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Assessment of Heavy Metals Concentrations in Some Irrigated Soils of Dadin-Kowa Dam, Gombe State, Nigeria

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Abstract

This study assessed heavy metals concentration in some irrigated soils of Dadin Kowa Dam, Gombe State Nigeria. The soils were collected along transect lines (different sampling points) within the farms and samples were taken to the laboratory for analysis. The analysis was conducted using (Thermo Fisher Scientific) Energy Dispersive X-ray Fluorescence Spectroscopy. The results give the following metals with their mean concentrations: Mo (8.200 and 8.926), Zr (432.990 and 440.236), Sr (204.358 and 87.142), Rb (47.642 and 42.533), Zn (44.165 and NA), Cu (42.161 and NA), Fe (43090.640 and 24846.236), Mn, (992.881 and 397.248), Cr (140.456 and 88.054), V (56.842 and 27.159), Ti (2403.982 and 1421.486), Ca (3344.789 and 982.722), K (4706.758 and 3172. 047), S (466.152 and 310.510), Ba (933795.090 and 959675.238) and Nb (26.285 and 24.964) were obtained from the onion and cabbage farms soils samples respectively (Values in part per millions (ppm)). The degree of pollution of the soils studied were ascertained and compared with literature toxicity data. Other pollution indices like Enrichment factor, Clarke ratio, Coefficient of variation, Contamination factor, Metal Pollution Index and Geo-Accumulation Index were assessed also and found out that the contamination level for the soils is tolerable for irrigation. At a = 0.01 significant level, positive correlation exists between Fe and Cu, Zn and Ca while Zn and Rb; Ca and Rb have significantly negative correlation between them. By implications, these results showed that the complexes of some elements within the soil strata could influence the presence of other given elements. Therefore, Dam irrigation area soils studied showed relatively low state of pollution for the elements determined.

Key words: Heavy metals, X-ray Fluorescence Spectroscopy, Soil samples, irrigation areas, Dadin Kowa dam

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INTRODUCTION

Soil is a mixture of sand and organic materials that serves as natural medium for plants growth. To date, most research in aquatic systems has been concerned with the form of contaminants present, rather than the amount of potential toxic material bound up in the soils. The low concentration elements are undoubtedly the most difficult to study because background levels are always present in the environment masking their presence, and a small perturbation on an ecosystem could bring about rapid increase in the rates of synthesis of these heavy metals (Seydou ,2008)

Heavy metals are naturally occurring elements, and are present in varying concentrations in all ecosystems. Heavy metals have atomic densities higher than 4 g/cm^3, and these include lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag), chromium (Cr), copper (Cu), iron (Fe), and platinum (Pt). (Onakpa *et al.,* 2018, Ghaderpoori *et al.,2018* and Ugonna *et al*.,2020)

Heavy metals in soil may dissolve in water and be up taken by plants and vegetation to enter the food chain. The high level of food contamination by these metals is dangerous because their uptake by plants and subsequent accumulation in food crops consumed by humans and animals is delaterious to health. (Sadovska, 2012; Ihedioha *et al.,*2017 and Zhou *et al.,*2019).

The main activities of people in Dadin Kowa village is animal husbandry and farming which includes irrigation. Consequently, assessment of elements concentrations in soil samples collected from the study area can educate the public on the contamination level of the soils. Conclusion can be drawn, when the results obtained is compared with the limit set by the standard regulatory bodies.

The aim of this work is to assess heavy metals concentrations in farm soils where onions and cabbages will be cultivated through irrigation near Dadin Kowa Dam, Gombe Sate, Nigeria.

MATERIALS AND METHOD

Description of the Study Area

Dadin Kowa Dam is located in Dadin Kowa. A village in Yamaltu-Deba Local Government Area of Gombe State in the north east of Nigeria. Which is about 35kilometres to the east of Gombe town. It provides drinking water for the neighboring villages and Gombe metropolis. The Dam was completed by Federal Government in 1984, with the goal of providing irrigation and electricity for the planned Gongola sugar plantation project. The coordinates for the study area are 10^o 19' 19'' N, 11^o 28' 54'' E and has the total capacity of eight hundred million metre cube (800,000,000 m^3). Tables 1 and 2 give the farms location with the referencing coordinates and sample codes with description respectively.

