Modern Chemistry & Applications
Osu et al., Mod Chem Appl 2018, 6:4
DOI: 10.4172/2329-6798.1000264

Research Article Open Access

Health Risk Assessment Indices and Diseases Suffered by the Dwellers around Asphalt Quarry Sites in Abia State, Nigeria

Osu CI*, Igbinovia OM, Iwuoha GN and Obuzor GU

Department of Pure and Industrial Chemistry, University of Port Harcourt, Nigeria

***Corresponding author:** Osu CI, Department of Pure and Industrial Chemistry, University of Port Harcourt, Nigeria, Tel: +2348037783246; E-mail: charsike@yahoo.com

Rec date: November 02, 2018; **Acc date:** November 28, 2018; **Pub date:** December 30, 2018

Abstract

This research work is a novel effort towards studying the effect of quarry activities on: concentration of heavy metals in the soil around two quarry sites and leaves of *Telfairia occidentalis* and *Amaranthus spinosus* as well as health risk assessment indices and diseases suffered by the dwellers around the quarry sites in Abia State, Nigeria. Geo-accumulation index (Igeo) rating indicated that all topsoil samples analyzed ranged from practically uncontaminated to moderately contaminate for most heavy metals except for nickel which was extremely polluted within 200 m around the quarry sites and arsenic which were strongly polluted within 100 m around the quarry sites. Contamination factor assessment implicated high level of contamination of the soil sample with lead. Other heavy metals studied showed low degree of contamination at points X and Y for the both quarry sites. The concentrations of the various metals also showed a wide range of variation in leaves with variable patterns in the order: Zn>Cu>Pb>Cr>Ni>Cd>As>Hg; *Telfairia occidentalis* and Zn>Cu>Pb>Cr>Ni>Cd>As>Hg; *Amaranthus spinosus* leaves. The bioaccumulation factor (BF) of the eight heavy metals in *Amaranthus spinosus* and *Telfairia occidentalis* revealed that these vegetables around both sites were poor accumulators of of the heavy metals studied. The daily intake of heavy metals ascribed to the consumption of the vegetables studied indicated low risk for humans as direct consumers. Comparing the health risk assessment parameters with standards from WHO, total agreement could not be obtained as some values beyond the allowable limit of the WHO standards were portrayed as safe level by the health risk assessment parameters.

Keywords: Health risk assessment; Accumulation; Heavy metals

Introduction

Industrial activities such as mining or blasting of rocks result in the release of the pollutants. These pollutants degrade the environment and pose potential danger to the ecosystem and human health [1]. With amplified quarry operations in Nigeria, enormous amounts of heavy metals are released to the environment through waste emission. They amass in land and water and ultimately in the systems of organisms. Subsequently, they reach injurious concentrations [2]. Worthy of note is the fact that protracted exposure to potentially harmful elements such as Cd and Pb could negatively affect human health [3]. The current amount of these metals in the soil could serve as a pointer to the effect of pollutants released into the surroundings [4]. There seems to be a vivid relationship between the contamination of the surrounding by these metals and activities in quarry sites [5]. These activities have been frequently observed to increase the heavy metals' profile of soil and vegetables. It is documented that plants grown in areas near quarry sites take up heavy metals. Upon consumption of these crops by man, there is accumulation of the metals in the body system and such buildup may reach very harmful levels [6]. This is the major cause of heavy metal toxin in man. In addition, heavy metals like Cu and Zn are required for typical growth of plant, but higher concentration of both essential and non-essential metals might lead to toxic symptoms and inhibition of growth [7]. *Telfairia occidentalis* and *Amaranthus spinosus* plant are important vegetables produced in Nigeria for food. Its cultivation is predominant in Abia state and other southern region of the country, mainly because of the high need for vegetables by the dwellers. Nevertheless, due to high cost, shortage of fertilizers and other agricultural materials in Nigeria, numerous sites and vacant lands have been changed to vegetable gardens. On the other hand, quarrying raises various environmental concern such as land pollution, emission of dust, noise and ground vibrations; the latter arising from movement of machinery and rock blasting [8]. Quarrying poses danger to the workers and occupants of quarry sites as dust produced from rock fall and movement of machines is harmful to their health. The size, concentration, mineral composition of dust particle and long-term exposure to it, are factors considered in evaluating the health risks involved. The inhalation of the dust causes severe health problems including respiratory and pulmonary problems, while dust deposition causes skin and eye problems [9].

This research work is a novel effort towards studying the effect of quarry activities on: concentration of heavy metals in the soil around two quarry sites and leaves of *Telfairia occidentalis* and *Amaranthus spinosus* as well as health risk assessment indices and diseases suffered by the dwellers around the quarry sites in A and B districts of Abia State, Nigeria.

