Malaysian Journal of Applied Sciences 2017, **Vol 2(2)**: 1-9

eISSN 0127-9246 (Online)

Malaysian Journal of Applied Sciences

ORIGINAL ARTICLE

Temporal Variation and Pollution Levels of Some Heavy Metals on Irrigated Land Along the Airport Road Kano State, Nigeria

**** Sadiq Mukhtar [a,b], Mansur Abdul Mohammed [b] and Rosniza Aznie CR [a]***

[a] Social, Environmental and Developmental Sustainability Research Centre, (SEEDS) FSSK, National University of Malaysia (UKM), Malaysia
[b] Department of Geography, Faculty of Earth & Environmental Sciences (FEES), Bayero University, Kano, Nigeria

*Corresponding author: smukhtar.goeg@buk.edu.ng

Received: 26/11/2017, Accepted: 24/12/2017

Abstract

This paper is aimed to evaluate the concentration of some heavy metals in order to assess the temporal variation, Contamination Factor (CF) and Pollution Load Index (PLI) in the soil along the airport road of Kano State. Soil samples were collected during 2009 and 2015 using the composite sampling techniques. 10 samples were collected in each period and then analysed using the standard laboratory procedures. The findings revealed that the mean values of Mn (52±7.2), Fe (281±19.4) and Cd (3.0±0.3) were found to be higher in 2009 soil samples. The mean value of Cu (100±16.3), Zn (161±47.7), Cr (20.8±1.5), Ni (53.9±9.7) and pH (9.0±0.56) were found to be higher in 2015 soil samples. The CF value shows that the collected soils of the sampling area have low contamination level and moderately contaminated with Cd. The soils samples also have been classified as low pollution level according to the PLI. The finding has concluded that there is gradual accumulation of Cu, Zn, Cr and Ni with reduction in Mn, Fe and Cd. The collected soils have low contamination level with selected heavy metal except Cd that moderately contaminates the soil of the area according to contamination factor. The PLI values of the heavy metals during 2009 and 2015 are 0.0006 and 0.02 respectively, indicating the increases in pollution load from 2009 to 2015 in the study area. Proper soil management such as the increase of pH and organic matter as well as the avoidance of using contaminated water for irrigation were recommended in the sampling area.

Keywords: Irrigated soil; heavy metals; contamination factor; pollution load index; Kano State.

Introduction

The disposal of domestic and industrial waste is a serious problem which has been increasing drastically throughout the world. The irrigated land along Malam Aminu Kano International Airport Kano (MAKIA) consumed a mammoth amount of waste that are generated mainly from Kano city abattoir, SabonGari and Brigade quarters of the Kano metropolitan city, likewise from the heavy traffic flow on the airport road and Bompai industrial area which are also discharged into the stream. The effluent/waste water proved useful and used for irrigation agriculture due to the scarcity of fresh water resources for that purpose in the area. Besides being useful sources of soil nutrient, these effluents often contain high amount of various organic and inorganic materials as well as toxic heavy metals (Dawaki and Adamu, 2010). However, these may accumulate in the soil in excessive quantities over a long period of time. Subsequently, these toxic heavy metals may have a detrimental effect on the environment such as the contamination of surface and ground water as well as soil which would interfere with key biochemical processes in the soil such as the decomposition of organic materials, mineralization, nutrient cycling and detoxification of noxious chemicals which affect the capacity of soil to provide ecosystem services and cause health problem to human being and animals by entering the food chain.

Pollution is one of the most serious problems around the world in which millions of world inhabitants suffer health problems related to industrial and atmospheric pollutants (Frac and Stefania 2011; Paul, 2008). In recent years, there have been significant attentions to the problems of environmental contamination by a wide variety of chemical pollutants including heavy metals, which are good indicators of contamination in soils (Popoola et al., 2012). Heavy metals enter into the environment from both natural and anthropogenic sources such as processing industries and incomplete combustion of burning fuel (Akporida and Asagba, 2013; Duffus, 2002). Manufacturing and distribution of products such as batteries, perfumes, soap, deodorant, metals scrap, textile, plastics and garbage have resulted in the generation of a gigantic volume of waste. The composition of these wastes is an important source of environmental pollution, contributing to the heavy metal load in soil (Haliru et al., 2014). All heavy metals are toxic in soil concentrations above the normal level. Heavy metal utilization in the biosphere by human activities has become an important process in the geochemical cycling of these metals (Chen et al., 2005). This is evident in the industrial areas where stationary and moveable sources released large quantities of heavy metals into the atmosphere, soil and vegetation that exceed the natural emission levels (Olukanmi and Adeoye, 2012).

