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THE QUANTITATIVE AND HEALTH RISK ASSESSMENT OF VOLATILE ORGANIC COMPOUNDS (VOCs) FROM MUNICIPAL SOLID WASTES DUMPSITES IN BAYELSA STATE, NIGERIA

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ABSTRACT

The reckless open burning of unsegregated waste stream releases toxic aerosols including volatile organic compounds (VOCs). This study focused on quantifying and assessing the health risk of VOC aerosol from dumpsites in Yenagoa Metropolis, Nigeria. Portable AEROQUAL meter was used for the air sampling from 7 locations, including control station. Result shows that the VOC levels ranged from 2.33 - 11.78 ppm, and below detection limit in the control station. Air quality model for the health risk assessment showed that the concentration of NOx emission was relatively safe, except for the 2 stations of the central dumpsites (LE and LF), which was predominantly very unhealthy. This study therefore concludes that the level of VOC emission and anthropogenic waste dumping should be checked regularly.

Key words: Air Quality, Municipal waste, Nitrogen oxides, Bayelsa State, Nigeria.

1. INTRODUCTION

Environmental sustainability and conservation of biodiversity is inevitably dependent on certain resources including ambient air quality (Angaye, 2019). Environmental pollution from the reckless handling of waste streams have been considered as a major issue of public health concern (Adejobi and Olorunnimbe, 2012; Njoku, 2014). Man's inevitable interface with the environment, has had its direct or indirect health effects in several ways including the exposure to toxicants, and infringment on vital resources (Tyagi *et al.*, 2014). The illicit dumping of MSWs across most cities in developing nation has had its attendant adverse effects on the ecosystem.

Even the adverse effects and green house effects of pollutant gases from dumpsites have become a global issue (Ighodaro *et al.*, 2015). In recent years, Volatile organic compound (VOCs) is considered as one of the major issues arising from poor handling of municipal solid waste (Ighodaro *et al.*, 2015). The components of VOC include methane and other non-methane aromatic hydrocarbon compounds including; benzene, butadiene, ethylbenzene, trichloroethylene, toluene and xylene. The bioavailability of VOCs varies depending on certain meteorological variables that influence ambient air quality (Angaye, 2019).

The toxicity of VOCs emission from dumpsite sites has become a major concern to waste workers and inhabitants around dumpsite (Deloraine, & Zmirou, 2015). Globally, several authors have reported on the levels of VOCs in ambient air (Ighodaro *et al.*, 2015), but few have reported on VOCs level around open dump sites in developing countries (Ojiodu *et al.*, 2013; Ighodaro *et al.*, 2015), where waste management is a major issue. As such data emanating from this study quantifying VOC emission and their associated health risk is worthwhile.

2. MATERIALS AND METHODS

2.1. Study Area

Yenagoa metropolis is the capital city of Bayelsa state, located in the southernmost part of Nigeria (latitude N04° 56' 57.8'' and longitude E006° 20' 08.2''). It was one of the states created by the Nigerian military Government in the Year 1996, with 8 Local Governments Areas (LGAs). It is an industrialized state with increasing level of urbanization due to oil discovery. The population of Yenagoa is over 300,000 (NPC 2006).

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2.2. Sampling of Air Quality

The sampling of air quality for VOC was carried out using portable hand-held aeroqual meter (AEROQUAL Series 300-New Zealand). The meter was switched on and the probe was projected to a height of 2 meters at the prevailing wind direction for suction, with a flow rate of 2.83 L/min (Angaye, 2019).

2.3. Air Quality Modeling and Risk Assessment

The health risk assessment modelling of VOC emission was carried out based on the schemes of Jayaraman 2007; Ligan *et al.*, (2014) and Wang *et al.*, (2017) as shown in Table 1. There median and geometric mean values were calculated using the formula for Air Quality index (AQI); described below:

$$AQI = \frac{Ci}{Si} X\ 100$$

Where AQI = Air Quality index

Ci = Individual concentration of the monitored pollutant

Si = geometric or median mean

Table 1: Range of threshold values for health risk assessments of AQI Index

Safe [0-50]	Moderate [51 -100]	Unsafe for sensitive group [101 - 150]	Unhealthy [151 – 200]	Very Unhealthy [201 – 300]	Hazardous [>300]

2.4. Statistical Analysis

Sampling of air quality was carried out in triplicates using SPSS-23 statistical software. Mean separation was carried out using Analysis of Variance (ANOVA), while level of significance was detected using Duncan multiple range Post Hoc ($p_{=}0.05$). In addition, Microsoft excel package was used to design the graph and chart.