Materials and Methods

Sample collection

A sum of twenty topsoil samples (0 to 15 cm depth) was gathered systematically at 100 and 200 m away from the crushing zone of the two quarry sites. Five topsoil samples were each taken from radii of 100 and 200 m from the crushing zone for quarry sites A and B. Adding all these samples up would give 20 samples mentioned previously. Random sampling was done at each point and mixed together to form composite samples. The two distances studied were denoted as X* (100 m) and Y* (200 m). Five background topsoil samples were also collected from an undeveloped location 15 km from the study area. A plastic trowel was used to bail the soil samples and they were stored in a clean five polythene bags labeled XA1, XA2, XA3, XA4 and XA5 and XB1, XB2, XB3, XB4 and XB5 for samples collected 100 m away from quarry A and B respectively; YA1, YA2, YA3, YA4 and YA5 and YB1, YB2, YB3, YB4 and YB5 from quarry A and B respectively for samples collected 200 m.

Also twenty samples each of *Telfairia occidentalis* leaves and *Amaranthus spinosus* leaves were taken with sterile bottles and labeled as that of the soil sample. These samples collected were moved to the laboratory for pre-treatment and analyses (Figure 1).

Figure 1: Areas around the Quarry site in A and B.

Concentration levels of heavy metals in soil

Soil samples were dried and sifted to particle sizes of less than 2 mm before analyses. Thereafter, 1.0 g of the sieved samples were added to 10 ml of concentrated HNO_3 solution (Mallinkrodt Ultrapure) and HCl (BDH AR Grade) (1:3 v:v) and gradually heated until about 2 ml of acid were left in the digestion vials. The samples were then made to 40 ml with deionized H_2O and filtered. Samples were analyzed by a solar thermo atomic absorption spectrometer.

Concentration levels of heavy metals in *Amaranthus spinosus* and *Telfairia occidentalis*

Harvested leaves were rinsed twice with deionized water to wash off unwanted particles prior to when they were chopped into tiny bits. The leaves and samples of soil collected were later dried at 70°C for three days with an oven. The dried samples were blended with the aid of a pestle and mortar sieved thereafter with a stainless sieve of 2 mm diameter and kept at room temperature for subsequent analysis. For extraction of heavy metal, dried grinded samples of about 1.0 g of were digested with 12 ml of 55% HNO_3 and 12 ml of H_2O_2 microwave digester at 160°C for 30 minutes and left to become cool for approximately 15 minutes. The digested solutions were filled to 100 ml mark of the volumetric flask with deionized water. It was then cooled to 4°C with the aid of a refrigerator. The sample was later analyzed with Atomic Absorption spectrophotometry analysis [10].

Method of data analysis

Geo accumulation index of heavy metals around the vicinity of the Quarry site: The geochemical index was assessed adopting the following expression:

$I_{geo}=\log_2(C_n/1.5Bn)$

Where C_n is the mean level of the element in the sampled soil and B_n is the background concentration in the crust which was gotten from the samples taken froman undeveloped location 15 km from the study area. The factor 1.5 was introduced to diminish the influence of likely disparities in the background values, which could be ascribed to lithogenic variations [11].

Contamination Factor: The contamination factor is calculated based on a formula reported [12].

$CF=C_{metal}/C_{background}$ CF<1

Low contamination factor: 1

CF<3: moderate contamination factor; 3=CF<6: considerable contamination factor; CF=6: very high contamination factor [13].

Transfer factor of heavy metals in *Telfairia occidentalis* and *Amaranthus spinosus*: Transfer factor was determined using the ratio of heavy metal concentrations in plants to those in the soil from which the plants were harvested [14].

Daily intake of heavy metals in *Telfairia occidentalis* and *Amaranthus spinosus:* The daily intake is simply contrasted with the RFD. If the CDI is below the RFD, an assumption of negligible risk is made for about all members of an exposed population [14].

Hazard index analysis of *Telfairia occidentalis* and *Amaranthus spinosus*: The toxicity is important only during the time of exposure which ranges from one day to years. The hazard index has been designated such that if it is below a value of 1.0, there should be no significant risk or systemic toxicity. Ratios above 1.0 could represent a potential risk, but there is no way to establish that risk with any certainty [14].

