Journal of Environmental Treatment Techniques 2018, Volume 6, Issue 2, Pages: 40-46

Journal of ENVIRONMENTAL Treatment Techniques

J. Environ. Treat. Tech.
ISSN: 2309-1185
Journal web link: http://www.jett.dormaj.com

Evaluation of the Environmental Contaminants Associated with Household Waste Dumpsites in Yenagoa Metropolis, Nigeria

[1]Tariwari C.N Angaye*, [2]Apollos P. Ubi [3]Donbebe Wankasi,

[1]Department of Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Bayelsa State.
[2]Department of Environmental Management, Faculty of Social Science, Imo State University, Owerri, Nigeria.
[3]Department of Chemical Science, Faculty of Science, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.

Received: 21/08/2017 Accepted: 12/09/2017 Published: 30/09/2018

Abstract

Due to urbanization and industrialization, large magnitude of streams of waste are generated on daily basis. The adverse impacts of this waste cannot be overemphasized due to their illicit and inappropriate discharge to the environment. This research assessed the environmental contaminants of top (0-15cm), and sub (15-30cm) soils with regards to heavy metals, microbial counts as well as some physicochemical parameters such as; temperature, pH, electrical conductivity from Household dumpsites in Yenagoa metropolis. Seven soil samples were collected including control. The mean result obtained showed that pH ranged from 4.96±0.38 - 6.75±0.61, electrical conductivity 65.40±0.50 - 90.48±0.77 µS/cm. Calcium (17.95±0.11 - 55.31±0.82 mg/kg), magnesium (7.36±0.82 - 17.22±0.23 mg/kg) and sodium (0.11±0.38 - 4.43±0.52 mg/kg) and potassium (1.15±0.43 - 5.46±0.42 mg/kg). While the result of the microbial counts ranged from 6.05±0.66 – 0.077±0.27 x 10^6 cfu/g (total heterotrophic bacteria); 2.07±0.31 - 8.82 ± 0.32 x 10^4 cfu/mg (total fungi). Furthermore, results of heavy metal analysis showed less impact on the control site however; significant levels of iron (8.75±0.37 - 17.79±0.19 mg/kg), copper (1.87±0.51 - 8.08±0.49mg/kg), zinc (1.04±0.18 - 4.52±0.14 mg/kg) and lead (5.25±0.72 - 11.37±0.09 mg/kg) were reported while chromium, Nickel and Cadmium were not detected. Generally, the results confirmed mild contamination of soil in dumpsites. As such drastic step should be taken in order to mitigate the incipient adverse consequences.

Keywords: Heavy Metals, Household Dumpsite, Bayelsa State, Pollution

1 Introduction

Soil is an inevitable basic component of the ecosystem that directly or indirectly provides support for all forms of biodiversity. This is sequel to the fact that it forms an anchor for vegetation, habitation to organisms and as resource which provides support to other basic structures (houses, road, bridges etc.), required for man's benefit [1]. As established in literature the soil interacts with other environmental media, supports biodiversity, and protects cultural heritage [2].

Wastes is seen as any irrelevant substance to the user, due to their invaluable importance. It is regarded to be of no further use, and wish to be rid of [3]; or superfluous materials that may be hazardous [4]. It can be defined waste as an unwanted or underserved materials or substances [5]. It is also referred to as rubbish, trash, garbage or junk defending upon the type of material and the regional terminology.

Notwithstanding, solid wastes are unwanted or ready to be discarded semi-solid or solid substances that cannot be applied for further use, as well as having no economic value or further resourceful application or value to the user [6]. Based on the sources, waste streams referred to as solid waste includes but not limited to Household Solid Waste (HSW), Commercial waste, Industrial waste, electronic waste, construction waste, Agricultural waste, Mining waste, Medical waste etc. [5]. According to the United State Environmental Protection Agency (USEPA), components or characters of MSWs basically includes but unlimited to; plastic, metals, paper, vegetable matter, textiles, rubber, and glass [7].

