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Full Length Research Paper

Analysis of heavy metals concentration in road sides soil in Yauri, Nigeria

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Assessment of seasonal variation in physiochemical properties and concentration of the heavy metals in road side soil in Yauri, was undertaking during the two major seasons of Nigeria. This was done to determine the environmental pollution status of the soil at the road side. Soil samples collected during the 2007/2008 rainy and dry seasons were treated and digested using microwave acid digestion methods. The heavy metal concentrations were determined with atomic absorption spectrophotometer. The mean levels range of As, Cd, Cr, Cu, Fe, Ni, Pb and Zn were 1.15 - 3.14, 0.14 - 7.0,1.64 - 22.36, 4.86 - 29.30, 2001 - 8091, 351.6 - 843.3, 35.9 - 306.7, and 79.6 - 202.4 µg/g for dry season and ND – 13.04 µg/g, ND - 7.02, ND - 13.79, 0.99 - 23.72, 748 - 6000, 201.13 - 507.10, 24.00 - 316.14 and 33.84 - 131.06 µg/g for wet season respectively. When metals concentrations in the soil of dry and wet seasons were correlated ($p < 0.05$) it was revealed that there were strong correlations between all the metals with the exception of Ni. Generally, higher mean heavy metal concentrations were recorded in the soil during the dry season than in wet season. The analytical results indicated that in both wet and dry seasons most of the heavy metals were above the natural heavy metals concentrations of surface soil which course for concern as these metals can accumulate to pollute the environment.

Key words: Pollution, heavy metals, Yauri, concentration.

INTRODUCTION

The dramatic increase in public awareness and concern about the state of the global and local environments which has occurred in recent decades has been accompanied and partly prompted by an ever growing body of evidence on the extent to which pollution has caused severe environmental degradation. The introduction of harmful substances into the environment has been shown to have many adverse effects on human health, agricultural productivity and natural ecosystems. Garbarino et al., (1995). Heavy metals is a general collective term which applies to the group of metals and metalloids with atomic density greater than 4 g/cm^3 or 5 times or more, greater than water (Nriagu and Pacyna, 1988; Hawkes, 1997). Their pollution of the environment, even at low levels and the resulting long - term cumulative health effects are among the leading health concerns all over the world (Huton and Symon, 1986; McCluggage, 1991).

The heavy metals are introduced into the environment through so many sources which include, decomposition of fossil fuels, smelting, glazing, electroplating e.t.c (Alloway and Ayres, 1997; Robert, 1997). Some heavy metals like As, Cd and Pb have been reported to have no known bio-importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic (EU, 2002; Nolan, 2003).

Soil is one of the repositories for anthropogenic wastes. Heavy metal contamination in the soils is a major concern because of their toxicity and threat to human life and the environment. To a small extent trace metals enter the body system through food, air and water and bio-accumulate over a period of time (Lenntech, 2004; UNEP/GPA, 2004). When agricultural soils are polluted,

