Assessment of Soil Pollution Status of AJAKANGA and Environs, Ibadan, Southwestern Nigeria, Using Heavy Metal Concentration and Pollution Indices

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***Abstract*- 10 topsoil samples were collected from Ajakanga area and analyzed using the Inductively Coupled Plasma Mass Spectrometer (ICP-MS), in order to assess the pollution status and the ecological risk of heavy metals in the soil. Results showed that Cd range from 0.5ppm to 0.7ppm, Cu range from 4.0ppm to 213ppm, Ni ranged from 4.0ppm to 30ppm while Pb range from 6.0ppm to 64ppm. Zn range from 17ppm to 561ppm, As range from 2.0ppm to 3.0ppm, Co ranged from 6.0ppm to 67.0ppm while Cr ranged from 13.0ppm to 88.0ppm. The concentration of heavy metals in the soil is of the order Zn>Cu>Cr>Pb>Co>Ni>As>Cd. All the values of Igeo for Cd, Cu, Ni, As, Co Pb, Zn and Cr fall into uncontaminated to moderately contaminated. The entire content of Ni were derived from natural sources as indicated by EF value of <1.5 while Cd, Cu, Pb, Zn, As, Co and Cr have some contributions from anthropogenic sources. The contamination factor range from 0.188 to 2.665. Cu, Ni and Cr have C^i_f < 1 indicating low contamination, while Cd, Pb, Zn, As and Co C^i_f range between 1< C^i_f< 3 indicating moderate contamination. Contamination degree calculated for Ajakanga soil is 11.054 indicating moderate degree of contamination. The calculated potential ecological risk index (RI) for the area is 116.9, indicating that the risk of potential contamination of the Ajakanga soil with the current concentration of Cd, Cu, Ni, Pb, Zn, As, Co and Cr is low.**

***Index terms*- Ajakanga, Soil pollution, Geoaccumulation index, Enrichment factor, Contamination factor, Ecological risk index**

1. INTRODUCTION

The consistent and persistent pollution of the environment through the release of heavy metals has been of great concern to the society in recent years [1]. Soil act as sink for heavy metals released into the environment as a result of numerous anthropogenic activities. Unlike organic contaminants, most metals do not undergo microbial or chemical degradation [2], and their total concentration in the soil persist for a long time after their introduction [3].

Some of these heavy metals are essential to life [4], while others such as As, Pb and Hg have no useful role in the human physiology [5]. As, Pb, and Hg are the first, second and third hazards on the priority list if heavy metal pollutants as designated by the United States Agency for Toxic substances and Disease Registry [6].

The present anthropogenic pollution sources, including transport, industry, agriculture, and mining have contributed to heavy metal accumulation in soil [7, 8, 9]. Heavy metals can be derived in situ through the natural process of weathering of underlying rocks or from long distance through emissions into the atmosphere [10, 11, 12].

A means of effectively assessing soil contamination with heavy metals is by the use of pollution indices [13]. Pollution indices can be used for a comprehensive geochemical assessment of the condition and pollution status of the soil environment [14, 15, 16, 17, 12]. Pollution indices can also be used to estimate environmental risk as well as the degree of soil degradation [18, 14].

Consequently, this study aimed at assessing the pollution status and potential environmental risk of the soil of Ajakanga and environs, a residential area in Ibadan, Southwestern Nigeria, to the ecosystem using several pollution indices.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

Ajakanga and environs lies between N7^{0}17' 30.5", E3^{0}49'29.15" and 7°19'59.0", 3°50'38.8" on Ibadan sheet No 59 (Figure 1) [19].

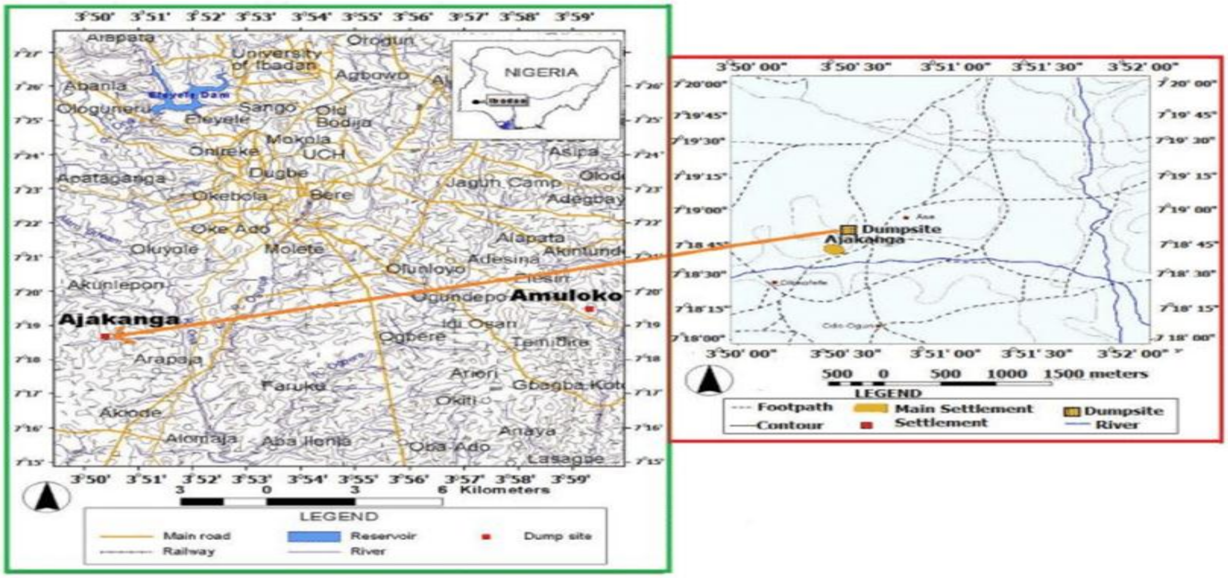

Figure 1: Map of Part of Ibadan Showing Ajakanga Area (Extracted from Nigeria Geological Survey Agency, Ibadan Sheet No.59, 1980)

Ibadan, generally, can be divided into two distinct climatic seasons; the rainy and dry seasons. Between March, and October, the city is under the influence of the moist maritime south-west monsoon winds which blow inland from the Atlantic Ocean. This period is marked by constant rainfall and is referred to as the rainy season. The dry season occur from November to February when the dry dust laden winds blow from the Sahara Desert. Within the two seasons there are slight variation in intensity of the rain and the dryness [20].