As documented in literature by several authors, the incidence of industrialization, urbanization and poor legislation uncontrollable and illicit waste generation have infringed on the ambient quality of the environment [3]. For instance, the soil water and air are fragile media of pollution that can be infringed upon as a result of some

Corresponding Author: Tariwari C.N Angaye, Department of Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Bayelsa State. E-mail: maktarry@yahoo.com.

lithogenic or anthropogenic activities [6]. As such the Evaluation of Environmental Contaminant associated with Household Solid Waste is hereby investigated.

2 Materials and Method

2.1 *Study Area*

The study area is located in Yenagoa Metropolis Bayelsa State, which is the capital city of Bayelsa in south-south Nigeria. It is located on latitude 4^0 49N and 5^0 23'N and longitude6^0 10'E and 6^0 33'E with a population estimate of over 300,000. Since attaining the status of a state capital in 1996, urbanization, as well as industrial and commercial activities have rapidly accelerated. The study area have a tropically humid hot climate with two predominantly dry and wet seasons. The wet or rainy ranges from April – October, with precipitation of over 2000mm per annum; while the dry season ranges from November - March. The research was conducted in randomly selected waste dumpsites in Yenagoa metropolis, which is the Capital city of Bayelsa State. The sampling stations of the study area are presented in Table 1.

Table 1: Description of Sampling Stations

Sampling Location	Direction	Coordinates		Elevation (Ft)
		Latitude	Longitude	
Yenegwe	NE	N05^{0}57'35.3"	E006^{0}23'23.0"	46
Akenpai	SW	N04^{0}57'59.8"	E006^{0}22'0.59"	47
Tombia	NE	N04^{0}59'30.2"	E006^{0}19'44.6"	38
Okutukutu	SE	N04^{0}57'12.0"	E006^{0}20'43.5"	24
Ekeki	NE	N04^{0}55'0.20"	E006^{0}18'0.03"	45
Swali	SW	N04^{0}54'58.9"	E006^{0}16'17.6"	34
Control	SW	N04^{0}53'33.7"	E006^{0}23'19.2"	43

2.2 *Sampling Techniques and Analysis*

2.2.1 Soil sampling

Seven soil samples including one control were collect from the household dumpsites. The composite soil sampling was carried out within depths of 0 - 15cm for top soil samples, and 15 - 30 cm for sub soil sample. Sampling was carried out with the aid of soil auger. The soil was aseptically dispensed into a polyethene zigloc bag, and labelled accordingly for laboratory for analysis.

2.2.2 Determination of pH and Electrical conductivity

The soil pH was assessed with pH meter (HANNA HI 9820), adopting the protocols of Ademoroti [8]. The pH electrode was first calibrated with buffers at pH 4, 7 and 10, and stabilized in diluted water. The electrode of the calibrated pH meter was then dipped into a 0.2g/ml solution for the analysis. The pH reading were taken when a stable reading was obtained. For electrical conductivity, similar protocol were adopted except that the EXTECH DO-700 Multi-probe conductivity Meter was utilized.

2.2.3 *Microbiological Analysis*

The evaluation of microorganisms in the soil for Total heterotrophic bacteria and Total fungi were carried out using serial dilution aerobic pour plate technique as described by Pepper and Gerba [9].

2.2.4 *Heavy Metal Analysis*

The heavy metals were assessed was analysed using Perkin Elmer 5100PC AA Spectrometer AAS (Atomic Absorption Spectrophotometer).

2.3 *Statistical Analysis*

The 2016 version of Microsoft excel was used to plot all charts from mean±SD derivatives obtained with the aid of SPSS Statistical software. Analysis of variance was used to fashion out the mean.

