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Environmental and Health Risk of Hydrogen Sulphide (H_2S) Levels Around some Dumpsites in the Niger Delta Region: A Case Study of Yenagoa Metropolis

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Abstract

Emission of Hydrogen Sulphide (H_2S) from dumpsites has become a global threat due to its impact on global climate change. This study assessed the spatial and seasonal levels of H_2S emissions from 6 dumpsites (LA - LF), with portable air quality meter (AEROQUAL-Series 300). Results showed that the spatial level of H_2S ranged from 1.40 ppm - 14.34 ppm. Based on seasonal variation level of H_2S ranged from 1.88 ppm – 3.86 ppm ($p<0.05$), with higher values in wet season. Meanwhile H_2S were not detected in the control station (LX). Based on model for Air Quality Index (AQI), H_2S emission was predominantly rated as safe and moderate, except for the two stations in the central dumpsite (LE and LF). These results confirmed the emission of H_2S from the dumpsite due to anthropogenic activities. We therefore recommend policies aimed at sequestration of H_2S, by the reduce, reuse and recycle policy of waste stream.

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Introduction

Air pollution is the introduction/emission of harmful solid or gaseous substances into the atmosphere, which are capable of inducing adverse effects to all forms of biodiversity including man and his valuable possessions. Harmful substances that impair air quality include Carbon monoxide, Oxides of Nitrogen and Sulphur, Hydrogen Sulphide, Methane, Ammonia, suspended particulates etc. Air pollution results from both anthropogenic and lithogenic activities [1], however anthropogenic impacts and their sources are more influential compared to lithogenic impacts [1]. As a result of poor and inappropriate management of Municipal solid waste, most cities are faced with serious health and environmental problems [2].

High concentration of individual pollutant gases or their synergy with others [3], could have adverse human and environmental effects. Inhalation of these gases is one of the commonest means of exposure. Accumulation of pollutants in the human body through inhalation of air is an important route [4]. Hydrogen Sulphide is basically responsible for the foul smell associated with dumpsites. According to Rim-Rukeh [5], it can be sensitive at concentration as little as 0.11 – 0.33 ppb, with flammability at highest and lowest concentrations of 44% and 4% respectively. Furthermore, it is colourless and denser than normal air, and has a characteristic property of an objectionable odour like rotten-egg, at a very minute concentration [5]. Emission of H_2S occurs when putrefying microbes decompose biomass under anaerobic conditions.

It was 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 [6, 7]. Another aspect of air pollution is Suspended Particulate Matter (SPM). Air pollution is largely linked to high rates of distress and mortalities resulting from respiratory and cardiovascular ailments [8 - 11], with the emission of some basic pollutant gases (NOX, SOX and CO) from most municipalities indicated as major contributors [11].

The research by Akinremi [12], has indicated a correlation between the rates of pollution, mortality and life expectancy. The adverse effects posed by air pollution cannot be overemphasized. Some signs and symptoms are wheezing, coughing, as well as exacerbation of already existing diseases like asthma. It can cause or promote other major health problems like heart disease, stroke and lung cancer etc. It is also worthy of note that when putrefying organism act on biomass from waste stream they enhance the release of pollutant gases [13], like methane, ammonia and hydrogen sulphide [1]. The broad spectrum of harmful effects on man and his environment traceable to gaseous air pollution demands a greater commitment to the development of environmental policies and strategies to manage the challenge posed by the emission of hydrogen sulphide from dumpsites in Yenagoa metropolis effectively.

Materials and Method

Study Area

Bayelsa State is located in the southernmost part of the Nigerian map, with its state capital as Yenagoa. Being a wetland, it has several swamps, creeks, rivers and mangrove vegetation. Due to the abundance of natural resources, the exploration of hydrocarbon products has become a mainstay. It is characterized by two climate regimes, being the wet season, which commence from April to October and dry season which ranges from November to March. It has an elevation of 45 m above mean sea level and a precipitation level of over 2000 mm per annum.

Sampling of Hydrogen Sulphide Gas (H_2S)

Hydrogen sulphide gas around the dumpsites was sampled in dry and wet seasons. The sampling was carried out in a post-monthly manner from November 2016 through September 2017. The sampling was carried out in seven stations (LA - LF) 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. Portable AEROQUAL multi-probe gas metre was used to monitor the level of H_2S (Aeroqual Limited Auckland-New Zealand-Series 300).

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 to establish Difference in means. The environmental risk was calculated based on air quality index (AQI) modelling scheme documented in literature [2, 3].

Results and Discussion

As presented in Figure 1, the mean background trending of Hydrogen Sulphide (H_2S) ranges from 1.35 - 8.89 ppm, with lower levels in dry season compared to wet season. It is noteworthy that the second station of the central dumpsite (CDS 2), recorded the highest mean value in wet season, compared to dry season value of Akenpai station indicating the lowest level of H_2S gas. Furthermore, it was noteworthy that the mean level of H_2S was below detection limit for both wet and dry seasons in the control stations (Figure 1).