Three major landform units-hills, plains and river valley dominate the scenery of the study area. The hills are the most striking features of Ibadan town, although they constitute less than 5% of the total area [20]. The plains form by far the most extensive landform system in the area. The elevation is between 180m and 210m above the sea level. It covers essentially the areas between the hill bases, and the usually entrenched valley bottoms. The third landform system is the river valleys, which are the narrowest landform in the area. The natural vegetation of the study area is of the tropical rainforest, and is comprised of multitudes of evergreen trees and tall grasses typical of rainforest vegetation.

2.2 Geological Settings

Ajakanga is underlain by the rocks of the Basement Complex of Southwestern Nigeria. (Figure 2). The Nigeria Basement complex forms a part of the Pan African mobile belt and it lies between the West African and Congo craton and South of the Touareg Shield. It is intruded by the Mesozoic calc-alkaline Ring Complexes (Younger granite) of the Jos Plateau and lays uncomfortably over the Cretaceous and younger sediments. The Nigeria Basement Complex was affected by the 600 Ma Pan-African orogeny and it occupies the re-activated region which resulted from the plate collision between the Passive continental margin of the West African craton and the active Pheurasian Continental margin [21]. The Basement rocks are believed to be the result of at least four major orogenic cycles of deformation, metamorphism and re-mobilization corresponding to the Liberian (2700 Ma), the Eburnean (2000 Ma), the Kiberian (1100 Ma) and the Pan-African cycle (600 Ma). The Basement Complex has been classified into six major groups of rocks [22]. They are; Migmatite-gniess-quarzite Complex ; Slightly migmatised to non-migmatised metasediments and metaigneous rocks; Charnockitic, Gabbroic and Dioritic rocks; Older granites; the Metamorphosed to unmetamorphosed calc-alkaline volcanic and hypabyssal rocks; and the Unmetamorphosed Dolerite dyke and Syenites dykes.

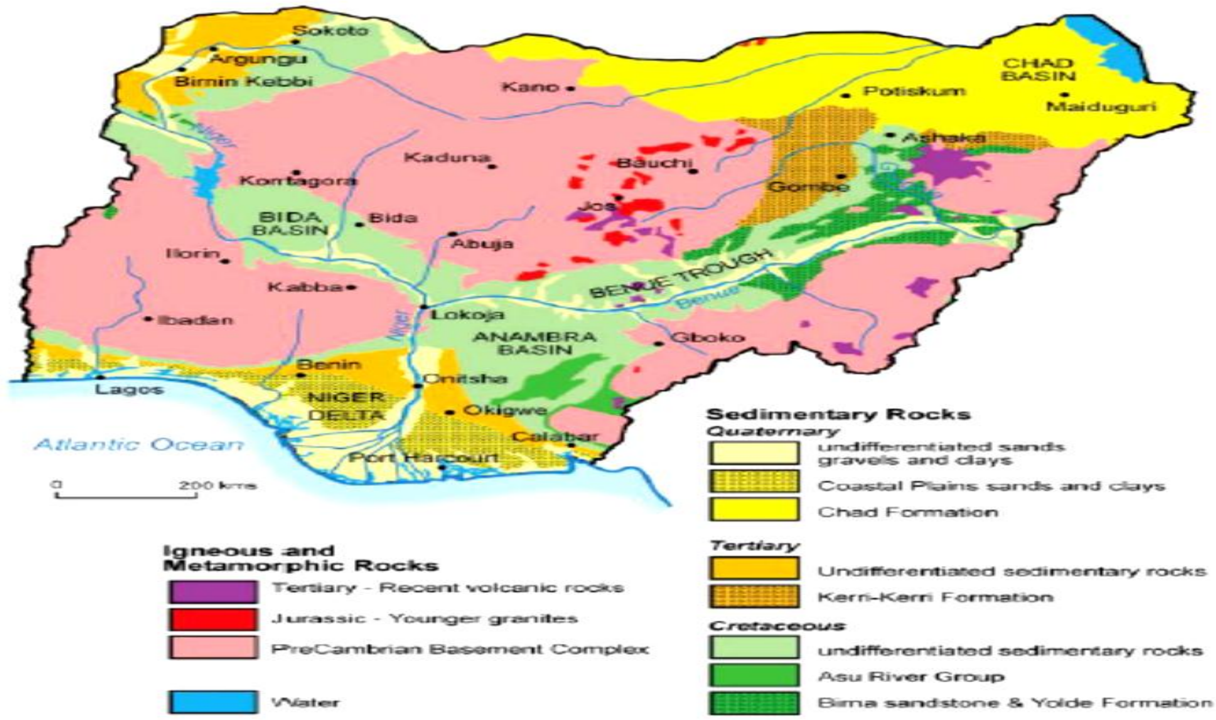

Figure 2: Geological Map of Nigeria

Major rock types in Ajakanga area are; quartzites, banded gneiss, with pegmatites and quartzo-feldspartic intrusions (Figure. 3). Essentially, the quartzites are composed of interlocking, medium grained quartz. Quartz is the dominant mineral, while muscovite, Biotite, and iron oxides are found in minor amounts. The banded gneisses are rarely found as outcrops. Most often they are strongly weathered and are found to dot the landscape. The gneisses are strongly foliated with a general strike of NNW-SSE direction. Usually, the bands are few centimeters in width, and the grains are predominantly medium sized. Pegmatite and quartz veins occur as concordant bodies within the major rock types. They vary both in length and width. Generally the pegmatites are pale-pink in color, while the quartz veins are white or grey.