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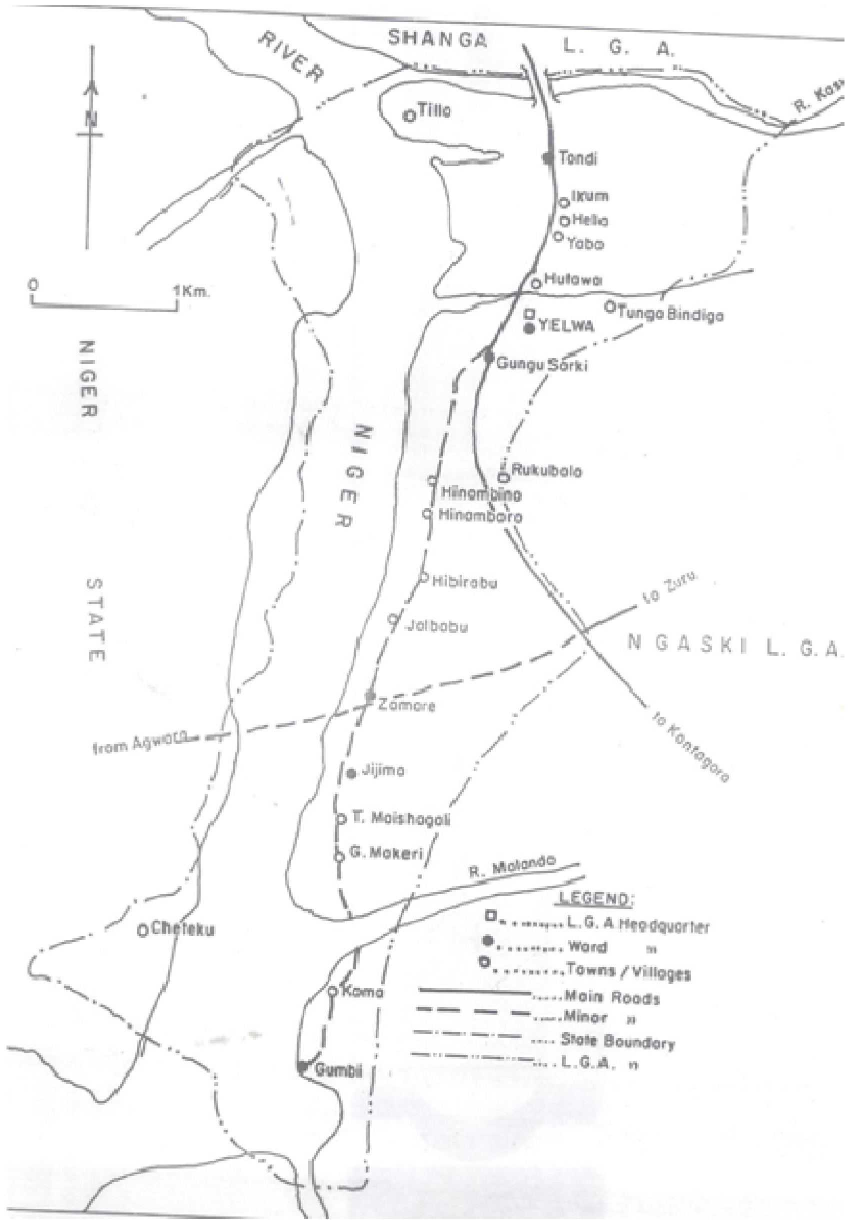

Figure 1. A map of Yauri Local Government Area, Kebbi State (study area).

these metals are taken up by plants and consequently accumulate in their tissues (Trueby, 2003). Animals that graze on such contaminated plants and drink from polluted waters, as well as marine lives that breed in heavy metal polluted waters also accumulate such metals in their tissues and milk if lactating (Horsfall and spiff, 1999; Peplow, 1999).

The situation is even more worrisome in the developing countries where research efforts towards monitoring the environment have not been given the desired attention by the stake holders, hence the need for the present study, which was carried out to determine the physiochemical properties and levels of heavy metals-As, Cd, Cr, Cu, Fe, Ni, Pb and Zn in road side soils in Yauri town and to assess if their levels are sufficient to pollute the soil.

METHODOLOGY

Study area

Yauri town in Yauri local government area of Kebbi state, Nigeria was the study area (Figure 1). It is located southward on the earthen bank of river Niger and falls within latitudes 10° N and 30° N and longitudes 3° W and 6° W of the globe. The area has flat topography with a few elevated areas. It is an extension of the Sokoto plain: dotted with some doom-shaped hills and complemented by a portion of the great river Niger and its numerous tributaries, which gently meanders on the landscape. Relative to its geographical location, the study area enjoys a tropical type of climate,

Table 1. Percentage recovery of heavy metals in road side soil.

Elements	Amount spiked ug/ml	Amount recovered (µg/ml)	Percentage recovery (%)
Cu	10	9.8	98
Cr	10	7.2	72
Fe	10	6.3	63
Zn	10	8.8	88
Pb	10	9.0	90
Ni	10	7.6	76

generally characterized by two extremes of temperatures (Adamu, 2000). The mean annual rainfall of the area is 1040 mm. The wet/ rainy season last for 5 - 6 months between April/May to October, with heaviest amount in August (Adefolalu, 2007). During the dry season temperature ranges from a minimum of 15 - 24°C in December/January to a maximum of 32 - 39°C in April/May.

Vegetation is that of typical northern Nigeria guinea savannah, which consist of an almost continuous grass cover of not less than one meter in height (Udu, 1991). Soil consist of well drained sand loam and clay loam soils on the Fadama site.

Sampling

Samples were obtained during the raining season of 2007 and in the dry season, 2008, around intersections involving round about, T-Junctions and freeways in Yauri town. At each sampling point about 2 kg of the road side soil were collected at surface level (0 - 10 cm in depth) at a distance of one metre away from the road and within an area of one square metre. A soil control sample at each point was also collected from a site about 500 m away from the sampling point bearing in mind that the distance from the road will make them to be less exposed to the pollutants. Three samples were collected in each point, thoroughly mixed in a clean plastic container to obtain a representative simple, crushed and sieved with 2 mm mesh before stored in labeled polythene bags prior to analysis.