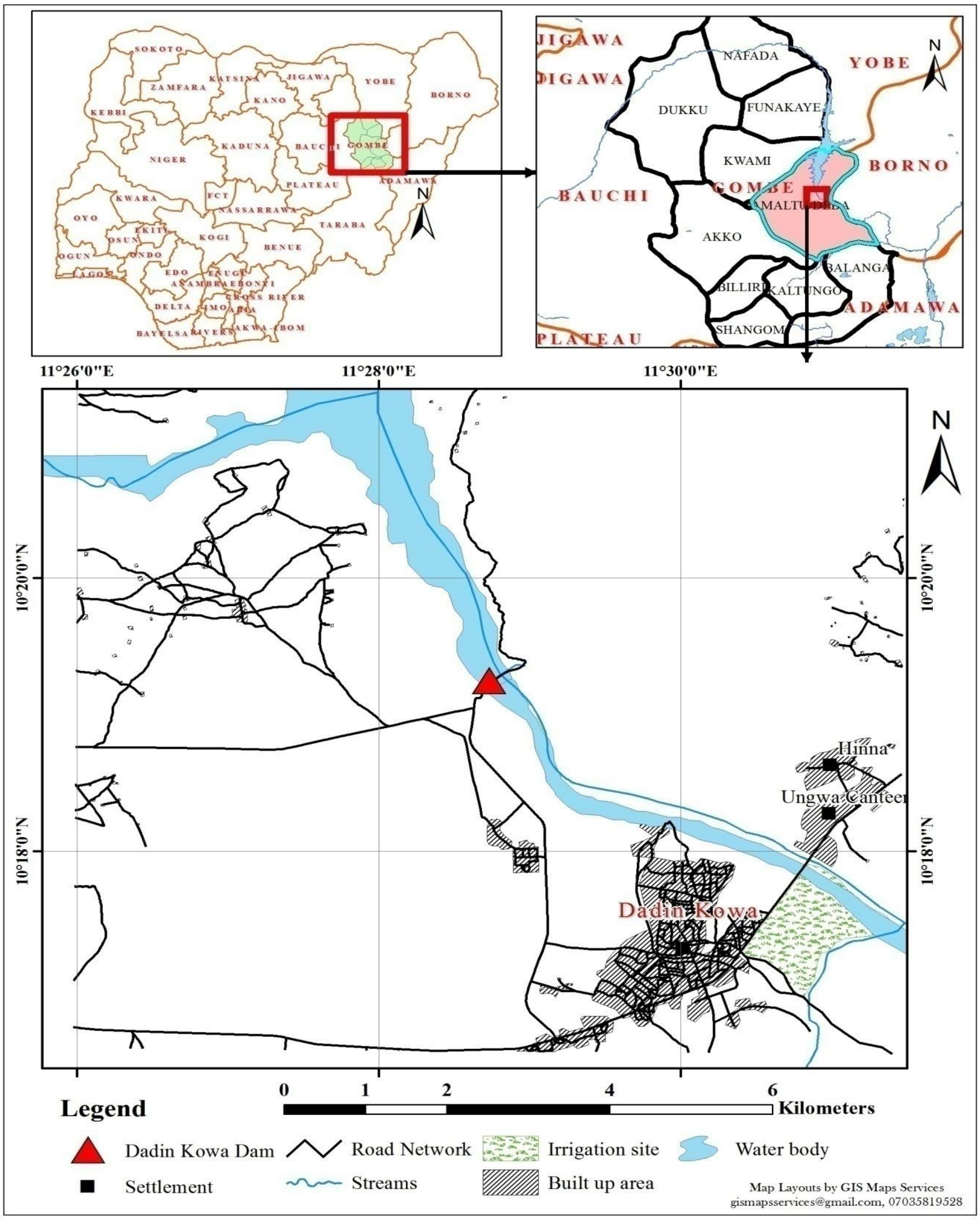

Figure 1: Map of the study area (GIS Maps Services Gombe) (Andrew,2021)

Table 1: Farms locations with their geo-referencing coordinates.

S/N	FARM LOCATIONS	LATITUDE	LONGITUDE	ALTITUDE
1	Onion Farm	10° 17' 35.49'' N	11°30' 40.60''E	210.12m
2	Cabbage Farm	10° 17' 50.19'' N	11° 30' 43.9'' E	210.25m

Table 2: Sample codes and their descriptions

S/N	SAMPLE CODES	SAMPLE CODES DESCRIPTION
1	ONSPA	Onion Soil Point A
2	ONSPB	Onion Soil Point B
3	ONSPC	Onion Soil Point C
4	ONSPD	Onion Soil Point D
5	ONSPE	Onion Soil Point E
6	CBSPA	Cabbage Soil Point A
7	CBSPB	Cabbage Soil Point B
8	CBSPC	Cabbage Soil Point C
9	CBSPD	Cabbage Soil Point D
10	CBSPE	Cabbage Soil Point E

Sample Collection and Preparation

The soil samples were collected along transect lines (Melville and Welsh, 2001). Five samples of the top soil were taken along each of the transect line. Soils samples were collected from five positions at a depth of 15 cm. 0-15 cm depth was considered to represent the plough layer and average root zone for nutrients uptake and heavy metals burden by vegetables (Eddy *et al.,* 2006; Odai *et al.,* 2008). The soil samples were then air dried, crushed, passed through a sieve, put in clean labeled polythene bags and stored at room temperature for EDXRF analysis.

Data Analysis and Evaluation

Heavy metals in soil samples were determining using energy dispersive x-ray Fluorescence Spectroscopy (EDXRF) system in the laboratory. The trend distribution of the elements was assessed by various statistical analysis tools after determining the heavy metals in the soil samples collected from the study sites. The pollution indices and statistical analysis includes: Enrichment Factor (EF), Clarke Ratio (CR), Coefficient of Variation (CV), Contamination Factors (CF), Metal Pollution Index (MPI), and Geo-Accumulation Factor. The statistical software SPSS (Statistical Package for Social Science) was used to obtain a descriptive interpretation of the Pearson correlation of the elements found in the vegetables.

Enrichment Factors

The enrichment factor of an element in the soil relative to its abundance in the earth's crust is termed Crustal Enrichment: usually known as Clarke Enrichment (Gluskoter, *et al.,* 1977). The enrichment ratios of trace elements determined for each of the deposits studied along the course of the farms soils, were calculated relative to the concentration of titanium in the samples, since titanium is always present in the earth's crust.

Enrichment factor as defined in this work is thus:

$$EF_{(crustal)} = \frac{[X]_S\,/\,[Ti]_S}{[X]_C\,/[Ti]_C} \quad (1)$$

where, EF denoted the Enrichment Factor:

$[X]_S$= Concentration of the element X in the sample.

$[Ti]_S$= Concentration of Titanium in the sample.