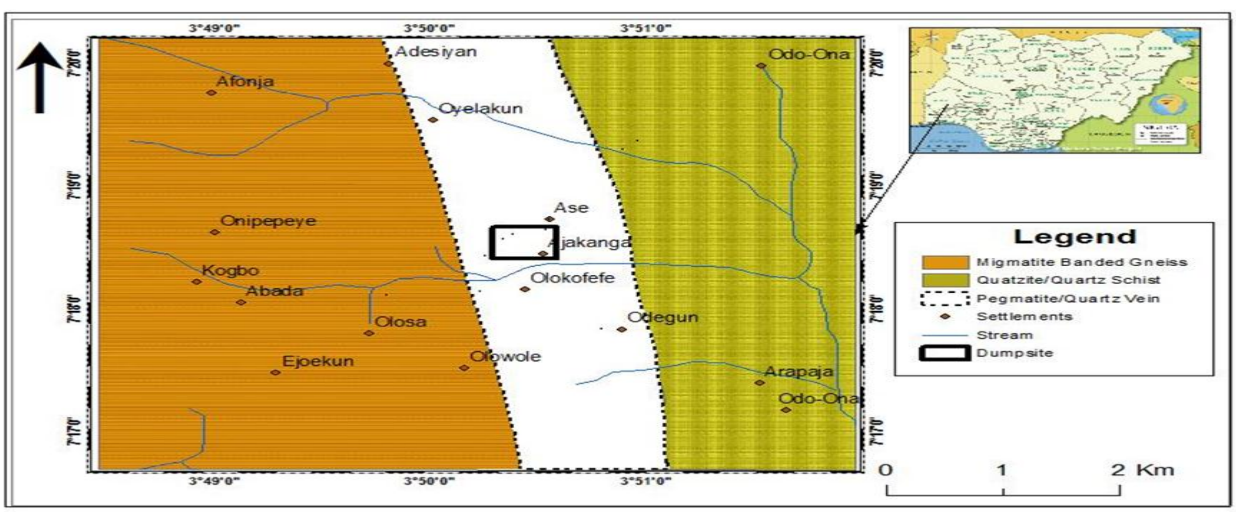

Fig 4: Geological map of the study area [23].

3. METHODOLOGY

3.1 Sampling, Sample Preparation and Laboratory Analysis

Topsoil samples were collected from 10 different locations at a depth of 1-15cm. The soil samples were air-dried and then disaggregated in a porcelain mortar and sieved through a (<0.075mm). Fractions collected from the sieved portion were then sent to Activation laboratories, Canada for geochemical analysis. Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) was used for the geochemical analysis of the samples.

3.2 Statistical Analysis

The range, mean, and standard deviation calculation were carried out using Microsoft excel 2013 Program.

3.3 Pollution and Ecological Risk Indices

The index of geo-accumulation *(Igeo)* enable the assessment of contamination by comparing the current and pre-industrial concentration originally used with bottom sediment [24]; it can also be applied to the assessment of soil contamination. The method assesses the degree of metal pollution in term of enrichment classes (Table 1) based on the increasing numerical values of the index. It is computed using the equation below.

$Igeo = \log_2 Cn/1.5Bn$

Where:

Cn is the measured concentration of the element in the politic sediment fraction (<2mm) and Bn is the geochemical background value/average shale concentration. The constant 1.5 allows for analysis of natural fluctuations in the content of a given substance in the environment and very small anthropogenic influences.

Table 1: Classes of Index of Geo-accumulation (Igeo) for soil

I geo Class	I geo Value	Contaminated Level
0	I geo≤0	Uncontaminated
1	0<Igeo≤1	Uncontaminated or moderately Contaminated
2	1<Igeo≤2	Moderately Contaminated
3	2<Igeo≤3	Moderately or Strongly Contaminated
4	3<Igeo≤4	Strongly Contaminated
5.	4<Igeo≤5	Strongly or Extremely Contaminated
6	Igeo>5	Extremely Contaminated

The enrichment factor was calculated using the formula:

$$EF = \frac{(Cx / Cref)}{(Bx / Bref)}$$

where:

Cx = content of the examined element in the examined environment,

Cref = content of the examined element in the reference environment,

Bx = content of the reference element in the examined environment and

Bref= content of the reference element in the reference environment.

Enrichment Factor is categories into five classes [25] (Table 2).

Table 2 Categories of Enrichment Factor

EF < 2	deficiency to minimal enrichment
EF 2-5	moderate enrichment
EF 5-20	significant enrichment
EF 20-40	very high enrichment
EF > 40	extremely high enrichment

The assessment of soil contamination was also carried out using the contamination factor **(C^i_f)** and the degree of contamination (C_d) (Tables 3 and 4). The (C^i_f) is the single element index; the sum of contamination factors for all elements examined represents the C_d of the environments and all four classes are recognized [26]. Table 3 shows the different contamination factors class and level. The equation is shown below:

$C^i_f = C^i_0 / C^i_n$

Where C^i_0 is the mean content of metals from at least five sampling sites and C^i_n is the pre-industrial concentration of the individual's metal.

Table 3: Classes of different Contamination Factor (C^i_f) for Soil [26]

C^i_f Class	Contamination factor Level
$C^i_f < 1$	Low contamination factor indicating low contamination
$1 < C^i_f < 3$	Moderate Contamination factor
$3 < C^i_f < 6$	Considerable Contamination factor
$6 < C^i_f$	Very High Contamination factor

The C_d is defined as the sum of C^i_f species specified by Hakanson.

The C_d is aimed at providing a measure of the degree of overall contamination in surface layers in a particular sampling site. The C_d was divided into four groups as given in Table 4. `

Table 4: Different classes of degree of contamination (C_d) for soil [26]

C_d Class	Contamination factor Level
$C_d < 8$	Low degree of contamination
$8 < C_d < 16$	Moderate degree of contamination
$16 < C_d < 32$	Considerable degree of contamination
$32 > C_d < 8$	Very High degree of Contamination

The ecological risk index (E_r^i) evaluates the toxicity of trace elements in sediment and has been extensively applied to soils [27].

