The International Journal of Earth & Environmental Sciences

www.advancejournals.org
Open Access Scientific Publisher

Research Article

PHYSICO-CHEMICAL, HEAVY METAL AND MICROBIOLOGICAL CONCENTRATIONS IN SOIL AND WATER SAMPLES AROUND VERITAS UNIVERSITY CAMPUS, OBEHIE, SOUTHEASTERN NIGERIA

H. O. Nwankwoala[1], P. O. Youdeowei[2], E. R. Daka[3]
[1]Department of Geology, University of Port Harcourt, P.M.B 5323 Choba, Port Harcourt, Nigeria
[2]Institute of Geosciences and Space Technology, Rivers State University of Science and Technology, Port Harcourt, Nigeria
[3]Department of Applied and Environmental Biology, Rivers State University of Science and Technology, Nkpolu - Oroworukwo, Port Harcourt, Nigeria

Correspondence should be addressed to **H. O. Nwankwoala**

Received July 10, 2016; Accepted July 20, 2016; Published August 03, 2016;

Cite This Article: Nwankwoala, H., Youdeowei, P., Daka, E.(2016). Physico-Chemical, Heavy Metal and Microbiological Concentrations in Soil and Water Samples Around Veritas University Campus, Obehie, Southeastern Nigeria. The International Journal of Earth & Environmental Sciences, 1(1).1-6

ABSTRACT

This study aims at evaluating the physico-chemical, heavy and microbiological concentrations in soil and water samples around Veritas University, Obehie, Abia State, Nigeriato prevent the risk on the public health.Standard sampling and analytical methods were employed during the study. Results of the study revealed that the concentrations of heavy metals in borehole water samples were low (mostly < 0.001), and hydrocarbon were also below detection limit in all borehole samples. The concentrations of heavy metals in surface water were also low, ranging from < 0.001 mg/l in some cases, with the highest single value being 0.165mg/l for iron. Total hydrocarbon content was also below detection levels in surface water showing unpolluted conditions.Heterotrophic bacteria densities were high in soil samples, ranging from 1.0×10^4 to 3.5×10^5 cfu/g soil. Densities of heterotrophic fungi were high in some locations, ranging from 1.0×10^3 to 1.5×10^5 cfu/g. Counts of petroleum degrading bacteria and fungi were generally high. Percentage petroleum degrading bacteria and fungi were greater than 1 % in all samples, except at one location. Microbial populations of soils particularly high in petroleum degraders (> 1 %) show that the soils have been exposed to contamination from petroleum products. High counts in some of the samples indicate normal microbial growth and activities. Heterotrophic bacteria and fungi contribute to good quality soil in terms of fertility. The quality of the borehole and surface water quality is fairly good hence, regular monitoring of water quality in the area is very necessary.

KEY WORDS: Surface water, soil microbiology, heavy metals, borehole, Pollution, Obehie

INTRODUCTION

Water is used for a variety of purposes such as drinking, washing, bathing, recreation as well as numerous other varied industrial applications, the wholesomeness of these water bodies has become an issue of great concern. Water pollution is a burning issue all over the world, in recent years; an increasing awareness has developed on the impact of human activities on the environment because the environment has witnessed a continuous and rapid deterioration which cause pollution in all its abiotic and biotic components.

Soil is the preeminent source of most biologically active trace elements such as Lead, Cadmium, Chromium, Nickel, Silver, and Zinc that reach man through plants and animals (Mitchell and Burridge, 1979). The trace element content of soil depends on the nature of its parent rocks and also the amount of sewage sludges, industrial wastes and fertilizer impurities entering the soil (Williams and David, 1976; Singh *et al.*, 2005).

The occurrence of heavy metalsin soils and groundwater is directly related to soil characteristicsthat determine the rate of water movementand the pollutant dynamics on the soil exchange complex (Nagendrappa *et al.,* 2010; Yerima *et al.,*2014).Therefore, heavy metal concentrations in soils andgroundwater resources vary from one place to anotherand depend on climatic conditions. Extensive studies have been conducted to obtain data on the heavy metals in soils from varieties of environments throughout the world, including industrialized cities (Edet & Ntekim, 1996; Singh *et al.*, 2005; Asaah *et al.*, 2006; Odigi *et al.,* 2011; Zhongping *et al.*, 2011; Amadi & Nwankwoala, 2013; and Onyeobi & Imeokparia, 2014).The impact of human activities in the urban, municipal and populated area makes surface water bodies like streams, river, lagoons, etc, and ground water bodies to be susceptible to contamination from pollutants. Pollution of soil and water by heavy metal occurs due to industrial wastes, application of fertilizer, corrosion of sheeting, wires, pipes, and burning of coal and wood (Hashem, 1992).