Determination of pH and organic matter

The pH of the soil samples was determined with Orion Research Analog pH metre/model 30 L according to standard analytical methods. Organic matter was determined using the chromic acid oxidation method (Walkey and Black, 1934).

Sample preparation for heavy metals determination

0.500 - 1.00 g of thoroughly mixed soil samples was digested using 9 ml of concentrated $HN0_3$, 4 ml of concentrated Hydrofluoric Acid (HF) and 1 ml of concentrated HCl at 120 PSI for 20 min, in a CEM MDS-2000 digestion microwave oven US- Environmental Protection Agency 1995 (EPA method 3052). After the digestion, 2.0 g of boric acid was added to neutralize excess HF prior analysis. The samples were then filtered and diluted to 100 ml with deionized distilled water.

Atomic absorption analysis of samples

The digested samples were analyzed for heavy metals using Atomic Absorption Spectrophotometer, Alpha Star Model 4 (ChemTech Analytical) at the Centre for Energy Research and Development of the Obafemi Awolowo University, Ile-Ife, Nigeria.

Recovery work

Recovery work in order to ascertain the accuracy of the method/analytical procedure was carried out by spiking one gram each of the soil sample with one gram of Cu, Cr, Fe, Zn, Pb and Ni salts in separate beakers and digested.

Statistical analysis of data

For statistical analysis, one – way analysis of variance (SPSS for Windows v.13) was used to test the significance of differences in heavy metal accumulation between the different sampling points during the wet and dry seasons. Results were considered significant with $p < 0.05$.

RESULTS

The results or the quality control study for heavy metals of soils in the road sides using the conventional wet acid digestion method were obtained as percentage recoveries of Cu, Cr, Fe, Zn, Pb and Ni from spiked soil samples and are presented in Table 1. The percentage recoveries of these elements ranged from 63 to 98% which are high percent recoveries that implies the accuracy of the method/analytical procedure that was used in the analysis.

Soil properties during wet season determined in the present study are shown in Table 2. Soil pH of the road side soil is mostly neutral with higher organic matter while the soil pH for control showed similar pattern. This pattern was probably due to the presence of refuse dumps along most of the sampling sites that contain broken cement blocks, and broken ceramic materials that were the source of calcium carbonate ($CaCO_3$) buffer and also the rainfall event during the wet season which dilutes the soil solution the more thus leading to pH increase.

While in the dry season (Table 3), the soil pH is more acidic in both the sample and control with higher percentage of organic matter than in the wet season, this can be attributed to the bush burning practice by farmers and hunters during the dry season which produced a lot of organic ashes and other carbonic materials from burned

Table 2. Some physicochemical parameters in wet season.

Sample collection points	pH	pH (Control samples)	% Organic matter	% Organic matter (control samples)	Soil depth (cm)
SS_1	7.35	7.12	5.34	5.10	0-10
SS_2	7.65	7.33	5.45	4.81	0-10
SS_3	7.54	6.91	6.62	6.11	0-10
SS_4	7.30	6.86	5.81	5.55	0-10
SS_5	7.48	7.24	6.94	5.08	0-10
SS_6	7.14	7.47	4.87	4.10	0–10
SS_7	6.67	7.13	5.62	4.32	0-10
SS_8	6.89	6.90	5.01	4.62	0-10
SS_9	7.46	7.31	5.79	4.66	0-10
SS_{10}	7.55	7.19	5.88	4.16	0-10
SS_{11}	6.79	6.82	6.13	5.30	0-10
SS_{12}	7.60	7.12	6.44	5.94	0-10
SS_{13}	7.29	7.09	5.91	5.77	0-10

SS = Sample collection points.

Table 3. Some physicochemical properties of the roadsides soils during dry season.

Sample collection points	pH	pH (Control samples)	% Organic matter	% Organic matter (Control samples)	Soil depth (cm)
SS_1	6.52	6.10	6.17	6.02	0-10
SS_2	6.60	5.49	7.10	6.53	0-10
SS_3	7.03	6.30	7.42	6.78	0-10
SS_4	6.47	6.05	7.42	6.02	0-10
SS_5	7.01	6.53	7.28	7.01	0-10
SS_6	7.18	6.29	5.94	5.63	0-10
SS_7	6.34	6.08	5.94	5.81	0-10
SS_8	7.11	7.03	6.59	6.19	0-10
SS_9	6.82	6.14	7.08	6.71	0-10
SS_{10}	7.03	6.77	6.39	6.13	0-10
SS_{11}	6.93	6.40	7.08	6.84	0-10
SS_{12}	7.12	7.01	7.39	6.46	0-10
SS_{13}	7.05	6.89	6.87	6.50	0-10

SS = Sample collection points.

vegetation and animals, these materials are carried–away by the harmattan wind and deposited on the road side soil leading to reduction in pH even in the presence of the buffering effect. In addition the absence of rainfall in the dry season makes dilution of soil solution almost impossible, this also contributed to the increase in pH.