$E_r^i = T_r^i \times C_f^i$

Where, T_r^i is toxicity coefficient, and has the following values; Cd = 30, As = 10, Co = 5, Cu = 5, Ni = 5, Pb = 5, Cr = 2, Zn = 1. [26].

C_f^i is contamination factor.

The potential ecological risk index (RI) reflects the general status of pollution as a result of the combined presence of the total heavy metal analyzed.

4. RESULTS AND DISCUSSION

4.1 Concentration of Heavy metals in the Soil of Ajakanga and environs

The analytical results, statistical analysis, and some indices of pollution (C_f^i, E_r^i, RI, PLI, and CD) for the heavy metals in the soil of Ajakanga are presented in Table 5

Table 5: Results for the heavy metals of the soil of Ajakanga and environs

	Cd(ppm)	Cu(ppm)	Ni(ppm)	Pb(ppm)	Zn(ppm)	As(ppm)	Co(ppm)	Cr(ppm)
L1	0.5	46	12	41	190	3	27	67
L2	0.5	17	14	64	41	2	67	31
L3	0.7	213	17	31	561	2	7	40
L4	0.5	43	30	23	131	2	31	57
L5	0.5	4	4	6	17	2	6	13
L6	0.5	17	11	21	52	2	22	61
L7	0.5	15	10	18	74	2	20	88
L8	0.5	14	10	15	155	2	16	23
L9	0.5	13	9	14	380	2	18	32
L10	0.5	20	18	16	94	2	17	40
Max	0.7	213	30	64	561	3	67	88
Min	0.5	4	4	6	17	2	6	13
Mean	0.533	51.583	14.083	26.583	189.417	2.167	25.333	46.083
Total	6.933	670.583	183.083	345.583	2462.417	28.167	329.333	599.083
C_f^i	2.665	0.938	0.188	2.127	2.706	1.204	1.013	0.461
E_r^i	79.95	4.69	0.94	10.635	2.706	12.04	5.065	0.922
R.I.	116.9							
Cd	11.301							

Results (Table 5) showed that Cd ranged from 0.5ppm to 0.7ppm with mean value of 0.533ppm (Figure 4), Cu ranged from 4.0ppm to 213ppm with mean value of 51.583ppm (Figure 5), Ni ranged from 4.0ppm to 30ppm with mean value of 14.083ppm (Figure 6), while Pb ranged from 6.0ppm to 64ppm with mean value of 26.583ppm (Figure 7). Zn ranged from 17ppm to 561ppm with mean value of 189.417ppm (Figure 8), As ranged from 2.0ppm to 3.0ppm with mean value of 2.167ppm (Figure 9), Co ranged from 6.0ppm to 67.0ppm with mean value of 25.333ppm (Figure 10), while Cr ranged from 13.0ppm to 88.0ppm with mean value of 45.2ppm (Figure 11).

The concentration of the heavy metals in the soil is of the order Zn>Cu>Cr>Pb>Co>Ni>As>Cd. Compared with the average crustal values, Cd and As have concentration for all locations higher than their average crustal value, Ni and Cr have concentrations for all locations lower than their average crustal value, while Cu, Pb, Zn and Co have concentrations above and below the average crustal value for different locations.

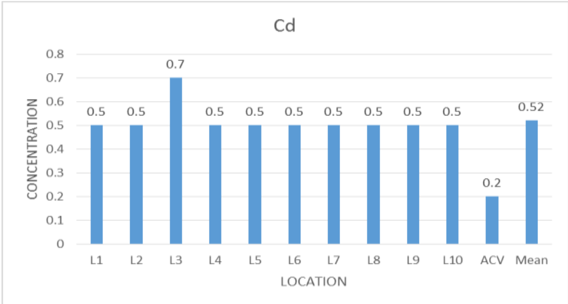

Figure 4: Concentration of Cadmium (ppm)

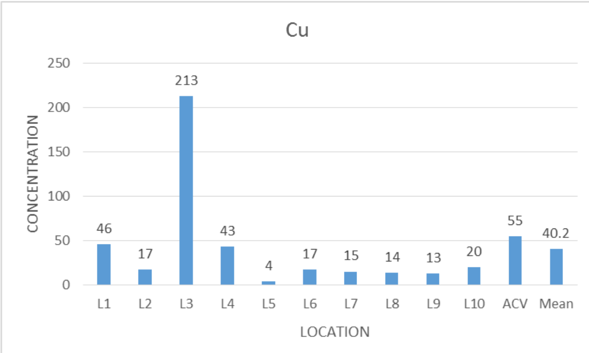

Figure 5: Concentration of Copper (ppm)

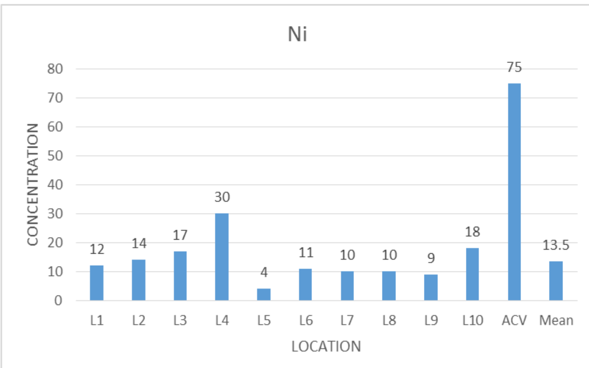

Figure 6: Concentration of Nickel (ppm)