3. RESULTS AND DISCUSSION

Result on the mean levels of Volatile Organic Compound (VOC) is presented in Figure 1. Results showed that the mean level of VOC ranged from 2.33 - 11.78 ppm, with higher values in wet season. In the first station of the central dumpsite (LE) recorded the highest VOC values, compared to station LD that recorded the lowest value in the dry season. In addition, the control station (LX) had VOC levels below detection limit for both seasons (Figure 1). Based on spatial variation, the mean VOC levels ranged from 2.39 – 9.56 ppm, with significant differences ($p<0.05$), apart from stations LA and LB. In addition, the control station (LX) indicated significant difference ($p<0.05$) compared to values in other stations (Figure 1).

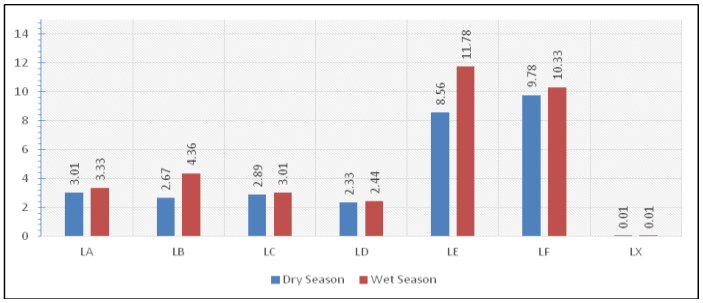

Figure 1: Mean levels of VOC emission around the dumpsites

Based on seasonal variation the levels of VOC ranged from 4.78 – 6.72 ppm with significant difference ($p<0.05$) between values of dry and wet seasons (Figure 2). The highest levels of VOC were recorded in the month of August during wet season, while lowest level was reported in March during dry season (Figure 2). Furthermore, statistically interaction of VOC levels between the stations and seasons showed significant difference ($p<0.05$).

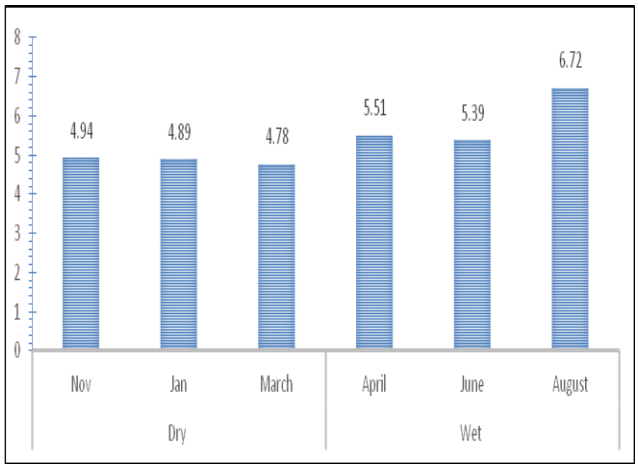

Figure 2: Monthly disposition of VOC emission around the dumpsites

The health risk assessment of the levels of VOCs associated with the dumpsite in all stations is presented in Table 2. At station LA the levels of VOCs were moderate in both scenarios and seasons. At station LB, health risk assessment of VOC based on median mean scenario was unsafe for sensitive group in dry season but moderate in wet season, as well as in both seasons using geometric mean. The median mean and geometric mean health risk assessments on VOC emissions in stations LC and LD were similarly moderate disposition in both dry and wet seasons. Apart from the first station of the central dumpsite (LE) which recorded an unhealthy condition in both seasons, very unhealthy dispositions of VOCs were reported in both seasons for the median mean and geometric scenarios (Table 2).

Table 2: Health Risk assessment of Volatile Organic Compounds associated with the dumpsites

	Median Mean Scenario		Geometric Mean Scenario	
	Dry Season	Wet Season	Dry Season	Wet Season
LA				
LB				
LC				
LD				
LE				
LF				

Safe [0-50]	Moderate [51 -100]	Unsafe for sensitive group [101 - 150]	Unhealthy [151 – 200]	Very Unhealthy [201 – 300]	Hazardous [>300]

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The values of VOCs in Eneka dumpsite of Port-Harcourt ranged from 0.40 – 1.30 ppm (Ezekwe *et al.*, 2016), was inconsistent compared to values recorded in Yenagoa metropolis. In Rumuolumeni dumpsite, Weli and Adekunle (2014), reported lower VOC values of 2.28 ppm, which was not in agreement with values recorded in Yenagoa metropolis. Higher VOC level than our current study ranging from 15.67 to 47.36µg/m^3 was recorded in Benin City (Ighodaro *et al*., 2015), and was attributed to the intensity of relative humidity and wind speed during the raining (wet) season (Cossu and Reiter, 1996; Bhaskar *et al*., 2010; Yousif *et al*., 2013). Higher levels of VOCs have been found to stagnate around many dumpsites (Weli and Adekinle, 2014; Angaye 2019). The attendant health effects of VOCs have been documented in literature (ATDSR, 2001; Efe, 2008; Weli, 2014).