Pollution in relation to soil is concerned with the presence of heavy metals in the soils. The metals are considered heavy when their density is greater than 6 or 5 mg/m^{-3} (Lal, 2006; Wild, 1996). Raju et al. (2013) adduced that in recent years, with the development of global economy, both the types and contents of heavy metals in the soil that are caused by human activities have gradually increased in the environment resulting to its deterioration. The contamination of soils by heavy metals is a significant problem that leads to negative influence on soil properties and limits its productive and environmental functions. The accumulation of heavy metals in the soil results in its bioaccumulation in edible parts of vegetables, which represents a direct pathway for their integration into the human food chain (Chiroma et al., 2014).

Soil serves as a medium through which plant grow, living organisms and their ecosystem also depends on soil resources directly or indirectly for their survival (Brady and Weil, 1999; Hall, 2008). Soil also acts as a key component of natural ecosystems. Indeed, environmental sustainability largely depends on sustainable soil ecosystem and any alteration as a result of either pollution or contamination ultimately alters the soil ecosystems and thus greatly affects agricultural activities (Ayeni et al., 2010). Heavy metal pollution in soil indicates that the water bodies (surface and groundwater) around the area may possibly as well be polluted with heavy metals due to continuous interactions between soil and water.

This situation is even more worrisome in Kano metropolis where research efforts on the soil heavy metals is limited. There is desirable attention on the assessment of the effect of heavy metals on pollution level and on continuous bases as a means of monitoring the status of the environment for the good of the soil ecosystem which is very crucial in Kano metropolis due to the limited data in that specific area. In order to achieve environmental sustainability, this research was set out to generate the soil database on the heavy metals concentration on irrigated land along Airport road in Kano State, Nigeria. The primary objectives of the research are to evaluate the level of some selected heavy metals, assess the temporal variation of heavy metals, and evaluate the contamination factor and pollution level of the selected heavy metals. Heavy metals are considered as serious pollutants because of their toxicity, persistent and non-degradable behaviours in the environment (Mohiuddin et al., 2010).

Materials and Methods

Description of the Study Area

The study area is located in north-eastern part of Kano city. It lies between latitude 12˚10ˈN to 12˚12ˈN and longitude 8˚33ˈE to 8˚35ˈE. The area is located in Fagge Local Government Area of Kano state with grown crops such as lettuce, carrot, onion and garden eggs, which are normally consumed raw (Mohammed, 2010). The climate of the area is tropical wet and dry type, coded AW by W. Koppen classification (Adamu, 2014; Ayoade, 1983). The area receives an annual rainfall of about 800mm and there is a great temporal variation in the amount of rainfall received in the area (Adamu, 2014; Olofin, 1987). The geology of the study areas fall within the basement complex rocks and the landform consist of little granitic and few lateral outcrop. The parent materials have great influence in the soil formation of the area and the soil type is ferruginous tropical soils type. According to Food and Agricultural Organization (FAO, 1991) this is equivalent to nitrosols, whilst according to United State Department of Agriculture (USDA, 1987) it is equivalent to Ultisol and Alfisol. Variety of hydromorphic soil, befalls in depression on the lower terrace and abandoned parts of the channels that are referred locally to as fadama soils as observed along the rivers in the study areas (Mohammed, 2004).

Materials

The materials used in this research include Global Positioning System (GPS) for recording the coordinate of sampling points. Soil auger and spade for soil samples collection, polythene bags for storing soil samples collected, marker for labelling the samples and pH meter to determine the soil pH. The Atomic Absorption Spectrophotometer (AAS, 210 VGP American Model) were used to measure the concentration of heavy metals in the soil and it was selected because of its sensitivity, reliability, affordability, versatility, accuracy and precision (Khamms et al., 2009).

