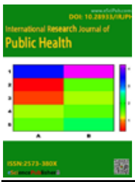
Research Article **IRJPH (2018) 2:18**



International Research Journal of Public Health (ISSN:2573-380X)

Spatial and Temporal Level of Methane Gas from Some Dumpsites in Yenagoa Metropolis

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ABSTRACT

The emission of methane from dumpsite have become a global mantra due to its remarkable effect on global climate change. This study assessed the levels of methane emissions from 6 dumpsites using portable air quality meter (AEROQUAL-Series 300). Results showed that the spatial level of methane ranged from 1.00 - 6.44 ppm. Based on temporal variation level of methane ranged from 1.59 – 4.09 ppm ($p<0.05$), with higher values in wet season. Meanwhile methane emission was not detected in the control station. Based on model for Air Quality Index (AQI), methane emission were predominantly rated as safe and moderate, except for stations LE and LF. Notwithstanding, these results confirmed the emission of methane from the dumpsite due to anthropogenic activities. We therefore recommend policies aimed at sequestration methane emissions, including the reuse, recycling and reduction of waste stream.

Keywords: Methane, Dumpsite, Waste stream, anthropogenic activities

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How to cite this article:
Tariwari C. N Angaye, Elijah I. Ohimain and Donbebe Wankasi.Spatial and Temporal Level of Methane Gas from Some Dumpsites in Yenagoa Metropolis.International Research Journal of Public Health, 2018; 2:18.

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Website: http://escipub.com/

1 INTRODUCTION

Methane is one of the foremost greenhouse gas with globalized effect on climate change. In terms of density methane is gas lighter than air, and have a stagnant and odourless characteristic that tends to accumulate in enclosed system and composting area (Rim-Rukeh, 2014). The origin of methane gas is linked to the anaerobic decomposition of biomass, by a group of microbes called methanogens (Nayono 2010; Lam and Lee, 2011; Amuda *et al.* 2014; Ohimain and Izah, 2017).

Depending on the temperature and moisture contents, methane gas forms about 45 - 60% of dumpsite gas (Börjesson and Svensson 1993; Metz, et.al, 2007). For instance, the concentration of methane were found to be lower in solid manure than liquid manure, with increase in temperature with propensity to explode if concentration reaches 50000ppm (Rim-Rukeh, 2014). The greenhouse propensity of methane is greater than carbon-monoxide (Gribben, 1986). Inappropriate application or poor management of municipal solid waste system will increase the greenhouse effect with incidence of global warming. For instance, as established in literature 49% of England's methane emissions in 2007 were attributed to application of landfills system for waste disposal (Burney *et al.*, 2011).

The ecotoxicity of waste stream normally depends the origin, magnitude and characteristic of waste produce (Angaye and Abowei, 2017). It was globally reported by the International Panel on Climate Change (IPCC) that, besides emissions from fossil fuel combustion, methane emission from landfills account for 3 - 19% of the anthropogenic sources and global warming (IPCC, 1996; Metz *et al*, 2007). Anthropogenic activities associated with waste stream is linked to methane emission and global climate change. Metropolis in most developing countries generate huge waste stream with inadequate management (Angaye and Abowei, 2017), as such this investigation have become a necessity.

2 MATERIALS AND METHOD

2.1 Study Area

Yenagoa metropolis is the capital territory of Bayelsa State in the Niger Delta Region of Nigeria, located on the Southermost part of the Nigerian map. It is a wetland, with several network of creeks, rivers and mangrove zones. It is one of the industrialized area of Nigeria due to the discovery and exploration of hydrocarbon produce. The study area have a tropical humid hot climate with two prevailing seasons. The wet season which commence from April to October is relatively cool and rainy. On the other hand, the dry season which ranges from November to March, is usually hot and dusty (Weli and Adekunle, 2014). The precipitation level is over 2000mm per annum, and elevation of 45m above mean sea level.