Tables 4 and 5 present the heavy metals concentrations in the road side soils sample and control in wet and dry season respectively. Except for As and Cd, the concentrations of metals in dry season were higher than those in the wet season. This might be due to the run off effect that is capable of removing heavy metals from the road side soil and the effect of rainfall which may facilitate the leaching of the soil and contributes to the dilution of soil solution during the wet season.

The concentration of Pb in the investigated samples ranges from 35.9 - 306.7 µg/g and 24.00 - 316.14 µg/g in the dry and wet seasons, respectively. Sample Collection Points, SS_1, SS_3, SS_4, SS_6, SS_7, SS_8, SS_9 and SS_{11} has the highest concentration in both season which may be due to deposition from automobile exhaust, garbage disposal, discarded batteries, filling stations, motor parks and other lead bearing materials. Cd, Cu, As and Zn concentrations in this study ranged as follows: ND - 7.02, 0.99 - 23.72 µg/g, ND - 13.04 and 33.84 - 131.06 µg/g during the wet season and 0.14-7.00, 14.86 - 29.30, 1.15 - 13.14 and 79.6 - 202.4 µg/g respectively in the dry season. The above heavy metals are among the wide

Table 4. Heavy metals concentration in the road side soil (µg/ml) during the wet season.

Sample collection points	As	Cd	Cr	Cu	Fe	Ni	Pb	Zn
SS_1	0.14 ± 0.2 (0.10 ± 1.3)	0.82 ± 1.0 (0.63 ±0.0)	ND (0.31 ± 0.2)	10.21 ± 0.1 (8.13 ± 2.1)	2040 ± 1.3 (1960 ±0.5)	365.5±0.2 (100 ±0.5)	50.60±1.6 (49.03±2.3)	52.13 ±1.7 (47.1 ± 2.0)
SS_2	0.53 ±0.4 (ND)	0.96 ± 1.1 (1.01 ±0.1)	2.34 ± 0.8 (1.32 ± 2.0)	23.72 ± 2.0 (16.3± 1.0)	748 ± 2.0 (890 ±0.4)	100.60 ±1.1 (85.51±0.3)	18.70±1.0 (10.18±2.0)	91.13 ±1.0 (67.5 ± 0.2)
SS_3	10.41 ±0.1 (9.10 ± 1.2)	5.06 ± 0.6 (4.11 ± 1.7)	5.18±3.1 (4.16± 1.1)	19.32 ± 1.3 (20.01±2.1)	4530 ± 3.1 (5000 ±1.0)	200.50±0.2 (198.31±2.0)	77.02±0.3 (53.13±1.0)	56.13 ± 1.3 (48.4 ± 0.6)
SS_4	9.80 ±2.0 (8.10 ±1.1)	7.02 ± 1.0 (6.43 ± 0.2)	3.04 ± 4.4 (2.70 ± 0.1)	16.06 ± 1.5 (14.1± 0.4)	3563 ±0.8 (3427±1.3)	253.51±1.3 (241.50±2.0)	66.73±0.9 (63.50±0.1)	84.26 ±2.7 (73.1 ± 0.5)
SS_5	ND (ND)	ND (0.16 ± 2.0)	10.01 ± 0.6 (8.14 ±3.1)	22. 22 ± 1.6 (20.31±0.2)	4038 ± 0.4 (4002 ±0.2)	116.15±2.4 (98.61±3.0)	31.61±1.3 (21.09±0.8)	101.06 ±2.1 (77.3 ± 0.9)
SS_6	4.02 ± 0.6 (3.17 ± 1.5)	4.13 ±0.2 (3.34 ± 1.1)	0.95 ± 0.4 (ND)	18.28 ± 0.6 (19.1± 0.8)	2951 ±0.6 (2990 ±1.0)	124.05±1.0 (101.80±3.0)	48.17±1.7 (33.26±2.0)	113.3 ± 1.5 (97.2 ±1.1)
SS_7	6.11 ± 1.2 (5.43 ±0.8)	0.92 ± 2.3 (0.68 ±0.6)	7.96 ± 2. 3 (5.10 ± 0.5)	15.65 ± 2.3 (11.3± 1.1)	748 ±2.3 (990 ±0.1)	175.15±1.4 (130.90±1.1)	56.55±1.4 (43.81±0.3)	122.07± 0.7 (103± 2.0)
SS_8	4.16 ± 1.6 (3.71 ±0.4)	1.07 ± 0.9 (1.00 ± 1.0)	4.13 ± 2.0 (3.06 ± 4.0)	0.99 ± 0.1 (1.02 ±1.3)	5038 ± 1.7 (4891± 0.4)	181.60±1.0 (185.40±2.3)	52.85±2.0 (34.68±0.1)	130.5 ±0.7 (114 ±2.1)
SS_9	2.03 ±1.7 (1.76 ± 2.0)	ND (ND)	11.40 ± 0.4 (9.16 ±1. 3)	19.75 ± 0.9 (16.1 ± 2.2)	2056 ± 1.3 (2100 ±2.3)	210.70±3.0 (196.05±1.0)	26.58±0.7 (19.51±1.1)	64.92 ±0.2 (50.1± 1.4)
SS_{10}	10.04 ± 0.2 (4.12 ±1.0)	0.63 ± 0.2 (ND)	13.79 ± 3.2 (11.68±1.5)	15.65 ± 3.0 (15.0± 0.2)	755 ± 0.9 (691 ± 0.1)	200.38±2.0 (186.65±1.7)	58.11±2.3 (38.27±1.2)	131.06± 3.1 (112.1±1.7)
SS_{11}	0.82 ±1.3 (ND)	1.13 ± 0.4 (0.87 ± 1.1)	0.86 ± 1.2 (0.72± 0.7)	23.6 ± 0.8 (20.1± 1.9)	863 ± 0.7 (872 ± 1.1)	172.52±1.1 (143.26±1.6)	44.07±1.4 (27.61±0.3)	89.11 ±0.6 (57.9 ± 1.3)
SS_{12}	0.64 ±1.4 (ND)	ND (0.04 ±0.1)	0.59 ±0.4 (ND)	16.40 ± 1.7 (13.5 ±3.0)	6000 ±1.0 (5632 ±2.3)	166.15±1.3 (136.01±3.0)	19.62±0.2 (15.07±2.3)	33.84 ± 0.2 (30.2± 1.6)
SS_{13}	1.35 ±0.3 (1.02 ±2.6)	0.54 ± 0.5 (0.43 ± 2.1)	1.20 ± 0.1 (ND)	17. 52 ±0.4 (15.1± 1.0)	5160 ± 0.1 (4893 ±2.3)	137.50±1.0 (95.11±1.5)	12.00±1.00 (9.59±0.2)	43.20±0.6 (35.1± 0.5)
*Elemental concentration of a typical Soil	7.2	0.35	54	25	26000	19	19	60