$[X]_C$= Concentration of the element X in the earth's crust.

$[Ti]_C$= Concentration of the Titanium in the earth's crust.

Other normalizing elements like Fe, Sc, and Si has been discussed by Pardue, *et al.*, (1988), Adetunji and Ong (1989), and Seydou (2011) respectively. But with some limitations for the soil in the case of iron.

Clarke Ratio (CR)

Clarke ratio is defined as the ratio of concentration of element in the sample to the mean global concentration of the same element in the earth's crust. Clarke Ratio tends to throw some light on the modification of elemental concentration in the soil depositions.it shows the magnitude of the variation of an element in a given location with respect to a geochemically accepted and globally fixed value called the 'Clarke Value (Seydou,1998).

Clarke Ratio as defined in this work is thus:

$$R = [X_s / X_c]\ 100 \qquad (2)$$

where X_s= Concentration of element in the sample

X_c = Clarke Value for the given element

Coefficient of Variation (CV)

The Coefficient of Variation is the ratio of the standard deviation of the concentration of a given element in the sample at a given site with respect to the average concentration of the element in the farms soils for all the sites determined, expressed as percentage.

Coefficient of Variation as defined in this work is:

$$CV = [S.D / X]\ 100\% \qquad (3)$$

where S.D = Standard deviation of the element concentration in the sample for different sites

X = Mean concentration of the element determined for a given site along the river course.

The evaluation of CV for each element gives an assessment of how each element varies along the farm course. The variation could be either due to depletion or enrichment that could arise due to various physic-chemical or geochemical factors. It could also be used to assess pollution along the farms if all the factors responsible for pollution are rightly assessed(Seydou,1998).

Contamination Factor (CF)

The term contamination factor refers to the degree of presence of strange substances apart from the original composition of the sample of interest (onion and cabbage). It can be obtained by taking the ratio of concentration of each metal in the samples (onion and cabbage) to that of the background (concentration in unpolluted onions and cabbage). It can be determined by the following equation (Lenntech,2004)

$$CF = \frac{(C)Heavy\ metal}{(C)Background} \qquad (4)$$

where, $(C)_{\text{heavy metal}}$ is the concentration of heavy metal in the sample and $(C)_{\text{Background}}$ is the background value for the same metal.

Metal Pollution Index (MPI)

Metal pollution index (MPI) index was calculated using equation 3.2 given by (Ureso *et al.,*1997; Seydou and Auwal,2019; Seydou and Jibrin,2020), which is the geometrical mean of concentrations of all the metals in the corresponding onions and cabbage samples. The MPI value of greater than 1 signifies that the sample is polluted, and that of less than 1 indicates that the sample only baseline pollutants level.

$$MPI = \sqrt[n]{CF1 \times CF2 \times CF3 \ldots, CFn} \qquad (5)$$

where, CF is the contamination factor, n is the number of heavy metals.

Correlation Analysis

The measure of similarity between paired data is termed correlation analysis. The degree of inter relation between variables can be estimated with the help of correlation coefficient (r) without any influence by measurement units. Correlation is the ratio of covariance (joint variation of two variables about their common mean) of two variables to the product of the standard deviation (Davis, 1973; Seydou, 2008).

Correlation Coefficient being a ratio is a dimensionless number and covariance may equal but can never exceed the product of the standard deviation of its variables. Correlation ranges from +1 to -1. A correlation of +1 is an indication of a perfect direct relationship between two variables. While that of -1 indicates that one variable changes inversely in relationship to the other. A spectrum of less than perfect relationship lies between the two extremes including zero which indicates the lack of any linear relationship.

The Geo Accumulation Index

The Geo Accumulation Index indicates the level of contamination of soils in the study area. An index of geo accumulation (I_{geo}) was originally defined by Muller (1969), and can be calculated by the following equation

$$I_{geo} = [C_s/(1.5 \times C_b)] \quad (7)$$

where C_s is the measured concentration of the examined heavy metal in sample; 1.5 is the background matrix correction due to terrigenous effect or is introduced to minimize the effect possible variations in the background and C_b is the geochemical background concentration or reference value of the metal or background value of the heavy metal in the uncontaminated sample

Table 3: Geo Accumulation Index and Pollution Category (Seydou and Jibrin,2020)

Geo accumulation index	Pollution
$I_{geo} \leq 0$	Unpolluted
$0 < I_{geo} \leq 1$	Unpolluted/Moderately
$1 < I_{geo} \leq 2$	Moderately
$2 < I_{geo} \leq 3$	Moderately/Heavily
$3 < I_{geo} \leq 4$	Heavily/Extremely
$4 < I_{geo} \leq 5$	Extremely

RESULTS AND DISCUSSION

Trace Element

The following metals (Mo, Zr, Sr, Rb, Th, Pb, Zn, Cu, Fe, Mn, Cr, V, Ti, Ca, K, S, Ba, and Nb) with their concentrations were obtained in the samples collected and their results were as shown in Table 4 and Table 5. Therefore, the results obtained in Table 6 from the farms' soils in this work will be discussed in terms of Enrichment factor (EFs), Clarke ratio, Co-efficient of Variation (CV), Contamination factor (CFs), Metal Population Index (MPI), and Geo Accumulation Index (I_{geo})

Table 4: Trace elements in the soil samples from onion farm (Values in ppm)