Sampling Techniques

A reconnaissance survey was conducted for familiarization of the study area and spontaneous observation of the farming patterns. Irrigational water sources, methods of watering and cropping pattern were observed. One square kilometre ($1km^2$) of irrigated land was selected randomly. Google earth map of the area was used as a base map whereby 100 small square grids of 100 x 100 meters was made and superimposed on the one square kilometre base map. Ten small squares were then selected using systematic sampling techniques and marked as sampling points. GPS was used to identify the actual ground sampling points that are marked on the base map. Soil auger and spade were used to collect the surface soil samples with a depth of 0 - 15 cm.Ten samples were collected each for the two different periods 2009 and 2015. The soil samples were collected using composite soil sampling techniques because the soil unit is homogeneous in term of soil forming factors, geology, soil management practice and topography. Various soil samples were collected randomly from different points within the same grid-square (bulk sample), the samples collected were mixed, shaken vigorously and a sub-sample (composite sample) of about half a kilogram was then taken. The collected samples were placed in polythene bags, labelled appropriately, air dried and then taken to the laboratory for further analysis.

Laboratory Analysis of Heavy Metals and pH in the soil samples

The soil sample was digested through wet digestion method as described by Anderson (1974). 10 g of soil was weight in 300 ml calibrated digestion tube. 5 ml of concentrated sulphuric acid

(H_2SO_4) was added into the samples in the fume hood, swirled and then placed in the block-digester. Gradually, the temperature setting was increased from 60 ˚C to 145 ˚C for one hour. 5 ml of tri-acid mixtures (HNO_3, H_2SO_4 and HCL) were then added and heated to 240 ˚C, then allowed to cool, filtered through Whitman No. 42 filter papers and stored in pre-cleaned polythene bottles for further analysis. The Atomic Absorption Spectrophotometer (210 VGP, American Model) was set up at a wavelength for each analysis. The flame was switched on and stabilized for 10 minutes. The digested and filtered samples were aspirated and the results were dispensed on the read out unit of atomic absorption spectrophotometer.

Calculations

$$\text{Concentration of heavy metal (mg/kg)} = \frac{\frac{X}{Y} \text{ X V.F X100}}{\text{1000 X W.T}} \quad (1)$$

Where x is the absorbance, y is the slope, V.F is equal to 100 and 10 g is the weight of the soil sample. For the determination of soil pH, 10 g of soil sample was placed in a 50 ml beaker, 25 ml of 1.0 (N) KCl was added and suspension was stirred for one hour. pH was measured with the glass electrode by immersing it into the suspension. The pH meter was switched on for at least 15 minutes for the pH meter to warm up and standardized the glass electrode. The standard buffer wasused and the test solution temperature was adjusted. The electrode was rinsed with distilled water after each determination and a blotting paper was used to clean up its surface. The standardization process was checked after every ten determinations.

Statistical Analysis

Dunken t-test was used to evaluate the statistical differences of each heavy metals concentration among the mean of two periods (2009 and 2015).The soil pollution was assessed using Contamination Factor (CF) and Pollution Load Index (PLI). CF is the ratio of the metal concentration in a contaminated soil sample and the maximum allowable limit value of the metal (Diatta et al., 2003).

$$CF = \frac{Cn}{Cr} \quad (2)$$

Where CF is the Contamination Factors, Cn is the concentration of heavy metal in the soil and Cr is the background level (maximum allowable limit was used). However, CF<1 indicates low contamination, 1≤CF<3 indicates the moderate contamination, 3≤CF≤6 indicates high contamination and CF>6 severe contamination. PLI was used to evaluate the pollution load of each selected heavy metal.

$$\text{PLI} = \sqrt{\text{CF1} \times \text{CF2} \times \text{CF3} \times \text{CF4} \times \ldots\ldots\ldots\ldots \times \text{CFn}} \quad (3)$$

Where PLI is the Pollution Load Index, n is the number of heavy metals under investigation. However, PLI can be interpreted as PLI < 1 indicating the absence of contamination, PLI = 1 indicating low contamination and PLI > 1 indicating high contamination.

Results and Discussion

The mean values and standard deviation of heavy metals in the irrigated soil of the study area (Table 1) shows spatial variation in the concentration of each individual heavy metals. This indicates that some heavy metals were found abundantly in nature like Mn, Cu, Fe, Cu and Ni because of their concentration is found to be higher due to the geological composition of the soil in the area. In the meantime Cd and Zn others have low mean concentration. The heavy metals spatial variation in the study area is probably attributed to the fact that the concentration of heavy metals in soilthe varies because some are relatively abundant in nature.Some of the metals are geologically rare, waste discharged and can be toxic even at low concentration such as Cd (Lal, 2006). This is contended by Abdu, Abdulkadir, Agbenin and Andreas (2010) that some heavy metals like Cd, Fe and Mn are dominated in bio sewage sludge.