According World Health Organisation report on guideline for drinking water 2008, Safe drinking-water, as defined by the Guidelines, does not represent any significant risk to health over a lifetime of consumption; including different sensitivities that may occur between life stages. For this reason, particular concern has become apparent regarding the adequacy of the quality of water resource; both surface and groundwater resources.If the distribution of heavy metals in soils and groundwater has been studied by several previous researchers around the world, very limited efforts have been devoted to the interrelationships between soil classes, occurrence of heavy metal in soil profiles and groundwater and the geochemical parameters affecting heavy metals retention in each class of soil.This study therefore, is aimed at determining the concentration and distribution of the physico-chemical, heavy metals in the soils and surface water as well as boreholes around the study area. This study also aims at evaluating the anthropogenic and/or geogenic contribution to the enhancement of heavy metals.

STUDY AREA DESCRIPTION

The study location (Fig. 1) is within the coast plan sand of the Niger Delta area.The area lies within a sub-horizontal geomorphologic terrain with a measure of undulations arising from uneven surface area erosion. Ground elevation ranges between 10-12 meters above mean sea level. The local geology is of the coastal plain sand, which is Miocene in age and form parts of the most strata of the outcropping Benin Formation. These consist of extensive thickness of brownish, coarse to medium sand with subordinate clay and silt. The area is associated with luxuriant freshwater vegetation typical of a tropical rainforest. Mean annual rainfall exceeds 2000m.

The hydrology of the study site is influenced by its high precipitation rate with a mean annual rainfall of over 2,500mm, the over burden lithologic strata that over lie the aquifer, and the sometimes undulating topography. Surface waters are received from non-tidal seasonal fresh water flows. Recharge of the aquifer will be by rainwater that eventually moves through the over burden into the aquifer. Recharge depends on rainfall intensity and distribution and amount of surface runoff. Groundwater occurs under confined conditions at the site on account of the essentially clayey soil overlying the aquifer. The existence of this over burden-confining layer will determine whether or not groundwater contaminants introduced into the soil will reach the aquifer. During construction at the site, the protective soil vegetation is removed. Concentrated surface flow of rainwater rills the soil and changes the slope value, which may eventually result in sheet/gully erosion. The cohesive, stiff consistency of the over lying clayey soil will help to limit the degree of this environmental hazard.

METHODS OF INVESTIGATION

Field and Laboratory Methods

Soil samples were collected using the grid format (Smith & Atkinson, 1975) and sampling location selected in such a manner as to adequately represent the ecological conditions of the study area. At the grid intersection, soil samples were collected by taking about five auger borings at random around the sampling station to depths of 0 – 15cm and compositing the soils from similar depth into well-labelled plastic bags (Hodgson, 1983). The quantity of composite samples collected was processed for analyses in the laboratory without sub-sampling in the field. This allowed for more accurate sub-samples that better represented the area and remove errors due to sample splitting and sub-sampling in the field. The analyses were performed on sub-samples of the air-dried soil samples using materials less than 2 mm diameter of the fine earth. Concentrations were expressed on a dry weight basis and the analyses for oil content (THC) were measured using fresh soil samples.For quality control, replicate samples were taken randomly from the sample areas. Microbiological assessment involved the analysis of water samples for total aerobic, heterotrophic and petroleum utilizing bacteria, total fungi and petroleum utilizing fungi. These parameters were screened by plating out (by spread plate method) 0.1 ml of diluted sample on each of the appropriate media, using sterile 1 ml pipettes. The abundance of microbial flora was reported as colony forming units (cfu/ml). Heavy metal concentrations (Pb, Cr, Ni and Cd) were determined after extracting with HCl/HNO_3 mixtures(Bloom & Ayling, 1975). This procedure releases heavy metals tightly bound in clay minerals. The concentrations of the metals were determined by atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Soil and Water Microbiology