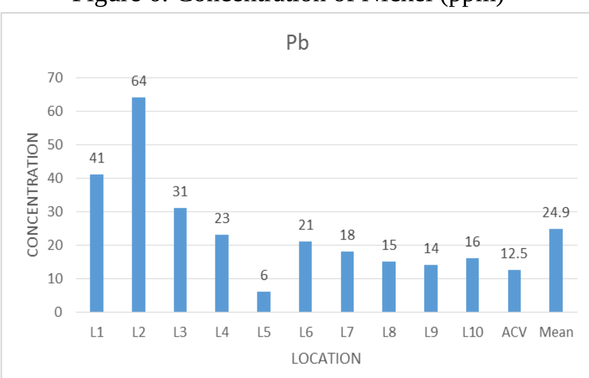

Figure 7: Concentration of Lead (ppm)

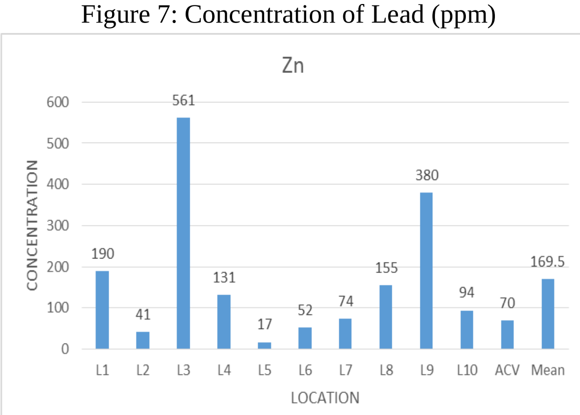

Figure 8: Concentration of Zinc (ppm)

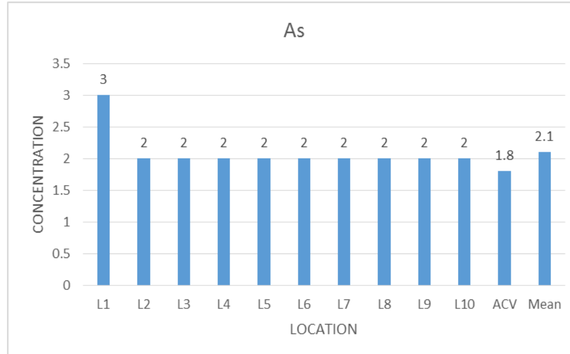

Figure 9: Concentration of Arsenic (ppm)

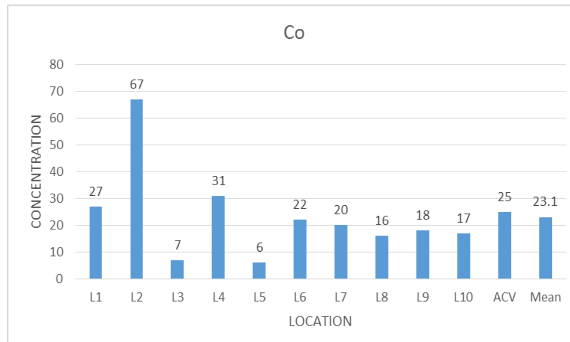

Figure 10: Concentration of Cobalt (ppm)

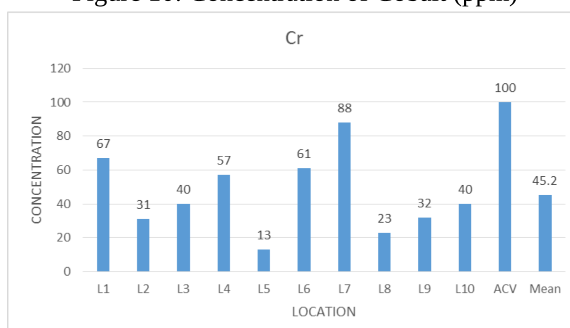

Figure 11: Concentration of Chromium (ppm)

4.2 Assessment of metal pollution in the soil

The following pollution and ecological risk indices were employed in assessing the soil pollution status. The index of geoaccumulation, enrichment factor, contamination factor, contamination degree, ecological risk index, and potential ecological risk index.

4.2.1 Geoaccumulation Index

Geoaccumulation index considered as an accurate index in the evaluation of the degree of contamination of environmental media [13, 28, 29, 30, 31], allows the assessment of soil contamination with heavy metals compared with its content in the A or O horizons [13] referenced to a specific geochemical background [24]. The calculated index of geoaccumulation for the heavy metals in the soil of Ajakanga is presented in Table 6

Table 6: Calculated Geoaccumulation Index for the soil of Ajakanga and environs

	Igeo Cd	Igeo Cu	Igeo Ni	Igeo Pb	Igeo Zn	Igeo As	Igeo Co	Igeo Cr
L1	0.502	0.168	0.032	0.658	0.545	0.334	0.217	0.134
L2	0.502	0.062	0.037	1.027	0.118	0.223	0.538	0.062
L3	0.702	0.777	0.045	0.498	1.608	0.223	0.056	0.080
L4	0.502	0.157	0.080	0.369	0.376	0.223	0.249	0.114
L5	0.502	0.015	0.011	0.096	0.049	0.223	0.048	0.026
L6	0.502	0.062	0.029	0.337	0.149	0.223	0.177	0.122
L7	0.502	0.055	0.027	0.289	0.212	0.223	0.161	0.177
L8	0.502	0.051	0.027	0.241	0.444	0.223	0.128	0.046
L9	0.502	0.047	0.024	0.225	1.089	0.223	0.144	0.064
L10	0.502	0.073	0.048	0.257	0.269	0.223	0.136	0.080
Max	0.702	0.777	0.080	1.027	1.608	0.334	0.538	0.177
Min	0.502	0.015	0.011	0.096	0.049	0.223	0.048	0.026
Mean	0.522	0.147	0.036	0.400	0.486	0.234	0.185	0.091
Total	5.217	1.467	0.361	3.997	4.859	2.341	1.854	0.907

Cd range from 0.502 to 0.702 with a mean of 0.522, Cu range from 0.015 to 0.777 with a mean of 0.0.147, Ni range from 0.011 to 0.080 with a mean of 0.036, while Pb range from 0.096 to 1.027 with a mean of 0.400. Zn range from 0.049 to 1.608 with a mean of 0.486, As range from 0.223 to 0.334 with a mean of 0.234, Co range from 0.048 to 0.538 with a mean of 0.185, while Cr range from 0.026 to 0.177 with a mean of 0.091.