3 Results and Discussion

Table 2 presents results of the physicochemical properties of composite soil samples in both surface (0 - 15cm), and sub-soil (15 -30cm) from the study area. Generally results indicated that the mean pH of the subsoil was more acidic (i.e. lower pH values) compared to the surface soil. Also, the soil pH was lower in the control site (4.28±0.66 – 4.46±0.29), compared to the pH of the study areas (i.e. the dump), which ranges from 4.96±0.38 to 6.75±0.61 indicating a weakly acidic status. Furthermore, the control station had lower electrical conductivity compared to the understudied dumpsites. Notwithstanding, results of electrical conductivity (EC), indicated values in the range of 65.40±0.50 – 90.48±0.77 µS/cm in the dumpsites compared to the control sites which had values of EC, in the range of 92.19±0.27 - 96.29±0.11.

Results of other mineral elements assessed showed that calcium ranges from 17.95±0.11 - 55.31±0.82 mg/kg in the dumpsites, while the control sites had values in the range of 22.33±0.73 - 23.91±0.63 mg/kg. Magnesium (Mg) assessments indicated values in the range of 7.36±0.82 - 17.22±0.23 mg/kg compared to the controlled site which had values in the range of 9.63±0.55 - 10.10±0.67 mg/kg as presented in Table 1.

Furthermore, Sodium (Na) concentrations of the dumpsites ranges from 0.11±0.38 - 4.43±0.52 mg/kg with the control site values in the range of 0.22±0.42 - 0.29±0.55 mg/kg. Meanwhile, Potassium (K) levels in the dumpsite was in the range of 1.15±0.43 - 5.46±0.42 mg/kg; comparatively the control site recorded lower level of potassium in the range of 1.25±0.44 - 1.32±0.61 mg/kg (Table 1).

Table 2: Result of Physicochemical Analysis

Soil Depth	Sampling Locations	pH	EC	Ca	Mg	Na	K
0 -15cm	Yenegwe	6.03±0.63	68.31±0.43	55.31±0.82	17.22±0.23	4.43±0.52	5.46±0.42
15 -30cm		5.85±0.41	72.19±0.73	26.67±0.13	11.09±0.43	3.27±0.61	4.29±0.41
0 -15cm	Akenpai	6.10±0.33	65.29±0.49	50.93±0.53	15.36±0.62	2.24±0.47	3.25±0.37
15 -30cm		5.45±0.40	79.40±0.53	33.41±0.48	12.12±0.49	1.96±0.18	2.95±0.28
0 -15cm	Tombia	5.80±0.48	74.82±0.33	29.93±0.13	11.86±0.62	0.91±0.82	1.92±0.52
15 -30cm		5.55±0.23	83.07±0.34	38.97±0.30	12.93±0.38	0.66±0.63	1.69±0.33
0 -15cm	Okutukutu	5.17±0.17	84.48±0.73	41.32±0.73	13.52±0.60	0.39±0.42	1.41±0.52
15 -30cm		4.96±0.38	89.31±0.43	17.95±0.11	7.36±0.82	0.32±0.97	1.34±0.67
0 -15cm	Ekeki	5.45±0.43	79.38±0.51	32.48±0.49	12.31±0.80	0.11±0.38	1.15±0.43
15 -30cm		4.77±0.70	90.48±0.77	19.17±0.40	8.12±0.53	0.19±0.97	1.20±0.95
0 -15cm	Azikoro	6.75±0.61	65.40±0.50	48.47±0.40	14.18±0.77	0.16±0.65	1.17±0.50
15 -30cm		6.05±0.33	66.08±0.43	53.43±0.83	16.84±0.82	0.13±0.82	1.16±0.61
0 -15cm	Control	4.43±0.29	92.19±0.27	22.33±0.73	9.63±0.55	0.29±0.55	1.32±0.61
15 -30cm		4.28±0.66	96.29±0.11	23.91±0.63	10.10±0.67	0.22±0.42	1.25±0.44