Results and Discussion

Heavy metal concentration in the soil

The heavy metal concentration was measured at quarry sites A and B for Cu, Cr, Pb, Ni, Cd, As, Hg and Pb at points X (100 m) and Y (200

m) respectively from the quarry site. The mean degree of each of the heavy metals in $mgk^{-1}g$ at points X and Y respectively were: Cu: 41.20 and 20.34 for A, 30.00 and 7.80 for B; Cr: 11.30 and 7.60 for A; 8.30 and 4.60 for B; Pb: 21.30 and 13.20 for A; 11.60 and 9.30 for B; Ni: 4.34 and 2.90 for A; 1.30 and 0.90 for B; Cd: 4.80 and 2.15 for A, 1.90 and 0.60 for B; As: 3.40 and 2.10 for A; 1.80 and 0.90 for B; Hg: 0.76 and 0.80 for A; 0.30 and 0.10 for B and Zn: 95.40, 46.30 for A; 106.80 and 28.90 for B as shown in Figure 2. The values of the concentrations of the selected metals showed a wide extent of variation with variable patterns in the order: Zn>Cu>Pb>Cr>Ni>Cd>As>Hg. There was a decrease in the concentration of Pb, Ni, Cd, Zn, Cr and As metals with increase in distance from quarry site (Figures 3 and 4). This suggests that the dispersion of Cu, Cr, Hg and Zn metals from the source could have been majorly by wind which disperses dust containing metals in all directions at different magnitude, space and time. Samples around 100 m seem to show higher concentrations for most metals than samples farther away. This is probably because of their closeness to the exploration area and leaching of metals from quarry tailings which were found within this distance. Chromium level in topsoil samples analyzed up to 200 m away from the crushing and blasting arena showed level in more than triple fold when compared with the background level; Lead level in topsoil is more than tenfold that of the background level; Nickel level is more than ninety times that of the background level; Cadmium level is more than twenty times; Arsenic is more than forty-five times; Mercury level is more than twenty times while zinc is less than half of the background level (Figures 2 and 3). The trend shown by these metals might be due to their high content in topsoil samples, possibly leached from quarry stones or transferred by wind during blasting and crushing.

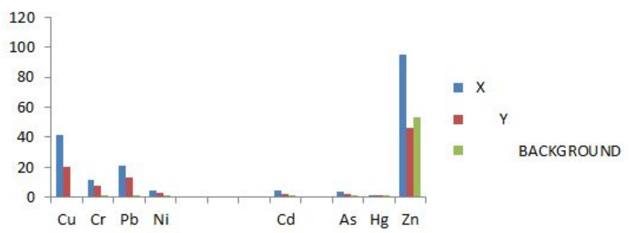

Figure 2: Concentration of heavy metals (mg/kg) in Soil around the vicinity of the quarry site A.

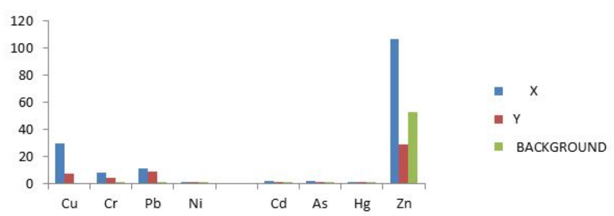

Figure 3: Concentration of heavy metals (mg/kg) in Soil around the vicinity of the quarry site B.

Generally, Cu was beyond that of the background. There was higher soil level of Cu at point X (100 m from the quarry site) than Y (200 m from the quarry site) - Showing a relationship between the quarry site and distance from it. This indicates that the quarry site is the point source of copper pollutant and could be related to crushing, loading and transporting activities of the stone quarry sites.

Heavy metal concentration in the leaves of *Telfairia occidentalis*

The heavy metal concentration was measured for Cu, Cr, Pb, Ni, Cd, As, Hg and Pb from the leaves of *Telfairia occidentalis* that were collected at approximate points X and Y respectively from the quarry sites A and B and digested. The average concentration of each of the heavy metals in $mgkg^{-1}$ at points X and Y for A and B respectively were: Cu: 14.30; 8.60 and 11.30; 3.14; Cr: 6.13; 4.10 and 4.90; 2.30; Pb: 8.30; 4.40 and 5.07; 2.10; Ni: 0.69 and 0.09; 0.03 and 0.14; Cd: 0.21 and 0.08; 0.16 and 0.07; As: 0.34 and 0.02; 0.13 and 0.03; Hg: 0.04 and 0.01; not detected and nil and Zn: 21.30 and 15.40; 9.00 and 5.60 as shown in Figures 4 and 5. The concentrations of the various metals also showed a wide range of variation with variable patterns in the order: Zn>Cu>Pb>Cr>Ni >Cd>As>Hg. All metals studied showed an inverse relationship with distance of the point of collection from the blasting and crushing area (Figures 4 and 5). This suggests that the dispersion of Cu, Cr, Hg and Zn metals from the source probably because of their closeness to the exploration area and leaching of metals from quarry tailings which were found within this distance.