Table 1. Concentration of heavy metal in 2009 & 2015 (n = 10)

Heavy metal (mg/kg)	2009		2015	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Mn	52.00	7.20	49.90	4.30
Fe	281.00	19.40	86.00	13.70
Cu	4.70	0.55	100.00	16.30
Zn	78.60	6.30	161.00	47.70
Cd	3.00	0.30	2.90	0.87
Cr	2.60	0.50	20.80	1.50
Ni	7.60	4.00	55.90	9.70
pH (Kcl_2)	6.30	0.20	9.00	0.56

The mean concentration values and standard deviation of some selected heavy metals in the study area during 2009 and 2015 (Table 1) shows that the mean values of Mn, Fe, Cu, Zn and Cd were found to be higher in 2009 compared to 2015.The mean values of Cr, Ni and pH were found to be higher in 2015 compared to 2009. This is probably attributed to the pH condition of the sampling area because of the high pH reduces the availability and solubility of heavy metals in the soil.

The mean values of Ni, Zn, Cr and Cu obtained in 2009 were found to be lower than the mean values obtained by Idodo-Umeh and Egbeibu (2010); Bichi and Bello (2013).This implies that there is gradual accumulation of these heavy metals from 2009 to 2015 in the study area, since Ni, Zn, Cr and Cu were found to be higher in 2015. Figure 1 shows the temporal variation in the mean concentration of heavy metal between 2009 and 2015. Cu, Zn, Cr and Ni were found to be higher in 2015 than that of 2009 It shows that there is a gradual increase of Cu, Zn, Cr and Ni in the study area, while Mn, Fe and Cd were found to be lower in 2009 than 2015 due to gradual reduction in their values.

The variation of heavy metals in the period 2009 and 2015 is probably due to the influence of pH variation towards the heavy metals the solubility, availability and mobility in the soil. High mean values of Mn, Fe, Cu, Zn and Cd in 2009 indicates that, there is reduction of these heavy metals in the soil, attributed to the high pH, leaching, runoff and redox reaction which are capable of removing heavy metals from subsurface soil. The t-test analyses (Table 2) shows the temporal variation of the mean concentration values of heavy metal between 2009 and 2015.There is no significant difference in the mean values of Mn and Cd in the two periods at $p < 0.05$, while there is a significant difference in the mean values of Fe, Cu, Zn, Cr, Ni and pH.