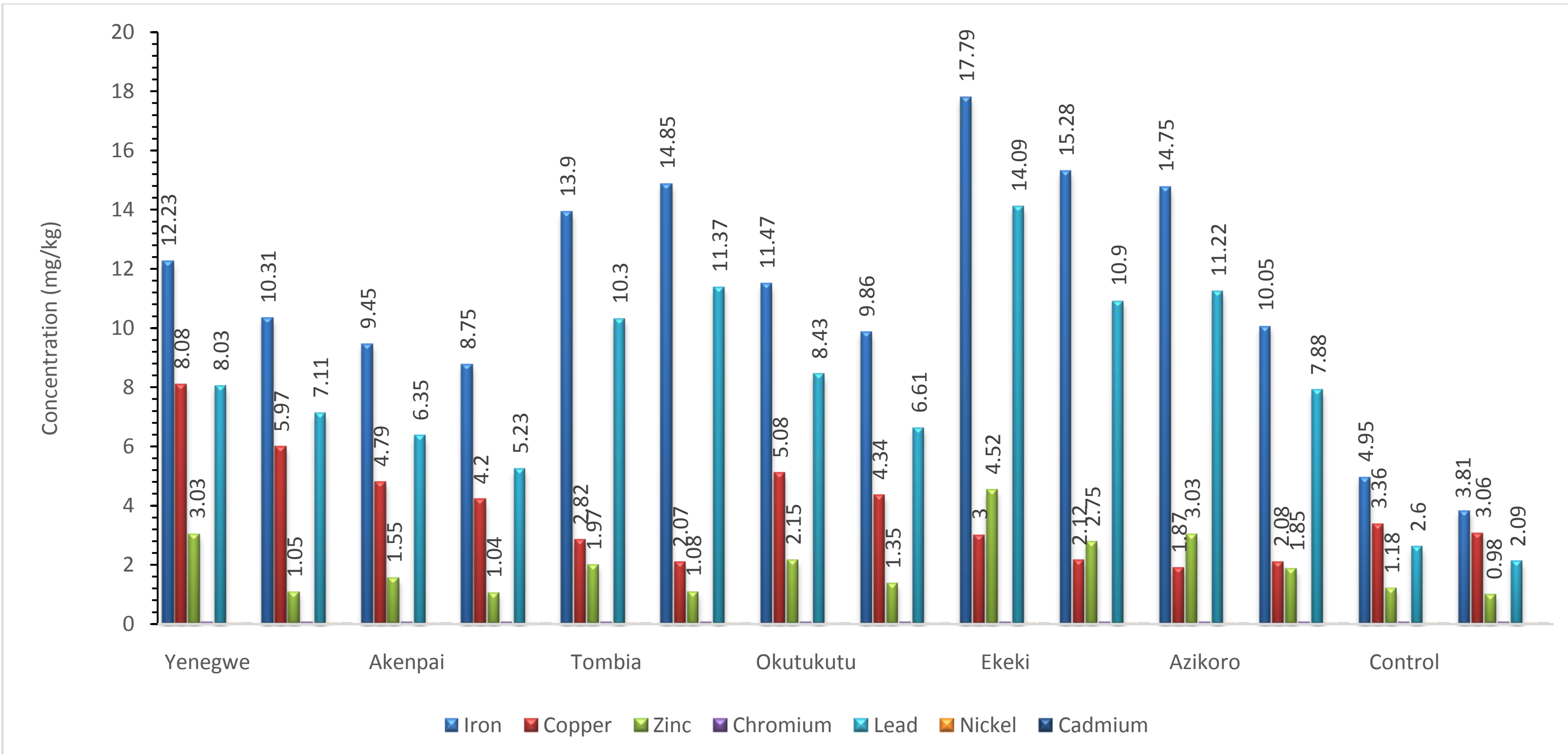

Figure 1: Spatial concentrations of Heavy Metals in the Household Dumpsite

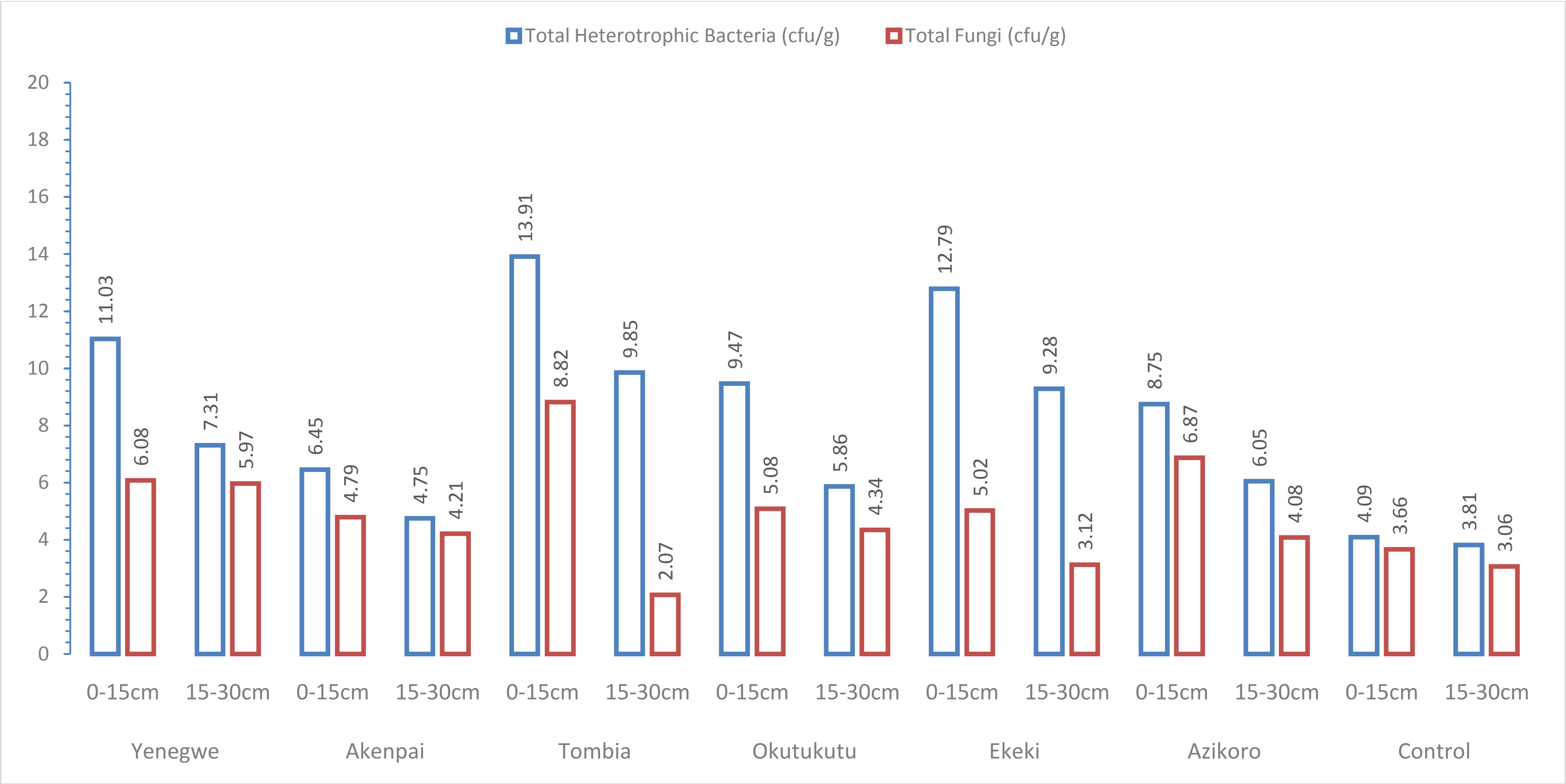

Figure 2: Results of Microbes associated with the Household Dumpsites

Figure 1 presents the results of the heavy metal assessment from the dumpsites as well as the control (i.e. un-impacted) site. Results generally showed that the surface soil (0-15cm), was more impacted compared to the subsoil (15-30cm). However, it was noteworthy that chromium, Nickel and Cadmium was not detected in all assessed dumpsites. On the other hand, the level of iron was highest amongst all assessed heavy metal, with Ekeki station being the most impacted.