Elements	ONSPA	ONSPB	ONSPC	ONSPD	ONSPE
Mo	6.031	6.739	10.248	9.068	8.915
Zr	471.390	336.074	515.068	391.524	450.892
Sr	207.081	207.016	226.767	191.884	189.044
Rb	44.119	42.039	63.349	45.240	43.461
Th	NA	NA	16.855	NA	NA
Pb	NA	NA	24.850	NA	NA
Zn	NA	NA	44.165	NA	NA
Cu	54.283	NA	30.038	NA	NA
Fe	49512.254	44147.176	46773.707	40084.285	34935.777
Mn	1318.617	1092.891	820.905	1091.514	640.480
Cr	166.796	143.620	126.437	126.858	138.561
V	73.211	65.270	67.147	40.321	38.262
Ti	2905.866	2590.296	3155.602	1593.939	1774.186
Ca	3931.248	3752.677	4844.439	2133.259	2062.316
K	5394.094	4971. 378	6298.826	3069.302	3800.188
S	376.690	476.393	670.233	458.721	348.721
Ba	924504.930	930887.938	930029.000	939458.625	944095.000
Nb	26.525	25.140	25.660	25.660	28.441

NA = not available

Table 5: Trace elements in soil samples from cabbage farm (Values in ppm)

Elements	CBSPA	CBSPB	CBSPC	CBSPD	CBSPE
Mo	7.854	8.540	11.026	10.190	7.022
Zr	447.104	449.617	427.184	450.200	427.075
Sr	94.551	101.341	86.348	75.285	77.546
Rb	44.032	50.355	39.098	35.958	43.221
Fe	25087.455	29166.145	22333.754	22478.271	25165.553
Mn	265.719	561.665	382.401	372.312	404.142
Cr	108.824	111.713	12.056	115.257	92.419
V	32.654	37.634	14.084	24.362	27.061
Ti	1389.735	2027.910	512.862	1475.680	1701.245
Ca	1281.080	1956.730	437.287	1238.515	NA
K	3066.020	4477.749	1529.578	2915.727	3871.160
S	351.936	264.325	411.132	263.470	261.686
Ba	958715.188	951932.250	967657.000	962219.563	957852.188
Nb	25.664	25.342	24.427	23.169	26.218

NA= not available

Table 4 and Table 5 gives the report of the abundance of the elements determined for all trace elements detected from the two farms soils (i.e. onion and cabbage farms) of this work. Some of the concentrations are reported as "less than" values because they are below the limit of quantitative accuracy but above zero (Gluskoter, *et al.,* 1977) several researchers for example Valkovic (1983), Seydou (2011), and Amour (2014) reported that less values do not alter much the statistics of the population notably where the total population is not in size with total member of such data sets. Most of the elements determined could be affected by the deposition rates since other factors could account for the variation. The dry season irrigation of the study area calls for intensive usage of the slowly moving debris-load of the farms land that happens to be used during irrigation. These factors determined the concentrations of the elements and could either lead to enrichment or depletion of the elements determined.

Table 6: Mean concentrations of the individual elements from the two farms' soils (in ppm)

Elements	Mean for Onion farm soil ± SD(n=5)	Mean for Cabbage farm soil ± SD(n=5)
Mo	8.200 ± 1.7534	8.926 ± 1.653
Zr	432.990 ± 70.0785	440.236 ± 12.021
Sr	204.358 ± 15.0563	87.142 ± 11.065
Rb	47.642 ± 8.8567	42.533 ± 5.453
Th	16.855 ± 3.613	NA
Pb	24.850 ± 4.904	NA
Zn	44.165 ± 7.902	NA
Cu	42.161 ± 19.152	NA
Fe	43090.640 ± 5733.7	24846.236 ± 2772.26
Mn	992.881 ± 112.9120	397.248 ± 121.9340
Cr	140.456 ± 16.4988	88.054 ± 43.376
V	56.842 ± 16.3044	27.159 ± 8.926
Ti	2403.982 ± 689.99	1421.486 ± 564.703
Ca	3344.789 ± 1211.59	982.722 ± 550.29
K	4706.758 ± 4706	3172.047 ± 1114.48
S	466.152 ± 136.4140	310.510 ± 81.9060
Ba	933795.090 ±7859.80	959675.238 ±5796.145
Nb	26.285 ± 1.3037	24.964 ± 1.19539

NA = not available

Table 6 reports the mean concentrations of the abundance trace elements in onion farm soil and cabbage farm soil. Concentrations in ppm or as indicated.

Enrichment Factor

Enrichment Factor (EFs) of each element were determined for onion and cabbage farms soils deposits investigated along the course of the study area as in Table 7. Where most of the elements enrichment factors were found to be low.

Table 7: Enrichment Factor for elements determined from the two farms' soils

Elements	Onion farm soil EFs	Cabbage farm soil EFs
M_o	5.013x10^{-03}	9.229 x10^{-03}
Z_r	7.027 x10^{-04}	1.208 x10^{-03}
S_r	1.399x10^{-04}	1.009 x10^{-04}
R_b	1.606x10^{-04}	2.424 x10^{-04}
Z_n	1.530	0.000
C_u	2.019	0.000
V	1.099x10^{-04}	8.879 x10^{-05}
F_e	1.821	1.776
C_a	0.189	1.174
K	0.673	0.767
C_r	3.693x10^{-04}	3.915 x10^{-04}
N_b	3.455x10^{-04}	5.551 x10^{-04}

A summary of Clarke enrichment factor for the two farms soils is as given in Table 8

Table 8: Summary of Clarke enrichment factors for the two farms' soils

Clarke Enrichment Factor Ranges	Elements for onion farm soil	Elements for cabbage farm soil
<1	M_o, Z_r, S_r, R_b, V, C_a, K, C_r and N_b	M_o, Z_r, S_r, R_b, V, K, C_r and N_b
>1	Fe, Zn and Cu	Fe and Ca

From Table 8, elements like Fe, Zn and Cu with enrichment factor greater than 1 in onion farm soil and Ca, are known to be toxic to some extent (Bowen, 1979: Seydou, 2008), even though useful in some cases. Among depleted elements (Ca, K, Zr, Sr, Rb, Zn, V, Cr and Nb) some are toxic while others are relatively harmless to all organisms. Calcium is known to be harmless to all organism (Bowen, 1979; Seydou, 2008). Though Zn and Cu were not available in cabbage farm soil samples but, Fe and Ca were also found to have an enrichment factor greater than 1.