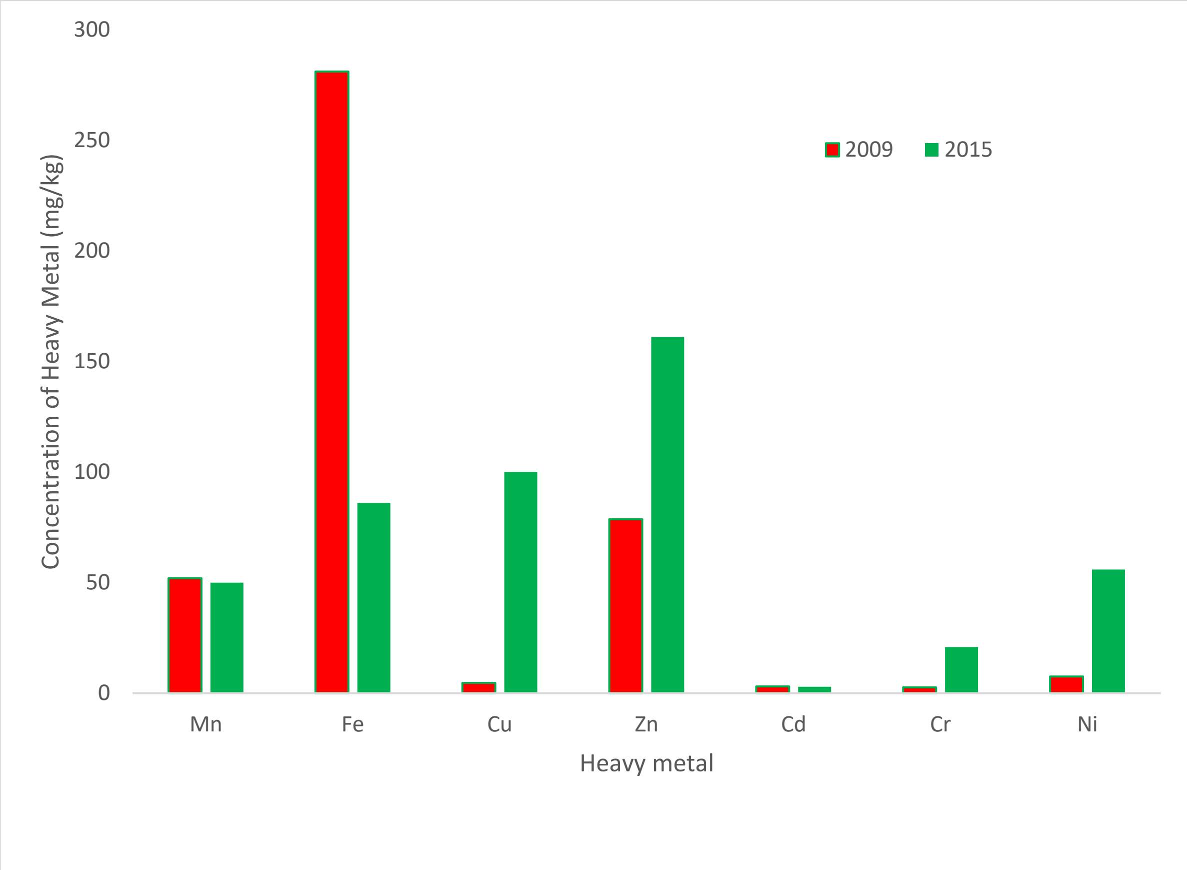

Figure 1. Concentration of heavy metals in 2009 & 2015

Table 2. Temporal variation of heavy metals in the study area

Heavy Metals	std err	t-stat	p-value	t-crit	Lower	Upper	sig	effect r
Mn	3.17	0.67	0.515	2.18	-9.04	4.79	No	0.19
Fe	8.96	21.79	5.11E	2.18	-214.90	-175.83	Yes	0.99
Cu	6.17	15.45	2.78E	2.18	81.85	108.73	Yes	0.98
Zn	18.19	4.56	9.57E	2.18	43.28	122.53	Yes	0.80
Cd	0.35	0.02	0.98	2.18	-0.77	0.75	No	0.01
Cr	0.60	30.53	9.57E	2.18	16.90	19.49	Yes	0.99
Ni	3.96	12.21	3.98E	2.18	39.68	56.91	Yes	0.96
pH	0.22	12.93	2.1E	2.18	2.35	3.31	Yes	0.97

Table 3 shows that, the collected soil sample during 2009 have low CF for Cd, Ni, Cu, Mn, Cr, Zn and Fe. The order of CF value for collected samples decreasing as follows: Cd<Ni<Cu<Zn<Mn<Cr<Fe. However, Cd and Ni have high CF value, therefore, Cd and Ni is required to be monitored in regular basis in order to reduce their accumulation rate in the soil of the area. The CF values of the heavy metal in 2015 (Table 3) shows that Mn, Zn, Fe, Ni, Cu and Cr were low. However, the soil is moderately contaminated with Cd (CF = 1.00). The order of CF value during the period of 2015 increased as follows: Cd<Mn<Zn<Fe<Ni<Cu<Cr. The result obtained in this work contradicts the finding reported by Islam et al. (2015) who discovered severe contamination level of Cd as well as moderate CF in Ni in the collected soil samples.

Table 3. Contamination Factor of heavy metal during the period of 2009 and 2015

Heavy metals	Mean values (mg/kg)	Background values (mg/kg)	CF	Rank
Contamination factor in 2009				
Mn	49.90	200.00	0.25	Low
Fe	86.00	1500.00	0.06	Low
Cu	100.00	140.00	0.71	Low
Zn	161.00	300.00	0.54	Low
Cd	2.90	3.00	0.97	Low
Cr	20.80	180.00	0.12	Low
Ni	55.90	73.00	0.77	Low
Contamination factor in 2015				
Mn	52.00	200.00	0.26	Low
Fe	281.00	1500.00	0.19	Low
Cu	4.70	140.00	0.03	Low
Zn	78.60	300.00	0.26	Low
Cd	3.00	3.00	1.00	Moderate
Cr	2.60	180.00	0.01	Low
Ni	7.60	73.00	0.10	Low