The microbiological profile of soil samples in the area is presented in Table 1. Heterotrophic bacteria densities were high in soil samples and CW A and CW D and slightly high in samples CW B and CW C, ranging from 1.0 x 10^4 to 3.5 x 10^5 cfu/g soil. Densities of heterotrophic fungi were high in sample CW A and not very high in other samples, ranging from 1.0 x 10^3 to 1.5 x 10^5 cfu/g. Counts of petroleum degrading bacteria and fungi were generally high. Percentage petroleum degrading bacteria and fungi were greater than 1 % in all samples, except at CW 1. Microbial populations of soils particularly high in petroleum degraders (> 1 %) show that the soils have been exposed to contamination from petroleum products. High counts in some of the samples indicate normal microbial growth and activities. Heterotrophic bacteria and fungi contribute to good quality soil in terms of fertility.The heterotrophic bacteria counts of surface water samples was 2.0 x 10^3 to 2.4 x 10^3 cfu/ml while that of borehole samples ranged from 3.1 x 103 at BH 1 to 2.5 x 10^4 cfu/ml. Fungi counts ranged from 1.0 x 10^2 to 1.4 x 10^2 for borehole and 1.4 x 10^2 to 1.5 x 10^3 cfu/ml, for surface water samples.Tables 2 & 3shows the microbial populations of water and borehole samples in the study area.Heavy metal concentrations are low (Table 4). The values obtained revealed that heavy metal concentrations do not pose a threat in the soil quality, hence poor indicator of heavy metal pollution.

Physico-Chemistry of Water

Water quality variables in borehole samples were compared with international standards for drinking water. pH values fell short of the WHO standards in all boreholes but was within the USEPA maximum criteria. The values of chloride and nitrate were however, within the WHO standards. The concentrations of heavy metals in borehole water samples were low (mostly < 0.001), and hydrocarbon were also below detection limit in all borehole samples.

The concentrations of heavy metals in surface water were low, ranging from < 0.001 mg/l in some cases, with the highest single value being 0.165mg/l for ion at WS 3. Total hydrocarbon content was also below detection levels in surface water showing unpolluted conditions. Table 5 shows the heavy metal and Total Hydrocarbon concentrations in water samples from the study area.