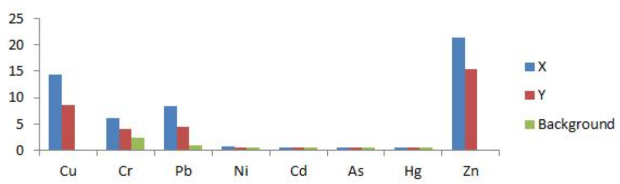

Figure 4: Concentration of heavy metals (mg/kg) in *Telfairia occidentalis* leaves around the vicinity of the quarry site A.

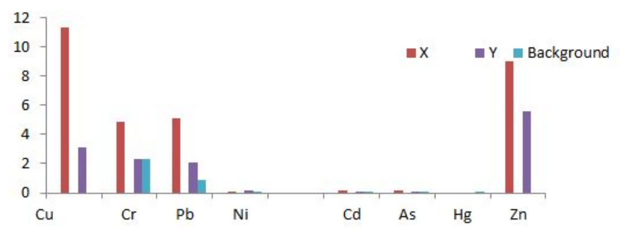

Figure 5: Concentration of heavy metals (mg/kg) in *Telfairia occidentalis'* leaves around the vicinity of the quarry site B.

Heavy metal concentration in the leaves of *Amaranthus spinosus*

The heavy metal concentration was measured for Cu, Cr, Pb, Ni, Cd, As, Hg and Pb from the leaves of *Amaranthus spinosus* which were harvested at approximate points X and Y around sites A and B respectively from the quarry site and digested. The average concentration of each of the heavy metals in $mgkg^{-1}$ at points X and Y around sites A and B respectively were: Cu: 11.40 and 7.60; 10.40 and 2.09; Cr: 3.20 and 2.70; 2.80 and 1.80; Pb: 4.10 and 3.70; 6.10 and 1.20;

Citation: Osu CI, Igbinovia OM, Iwuoha GN, Obuzor GU (2018) Health Risk Assessment Indices and Diseases Suffered by the Dwellers around Asphalt Quarry Sites in Abia State, Nigeria. Mod Chem Appl 6: 264. doi:10.4172/2329-6798.1000264

Ni: 0.60 and 0.02, 0.03 and 0.10; Cd: 0.18 and 0.04; 0.13 and 0.01; As: 0.15 and 0.06; 0.09 and 0.00; Hg: 0.04 and 0.04, 0.01 and 0.01 and Zn: 16.40 and 11.80; 6.00 and 4.70 as shown in Figures 6 and 7. The concentrations of the various metals also showed a wide range of variation with variable patterns in the order: Zn>Cu>Pb>Cr>Ni>Cd>As>Hg. Also, all the metals showed a reduction in concentration with greater distance from quarry site except Nickel at site B (Tables 1 and 2).

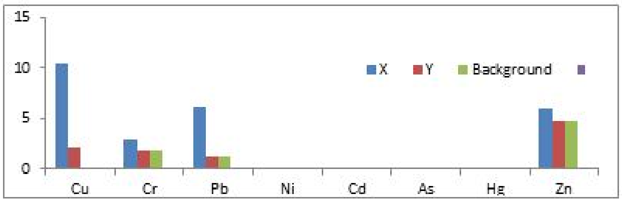

Figure 6: Concentration of heavy metals (mg/kg) in *Amaranthus spinosus*' leaves around the vicinity of the quarry site A.

Metals	X	Y	Control
Cu	12.67692	6.258462	3.25
Cr	9.04	6.08	1.25
Pb	24.76744	15.34884	0.86
Ni	434	290	0.01
Cd	160	71.66667	0.03
As	170	105	0.02
Hg	15.2	16	0.05

Table 1: Contamination Factor of Heavy Metals around the vicinity of the quarry site A.

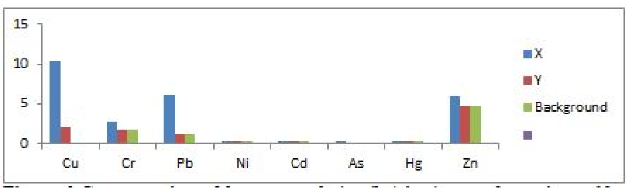

Figure 7: Concentration of heavy metals (mg/kg) in *Amaranthus spinosus* leaves around the vicinity of the quarry site B.

Metals	X	Y	Control
Cu	9.230769	2.4	3.25
Cr	6.64	3.68	1.25
Pb	13.48837	10.81395	0.86
Ni	130	90	0.01
Cd	63.33333	20	0.03
As	90	45	0.02
Hg	6	2	0.05

Table 2: Contamination Factor of Heavy Metals around the vicinity of the quarry site B.