*Source: Brady (1984).

the wide range of heavy metals found in fossil fuels, which are either emitted into the environment as particles during combustion or accumulate in ash, which may itself be transported in air and contaminate soils.

In this study Ni ranged from 201.13 to 507.10 µg/g in the wet season and from 351.6 to 843.3 µg/g during the dry season. Plants appear to be more sensitive to nickel toxicity than animals. Generally the high concentrations obtained for Ni in both sample; soil and control for wet and dry seasons compared with those of the typical soil concentration (Table 4) may be due to deposition of sewage sludge, dispose car batteries, pigments and paints, poultry waste and fossil fuel combustion. This high concentration level of Nickel will end up in the soil as sink when they are leached into the soil and can dissolve in soil water and in rivers as

Table 5. Heavy metals concentration in the road side soil (µg/g) during the dry season.

Sample collection points	As	Cd	Cr	Cu	Fe	Ni	Pb	Zn
SS_1	12.07 ±1.5	1.07 ±0.3	1.64 ± 0.3	19.12 ±1.3	3513 ± 0.4	420.9 ± 2.0	202.3 ± 0.1	95.6 ± 0.7
	(10.13 ± 0.3)	(0.96 ±1.2)	(0.92 ± 1.5)	(14.05 ± 0.1)	(3061 ± 1.2)	(368.1 ± 1.0)	(200.1 ± 2.3)	(93.4 ± 0.3)
SS_2	3.46 ±1.0	1.13 ± 1.1	6.01 ±1.2	26.21 ± 1.6	2819 ± 0.3	453.7 ± 1.6	84.9 ±0.6	109. 8 ± 1.6
	(2.92 ±0.5)	(0.69 ±0.3)	(4.20 ±0.1)	(20.11 ± 0.1)	(1960 ± 0.1)	(461.3 ± 0.2)	(40.3 ± 0.0)	(94.5 ± 1.4)
SS_3	13.14 ± 0.7	7.00 ± 1.2	9.21 ±0.8	24.01 ± 3.0	6481 ±1.6	600.7 ± 0.6	306.7 ± 1.0	79.6 ± 0.8
	(10.12 ± 2.0)	(5.13 ± 0.9)	(5.10 ±1.0)	(21.72 ±0.1)	(5010±0.3)	(512.9 ± 1.3)	(302.4 ±2.0)	(72.3 ± 1.0)
SS_4	11.13 ± 3.0	0.14 ± 0.1	10.13 ±0.6	24.01 ± 3.0	5356 ± 1.4	692.4 ± 2.1	301.9 ±1.1	103.8 ± 1.2
	(7.94 ± 0.9)	(0.92 ±1.8)	(5.14 ±1.2)	(16.31 ±0.7)	(4792 ± 0.1)	(600.1± 3.0)	(300.2 ± 1.3)	(100.3 ± 0.1)