The PLI values of Mn, Fe, Cu, Zn, Cd, Cr and Ni during 2015 (PLI = 0.02) was found to be higher than 2009 (PLI = 0.00062) this indicates that there is gradual increase in the pollution level of the selected heavy metal since the PLI values of 2015 is higher than 2009. However, the PLI values shows that the soil of the study area has low pollution load during the sampling periods

The temporal variation of contamination level was evaluated by comparing the CF values of heavy metals in soil sample during 2009 and 2015. It was shown that soil sampled in 2009 have higher CF of Cu, Zn, Cr and Ni and low CF in Mn, Fe and Cd. In the meantime the soil sampled in 2015 have higher CF values of Mn, Fe and Cd while, the CF values of Cu, Zn, Cr and Ni were low as presented in Table 3. The PLI evaluation shows that, the soil of the study area recorded low value of PLI of 0.25 and 0.0032 for soil sampled in 2009 and 2015 respectively.

Conclusion

The present study proved that heavy metal pollution is a major issue in the study area as the result obtained show an increasing of PLI in the selected heavy metals. Thus it was concluded that there is a gradual accumulation of some heavy metal from 2009 to 2015 which led to the increasing of CF and PLI during the study period. The soil of the study area is classified as low pollution level since the PLI values are within the low level according to the PLI model.

References

Abdu, N., Abdulkadir, A., Agbenin, J. O., and Andreas, B. (2010). Vertical distribution of Heavy Metals in Waste Water Irrigated Vegetable Garden Soils of Three West African cities, *Nutrition Cycle Agroecosystem,* 89: 387–397.

Adamu, G., K., (2014). An Assessment of the Characteristics and Potentials of Fadama Soils in the Reaches of Two Major Stream in Kano State, Nigeria.Unpublished Ph.D. Thesis. Department of Geography Bayero University Kano, Nigeria.6–19.

Akporida, S. O. and Asagba, S. O. (2013). Quality characteristics of soil close to the BeninRiver in the vicinity of a lubricating oil producing factory, Koko, Nigeria. *International Journal of Soil Science,* 10: 3923.

Anderson, J., (1974). Wet Digestion versus Dry for the Analysis of Fish Tissue for Trace Metals, *Afon Absorption Newsletter.*

Ayeni, O. O., Ndakidemi, P. A., Snyman, R. G. and Odendaal, J. P. (2010). Chemical, biological and Physiological indicators of metals pollution in wetlands. *Scientific Research and Essays,* 5(15): 1938–1949.

Ayoade, J. A. (1983). *Introduction to Climatology of the Tropics*; Ibadan Spectrum Book Limited Sunshine House, Oluyole Industrial Estate Ibadan – Nigeria. 204 – 221.

Bichi, M. H. and Bello, F. U. (2013). Heavy metals in soils used for irrigation of crops along River Tatsawarki in Kano. *International Journal Of Engineering Research and Development,* 8(4): 1-17.

Brady, N. C. and Weil, R. R. (1999). *Nature and Properties of Soils;* Fourteenth Edition, Pearson Education Inc.; Upper Saddle River New Jersey.

Chen, T., Zheng, Y., Lai, M., Huang, Z., Wu, H., Chen, H., Fan, K., Yu, K., Wu, X. and Tian, Q.,(2005). Assessment of Heavy Metal Pollution in Surface Soils Of Urban Parks in Beijing, China. *Chemosphere,* 60: 542–551.

Chiroma, T. M., Ebewele, R. O. and Hymore, F. K. (2014). Comparative Assessment of HeavyMetals Levels in Soil, Vegetables and Urban Grey Waste water used for irrigation in Yola and Kano. *International Refereed Journal of Engineering and Science,* 3(3): 01–09.

Dawaki, M. U. and Adamu, G. K. (2010). Effect of Some Heavy Metals Pollution on Fertility Characteristics of an Irrigated Savannah Alfisol. *Bayero Journal of Pure and Applied Science*, 3(1): 255 – 259.

Diatta, J. B., Gezebisz, W. and Apolinarska, K., (2003). A Study of Soil Pollution by Heavy Metals in the City of Poznan (Poland) using Dandelion (Taraxacumofficinale) as a Bioindicator. *Electronic Journal of Polish Agricultural Universities,* 6(2): 9.

Duffus, J. H., (2002). "Heavy metals" - a meaningless term. *Pure Applied Chemistry*, 74: 793-807.