Assessment according to contamination factor

Contamination Factor assessment in this study implicated a high degree of contamination (CF>6) of the soil sample with lead at points X (100 m) and Y (200 m) for quarry site A while points X and Y showed mild level of contamination (CF of 2.9 and 2.0 respectively) for quarry site B. The assessment of arsenic at point X indicated considerable degree of contamination (CF=4) but other points (Y at A, X and Y at B) showed moderate degree of contamination (CF=2.4, 2.1 and 1.0 respectively). The level of contamination for Pb was moderate at points X and Y for sites A and B (CF=2.5, 1.5, 1.4 and 1.1 respectively). The remaining heavy metals studied showed low level of contamination (CF>1.5) at points X and Y for A and B as shown in Tables 3 and 4.

Heavy Metals	X	Y
Cu	1.10 0425	0.891538
Cr	1.865734	1.560533
Pb	3.420761	2.885633
Ni	14.11797	10.24035
Cd	5.028965	2.454081
As	5.885116	3.567964
Hg	-0.5279	-0.42924
Zn	0.028653	0.024109

Table 3: Geo accumulation indices of heavy metals (mg/kg) in the soil around the vicinity of quarry site A.

Geo accumulation index of heavy metals around the vicinity of the quarry sites

Geo accumulation index (I_{geo}) rating is presented in Tables 3 and 4. Here, the content permitted as background was multiplied in each case by a factor (1.5) so as to account for natural changes in a particular metal in the surrounding as well as little human prompted effects [11]. Geo-accumulation index (I_{geo}) rating indicated that all topsoil samples analyzed ranged from practically uncontaminated (I_{geo}<0) to moderately contaminated (I_{geo} of 1 to 2) for a lot of heavy metals with the exception of Nickel (which was extremely polluted or I_{geo}>13 within 200 m around the quarry site A), lead (moderately polluted or I_{geo}>2 within 200 m from the site B) and Arsenic (which is strongly polluted or I_{geo} ~ 5 within 100 m around the quarry site A) (Tables 3 and 4). The geo-accumulation indices of copper, chromium, cadmium, mercury and zinc which were less than zero suggests that their input in the soil is associated with the parent material that formed the soil or other natural or low degree of anthropogenic non-point sources.

Heavy Metals	X	Y
Cu	0.9	0.2

Cr	0.8	0.4
Pb	1.4	1.1
Ni	2.9	2
Cd	0.4	0.1
As	2.1	1
Hg	0.3	0.1
Zn	0.7	0.2

Table 4: Geo accumulation indices of heavy metals (mg/kg) in the soil around the vicinity of quarry site B.

Bioaccumulation factor assessment in *Amaranthus spinosus* and *Telfairia occidentalis*

The bioaccumulation factor (BF) obtained for the eight metals studied in the leaves of *Amaranthus spinosus* and *Telfairia occidentalis* revealed that these vegetables around both sites were poor accumulators of Cu, Cr, Pb, Ni, Cd, As, Hg and Zn (with bioaccumulation factor<1) (Tables 5-8). This result indicates the speciation of the heavy metals in the soil to be non-labile and as such is not easily absorbed by the plant's roots [15]. This agrees with the statement that only small quantity of heavy metals absorbed by the roots is translocate to other regions of the plants [16].

Heavy Metals	X	Y
Cu	0.347	0.423
Cr	0.542	0.539
Pb	0.39	0.333
Ni	0.159	0.031
Cd	0.044	0.037
As	0.1	0.01
Hg	0.053	0.013
Zn	0.223	0.333

Table 5: Bioaccumulation Factor of heavy metals in the leaves of *Telfairia occidentalis* around the vicinity of the quarry site A.

Heavy Metals	X	Y
Cu	0.377	0.403
Cr	0.59	0.5
Pb	0.437	0.226
Ni	0.023	0.156
Cd	0.084	0.117
As	0.072	0.033
Hg	ND	ND
Zn	0.084	0.194

Table 6: Bioaccumulation Factor of heavy metals in the leaves of *Telfairia occidentalis* around the vicinity of the quarry site B.

Heavy Metals	X	Y
Cu	0.228	0.374
Cr	0.283	0.355
Pb	0.192	0.28
Ni	0.138	0.007
Cd	0.038	0.019
As	0.044	0.029
Hg	0.053	0.05
Zn	0.172	0.255

Table 7: Bioaccumulation Factor of heavy metals in the leaves of *Amaranthus spinosus* around the vicinity of the quarry site A.

Heavy Metals	X	Y
Cu	0.347	0.268
Cr	0.337	0.391
Pb	0.526	0.129
Ni	0.023	0.111
Cd	0.068	0.017
As	0.05	
Hg	0.033	0.1
Zn	0.056	0.163

Table 8: Bioaccumulation Factor of heavy metals in the leaves of *Amaranthus spinosus* around the vicinity of the quarry site B.