SS_5	6.21 ±0.2	2.03 ± 0.4	16.17 ±2.3	20.04 ± 1.2	7093 ± 2.3	394.6 ± 3.6	35.9 ± 0.2	133.0 ±0.5
	(3.82 ± 1.3)	(1.06 ±1.5)	(11.13 ±1.7)	(23.06 ± 0.1)	(6989 ±1.6)	(401.2 ± 1.2)	(34.1 ±1.0)	(126.4 ± 1.6)
SS_6	7.10 ± 1.5	6.06 ±0.2	4.82 ±0.2	24.38 ±1.2	4992 ± 0.4	351.6 ± 0.1	149.5 ± 0.9	200.1 ± 1.3
	(5.04 ± 0.2)	(2.84 ± 2.0)	(2.06 ±1.3)	(20.10 ±0.4)	(3236 ±0.1)	320.7 ± 0.3	(136.7 ±2.1)	(192.0 ± 2.1)
SS_7	8.03 ± 2.1	1.03 ± 2.0	13.28 ±2.0	21.91 ± 0.3	2001 ± 0.2	720.3 ± 0.4	199.2 ± 0.3	198.4 ± 1.0
	(6.14 ± 0.9)	(1.00 ± 1.3)	(7.11 ± 0.4)	(17.12 ± 1.0)	(1633 ±1.0)	(689.7 ± 0.8)	(186.5 ±1.4)	(160.3 ± 0.2)
SS_8	6.86 ± 0.0	2.00 ± 0.6	18.07 ±3.2	14.86 ±1.3	7006 ± 1.5	650.3 ± 2.1	175.8 ± 0.7	202.4 ± 0.9
	(5.01 ± 1.1)	(1.83 ± 1.5)	(12.61 ± 2.1)	(10.13 ± 0.1)	(5928 ±1.6)	(600.1 ±1.0)	(169.1 ±0.4)	(200.6 ± 1.1)
SS_9	5.07 ± 1.3	0.86 ± 1.0	20.52 ±3.4	26.20 ± 1.4	4071 ± 1.0	843.3 ± 0.7	84.9 ± 0.6	98.7 ± 0.8
	(3.13 ±2.0)	(0.52 ± 2.4)	(14.13 ±1.0)	(19.38 ±0.2)	(3630 ± 1.3)	(796. ± 1.6)	(80.3 ± 0.2)	(90.3 ± 1.0)
SS_{10}	13.06 ± 1.3	1.02 ± 0.7	22.36 ±3.0	18.96 ±0.3	8091 ± 1.9	801.7 ± 3.0	183.5 ± 3.0	105.3 ± 1.8
	(6.38 ± 0.8)	(0.93 ±1.8)	(13.62 ±1.2)	(16.13 ±0.1)	(7023 ±6.0)	(794.3 ±1.4)	(180.4 ± 1.2)	(97.4 ± 0.9)
SS_{11}	1.15 ± 0.6	1.53 ± 2.5	9.73 ±2.1	29.30 ± 0.4	2134 ±1.3	690.1 ±0.1	101. 6 ± 1.3	126.5 ± 1.7
	(0.93 ±1.1))	(1.04 ± 1.4)	(6.24 ±0.3)	(22.14 ± 0.7)	(1196 ±1.2)	(700.5 ± 1.7)	(97.4 ±1.0)	(120.3 ±0.3)
SS_{12}	2.45 ± 4.0	0.86 ±1.5	8.75 ± 3.1	23.05 ± 0.2	6096 ± 0.4	689.3 ± 1.0	46.8 ± 2.0	81.6 ± 1.0
	(1.64 ±0.2)	(0.40 ±1.0)	(5.93 ±0.7)	(16.40 ± 0.5)	(5213 ±2.0)	(644.7 ± 0.4)	(45.2 ±1.1)	(72.5 ± 1.1)
SS_{13}	2.61 ± 1.4	1.01 ±4.0	10.34 ± 1.6	25.11 ±1.3	7072 ± 2.3	551.6 ±0.7	69.3 ± 0.2	91.3 ±0.2
	(11.50 ± 3.0)	(0.69 ± 2.1)	(8.21 ± 0.4)	(22.20 ± 0.2)	(5439 ±3.0)	(508.9 ±1.3)	(61.2 ±1.0)	(84.9 ± 0.4)