Toxicity

Table 9 shows that the toxicity of some elements obtained in both onion and cabbage farms soils with comments on their toxicity as reported by (Bowen, 1979 and Seydou, 2008) it's clearly shown that Ca, Fe, K, and Zn are probably essential to all plants. This could be used to the seasonal crops grown in the study area. Element like Ti is relatively harmless and essential to some group, not necessary for all. Rb, K, Sr, and Ca are known to have a very high toxicity, which only arises when a large proportion of the essential ion has been replaced. Fe, V, and Zn are moderately toxic while Ca, K, Rb, and Sr are only toxic to very high concentrations, Table 9 clearly shows that they are scarcely toxic. Zr was found to be toxic while element like Nb moderately toxic. Molybdenum (Mo) is a requirement for nitrogen assimilation via nitrate, as this enzyme reduces nitrate to ammonium before assimilation in to biochemical pathways. Mo is an essential compound of two major enzymes in higher plants, nitrate reductase and nitrogenize which is present in nodulated legumes and required in the N fixation process but found to be toxic in this work.

Zinc is the element most frequently concerned with plants damage from industrial emissions, e.g. on mine wastes, near smelters, sewage sludge, river dredging, near galvanized steel buildings and where rubber tyres are burnt (Patterson, 1971; Barrow and Weber 1972; Seydou, 2011). The onion farm soil Zn was found to be in only ONSPC sampling point and the concentration was found to be 44.165ppm as shown in Table 4.1 which was less than 900ppm maximum limit for animals (Jenett *et al.*, 1980). Among the elements reported to be enriched in soil are Fe, Ti, V, and Zr (Bowen, 1979). In this work Fe, K,Ca and Ti was found to be enriched, while the remaining elements under study were depleted.

Table 9: Toxicity of elements from the two farms' soils (Values in ppm or as stated)

Elements	Values from onion farm soil	Values from cabbage farm soil	Reported toxicity by Bowen (1979)	Remarks on toxicity in onion and Cabbage farm soils
Mo	8.200	8.926	0.2 - 5 ppm	Toxic
Zr	0.433	0.440	250-700mg/day lethal to rats	Not toxic
Sr	204.358	87.142	Scarcely toxic to plants	Scarcely toxic
Rb	47.642	42.533	Scarcely toxic to plants	Scarcely toxic
Zn	44.165	…	60-400ppm toxic to plants	Expected to be toxic
Cu	42.161	…	50 - 140 ppm toxic to plants	Expected to be toxic
V	56.842	27.159	10-40ppm toxic to plants	Toxic
Ti	2403.982	1421.486	Relatively harmless	Relatively harmless
Ca	3344.789	1279.944	Relatively harmless	Relatively harmless
K	4706.758	3172.047	Scarcely toxic	Scarcely toxic
Nb	26.285	24.964	Moderately toxic to mammals	Moderately toxic
Fe	43090.640	24846.236	10-200ppm toxic to plants	Toxic
Cr	140.456	88.054	14 – 70 ppm toxic to plants	Toxic

Onion and cabbage farms soils' Clarke Ratio as defined in chapter three was calculated and the results were shown in the Table 10.

Table 10: Clarke Ratio for Trace Elements from the two Farms' Soils

Elements	Clarke ratio for onion farm soil	Clarke ratio for cabbage farm soil
Mo	8.200	8.926
Zr	267.278	271.751
Sr	53.218	22.693
Rb	61.080	54.530
Zn	58.112	00.000
Cu	76.656	00.000
V	41.796	19.970
Cr	140.456	88..054
Ti	37.975	22.468
Fe	69.277	39.952
Ca	7.189	2.640
K	25.598	17.228
Nb	131.425	124.820

Table 11: Clarke ratio summary for farms soils

Clarke ratio ranges		Elements for onion farm soil	Elements for cabbage farm soil
R < 10		Mo and Ca	Mo and Ca
10 < R < 100	Depleted	Sr, Rb, Zn, Cu, V, K, Ti and Fe	Sr, Rb, Cr, Ca, V, K ,Ti and Fe,
100 < R < 1000	Enriched	Zr, Nb and Cr	Zr, and Nb

The summary of Clarke ratio is given in Table 11 above and shows that elements like Mo, Fe,Sr, Rb, Zn, Cu,Ca, Ti, K and V were depleted. While Zr,Cr and Nb, are enriched in the onion farm soil. In the case of the cabbage farm soil, Zr and Cr were enriched while the remaining elements remained depleted as in the case of onion farm soil. Therefore, we will conclude that

Ti is a good normalizing element as the enrichment factor results are in good agreement with the Clarke ratio results.