All the values of Igeo for Cd, Cu, Ni, As, Co and Cr fall in the class 0<Igeo≤1: uncontaminated to moderately contaminated, while Pb and Zn range from 0<Igeo≤1: uncontaminated to moderately contaminated to 1<Igeo≤2: moderately contaminated. These results shows that the soils of the study area are uncontaminated to moderately contaminated in all the metals studied. For Pb, only 10% of the Igeo value falls in the moderately contaminated category, while the remaining 90% are in the uncontaminated to moderately contaminated category. For Zn, 20% of the Igeo value falls in the moderately contaminated category, while the remaining 80% are in the uncontaminated to moderately contaminated category.

4.2.2 Enrichment Factor (EF)

Enrichment Factor (EF) assesses the impact of anthropogenic activities on soil heavy metal concentrations. An EF ranging from 0.5 to 1.5 indicates that enrichment was caused by natural processes. Whereas, an EF greater than 1.5 indicated contribution from an anthropogenic source [32, 33, 15, 17]. The result of the enrichment factor is presented in Table 7.

Table 7: Enrichment Factor for the Soil of Ajakanga and environs

	EF Cd	EF Cu	EF Ni	EF Pb	EF Zn	EF As	EF Co	EF Cr
L1	5.009	1.676	0.321	6.572	5.438	3.339	2.164	1.343
L2	6.015	0.744	0.449	12.319	1.409	2.673	6.448	0.746
L3	16.285	18.019	1.055	11.539	37.290	5.170	1.303	1.861
L4	4.278	1.338	0.684	3.149	3.202	1.901	2.122	0.975
L5	17.816	0.518	0.380	3.421	1.731	7.918	1.710	0.926
L6	4.497	0.556	0.264	3.022	1.336	1.999	1.583	1.097
L7	7.408	0.808	0.395	4.267	3.132	3.292	2.371	2.608
L8	8.852	0.901	0.472	4.249	7.841	3.934	2.266	0.814
L9	7.776	0.735	0.373	3.484	16.886	3.456	2.240	0.995
L10	8.378	1.219	0.804	4.290	4.500	3.724	2.279	1.340
Max	17.816	18.019	1.055	12.319	37.290	7.918	6.448	2.608
Min	4.278	0.518	0.264	3.022	1.336	1.901	1.303	0.746

Cd range from 4.278 to 17.816, Cu range from 0.518 to 18.019, Ni range from 0.264 to 1.055, while Pb range from 3.022 to 12.319. Zn range from 1.336 to 37.290, As range from 1.901 to 7.918, Co range from 1.303 to 6.448, while Cr range from 0.746 to 2.608.

The entire content of Ni were derived from natural sources as indicated by EF value of <1.5 for Ni for the entire area. All the other elements including Cd, Cu, Pb, Zn, As, Co and Cr have some contributions from anthropogenic sources as shown by >1.5 Enrichment factor.

EF for Cd range from moderate enrichment (2-5, representing 20% of Cd in the area) to significant enrichment (5-20, representing 80% of Cd in the area). EF for Cu range from deficient to minimal enrichment (<2, representing 90% of Cu in the area) to significant enrichment (5-20, representing 10% of Cu in the area). EF for Ni showed deficient to minimal enrichment (<2, 100%). EF for Pb range from moderate enrichment (2-5, 70%) to significant enrichment (5-20, 30%). EF for Zn range from deficient to minimal enrichment (<2) to very high enrichment (20-40). (<2, 30%, 2-5, 30%, 5-20, 30%, 20-40, 10%)

EF for As range from deficient to minimal enrichment (<2) to significant enrichment (5-20). (<2, 20%, 2-5, 60%, 5-20, 20%). EF for Co range from deficient to minimal enrichment (<2) to significant enrichment (5-20). (<2, 30%, 2-5, 60%, 5-20, 10%). EF for Co range from deficient to minimal enrichment (<2) to moderate enrichment (5-20). (<2, 90%, 2-5, 10%).

4.2.3 Contamination Factor (C_f^i), and Contamination Degree (Cd)

The contamination factor (C^i_f) for the heavy metals in the soil of Ajakanga and environs range from 0.188 to 2.665 (Table 5). Cu, Ni and Cr have C^i_f < 1 indicating low contamination of the soil of the area C, Ni and Cr, while for Cd, Pb, Zn, As and Co C^i_f range fron greater than 1 to less than 3 (1< C^i_f< 3) indicating moderate contamination of the soil by Cd, Pb, Zn, As and Co.

Contamination degree calculated for Ajakanga soil is 11.054 (Table 5), indicating moderate degree of contamination.

4.3 Assessment of Potential Ecological risk

The ecological risk index (E_r^i) and the potential ecological risk index (RI) were used to assess the potential risk of the concentration of the heavy metals to the ecological system of Ajakanga as a whole (Table 5).

The ecological risk index (E_r^i) showed that the soil has low risk of contamination with Cu, Ni, Pb, Zn, As, Co and Cr (E_r^i<40), while the soil is at a moderate risk of contamination with Cd. Cd (40≤ E_r^i<80), therefore Cd is the main component causing the moderate risk factor in the soil of Ajakanga and environs.

The calculated potential ecological risk index (RI) for the area is 116.9 (Table 5), indicating that the risk of potential contamination of the Ajakanga soil with the current concentration of Cd, Cu, Ni, Pb, Zn, As, Co and Cr is indeed low.

4.4 Spatial Distribution of the Metals in the Soil of Ajakanga and environs

Generally, distribution patterns for metals in soils will be influenced by parent rocks, geochemical affinity and behaviour of metals in weathering environment. The graphical representation of the spatial distribution of the metals in the studied area are shown from Figures 12 to 19.

