings and tyres (Sharma & Prasade, 2010, Zhang et al., 2012; Soerme & Langerkvsith, 2002).

The concentrations of nickel in the soils from all the sites ranged from (mgkg^{-1}) 6.92 to 58.23 with a mean value of 24.98 ± 15.57 . The mean value of nickel obtained in this study is consistent with the values reported by Najeb et al. (2012), Ogundiran and Osibanjo (2009); Oguntimehin and Ipinmoroti (2007), Nwachukwu et al. (2013). The mean level of nickel obtained in this study is however higher than that reported by Pam, et al. (2013); Matthews – Amune and Kakulu, 2013; Ubwa et al. (2013). Airborne particles emitted by brakes and wears from vehicle tyres can contain considerable amounts of nickel (Onder et al., 2007). This is a probable source of nickel in the recorded soils. Anthropogenic input of nickel in the study areas could also be from the diesel used in the automobiles (Iwegbue, 2013).

Table 3. Concentration of heavy metals in soils from all the sites (mgkg^{-1})

Sample site	Depth (cm)	Fe	Zn	Cr	Ni	Pb
A	0-15	204.12	104.4	14.25	58.23	14.85
	15-30	170.24	67.30	10.54	38.42	12.14
	30-45	95.46	40.28	7.10	24.58	6.82
B	0-15	109.64	93.52	18.62	49.42	17.13
	15-30	138.23	58.21	13.10	25.62	13.74
	30-45	62.32	38.04	8.64	17.81	9.46
C	0-15	184.72	105.78	28.52	18.62	18.21
	15-30	146.81	56.12	16.48	13.42	14.43
	30-45	103.42	39.24	12.23	8.56	10.64
D	0-15	166.23	55.29	19.26	15.82	15.83
	15-30	146.22	42.45	15.47	9.62	10.56
	30-45	99.24	30.34	11.67	6.92	6.84
Mean \pm SD		142.93 \pm 42.16	59.34 \pm 25.21	14.27 \pm 5.39	24.98 \pm 15.57	13.63 \pm 5.41
Control Mean		37.87	8.72	0.88	0.28	0.103

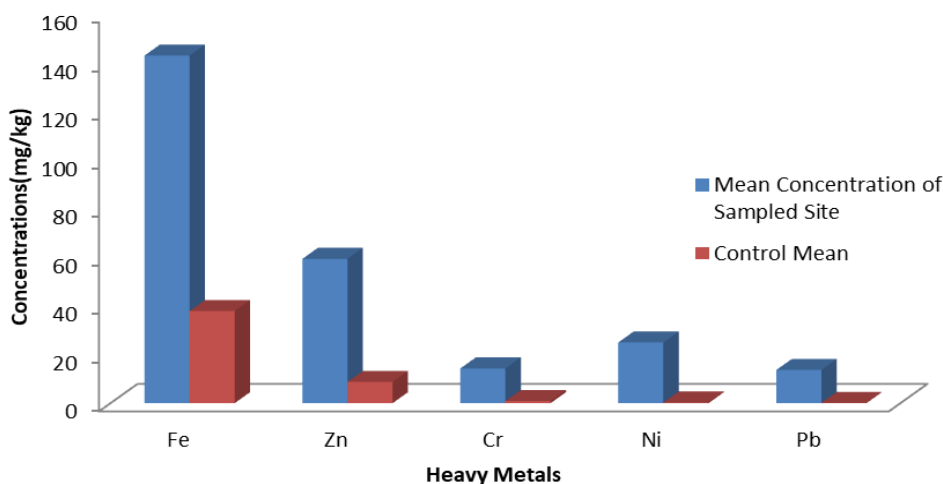


Figure 2. Heavy metals concentration in the soil of Elebele community

5. Conclusions

The physical properties of soil in Elebele varied in texture along the sampled stations. The texture varied from sandy, clay, loam and clayey texture due to the inherent environmental condition as at the time of sample collection. For soil chemical properties which was made up of, k, Mg, Na, TOC, PH, Ec, A.V.P, Ex. Acidity, k THC, the following range and mean value were observed:

Potassium (K): The range was between 0.074 cmol/kg- 0.468 cmol/kg and mean of 0.9 cmol/kg (surface) and at the subsurface ranged between 0.068 cmol/kg-0.587 cmol/kg and mean of 0.18 cmol/kg.

Magnesium (Mg): This ranged between 0.873 cmolo/kg - 1.668 cmol/kg and mean value of 1.48 cmol/kg at the surface and ranged between 1.317 cmol/kg -1.774 cmol/kg and mean value of 1.57 cmol/kg at the surface layer of the soil.

Sodium (Na): The range was between 0.746 cmol/kg - 1824cmol/kg and mean of 1.14 cmol/kg at the surface and ranged between 0.804 cmol.kg - 2.431 cmol/kg and mean of 1.12cmol/kg at the subsurface.

pH: This ranged between 3.53-5.20 with a mean of 4.27-5.16 with mean of 4.83 at the subsurface soil.

Exchangeable Cation (EC): This ranged between 55.8 Ns/cm-335 Ns/cm and mean of 123.74 Ns/cm at the surface and range between 46.9 Ns/cm - 122.3 Ns/cm and mean of 72.89 Ns/cm at the subsurface layer of the soil.

Available Phosphorus (AVP): This range between 0.33 mg/kg - 3.33 mg/kg and mean of 1.29 mg/kg at the surface and 0.33 mg/kg - 1.00 mg/kg with a mean of 0.59 mg/kg (subsurface).

Exchangeable Acidity: This ranged between 0.86 xmol/kg - 1.56 cmol/kg and mean of 0.86 cmg/kg (surface) and 0.48 cmol/kg-2.12 cmol/kg with mean 0.91 (subsurface).

Total Hydrocarbon (THC): The range for this was 0.01 mg/kg- 1.85 mg/kg with a mean of 0.54 mg/kg(surface) and on the subsurface it ranged between 0.01 mg/kg - 2.00 mg/kg with mean of 0.59 mg/kg.

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