Transfer factor of heavy metals in *Telfairia occidentalis* and *Amaranthus spinosus*

Transfer factor values estimated from the result of this study indicates that the uptake capabilities of heavy metals from soils (from sites A and B) to: *Telfairia occidentalis* leaves'concentration were in the order of Cr>Cu>Pb>Zn>Ni>Cd>As>Hg and *Amaranthus spinosus* is in the order of Cr>Cu>Pb>Zn>Ni>Cd >Hg>As as shown in Tables 9-12.

Metals	X	Y
Cu	34.70874	42.28122
Cr	54.24779	53.94737
Pb	38.96714	33.33333
Ni	15.89862	3.103448
Cd	4.375	3.72093

As	10	0.952381
Hg	5.263158	1.25
Zn	22.32704	33.26134

Table 9: Transfer factor of heavy metals in the leaves of *Telfairia occidentalis* around the vicinity of the quarry site A.

Heavy Metals	X	Y
Cu	37.66667	40.25641
Cr	59.03614	50
Pb	43.7069	22.58065
Ni	2.307692	15.55556
Cd	8.421053	11.66667
As	7.222222	3.333333
Hg	Nil	Nil
Zn	8.426966	19.37716

Table 10: Transfer Factor of heavy metals in the leaves of *Telfairia occidentalis* around the vicinity of the quarry site B.

Heavy Metals	X	Y
Cu	22.81553	37.3648
Cr	28.31858	35.52632
Pb	19.24883	28.0303
Ni	13.82488	0.689655
Cd	3.75	1.860465
As	4.411765	2.857143
Hg	5.263158	5
Zn	17.19078	25.48596

Table 11: Transfer Factor of heavy metals in the leaves of *Amaranthus spinosus* around the vicinity of the quarry site A.

Heavy Metals	X	Y
Cu	34.66667	26.79487
Cr	33.73494	39.13043
Pb	52.58621	12.90323
Ni	2.307692	11.11111
Cd	6.842105	1.666667
As	5	0
Hg	3.333333	10
Zn	5.617978	16.26298

Table 12: Transfer Factor of heavy metals in the leaves of Amaranthus spinosus around the vicinity of the quarry site B.

Daily intake of heavy metals in *Telfairia occidentalis* and *Amaranthus spinosus*

CDI Figures for all eight metals studied around the two sites were less than the RFD indicating negligible danger for the eaters of *Telfairia occidentalis* and *Amaranthus spinosus* (Tables 13-16) as these vegetables studied showed poor tendency to absorb the eight heavy metals studied.

Metals	A	B	RFD
Cu	7E-04	0.0004	0.037
Cr	3E-04	0.0002	75
Pb	4E-04	0.0002	0.00043
Ni	3E-05	4E-06	0.02
Cd	1E-05	4E-06	5.1
As	2E-05	1E-06	0.02
Hg	2E-06	5E-07	0.0003
Zn	0.001	0.0008	0.3

Table 13: Daily Intake of the heavy metals as a result of the consumption of *Telfairia occidentalis* around the vicinity of the quarry site A.

Heavy Metals	A	B	RFD
Cu	0.0006	0.0002	0.037
Cr	0.0002	0.0001	75
Pb	0.0002	0.0001	0.00043
Ni	1E-06	7E-06	0.02
Cd	8E-06	3E-06	5.1
As	6E-06	1E-06	0.02
Hg	Nil	Nil	0.0003
Zn	0.0004	0.0003	0.3

Table 14: Showing the Daily Intake of the heavy metals as a result of the consumption of *Telfairia occidentalis* around the vicinity of the quarry site B.

Heavy Metals	A	B	RFD
Cu	0.0005	0.0004	0.037
Cr	0.0002	0.0001	75
Pb	0.0002	0.0002	4E-04
Ni	3E-05	1E-06	0.02

Cd	9E-06	2E-06	5.1
As	7E-06	3E-06	0.02
Hg	2E-06	2E-06	3E-04
Zn	0.0008	0.0006	0.3

Table 15: Daily Intake of the heavy metals as a result of the consumption of *Amaranthus spinosus* around the vicinity of the quarry site A.

Heavy Metals	A	B	RFD
Cu	5E-04	1E-04	0.037
Cr	1E-04	9E-05	75
Pb	3E-04	6E-05	4E-04
Ni	1E-06	5E-06	0.02
Cd	6E-06	5E-07	5.1
As	4E-06	Nil	0.02
Hg	5E-07	5E-07	3E-04
Zn	3E-04	2E-04	0.3

Table 16: Daily Intake of the heavy metals as a result of the consumption of *Amaranthus spinosus* around the vicinity of the quarry site B.