SS_1 = Low Cost housing Junction. SS_2 = Nepa Junction SS3 = Tashar Garkuwa SS_4 = Central Garage SS_5 = Nitel Junction SS6 = Go slow Junction SS_7 = Liberia Junction SS8 = Market Roundabout SS9 = Police Station Junction SS_{10} = Central Market Road SS_{11} = Yauri Kontagora Road SS_{12} = Tondi Gada SS13 =Governor's Lodge Junction.

Table 6. Correlation of metals between wet and dry seasons.

Elements	As	Cd	Cr	Cu	Fe	Ni	Pb	Zn
Correlation	0.71	0.46	0.86	0.75	0.56	0.23	0.87	0.66

P < 0.05 level.

a result of run off during wet season. According to Tables 4 and 5, Cr ranges are ND- 13.79 µg/g in the wet season and 1.64 - 22.36 µg/g in the dry season. These concentrations can be as a result of dumping of chromate wastes, such as those from tanneries or electroplating and from sewage sludge disposal on land.

Although Fe is not classified as a toxic metal, its concentrations and chemical form can influence the speciation of Pb and hence its toxicity. In this study it ranges from 748 - 6000 ug/g in the wet season and 2001 - 8091 ug/g in the dry season. Yauri town in Kebbi State of Nigeria is not industrialized, however, like most of the towns and cities in Nigeria it is traffic-laden due to congested traffic (especially during market days), poor road conditions and outdated automotive technology contributed to the increase in vehicular emissions which could be deposited along the road and thereby accumulate to pollute the environment.

DISUCSSION

Undesirable and unnatural concentrations of Lead are found in air, water, soil and vegetation, particularly near smelters and heavily played automobile free ways (Fuller, 1997; Habashi, 1992). These results also supported Fergusson's (1990) claimed that Pb- containing particles in motor vehicle exhausts tend to be larger in rural areas and near motorways than in urban areas. Zinc can decrease the carcinogenicity and toxicity of cadmium (Coogan et al., 1992; Brzoska et al., 2001), possibly through decreased Cadmium absorption or alterations in metallothionein levels. Toxic levels of cadmium may inhibit zinc absorption (Lonnerdal, 2000; Fosmire, 1990). Studies conducted in isolated cells or membranes from kidney proximal tubule or small intestine indicate that zinc and cadmium may share common transport and/or binding mechanisms in transporting epithelia (Tacnet et al., 1990, 1991; Prasad et al; 1996; Endo et al., 1997). Natural concentration of Nickel in soil is less than 100 mg/mg though it can be exceptionally high in some cases especially the soil formed from ultra basic rocks (Allen et al., 1974). Nickel can be extremely toxic to man even at low concentrations in domestic water supply when consumed (Stoeppler, 1991; Gauglhofer and Bianchi, 1991), it has as well been shown to have mutagenic, carcinogenic and teratogenic effects. (Frieberg et al., 1896; Fishbein, 1987) Soils developed on ultramafic rocks, such as serpentinites, can contain very high concentrations of chromium of geochemical origin and cannot be considered polluted but either naturally or geo-chemically enriched. Soluble chromate concentrations of 0.5 µg/ml have been shown to be significant (Alloway and Agres, 1997). Fe and Mn normally act as metal scavengers, due to their tendency to form colloidal particulate hydrous oxides (Stumn and Morgan, 1971; Mill, 1980) which have strong adsorption affinities for certain metals like Pd and Cd (Gadde and Laitinen, 1974; Holum, 1983).

The heavy metals concentrations in soil sample are mostly higher than those in the soil for control. That is to say heavy metals concentration decreases with distance from the road due to metals emitted from vehicle exhaust and other sources. Generally, higher mean heavy metal concentrations were recorded in the soil during the dry season than in wet season as illustrated in Table 6. In the wet season, soil samples metal concentration Cd has the least concentration of 7.02 µg/g while Fe has the highest concentration of 6000 µg/g. For the dry season samples soil metal concentration also Cd has the least concen-tration of 7.00µg/g while Fe has the highest concentration of 8091 µg/g. As, Cd, Ni, Pb and Zn concentrations levels in this study were above the background levels range for farming (Brady, 1984) in both wet and dry seasons. While levels of Cr and Fe are below the background levels in all the seasons. Cu concentrations were below the back-ground levels in the wet season but are above during the dry season.