Furthermore, the level of iron ranged from 8.75±0.37 - 17.79±0.19 mg/kg, compared to the control with values in the range of 3.81±0.77 - 4.95±0.30 mg/kg. The level of copper (Cu) ranged from 1.87±0.51 - 8.08±0.49 mg/kg with the control having values within the range of 3.06±0.30 - 3.36±0.36 mg/kg. While Zinc was in the range of 1.04±0.18 - 4.52±0.14 mg/kg. The level of Lead (Pb) ranged from 5.25±0.72 to 11.37±0.09 mg/kg, while the control samples ranges from 2.09±0.87 - 2.60±0.39 mg/kg (Figure 1).

Figure 2 presents the microbial density from Yenagoa, Bayelsa state, Nigeria as well as their corresponding control samples. The total heterotrophic bacteria counts ranged from 6.05±0.66 – 0.077±0.27 x 10^6 cfu/ml and 3.81±0.62 – 4.09±0.12 x 10^4 cfu/ml for dumpsites and control respectively. Generally the microbial densities of the topsoil was higher than the subsoil across the different locations. The differences that exist are presented in Appendix A2. The total fungi densities ranged from 2.07±0.31 – 8.82±0.32 x 10^4 cfu/ml, while the control sample was in the range of 3.06±0.17 – 3.66±0.53 x 10^4 cfu/ml. Similarly, the microbial densities of the topsoil was higher than the subsoil across the different locations.

Amos-Tantua et al. [10] reported that the pH of a soil affects the kinesis of heavy metals in soil. It has already been establish that soil pH is linked with the bioavailability of nutrients such as; calcium, magnesium, sodium and potassium. Although, when mineral element are bioavailable in excess they might have detrimental effects of living organisms. The level of mineral elements indicated in this study (Table 2), were below 10 mg/kg which are considered suitable for crop production [11]. Also, it has been established in literature that pH decreases, as the leachability of metallic elements in the soil rises and they become bioavailable [12, 13].

Furthermore, Lower pH would intensifies the bioavailability, kinesis and redistribution of heavy metals like; Lead (Pb) and Cadmium (Cd) in the various segments as a results of amplified solubility in ionized or acidic soil [14]. In this study, soil pH ranged from 4.96±0.38 – 6.75±0.61 with control of 4.28±0.66 – 4.46±0.29 compared to a previous study with 7.60±0.02 and control 4.89±0.05 [10]. Moderately acidic soil may tend to have an increased bioavailability of micronutrient as well as its solubility and mobility in the soil [15].

The evaluation of dumpsite soils for the levels of toxic elements is essential for healthy crop production, thus this study has endeavoured to determine the levels of iron, copper, Zinc, Lead, Nickel, Cadmium and Chromium of soil samples from the dumpsites. Amongst the assayed dumpsite soil samples; Iron (Fe), copper (Cu), lead (Pb), and zinc (Zn) were the most abundant in the soil samples (Figure 1). This was in tandem with the study of Amos-Tantua *et al.* [11], with recorded average levels of lead (14.75±0.05 - 16.14±0.04 mg/kg), while Chromium (0.05±0.01 and 0.06±0.01 mg/kg), and Cadmium (<0.0001±0.01 mg/kg). Lead and cadmium have been reported as anthropogenic metal which might originated from batteries in dumpsite and more available in topsoil than subsoil [16, 17].

High level of iron is natural and very prominent to Bayelsa state from the foregoing; Iron is one of the most abundant lithogenic soil element in Bayelsa soil [18]. The high levels of zinc (Zn) at the dumpsites may be attributed to leachability through insitu-burning of the waste, as well as the dismantling activities to recover various metals [3]. High levels of Zn can also influence the activity of microorganisms and earthworms thereby retarding the breakdown of organic matter [19]. In the case of copper (Cu) the concentrations in all the soil samples were significantly high than tolerable limit and hence toxic. Generally, the levels of Copper obtained from this study were than the one reported by several authors; 21.00 - 33.50mg/kg [20], 22.50-31.00 [21], 3.60-4.30 [22] but similar to 0.79-2.07 values of Buteh et al [23].