2.2 Sampling of methane

Data on methane level around dumpsites were collected in dry and wet seasons. The sampling was carried out biweekly in a post-monthly manner from November 2016 through September 2017. The sampling was carried out in seven stations including the control (LX). The sampling stations were; Akenpai (LA), Etegwe (LB), Opolo Market (LC), Kpansia Market (LD), and two sampling Stations (LD and LF), in the Central Dumpsites in the outskirt of Yenagoa. The geo-referencing of the sampling stations were carried out using Germin etrex GPS (Taiwan). The level of methane was monitored using portable AEROQUAL multi-probe gas metre (Aeroqual Limited Auckland-New Zealand-Series 300).

2.3 Statistical analysis

All data in this study were sampled in triplicates and expressed as Mean ±Standard Deviation. Duncan's multiple range test ($P = 0.05$), was used as the Post-Hoc used to establish Difference in means. The environmental risk was calculated based on model of air quality index (AQI) as described by several authors (Kaushik et al., 2005; Ligan et al., 2014; Bhutiani et al., 2017).

3 RESULT AND DISCUSSION

As presented in Figure 1, the spatial mean background trending of methane gas (CH4) ranges from 1.00 - 6.44 ppm. Generally, the levels of CH4 was higher during wet season compared to dry season. It is noteworthy that station LF, recorded the highest mean values, compared to station LD in both seasons indicating the lowest levels of CH4 gas.

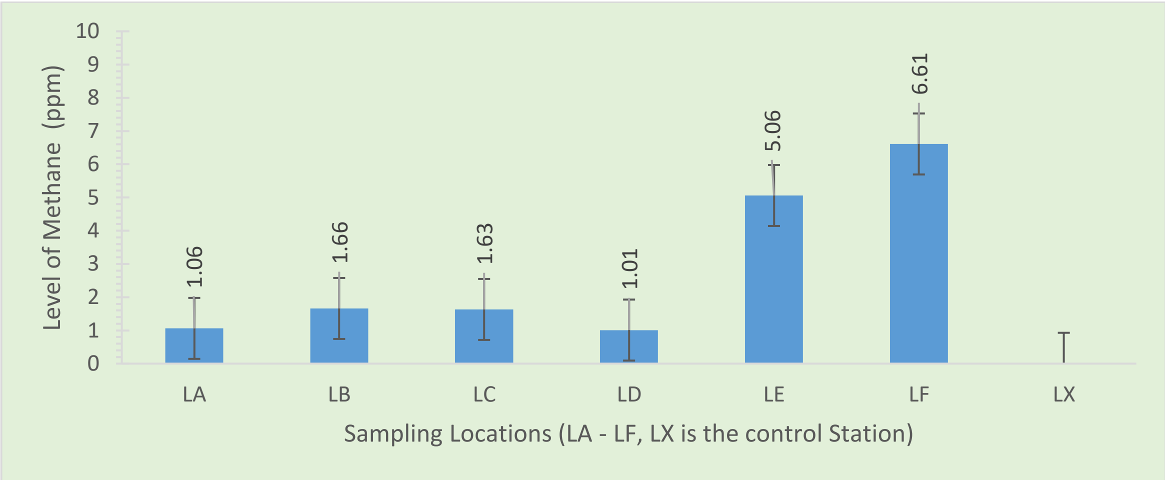

Figure 1: Spatial Level of Methane gas associated with the dumpsite

Furthermore, it was noteworthy that in the control station (LX), the mean level of methane was below detection limit for both seasons (Figure 1). Notwithstanding, based on spatial variation, the mean methane levels ranges from 1.00 - 6.61 ppm, with significant differences ($p<0.05$), apart from stations LB and LC. In addition, the control station (LX), indicated significant difference ($p<0.05$) compared to values in other stations as presented in Figure 1.