Frac, M. and Stefania, J. T. (2011). Agricultural utilization of dairy sewage sludge: Its effect on Enzymatic activity and microorganisms of the soil environment.*African Journal of Microbiology Research*, 5(14): 1755 – 1762.

Haliru, A. H., Law, P. L. and Suhaiza, S. O. (2014). Heavy metals concentration levels in soil at Lake Geriyo irrigation site, Yola, Adamawa State, Northern Eastern Nigeria, *International Journal of Environmental Monitori and Analysis,* 2(2): 106 – 111.

Hall, R. (2008). *Soil Essentials, Managing Your Farms Primary Asset*: Landlinks Press, 150 Oxford Street Collingwood, C16, 3066 Australia.

Idodo-Umeh, G. and Ogbeibu, A. E. (2010). Bioaccumulation of the heavy metals in cassava Tubers and plantain fruit Grown in soils impacted with petroleum and non-petroleum activities. *Research Journal of Environmental Science,* 4(1): 3341.

Islam, M. S., Ahmed, M. K., Raknuzzaman, M., Habibullah-Al-Mamun, M., & Islam, M. K., (2015). Heavy Metal Pollution in Surface Water & Sediment: A Preliminary Assessment of an Urban River in a Developing Country. *Ecological Indicators*, 48: 282-291.

Khamms, A. A., Al-Ayash, A. S. and Jasin, F. (2009). Indirect Electrothermal Atomization AAS Spectrometric Determination of Drugs Desfeiroxamine in Soe Pharmaceutical Preparations using Vanadium (V) as a Mediatory Element Elestial. *Journal of Analytical Chemistry*, 3: 257-269.

Lal, R. (2006). *Encyclopedia of Soil Science*. The Ohio State University Columbus, Ohio,U.S.A., New York, and London. 817 – 1813. Tailor and Francis Group. 2nd Edition (1 & 2).

Mohammed, M. A. (2004). *Soil Fertility Assessment between Fadama and Upland Soil in Dambatta Tomas Dam, Kano State Nigeria*. Unpublished B.Sc. Project, Department of Geography Bayero University Kano, Nigeria. 21 – 39.

Mohiuddin, K. M., Zakir, H. M., Otomo, K., Sharmin, S., and Shikazono, N., (2010) Geochemical Distribution of Trace metal Pollutants in Water and Sediment of Downstream of an Urban River. *International Journal of Environmental Science & Technology,* 7: 17-28

Nabegu, A. B. (2010).*The Impact of Urbanization on the Morphology of Jakara Stream Channel*. Unpublished Ph.D. Thesis, Department of Geography, Bayero University Kano, Nigeria.

Olofin, E.A. (1987). *Some Aspect of Physical Geography of Kano Region*: Departmental of Geography Lecture Series BUK: Dabis Standard Printers 73A, Zaria Road Kano. 5 – 34.

Olukanmi, O. D. and Adeoye, D. O. (2012). Heavy metals concentrations in roadside from selected locations in the Lagos Metropolis, Nigeria. *International Journal of Engineering and Technology*, 2(10): 23 – 31.

Paul, E. (2008). “Pollution” Microsoft®student (DVD), Redmond WA: Microsoft Cooperative. Retrieved On 10th June, 2014 20:13 GMT.

Popoola, O. E., Bamgbose, O., Okonkwo, O. J., Arowolo, T. A., Odukoya, O. and Poppola, A. O. (2012). Heavy metals content in playground topsoil of some public primary school in Metropolitan Lagos, Nigeria. *Research Journal of Environmental Earth Science*, 4(1): 434 – 439.

Raju, K. V., Somashekar, R. K., Prakash, K. L. (2013). Spatio-temporal Variation of Heavy Metals in Cauvery River Basin. *Proceedings of the International Academy of Ecology and Environmental Sciences,* 3(1): 59-75.

Wild, A. (1996). *Soil and the Environment: An Introduction.* Emeritus Professor, University of Reading Cambridge low price edition. Cambridge.

How to cite this paper:
Mukhtar, S., Mohammed, M.A. & Rosniza Aznie, C.R. (2017). Temporal Variation and Pollution Levels of Some Heavy Metals on Irrigated Land Along the Airport Road Kano State, Nigeria. *Malaysian Journal of Applied Sciences, 2*(2), 1-9.