Microbes are ubiquitous organisms found in every aspect of the environment. Unfortunately their activities could be beneficial or detrimental to human [18]. Most microbes found in dumpsites are detrimental to human health as they cause most terminal diseases such as Typhoid fever, cholera, dysentery amongst others [24]. In this study, high level of microbes were discovered in the soil samples which indicates high level of contamination. Globally, the World Health Organization projected that about 4 billion cases of diarrhea related illness and 2.2 million deaths occur annually. In Nigeria, Federal Ministry of Health and various State Ministries of Health have reported an increased rate of poor hygiene related diseases [25].

From Figure 3, the microbial quality (i.e. total heterotrophic bacteria and total fungi) of the soil sample from the study area was generally higher in the surface soil than subsoil samples. The presence of these total heterotrophic bacteria and total fungi in the soil sample could be attributed to domestic and municipal waste contaminants. Depending on the degree of soil porosity and permeability wastes from dumpsites remain a major pollutant of the ground water, as a result of surface runoff and infiltration [18]. Microbes in soil can be medium through which waterborne pathogens that can transmit diseases are transmitted [25]. Basically contaminated soils could also be medium through which diarrhea diseases like; typhoid fever, hepatitis, gastroenteritis, dysentery, cholera, hepatitis A and poliomyelitis.

4 Conclusions

Generally, from all monitored parameters, results indicates that, there was significant level of contamination from the dumpsites water in Yenagoa. Notwithstanding, iron ranks highest amongst all heavy metals assessed, while there were moderate, low and non-detected levels of other heavy metals. However the high and significant level of detected iron is not attributed to anthropogenic activities but a lithogenic factor. Also, some of the heavy metals exceeding the allowable limit for aseptic measures as specified by World Health Organization. Pollution of both surface and groundwater from dumpsites can occur as a result of infiltration and runoffs. The Niger Delta is a terrain is associated with shallow water table. Similarly, the microbial population is also high. Results of the microbial analysis also showed lesser contamination of subsoil compared to surface soil. Generally, Bayelsa is characterized by shallow water table which might enhance the leachability of unsanitary disposed sewage.