When heavy metals concentration range obtained from this study were compared with the levels in similar studies elsewhere (Table 7) As and Cd values are higher than findings in US, Poland, India and Ethiopia. Cr values are lower than findings in US, China, Poland, India and Ethiopia. Cu is lower in all the compared countries with the exception of Poland. Fe and Ni have higher values than from all the compared findings from these countries with the exception of India. In this study Pb values are greater than that of China and Poland but less in the other countries. Likewise Zn values are greater than findings in US and China but less than of other countries.

Statistical analysis revealed that there was strong correlations (at $p < 0.05$ level) between metals concen-tration in soil of dry seasons that is As($r = 0.6$), Cd($r = 0.9$), Cr($r = 0.9$), Cu($r = 0.7$), Fe($r = 0.9$), Ni($r = 0.9$), Pb($r = 1.0$) and Zn($r = 0.9$) and their controls. Similar pattern was found in wet season's soil that is As($r = 0.9$), Cd($r = 1.0$), Cr($r = 1.0$), Cu($r = 0.9$), Fe($r = 1.0$), Ni($r = 0.4$), Pb($r = 0.9$) and Zn($r = 0.9$) with their controls, Ni being the only exception. Also when metals concentration in the soil of dry and wet seasons were correlated [As($r = 0.7$),

Table 7. Comparison of heavy metal concentration range in soil analyzed in this study with the levels in similar studies elsewhere (µg/g).

Metal	This study	U.S soil [a]	China Soil [b]	Poland soil [c]	India soil [d]	Ethiopia soil [e]
As	ND - 13-04	1.05 - 25.9	2.52 - 33.6	0.8 - 9.1	NA	N
Cd	ND - 7.02	NA	0.02 - 0.33	0.1 - 1.7	NA	0.12 - 1.61
Cr	ND - 13.79	6.59 - 208	19.3 -150	3.7 - 75.3	ND - 145.45	86.3 - 15790
Cu	0.99 - 23.72	2.86 -101	7.26 - 55.1	2.0 - 18.0	5.34 - 198.23	23.7 - 93.0
Fe	748 - 6000	NA	NA	NA	676 - 16234	NA
Ni	351- 843.3	2.44 - 69.4	7.73 - 70.9	2.0 - 27.0	343 - 1409	47.3 - 200.6
Pb	35.9 - 484.9	4.62 - 554	9.95 - 56.0	7.1 - 50.1	ND - 623.95	20.3 - 325.4
Zn	79.6 - 202.4	12.6 -183	28.5 -161	10.5 - 1547	ND	140.9 - 302.8

A = Shacklette and Boerngen (1984), b = Bradford et al. (1996), c = Dudka (1992), d = Abida et al. (2009), e = Melaku et al. (2005), ND = not detected, NA = not available.

Cd(r = 0.5), Cr(r = 0.9), Cu(r = 0.8), Fe(r = 0.6), Ni(r = 0.2), Pb(r = 0.9) and Zn(r = 0.7)] it was revealed that there were strong correlation between all the metals with the exception of Ni. According to Fifield and Haines (2000), natural heavy metals concentration of surface soils in ug/g are As = 2.5, Cd = 0.25, Cr = 60, Cu = 15, Fe = 5%, Ni = 20, Pb = 20 and Zn = 60. Comparing these values with both the dry and wet seasons' values obtained in this study, Cr and Fe were below the standard surface soil concentration while As, Cd, Cu, Ni, Pb and Zn were higher. Since soils are considered as sink for heavy metals and run offs can dissolve and washed away these metals, there is the possibility of transporting these dissolved metals into river Niger, which the inhabitants of Yauri town depends on for drinking and domestic water supply and can lead to increase in the rate at which the heavy metals can pass to populace.

Conclusion

Physiochemical properties and levels of heavy metals-As, Cd, Cr, Cu, Fe, Ni, Pb and Zn in road side soils in Yauri town, Nigeria were determine in this study. Heavy metals concentrations in soil sample are mostly higher than those in the soil for control. That is to say heavy metals concentration decreases with distance from the road due to metals emitted from vehicle exhaust and other sources. Generally, higher mean heavy metal concentrations were recorded in the soil during the dry season than in wet season. The analytical results indicated that in both wet and dry seasons most of the heavy metals were above the natural heavy metals concentration of surface soil which course for concern as these metals can accumulate to pollute the environment.

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