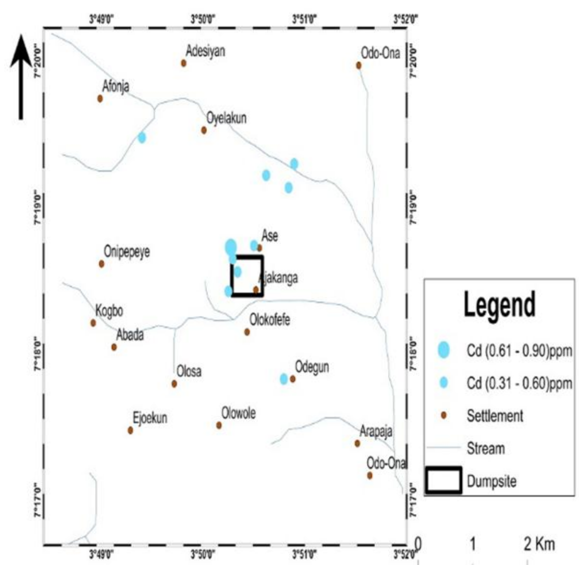

Figure 12: Spatial distribution of Cd in the soil of Ajakanga and environs.

Cd spatial distribution map showed that Cadmium has the highest concentration of 0.7ppm in location 3 and the minimum concentration 0.5ppm in L1

(0.5ppm), L2 (0.5ppm), L4 (0.5ppm), L5 (0.5ppm), L6 (0.5ppm), L7 (0.5ppm), L8 (0.5ppm), L9 (0.5ppm) and L10 (0.5ppm).

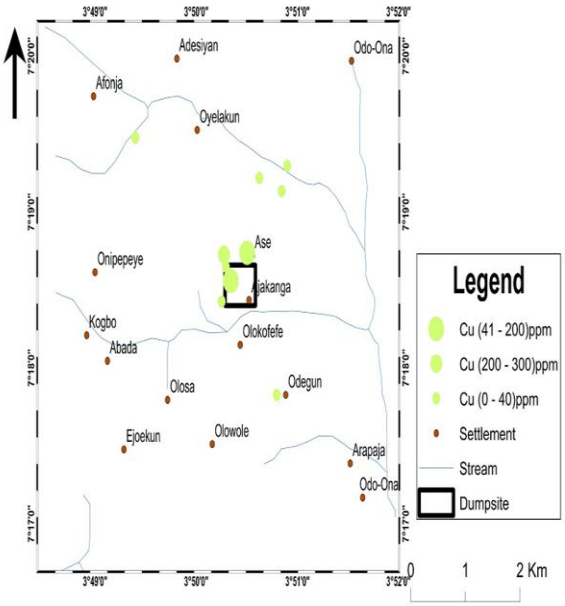

Figure 13: Spatial distribution of Cu in the soil of Ajakanga and environs.

Cu spatial distribution map shows that Copper has its highest concentration of 213ppm in L3, and the minimum concentration of 13ppm in L9.

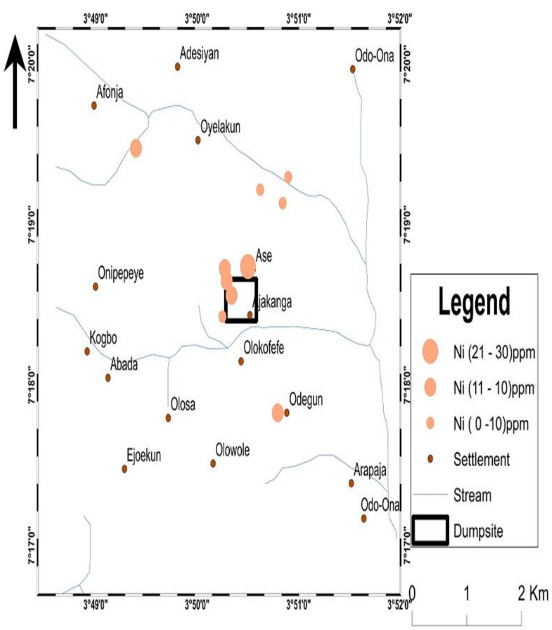

Figure 14: Spatial distribution of Ni in the soil of Ajakanga and environs.

Ni spatial distribution map shows that Nickel has its highest concentration of 30ppm in L4 and the minimum concentration of 4.0ppm in L5.

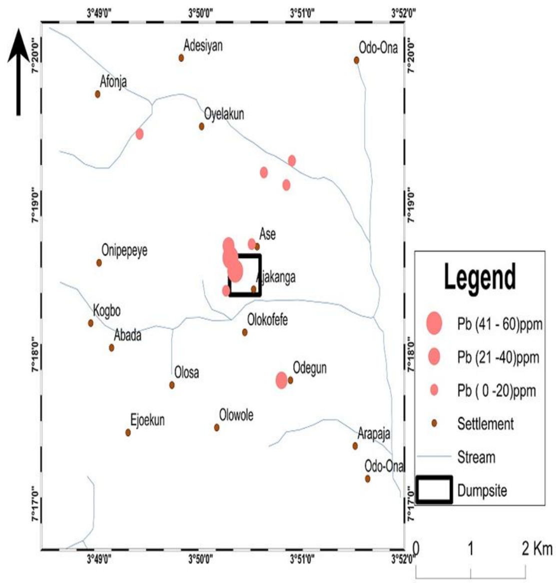

Figure 15: Spatial distribution of Pb in the soil of Ajakanga and environs.

Pb spatial distribution map shows that Lead has its highest concentration of 54ppm in L2, and the least concentration 6ppm in L5.