Figure 1: Map Showing the Study Location

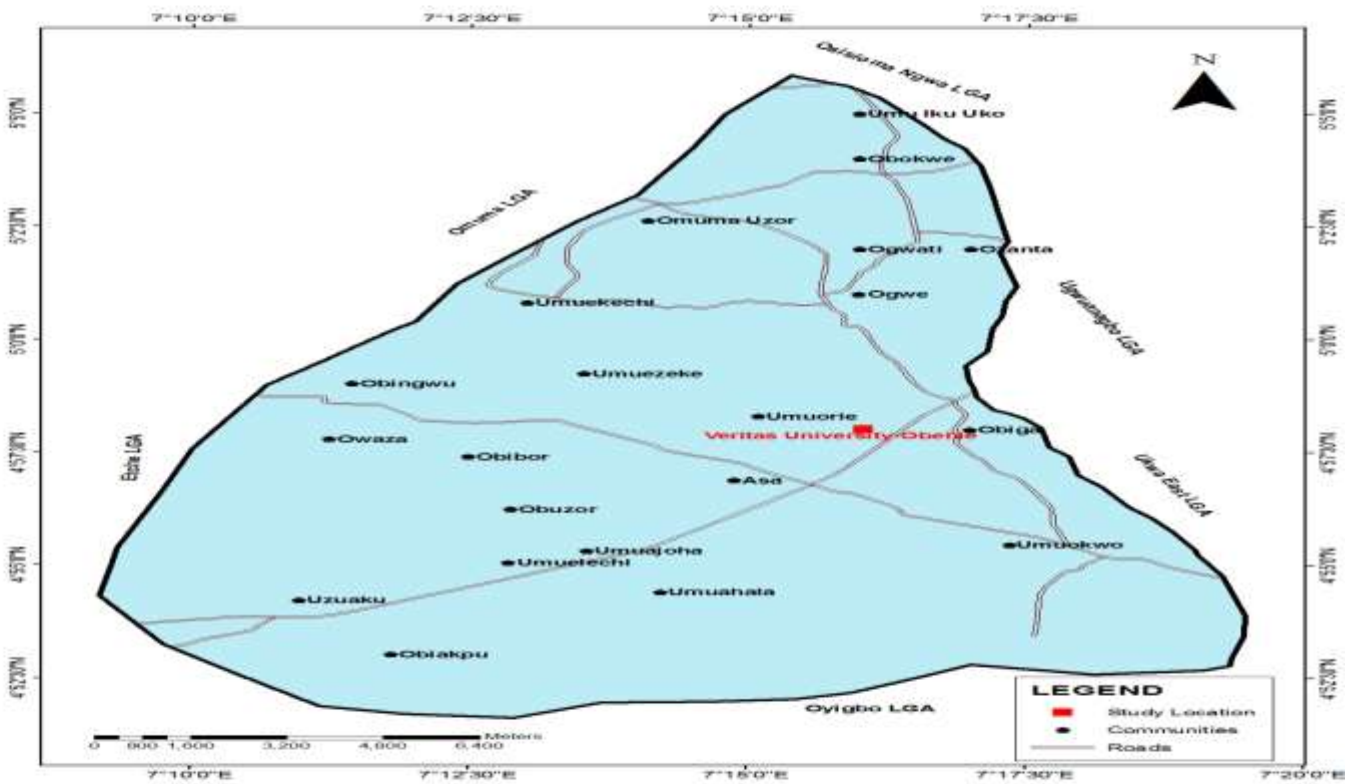

Table 1: Microbial Populations of Soil Samples from the Study Area

S/N	Sampling Station	THB (cfu/g)	THF (cfu/g)	PDB (cfu/g)	PDF (cfu/g)	%PDB (cfu/g)	%PDF (cfu/g)
1	CW A	3.1×10^5	1.5×10^4	1.0×10^3	3.9×10^3	0.3	26
2	CW B	2.9×10^4	4.2×10^3	1.8×10^3	1.6×10^3	62.1	38.1
3	CW C	1.0×10^4	1.0×10^3	3.5×10^3	3.5×10^3	30.0	> 100
4	CW D	2.7×10^5	1.8×10^3	1.8×10^3	1.8×10^3	6.3	100

Table 2: : Microbial Populations of Water Samples in the Study Area

Metal	Boreholes Samples			Surface Water Samples		
	BH 1	BH 2	BH 3	WS 1	WS 2	WS 3
Nickel (mg/l)	2.5×10^4	3.1×10^3	2.0×10^4	2.0×10^3	2.4×10^3	2.4×10^3
Vanadium (mg/l)	1.0×10^2	1.4×10^2	1.0×10^2	1.4×10^2	1.5×10^3	3.0×10^2

Table 3: Physico-Chemical Parameters of Water Samples from the Study Area

Parameter	Boreholes Samples			Surface Water Samples			Standards
	BH 1	BH 2	BH 3	WS 1	WS 2	WS 3	
pH	8.5	8.4	6.0	6.0	5.8	6.1	7-8[a]
							5-9[b]
Conductivity (µS/cm)	24	13	18	9	9	10	-
TDS (mg/L)	10	7	7	3	5	4	-
Salinity (ppt)	0	0	0	0	0	0	-
	0.2	0.2	0.2	0.2	0.2	0.1	200[a]
Chloride (mg/L)	-	-	-	-	-	-	250[b]
Turbidity (NTU)	4.2	51	49	1	1	2	-
Nitrate (mg/L)	1.4	0.8	2.4	0.2	0.5	0.4	45[b]
Phosphate (mg/L)	0.21	0.18	0.19	0.25	0.31	0.22	-

a = World Health Organization Highest Desirable Level (WHO, 2006)

b = United States Environmental Protection Agency Maximum Criteria (USEPA, 1991)

Table 4: Heavy Metal Concentration (mg/kg) of the Related Soil Samples

S/N	Sampling Station	Cm Depth	Pb	Cr	Cd	Ni
1	CW A 01	0 - 15	0.24	0.31	<0.001	0.08
2	02	0 - 15	0.20	0.28	<0.001	0.06
3	CW B 01	0 - 15	0.15	0.24	<0.001	0.10
4	02	0 - 15	0.18	0.18	<0.001	0.05
5	CW C 01	0 - 15	0.10	0.22	<0.001	0.12
6	02	0 - 15	0.22	0.20	<0.001	0.10
7	CW D 01	0 - 15	0.16	0.14	<0.001	0.18
8	02	0 - 15	0.12	0.16	<0.001	0.20
9	Soil Standard*		2 – 100	5 - 1000	0.01 - 7	10 - 1000

Table 5: Heavy Metal and Total Hydrocarbon Concentrations in Water Samples from the Study Area

Metal	Boreholes Samples			Surface Water Samples		
	BH 1	BH 2	BH 3	WS 1	WS 2	WS 3
Nickel (mg/l)	<0.001	0.012	0.002	<0.001	<0.001	<0.001
Vanadium (mg/l)	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Chromium (mg/l)	0.018	0.012	<0.001	0.002	0.001	<0.003
Cadmium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (mg/l)	<0.001	<0.001	<0.001	0.033	<0.001	<0.001
Iron (mg/l)	0.182	0.097	0.079	0.004	0.165	0.064
Copper (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (mg/l)	0.034	0.045	0.172	0.002	0.002	0.004
Manganese (mg/l)	0.008	0.005	0.011	0.002	0.011	0.18
Oil & Grease (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL

CONCLUSION

This study provides an update on our current understanding of the environmental health effects of heavy metal pollution, soil and water quality around the study area. This study revealed that the values of the pysico-chemical properties were however, within the WHO standards. The concentrations of heavy metals in borehole water samples were low (mostly < 0.001), and hydrocarbon were also below detection limit in all borehole samples. The concentrations of heavy metals in surface water were low, ranging from < 0.001 mg/l in some cases, with the highest single value being 0.165mg/l for iron at WS 3. Total hydrocarbon content was also below detection levels in surface water showing unpolluted conditions.

Counts of petroleum degrading bacteria and fungi were generally high. Percentage petroleum degrading bacteria and fungi were greater than 1 % in all samples, except at CW 1. Microbial populations of soils particularly high in petroleum degraders (> 1 %) show that the soils have been exposed to contamination from petroleum products. High counts in some of the samples indicate normal microbial growth and activities. Heterotrophic bacteria and fungi contribute to good quality soil in terms of fertility.There is need for regular monitoring of soil, surface and groundwater quality in the area for heavy metal contamination and pollution.

REFERENCES

1. Amadi, A. N., & Nwankwoala, H. O. (2013). Evaluation of heavy metal in soils from Enyimba Dumpsite in Aba, Southeastern Nigeria using contamination factor and geo-accumulation index. *Energy and Environment Research*, 3(1): 125–134.
2. Asaah, V. A., Abimbola, A. F., & Suh, C. E. (2006). Heavy metals concentrations and distribution in surface soils of the Bassa industrial zone 1, Douala, Cameroon. *Arabian Journal forScience and Engineering,* 31(2):1–12.
3. Bloom, H and Ayling, G.M (1977). Heavy metal in the Derwent Estuary. *Environmental Geology*, 2:3 – 22.
4. Edet A.E., and Ntekim E.E.U., (1996). Heavy metal distribution in ground water from Akwa Ibom State, eastern Niger delta- A preliminary pollution assessment. *Global Journal of Pure and Applied Sciences* 2(1): 67-77.
5. Mitchell, R.L. Burridge, S.C. (1979). Trace Element in soils and crops. Phil. Trans. Royal Soc. London B 288, 15 – 24
6. Nagendrappa, G., Bhaskar, C. V., & Kumar, K. (2010). Assessment of heavy metals in water samples of certain locations situated around Tumkur, Karnataka India. *Electronic Journal of Chemistry,* 7(2): 349–352.
7. Odigi M. I, Ukrem L. O. and Nwankwoala H. O. (2011) Distribution of heavy metals in soils of Port Harcourt and its environs, Niger Delta, Nigeria. *Chinese Journal of Geochemistry,*30: 415 - 429
8. Onyeobi, T.U.S, and Imeokparia, E.G. (2014). HeavyMetal Contamination and Distribution inSoils around Pb-Zn Mines of Abakaliki District, South Eastern Nigeria. *Frontiers in Geosciences,* 1(2): 30 - 40
9. Singh, A.N., Zeng, D.N., and Chen, F.S., (2005). Heavy metals concentration in re-developing soil of mine spoil under plantation of certain native woody species in dry tropical environment. *Indian Journal of Environmental Science,* 17(1): 123 - 129.
10. Williams, C. H. David J. (1976). The accumulation of Cadmium from Phosphorus Fertilisers and their effect on the Cadmium Content of Plants. *Soil Science,* 121: 86 - 93
11. World Health Organisation, (2008). Guidelines for Drinking-water Quality, 3rd edition incorporating the first and second addenda, Volume 1.
12. Yerima, B. P. K., Van Ranst, E., Sertsu, S., & Verdoodt, A. (2014). Pedogenic impacts on the distribution of total and available Fe, Mn, Cu, Zn, Cd, Pb and Co contents of vertisols and vertic inceptisols of the Bale Mountain area of Ethiopia. *African Journal of Agricultural Research,* 8(44), 5429–5439.
13. Zhongpring, Y. Wenxi Lu, Yugioo Long, Xinhau, B., Qingchun Y. (2011). Assessment of heavy metals contamination in urban topsoil from Changchun City, *China Journal of Geochemical Exploration.* 108: 27 - 38.