The trace elements concentrations were found within the range 0 to 224. Six elements namely Nb, Sr, Fe, Cr, Zr and Rb show low coefficient variation (<20), while Nb, Fe, Rb, Zr, Sr and Mo show low coefficient of variation (<20). This could be probably due to low deposition, high washout or that the elements exist in highly soluble forms. The other elements that had high coefficient variation ranging from 20 to 224, could be due to high deposition and low washout which suggests that elements might have come from external sources, there by polluting the farm soil. This sources could be from fertilizers, pesticides, herbicides, laundry wastes, sewage sledges or any other way suspected of causing pollution.

Metal Pollution Index

For us to calculate metal pollution index we first calculate contamination factor (Table 12). CF was calculated as stated in chapter three. The background Concentrations ($Conc._{background}$) of the individual heavy metals Mo, Zr, Sr, Rb, V, K, Ca, Cr, Nb, Fe, Cu, Ti, and Zn sets by regulatory bodies are 0.43, 220, 87.62, 85.46, 63.9, 740, 4.6, 100, 92.906, 0.3, 1.0, 0.014, and 0.001 mg/kg respectively, (GEMS/FOOD,2000) and (WHO,2001). The background concentrations above are used to calculate the contamination factors of each of the elements from the five (5) sampling points of the two (2) farms.

Table 12: Contamination factor for the trace elements from farms soils

Elements	CF for onion farm soil	CF for cabbage farm soil
Mo	19.070	20.759
Zr	1.968	2.000
Sr	2.332	0.993
Rb	0.557	0.498
Zn	8.833	0.000000
Cu	16.864	0.000000
Fe	14.364	8.282
Ti	17.171	10.154
Ca	0.073	0.0214
K	0.000636	0.000428
V	0.890	0.425
Cr	1.405	1.098
Nb	0.283	0.269

Table 12 shows the mean contamination factor of each element from onion farm soil and cabbage farm soils where most of the elements from the two farms soil were within limit set by the regulating agencies. Only Mo showed higher value.

Metal pollution index as defined in chapter three was calculated and the results were shown in Table 13

Table 13: Metal pollution index of the trace elements obtained from farms soils

Elements	MPI for onion farm soil	MPI for cabbage farm soil
Mo	21.835	22.781
Zr	7.014	7.071
Sr	7.635	4.983
Rb	3.732	3.529
Zn	14.860	0.000
Cu	20.533	0.000
Fe	0.1895	0.1438
Ti	0.2072	0.1593
Ca	0.01348	0.0073
K	0.00126	0.00104
V	4.717	3.260
Cr	5.927	5.239
Nb	2.660	2.593

The MPI for elements like Mo, Zr, Sr, Rb, Zn, Cu, V, Cr and Nb were found to be above one in both the farms. Though Zn and Cu were not detected in cabbage farm soil. The remaining elements (Fe, Ti, Ca and K) in both farms were found to have MPI values less than one. The MPI value of greater than 1 signifies that the sample is polluted, and that of less than 1 indicates that the sample is within baseline pollutants level (Ureso *et al.,* 1997 and Esmaeilzadeh *et al.,* 2019). So, it was concluded that, elements like Mo, Zr, Sr, Rb, Zn, Cu, V, Cr and Nb found from the two farms soil indicate pollution while the remaining were within the baseline pollutants level.

Table 14: Comparison of this work mean values of farms soils with other related Works (Values in ppm or as stated)

Elements	Onion Farm Soil	Cabbage Farm Soil	Seydou (2011)	Amour (2014)	World Value(2001)
Zr	432.990	440.236	712.64	-	(32 – 850)
Sr	204.358	87.142	66.13	-	53.4
Rb	47.642	42.533	117.17	-	(18 - 116)
Fe(%)	4.309	2.485	1.16	6.6454	0.0426
Zn	44.165	-	107.17	629.89	300
V	56.842	27.159	27.14	BDL	100
Nb	26.285	24.964	28.15	-	12
Cr	140.456	88.054	-	57.08	44.5
Mo	8.200	8.926	-	-	5
Cu	42.161	-	-	70.71	50 – 140
Ti(%)	0.240	0.142	0.45	-	0.46
Ca(%)	0.335	0.123	0.38	0.0011	1.37
K(%)	0.471	0.317	2.36	0.0002	1.4

BDL = Below Detection Limit

Table 14 shows the comparison of this work mean values for onion and cabbage farms soil with other related material. Zr, Rb, and Nb in cabbage farms soil were found to have lower concentrations in comparison with the reported literature values. Sr, Fe, and V in this work was found to be higher concentrated than Sr, Fe and V reported by Seydou, (2011). While Zn and Cu was not found in cabbage farm soil. Also Cr was found to be higher concentrated compared to that of Amour, (2014). Ca and K in cabbage farm soil happen to be lower than that of Seydou, (2011) but lower than that of Amour, (2014). Ti in this work was found to have lower concentration than Ti reported by Seydou, (2011) but was not detected by Amour.

In the case of onion farm soil, it shows that Zr, Rb, and Nb in onion farms soil were found to be lower in concentration compared to the literature values. Sr in this work was found to be higher concentrated than Sr reported by Seydou, (2011). While Zn was found to be lower than the literature values. Fe from farms soil in this work was found to be higher than that of Seydou, (2011) but lower than that of Amour, (2014) reports. Cu in onion farm soil was found to be lower concentrated than what was reported by Amour (2014). Ca and K in onion farm soil happen to be lower than that of Seydou, (2011) but higher than that of Amour, (2014). Ti in this work was found to be higher concentrated than Ti reported by Seydou, (2011) but not detected by Amour, (2014).

Table 14 also shows the comparison of the mean concentration from the two (2) farm soils in this work with the world values. Where Zr, Zn, V, Cu and Rb in both the farms were found to be within the average world values of the stated elements in the soil. While Mo, Sr, Fe, Nb, and Cr were found to be above the world values of the same elements. Also Ti, Ca, and K were found to be very high concentrated in onion farm soil than the average world value.