4. CONCLUSION

The Health Risk and environmental impacts of VOCs associated with Municipal Solid Waste was assessed. Based on the results of the Air Quality Index (AQI) modling VOC emissions from the dumpsites were found to be safe, except for the two stations of the central dumpsites (LD and LE) which recorded a very unhealthy health risk. The levels of VOC go a long way to show levels of anthropogenic activities and poor management of waste streams which should be ameliorated without much ado.

REFERENCES

Adejobi, O. S., and Olorunnimbe, R. O. (2012). Challenges of Waste Management and Climate Change in Nigeria, Lagos State Metropolis Experience. *African J. Sci. Res*. 7(1), 346 - 362.

Angaye, T.C.N. (2019). Ecotoxicological activities of Municipal Solid Waste in Bayelsa State, Nigeria. Ph.D Thesis, Niger Delta University, Wilberforce Island, Nigeria.

ATSDR (1999). Toxicological Profile for Hydrogen Sulfide. US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta.

Bhaskar, B. V., and Mehta, V. M. (2010). Atmospheric pollutants and their relationship with meteorology in Ahmeddabad". *Aerosols and Air quality Research*, 10(4), 301 - 315.

Cossu R. and Reiter M. (1996), Landfill gas condensate production and disposal, In T.H. Christensen, R. Stegmann, R. Cossu, (editors) Landfilling of Waste. Published by Taylor and Francis Books Ltd., p485.

Efe, S. I. (2008). Spatial distribution of particulate air pollution in Nigerian cities: Implications for human health. *The Environmentalist*, 7(2), 1 - 5.

Ezekwe, C. I., Agbakoba, C., and Igbagara, P. W. (2016). Source Gas Emission and Ambient Air quality around the Eneka co-disposal landfill in Port-Harcourt, Nigeria. *International Journal of Applied Chemistry and Industrial Sciences*, *2*(1), 11 - 23.

Ighodaro, A., Anegbeb B., and Okuo, J. M. (2015). Emission Levels of Volatile Organic Compounds from open Dumpsite in Benin Metropolis. *Nigerian Journal of Applied Science*, 33, 253 – 264.

Jayaraman, N. G. (2007). Air Quality and Respiratory Health in Delhi. *Environmental Monitoring and Assessment*, *135*, 313 - 325.

Ligan, B. A., Poyyamoli, G., Chandira J., and Boss, U. (2014). Assessment of Air Pollution and its Impacts near Municipal Solid Waste Dumpsites Kammiyampet, Cuddalore, India. *International Journal of Innovative Research in Science, Engineering and Technology*, *3*(5), 12588 - 12598.

Njoku, C. (2014). Effect of Waste Dumpsites on Water and Air Qualities in Abakaliki, Southestern Nigeria. *International Journal of Plant & Soil Science*, 4(5), 455 - 460.

NPC (2005). Report on the 2003 National Demographic and Health Survey. National Population Census Commission, Abuja, Nigeria.

Ojiodu, C. C., Okuo, J. M., and Olumayede, E. G. (2013). Volatile Organic Compound (VOCs) Pollution in Iganmu Industrial Area, Lagos State, Southwestern Nigeria. *Scholarly Journal of Biotechnology.* 2(4), 43-49 (2013).

Tyagi, S., Garg, N., and Paude, N. (2014). Environmental Degradation: Causes and Consequences. *European Researcher*, 8(81), 1491 - 1498.

Wang, Y., Zhou, M., Han, Y., Zhou, J. (2017). A Fuzzy Expression Way for Air Quality Index with more comprehensive information. *MPDI Sustainability*, 9(8), 1 - 16.

Weli, V.E. (2014) Spatial and seasonal variation of atmospheric pollutants concentration in Port Harcourt metropolis. An Unpublished Ph.D thesis. University of Ibadan. Nigeria.

Weli, V.E., Adekunle, O. (2014). Air Quality in the Vicinity of a Landfill Site in Rumuolumeni, Port Harcourt, *Nigeria. Journal of Environment and Earth Science*, *4*(10), 1 - 9

Yousif, T. A., and Tahir H. M. M. (2013). The Relationship between Relative Humidity and the Dew point Temperature in Khartoum State, Sudan. *Journal of Applied and Industrial Sciences*, 1(5), 20 – 23.

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