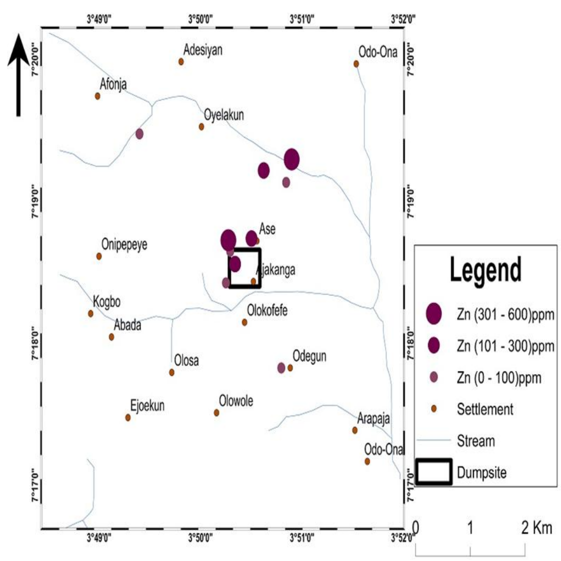

Figure 16: Spatial distribution of Zn in the soil of Ajakanga and environs.

Zn spatial distribution map shows that Zinc has its highest concentration of 561ppm in L3 and the minimum concentration 17ppm in L5.

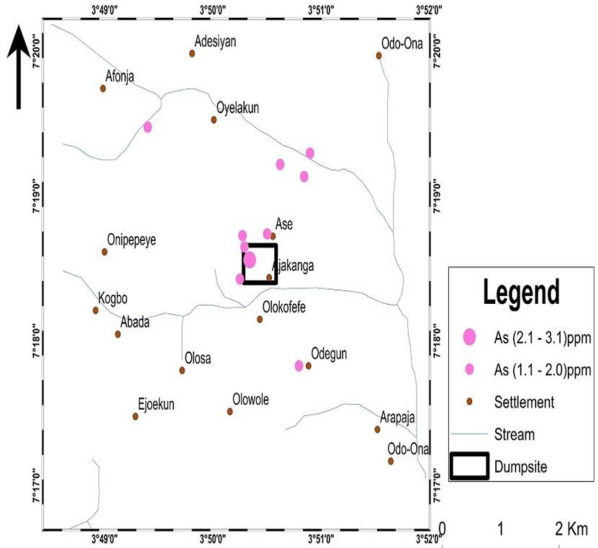

Figure 17: Spatial distribution of As in the soil of Ajakanga and environs.

As spatial distribution map shows that Arsenic has its highest concentration of 7.0ppm in L1 and the least concentration 2.0ppm in L2, L3, L4, L5, L6, L7, L8, L9 and L10.

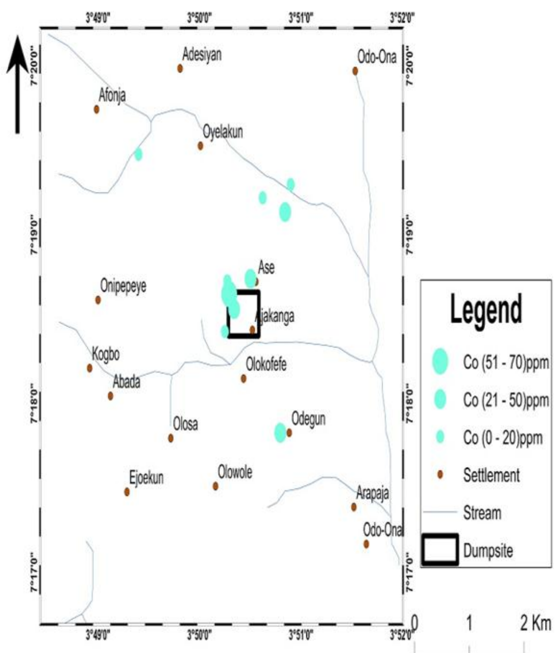

Figure 18: Spatial distribution of Co in the soil of Ajakanga and environs.

Co spatial distribution map shows that Cobalt has its highest concentration of 67ppm in L2 and the minimum concentration of 6ppm in L3.

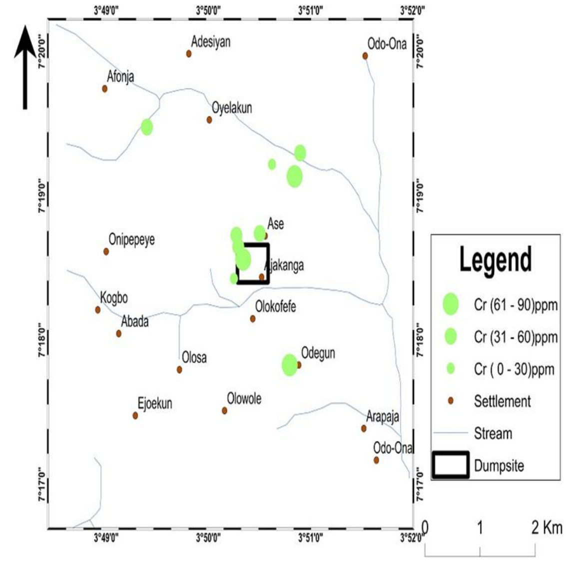

Figure 19: Spatial distribution of Cr in the soil of Ajakanga and environs.

Cr spatial distribution map shows that Chromium has its highest concentration of 88ppm in L7 and the minimum concentration of 13ppm in, L5.

5. CONCLUSION

Geochemical analysis showed that the average concentration of the heavy metals in the soil of Ajakanga and environs varied significantly and decrease in the order of Zn>Cu>Cr>Pb>Co>Ni>As>Cd. Compared with the average crustal values, Cd and As have concentrations for all location being higher than their average crustal value, Ni and Cr have concentrations for all locations lower than their average crustal value, while Cu, Pb, Zn and Co have concentrations above and below the average crustal value for different locations.

Assessment of metal pollution in the soil using index of geoaccumulation and enrichment factor indicated that the soil range from uncontaminated to moderately contaminated and from minimal enrichment to very high enrichment respectively.

Results of contamination factor and contamination degree showed that the pollution status of the the soil vary from low to moderate contamination. The calculated potential ecological risk index indicated that the risk of potential contamination of the soil of

Ajakanga and environs with the current concentration of Cd, Cu, Ni, Pb, Zn, As, Co, and Cr is indeed low.

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