Table 14 finally shows the comparison of this work mean values of the two (2) farms soil (onion and cabbage farm). Mo, Ti, Ca, K and Zr in onion farm soil were found to be lower concentrated compared to cabbage farm soil values. And Sr, Rb, Fe, V, Nb and Cr were found to be higher concentrated than reported values from cabbage farm soil. While Zn and Cu were found only in onion farm soil.

Geo accumulation Index (I_{geo}) of the two farms soils was calculated as defined above and the results were shown in the Table 15.

Table 15 shows the geo accumulation index of the two farms. Where Sr, Rb, V, Nb, Ca, K, Cr, Cu, Fe, Zn, and Ti were found to be greater than zero but less than one showing unpolluted level. While Zr shows moderate pollution level, because is greater than one but less than two in both the farm soils. Mo was greater than five so, is extremely polluted.

Table 15: Geo accumulation Index (I_{geo}) for farms soils

Element	I_{geo} for onion farm soil	I_{geo} for cabbage farm soil
Mo	12.7132	13.8387
Zr	1.7819	1.8117
Sr	0.3548	0.1513
Rb	0.4072	0.3635
V	0.2786	0.1331
Nb	0.8762	0.8321
Fe	0.4619	0.2663
Cu	0.2044	-
Zn	0.0775	-
Cr	0.9364	0.5870
Ti	0.2536	0.1500
Ca	0.0479	0.0141
K	0.1705	0.1149

Pearson's Correlation matrices among the studied metals (Mo, Zr, Sr, Rb, Zn, Cu, Fe, Ti, Ca, K, Ba, and Nb) in soil samples were obtained using SPSS Version 25 (IBM Corp., USA) software and the results are shown in Table16. However, at (α = 0.05) positive correlation exist between K with Sr, Rb, Zn and Fe. Ti with Sr, Rb, Zn, and Fe. Ca with Rb, Zn and Cu. Negative correlation only exist between Ba with Fe. At (α = 0.01) Ca with Sr, Fe,Ti and K. Fe with Sr, Ca, Ti and K all has significantly positive correlation between each other. While Ba with Fe, Sr, Ti, Ca and K has negative correlation exist between them. By implications, these results shows that the complexes of some elements within the soil strata could influence the presence of other given element.

Table 16: Person's correlation matrices between variable parameters in the farms soils samples

	Mo	Zr	Sr	Rb	Zn	Cu	Fe	Ti	Ca	K	Ba	Nb
Mo	1											
Zr	0.305	1										
Sr	-0.225	0	1									
Rb	0.11	0.529	0.501	1								
Zn	0.358	0.58	0.452	.863**	1							
Cu	-0.313	0.531	0.544	0.397	0.407	1						
Fe	-0.386	0.032	.956**	0.515	0.428	.695*	1					
Ti	-0.455	0.242	.743*	.640*	0.554	.689*	.851**	1				
Ca	-0.335	0.184	.860**	.665*	.634*	.695*	.928**	.963**	1			
K	-0.433	0.296	.681*	.711*	0.596	.641*	.786**	.985**	.932**	1		
Ba	0.46	-0.015	-.941**	-0.499	-0.388	-.673*	-.992**	-.886**	-.934**	-.824**	1	
Nb	-0.403	0.154	0.471	0.258	0.009	0.217	0.389	0.286	0.265	0.329	-0.419	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

CONCLUSION

In the farms, soil samples studied showed that most of the elements identified were heavy metals of environmental concern. The elements studied include: Mo, Zr, Sr, Rb, Zn, Cu, Fe, Ti, Ca, K, Ba, and Nb. Among these elements, only Fe was found to be enriched, while the remaining elements are depleted. The depletion showed by certain elements could be due to dilution if the elements had existed in highly soluble form, while the enrichment could be attributed to high sedimentations rates of the derivative complexes of the elements in solution.

Sr, Rb, V, Nb, Ca, K, Cr, Cu, Fe, Zn, and Ti showed absence of pollution while Zr was found moderate

The enrichment, contamination as well as high coefficient of variation could be as a result of the contamination from external sources of pollutants such as fertilizers from farmlands within the vicinity, pesticides, herbicides, or any other wastes capable of polluting the farmlands as a result of human activities. In next work concentration of heavy metals from onion and cabbage plantations will be considered vis ά vis the determination of heavy metals intake.

REFERENCES

Amour, K. O. (2014): Assessment of Heavy Metal Concentrations in Soil and Green Vegetables (Vigna Unguiculata) Around the Volcanic Mountain of Oldoinyo Lengai in Ngorongoro District Arusha, Tanzania. M.Sc Thesis, University of Dar es Salaam

Adetunji, J. and Ong, C. K. (1989): The Concentration of Trace Element in the Harmattan Haze. *Discovery and Innovation*, Vol. 1 No 1, pp 63 - 66

Andrew Adamu (2021): determination of Heavy Metals Concentration in Soils and Vegetables in the Irrigation Area of Dadin Kowa Dam, Gombe State Nigeria, Unpublished M.Sc. Dissertation, Department of Physics Gombe State University.

Berrow, M. C. and Weber, J. (1972) *J. Sci. Food Agric* 23, 93

Bowen, H. J. M. (1979): Environmental Chemistry of the Elements, Academic Press, London, 213-235.