Hazard quotient analysis of *Telfairia occidentalis* and *Amaranthus spinosus*

Estimation of HI for sites A and B for the eight heavy metals gave values less than one indicating no impending risk yet as shown in Tables 17-20.

Metals	X	Y
Cu	0.0189	0.0113
Cr	3.99E-06	2.67E-06
Pb	0.943401	0.500116
Ni	0.001686	0.00022
Cd	2.01E-06	7.67E-07
As	0.000831	4.89E-05
Hg	0.006517	0.001629
Zn	0.00347	0.002509

Table 17: Health quotient of Heavy Metals *Telfairia occidentalis* around the vicinity of the quarry site A.

Heavy Metals	A	B
Cu	0.0149	0.00414
Cr	3.19E-06	1.50E-06
Pb	0.57627	0.238692
Ni	7.33E-05	0.000342
Cd	1.53E-06	6.71E-07
As	0.000318	7.33E-05
Hg		0
Zn	0.001466	0.000912

Table 18: Health Quotient of Heavy Metals *Telfairia occidentalis* around the vicinity of the quarry site B.

Metals	X	Y
Cu	0.012417	0.010039
Cr	2.09E-06	1.76E-06
Pb	0.466017	0.420552
Ni	0.001466	4.89E-05
Cd	1.73E-06	3.83E-07
As	0.000367	0.000147
Hg	0.006517	0.006517
Zn	0.002672	0.001922

Table 19: Health Quotient of Heavy Metals *Amaranthus spinosus* around the vicinity of the quarry site A.

Heavy Metals	X	Y
Cu	0.013738	0.002761
Cr	1.82E-06	1.17E-06
Pb	0.693343	0.136395
Ni	7.33E-05	0.000244
Cd	1.25E-06	9.58E-08
As	0.00022	0
Hg		0
Zn	0.000978	0.000766

Table 20: Health Quotient of Heavy Metals *Amaranthus spinosus* around the vicinity of the quarry site B.

Air pollution related diseases affecting people living around quarry sites

26.53% of the dwellers around a quarry site suffered from headache, 28.57% from coughing, 24.49% from catarrh, 9.18% from chest pains and 11.22% from eye infections as shown in Table 21 and Figure 8. These diseases are related to the high concentration of air quality parameters (Table 21) and activities of the quarry environments. This can be attributed to the high concentration of particulate matter in the atmosphere of the sites [17]. This result also agrees with it [18,19].

Citation: Osu CI, Igbinovia OM, Iwuoha GN, Obuzor GU (2018) Health Risk Assessment Indices and Diseases Suffered by the Dwellers around Asphalt Quarry Sites in Abia State, Nigeria. Mod Chem Appl 6: 264. doi:10.4172/2329-6798.1000264

Type of Disease	Frequency	Percentage
Headache	26	26.53
Coughing	28	28.57
Catarrh	24	24.49
Chest Pains	9	9.18
Eye Infections	12	11.22
Total	100	99.99

Table 21: Air Pollution Related Diseases Affecting People living around quarry sites.

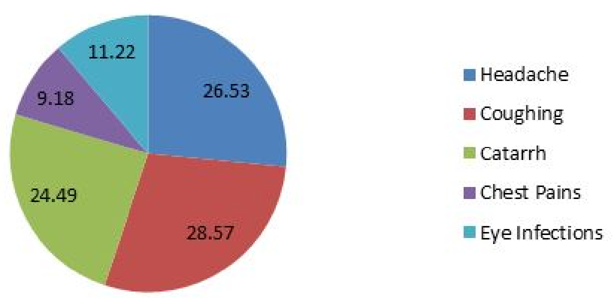

Figure 8: Air Pollution Related Diseases Affecting People living around quarry sites in Percentage.

Conclusions

The soil concentrations of the various metals showed a wide range of variation with patterns in the order: Zn>Cu>Pb>Cr>Ni>Cd>As>Hg. There was a decrease in the concentration of Pb, Ni, Cd, Zn, Cd, Cr and As metals with increase in distance from quarry site. All the heavy metals measured at every point around both quarry sites showed higher values than those of the background levels in a minimum of seven fold.

Geo-accumulation index (I_{geo}) rating indicated that all top soil samples analyzed ranged from practically uncontaminated to moderately contaminated for most heavy metals except for nickel which was extremely polluted within 200 m around the quarry sites and arsenic which were strongly polluted within 100 m around the quarry sites at A and B.