References

1 P.A. Ubi. The effects of indiscriminate dumping of Solid waste on soil in yenagoa metropolis, Imo State University, Owerri, Nigeria. M.Sc Thesis 2016.
2 G.A. Ibrahim, S. Gary, J.R.J French, M. Berham. Ecological Benefits of Soil Termite Interaction and Microbial Symbiosis in Soil Ecosystem. Journal of Earth Scince and Geotechnical Engineering 3(4) :65 – 85.
3 T.C.N. Angaye, J.F. N. Abowei (2017). Review on the Environmental Impacts of Municipal Solid Waste in Nigeria: Challenges and Prospects. Greener Journal of Environment Management and Public Safety 6 (2): 18-033
4 T.N. Eshalomi-Mario, and F.G.B Tanee (2015). Phytodiversity Assessment in Abandoned Solid Waste Dumpsites in Port Harcourt, Nigeria. *Annual Research & Review in Biology*, 6(6): 379 – 389.
5 S. Uba, (2015). Environmental Impact Assessment of Dumpsites in Zaria Metropolis, Kaduna State, Nigeria. M.Sc Thesis, Ahmadu bello University, Zaria Nigeria.
6 T.C.N. Angaye (2018). Characterization and Environmental Impact of Municipal Solid Waste in the Niger Delta. Niger Delta University. PhD Dissertification.
7 United State Environmental Protection Agency-USEPA (2015). Health Particulate Matter Air and Radiation. Epa.gov. 17 November 2010. Archived from the original on 2 October 2006. Retrived 1 February 2015.
8 C.M.A, Ademoroti. (2006). Standard Method for Water & Effluents Analysis. 1st Edition. Foludex press limited, Ibadan, Nigeria.
9 I.L. Pepper, and C.P Gerba (2005). *Environmental microbiology*. A laboratory manual. Second edition. Elsevier academic press.
10 Amos-Tautua, B. M. W., Onigbinde, A. O., Ere, D. (2014). Assessment of some heavy metals and physicochemical properties in surface soils of municipal open waste dumpsite in Yenagoa, Nigeria. *African Journal of Environmental Science and Technology*, 8(1), 41-47.
11 FAO (1976). A Framwork for Land Evaluation. FAO Bulletin 32, FAO/UNESCO, France.
12 Oliver DP, Tiller KG, Alston AM, Cozens GD, Merry RH. Effect of soil pH and applied cadmium on cadmium concentration in wheat grain. Aust. J. Soil Res. 1998; 36:571-583.
13 A.K. Salam, P.A. Helmke. The pH dependence of free ionic activities and total dissolved concentrations of copper and cadmium in soil solution. Geoderma 1998; 83:281-291
14 P.O. Oviasogie, C.L. Ndiokwere. Fractionation of lead and cadmium in refuse dump soil treated with cassava milling effluent. J. Agric. Environ. 2008: 9:10.
15 Odu CTI, Esurosu OF, Nwaboshi IC, Ogunwale JA (1985). Environmental study (Soil and Vegetation) of NigeriaAgip Oil Company Operation Area. A report submitted to Nigeria Agip Oil Company Limited, Lagos, Nigeria. pp. 102-107.
16 Al-Turki AI, Helal MID (2004). Mobilization of Pb, Zn, Cu and Cd, in Polluted Soil. Pak. J. Biol. Sci. A. 7:1972-1980.
17 H.M, Ren, J.D, Wang, X.L Zhang. Assessment of Soil Lead Exposure in Children in Shenyang, China. Environ. Pollut. 2005; 144:327-335.
18 E.I. Ohimain, T.C.N Angaye. Iron levels, other selected physicochemical and microbiological Properties of earthen and concrete catfish ponds in central Niger Delta. International *Journal of Biological and Biomedical Sciences*, 2014; 3(5), 041-043.
19 R.A Wuana, F.E Okieimen. Heavy Metal in Contaminated Soils a Review of Sources, chemistry, Risk and Best Available strategies for remediation ISRN ECOLOGY, Vol. 2011, Article ID 40264720 pages, doi 10.5402/2011/402647.
20 A. N. Amadi, P.I, Olasehinde, E.A. Okosun, N.O. Okoye, I.A. Okunlola, Y.B Alkali, M.A. Dan-Hassan. A Comparative Study on the Impact of Avu and Ihie Dumpsites on Soil Quality in South-eastern Nigeria. *American Journal of Chemistry*, 2012; 2(1): 17 - 23.
21 M.A.N., Anikwe, K.C.A. Nwobodo. Long term effect of municipal waste disposal on soil properties and productivity of sites used for urban agriculture in Abakaliki, Nigeria. Bioresource Technology 2001; 83(2002): 241 - 250.
22 C. Njoku. Effect of Waste Dumpsites on Water and Air Qualities in Abakaliki, Southestern Nigeria. *International Journal of Plant & Soil* Science, 2014: 4(5): 455 - 460.
23 D.S., Buteh, I. Y. Chindo, E. O., Ekanem, E.M. Williams. “Impact Assessment of Contamination Pattern of Solid Waste Dumpsites Soil: A Comparative Study of Bauchi Metropolis.” *World Journal of Analytical Chemistry*, 2013; 1(4): 59 - 62.
24 T.C.N., Angaye, D.V. Zige, S.C., Izah. Microbial load and heavy metals properties of leachates from solid wastes dumpsites in the Niger Delta, Nigeria. *Journal of Environmental Treatment Techniques*, 2015; 3(3): 175 – 180.
25 E.C. Agedah, E.R. Ineyougha, S.C Izah, L.A., Orutugu. Enumeration of total heterotrophic bacteria and some physico-chemical characteristics of surface water used for drinking sources in Wilberforce Island, Nigeria. *Journal of Environmental Treatment Techniques*. 2015; 3(1), 28 – 34.