Davis, J. C. (1973): Statistic and Data Analysis in Geology; John Wiley and Sons, New York. 550

Esmaeilzadeh M., Jaafari J., Mohammadi A. A., Panahandeh M., Javid A., and Javan, S.:(2019): Investigation of the extent of contamination of heavy metals in agricultural soil using statistical analyses and contamination indices, *Human and Ecological Risk Assessment: An International Journal*, vol. 25, no. 5, pp. 1125–1136.

GEMS/Food, (2000): Regional Diets prepared by Global Environmental monitoring system/food contamination monitoring and Assessment programme (GEMS/FOOD).

Ghaderpoori M., Kamarehie B., Jafari A., Ghaderpoury A. and Karami M.:(2018). Heavy metals analysis and quality assessment in drinking water—Khorramabad city, Iran, *Data in Brief*, vol. 16, pp. 685–692.

Gluskoter, H. J., Ruch, R. R., Miller, W. G., Cahill, R. A., Drohen, G. B. and Kuhn, J. K.(1977): Trace Elements in Coal. Occurrence and Distribution, Illinois State Geological Survey, Urban, EPA – 600/7, 64 - 77

Haluschak, P., Eilers, R. G., Mills, G. F. and Grift, S. (1998): Status of Selected Trace Elements in Agricultural Soils of Southern Manitoba. Canada: Agriculture and Agri-Food Canada.

Hankouraou S. and Jibrin S. (2020)**:** Determination of Heavy Metals' Pollution from Motor Parks' Soils of Gombe Metropolis, Nigeria. *Bima Journal of Science and Technology, Vol. 4(1), pp324-33.*

Hankouraou S. and Yusuf M.A. (2019): Determination of Concentrations of Heavy Metals in Cow Fresh Milk Obtained from Gujba Local Government Area, Yobe State. *Journal of the Nigerian Association of Mathematical Physics vol. 53, pp123-130. © J. of NAMP*

Ihedioha J. N., Ukoha P. O., and Ekere N. R. (2017): Ecological and human health risk assessment of heavy metal contamination in soil of a municipal solid waste dump in Uyo, Nigeria, *Environmental Geochemistry and Health*, vol. 39, no. 3, pp. 497–515.

Jenett, J. C., Sten, W. E. and Bobby G. W. (1980): Sediment and Toxicological Aspects of Sedimentary Contamination **In**: Contaminants and Sediment Volume 1 (R. A. Baker, Ed) Ann Arbor Science, 429 – 444

Lenntech, J. (2004): Water Treatment and Purification, Lenntech, Rotterdamsewage, Netherland.

Li, C., Zhou, K., Qin, W. et al., (2019): A review on heavy metals contamination in soil: effects, sources, and remediation techniques, *Soil and Sediment Contamination: An International Journal*, vol. 28, no. 4, pp. 380–394.

Melville, G. J. and Welsh, A. H. (2001): Line transect sampling in small regions. Biometrics, 57, 1130-1137.

Muller, W.P. and Mcfree, W.W. (1969): Distribution of Cd, Zn, Cu and Pb in soils of industrial Northwestern India. *Journal of Environmental Quality*, 12, 29-33.

Odai, S. N., Mensah, E., Sipitey, D., Ryo, S. and Awuah, E. (2008): Heavy metals uptake by vegetables cultivated on urban waste dumpsites: Case study of Kumasi, Ghana. *Research Journal of Environmental Toxicology*, 2, 92-99.

Onakpa M. M., Njan A. A., and Kalu O. C. (2018): *A Review of Heavy Metal Contamination of Food Crops in Nigeria. Annals of Global Health*. 2018; 84(3), pp. 488–494. DOI: https://doi.org/10.29024/aogh.2314

Pardue, J. A., Delaune, R. D., Smith, C. J. and Patrick, W. H. (1988): Heavy Metal Concentration along the Louisiana Coastal Zone. *Environmental International,* Vol. 14, 403 – 406

Patterson, J. B. E. (1971): Trace Elements in Soils and Crops. *Ministry of Agriculture, Fish and Food Technology, Bulletin* 21, 193, HM Stationary Office, London

Sadovska, V. (2012): Health risk assessment of heavy metals adsorbed in particulates. *World Academy of Science, Engineering and Technology*. 68. 2151-2158.

Seydou, H. (1998). Determination of Trace Elements in Kubanni River Sediment Using Energy Dispersive X-ray Fluorescence Techniques: Unpublished MSc Thesis in Department of Physics Ahmadu Bello University Zaria.

Seydou, H. (2008): Toxicity Assessment of Heavy Metals in River Sediments Using X-ray Fluorescence Technique, *Continental Environmental of Sciences, CJEnv Sci/2008/003, Wilolud Online Journals.*

Seydou, H. (2011): Soil Contamination in Fadama Area in Zaria, Nigeria, Using X-ray Fluorescence Techniques. *Journal of the Nigerian Association of Mathematical Physics. Vol.19, pp 559 – 564*

Ugonna C. Nkwunonwo , Precious O. Odika , and Nneka I. Onyia (2020): A Review of the Health Implications of Heavy Metals in Food Chain in Nigeria. *Hindawi*. *The Scientific World Journal Volume 2020*, Article ID 6594109, 11 pages. https://doi.org/10.1155/2020/6594109

Ureso, J., Gonzalez–Regalado, E. and Gracia, L., (1997): Trace element in bivalve

Valkovic, (1983): Trace Elements in Coal. I and II, CRC Press, Boca, Raton, Florida, 130 - 150

WHO (2001): Food additives and contaminant. Joint FAO/WHO. Food standards Programme. ALINORM 01/12A: 1-28.