Contamination factor assessment implicated high level of contamination of the soil sample with lead at points X (100 m) and Y (200 m) for quarry site at A while points X and Y showed moderate degree of contamination for quarry site at B. The assessment of arsenic at point X indicated considerable level of contamination but other points (Y at A, X and Y at B) showed moderate degree of contamination. The degree of contamination for lead was moderate at points X and Y for both sites. Other heavy metals studied showed low degree of contamination at points X and Y for the both quarry sites.

The concentrations of the various metals also showed a wide range of variation in *Telfairia occidentalis* leaves with variable patterns in the order: Zn>Cu>Pb>Cr>Ni>Cd>As>Hg while *Amaranthus spinosus* leaves were in the order of Zn>Cu>Pb>Cr>Ni>Cd>As>Hg. All metals studied showed a decrease in concentration with increase in distance of the point of collection from the blasting and crushing areas.

The bioaccumulation factor (BF) of the eight heavy metals in *Amaranthus spinosus* and *Telfairia occidentalis* revealed that these vegetables around both sites were poor accumulators of Cu, Cr, Pb, Ni, Cd, As, Hg and Zn. The health risk assessment indices proved limited in predicting health risk as it assumed a body mass of 60 kg which does not apply to children whose body masses are far less than 60 kg. Comparing the health risk assessment parameters with standards from WHO, total agreement could not be obtained as some values beyond the allowable limit of the WHO standards were portrayed as safe level by the health risk assessment parameters. The daily intake of heavy metals ascribed to the consumption of the vegetables studied indicated low risk for humans as direct consumers.

References

1. Oketola AA, Osibanjo O (2007) Estimating sectorial pollution load in Lagos by industrial pollution projection system (IPPS). Sci Total Environ 377: 125-141.
2. Pickering KT, Owen LA (1997) Water resources and pollution. University of Cincinnati, New York.
3. Adeniyi AA, Yusuf KA, Okedeyi OO (2008) Assessment of the exposure of two fish species to metals pollution in the Ogun river catchments, Ketu, Lagos, Nigeria. Environ Monit Assess 137: 451-458.
4. Hamza SB, Habli S, Said NM, Bournot H, Le Palec G (2015) Simulation of pollutant dispersion of a free surface flow in coastal water. Ocean Engg 108: 81-97.
5. Harrop DO, Mumby K, Pepper B, Nolan J (1990) Heavy metal levels in the near vicinity to roads in a north London brough. Sci Total Environ 93: 543-546.
6. Chaulya SK, Chakraborty MK, Singh RS (2001) Air pollution modelling for a proposed limestone quarry. Water Air Soil Pollut 126: 171-191.
7. Agrawal J, Sherameti I, Varma A (2011) Detoxification of heavy metals: state of art. Springer, Berlin Heidelberg, Germany.
8. Langer WH, Drew LJ, Sachs JS (2004) Aggregates and the environment. American Geological Institute (US Geological Survey) Alexandria, American Geoological Institute in Cooperation.
9. Ugbogu OC, Ohakwe J, Foltescu V (2009) Occurrence of respiratory and skin problems among manual stone-quarrying workers. Afr J Respir Med 3: 23-26.
10. Allen SE, Grimshaw HM, Rowland AP (1986) Methods in Plant Ecology. Scientific Publication, Oxford, London.
11. Loska K, Wiechulła D, Korus I (2004) Metal contamination of farming soils affected by industry. Environment International 30: 159-165.
12. Thomilson DC, Wilson DJ, Harris CR, Jeffrey DW (1980) Problem in Heavy Metals in Estuaries and the Formation of Pollution Index. Helgol Wiss Meeresunlter 33: 566-575.
13. Akoto O, Ephraim JH, Darko G (2008) Heavy metal pollution in surface soils in the vicinity of abundant rail way servicing workshop in Kumasi, Ghana. Int J Environ Res 2: 359-364.
14. Gerba CP (2000) Environmental Microbiology. Elsevier, New york, USA.
15. Osakwe SA, Akpoveta OV, Okoh BE, Ize-Iyamu OK (2012) Chemical forms of heavy metals in soils around municipal waste dumpsites in Asaba Metropolis, Delta State, Nigeria. Chemical Speciat Bioavailab 24: 23-30.
16. Kramer PJ, Boyer JS (1995) Water relations of plants and soils. Academic Press, New york, United States.
17. Ndiokwere CL (2004) Chemistry and Environment. University of Benin Press.

18. Olusegun O, Adeniyi A, Adeola GT (2009) Impact of granite quarrying on the health of workers and nearby residents in Abeokuta Ogun State, Nigeria. Ethiop J Environ Stud Manag 2: 45-49.

19. WHO (2009) Global health risks: mortality and burden of disease attributable to selected major risks. World Health Organization.