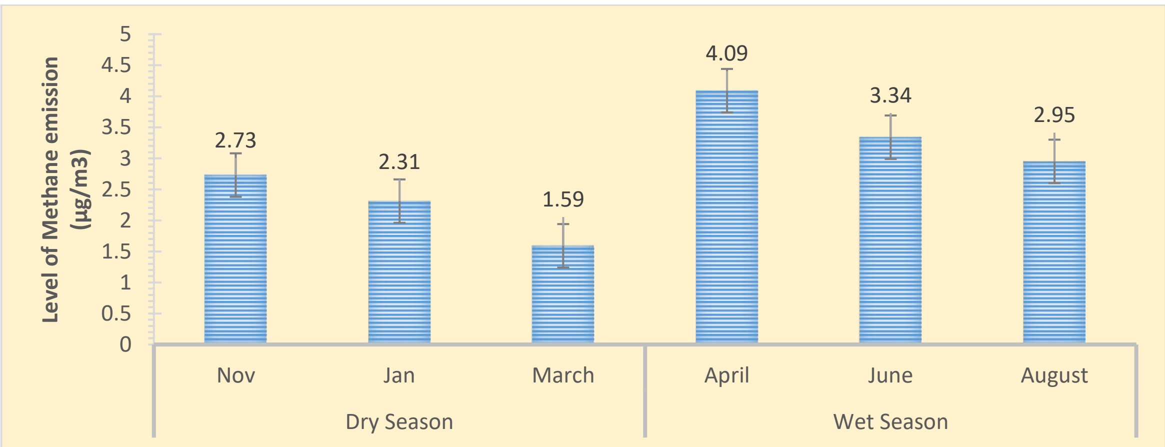

Figure 2: Seasonal Level of Methane gas associated with the dumpsite

Based on seasonal variation the levels of methane ranges from 1.59 – 4.09 ppm with significant difference ($p<0.05$) between values of dry and wet seasons (Figure 2). Notwithstanding, highest levels of methane was reported in the month of April during wet season, while lowest level was reported in March during dry season (Figure 2). Furthermore, statistically interaction of methane levels between the stations and seasons showed significant difference ($p<0.05$).

Table 1: Environmental Risk assessment for Methane gas

	Scenario A (Median Mean)		Scenario B (Geometric Mean)	
	Dry Season	Wet Season	Dry Season	Wet Season
LA				
LB				
LC				
LD				
LE				
LF				

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

Table 1 presents the environmental risk assessment on the levels of methane associated with the dumpsite. Based on scenario A, the levels of methane gas in station LA was moderate in both season; but safe in both seasons based on scenario B. Whereas in station LB, based on scenario A, the levels of methane was moderate in dry season, and unsafe for sensitive group in wet season.

In addition, based on scenario B methane emission in LB was safe and moderate in dry season and wet seasons respectively. Station LC indicated an unsafe level for sensitive group in dry and moderate level in wet season, but based on geometric mean it was relatively safe for both seasons. Results of station LD, indicated a moderate level in both season for median mean, but safer levels in both seasons based on scenario B. Furthermore, methane levels were hazardous in both seasons and scenarios as reported in station LE. However, it was safe for wet season in both scenarios, but hazardous in dry season for both scenarios (Table 1).

Our result is comparable to findings of other authors. Methane emissions in Eneka dumpsite located in Port-Harcourt was below detection limit as reported by Ezekwe *et al.*, (2016). Result of CH_4 from another dumpsite located in Rumuolumeni of the same state indicated emission with value of 0.06 ppm according to Weli and Adekunle (2014). Higher CH_4 emission in the range of 2310 - 2771 ppm was reported in Delta State according to (Rim-Rukeh, 2014). In Nekede dumpsite of Imo State, the incidence of methane emissions was in the ranges of 0.12 – 0.14 and 0.09 – 0.12 ppm in morning and evening respectively (Ubouh, et al., 2016).

4 CONCLUSION

This research investigated the spatial and temporal level of methane gas associated with MSWs dumpsites in Yenagoa metropolis. Results showed significant level of methane emission, especially from the central dumpsites (LE and LF). Meanwhile, methane level was below detection limit in the control station (LX). Consequently, upon our finding the level of methane is on the rise due to anthropogenic activities associated with poor management of waste stream. Methane emission pose grave environmental threat due to its greenhouse effects; as such the sequestration of methane have become necessary. We therefore recommend the gasification of methane for power generation, as a waste to wealth policy. In addition, dumping of waste close to public places should be prohibited, effective legislations and policies should be enacted to ensure the reduction, reuse and recycling of waste stream.

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- Title: International Research Journal of Public Health
- ISSN: 2573-380X
- DOI: 10.28933/IRJPH
- IF: 1.36 (citefactor)
- Email: IRJPH@escipub.com
- TEL: +1-281-656-1158