The spatial variation of H_2S level amongst the dumpsite stations is presented in Figure 2. Results showed that H_2S level was low, apart from the two stations of the central dumpsite. Notwithstanding the level of H_2S ranged from 1.40 - 14.34 ppm. In addition, the control station recorded values below detection limit (0.01 ppm), compared to values in other stations (Figure 2). Based on seasonal variations (Figure 3), the levels of H_2S ranged from 1.88 – 4.43 ppm with highest and lowest values in the months of April and March respectively (Figure 3).

Table 1 presents the seasonal health risk assessment on the levels of H_2S associated with the dumpsites in all stations. The health risk assessment was based on two scenarios, which were the median mean scenario (MMS), and the Geometric Mean Scenario (GMS). Based on the MMS, the levels of H_2S in Akenpai (LA) station were moderate in both seasons; and also safe in both seasons based on the GMS. In the Etegwe station (LB), the MMS indicated that H_2S level was moderate in dry season, but unsafe for sensitive group in during the wet season. However, based on the GMS H_2S levels were safe in dry season and moderate in wet season (Table 1). The level of H_2S in Opolo station (LC) was unsafe for sensitive group in dry season, and moderate in wet season based on the MMS. In the same vein, moderate condition was observed in both seasons based on the GMS. In Kpansia market (LD), the GMS, showed that H_2S was safe in the dry season and moderate in the wet season. Comparatively, based on the MMS H_2S levels were moderate in both seasons. Furthermore, in the two stations of the central dumpsites (LE and LF), the levels of H_2S were hazardous in both seasons and scenarios, except for the GMS in station 1 during wet season which had an unhealthy condition (Table 1).

Hydrogen Sulphide emissions associated with dumpsites in Port-Harcourt were reported as 0.19 mg/m^3 [14]. In Delta State, it ranged from 3.4 - 7.7 ppm [5]. Zaria Metropolis in Kaduna State, results showed that H_2S levels ranged from 0.00135 ppm - 0.0315 ppm in dry season, and 0.0005 ppm - 0.0037 ppm in wet season [15]. In Nekede, it was reported that morning and evening emissions of H_2S from dumpsites range from 0.80 ppm – 0.84 ppm and 0.79 ppm – 0.82 ppm respectively [16].

Beside the environmental hazard associated to H_2S, Health hazard have also been reported. According to the Occupational Safety and Head Administration [17], exposure to H_2S at low concentration can cause nasal, eye, throat, respiratory tract irritation and exacerbate conditions of sensitive groups like asthmatic patient. Exposure to moderate emission can result to severe eye and respiratory impairment including coughing, dyspnea, headache, dizziness, nausea, vomiting, staggering and excitability [17, 18]. High level exposure to H_2S have been documented to cause rapid grave health problems including; shock, convulsions, suffocation, extremely rapid unconsciousness, coma and death [17]. Large volume of H_2S emanate from dumpsite [1], and the need to mitigate their envisaged adverse consequences have become necessary.

Conclusions

This research investigated the level of H_2S associated with MSWs dumpsites in Yenagoa metropolis. Results showed significant levels of H_2S, especially from the central dumpsites (LE and LF). Meanwhile, H_2S level was below detection limit in the control station (LX). Consequent upon our findings, the level of H_2S may be on the rise due to a rise of anthropogenic activities together with poor management of waste stream. The emission of H_2S may pose grave environmental threats

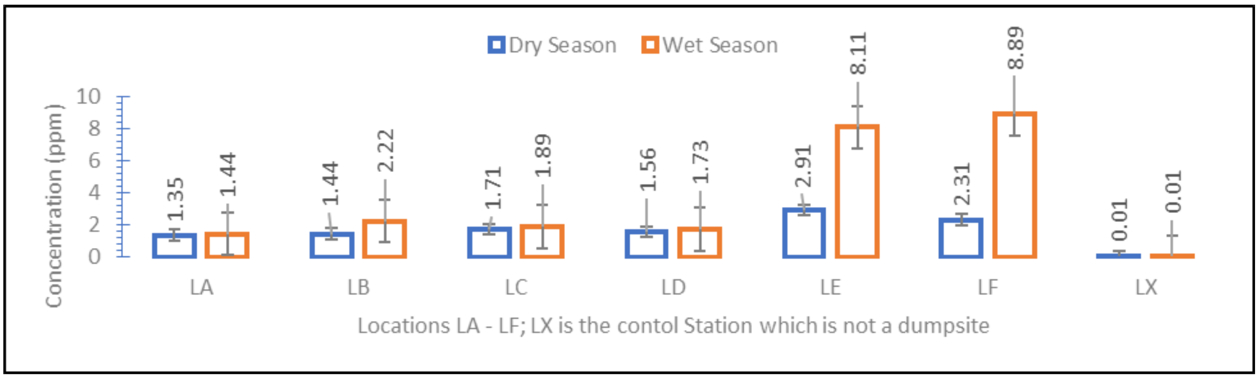

Figure 1. Mean background of Hydrogen Sulphide gas associated with the dumpsites

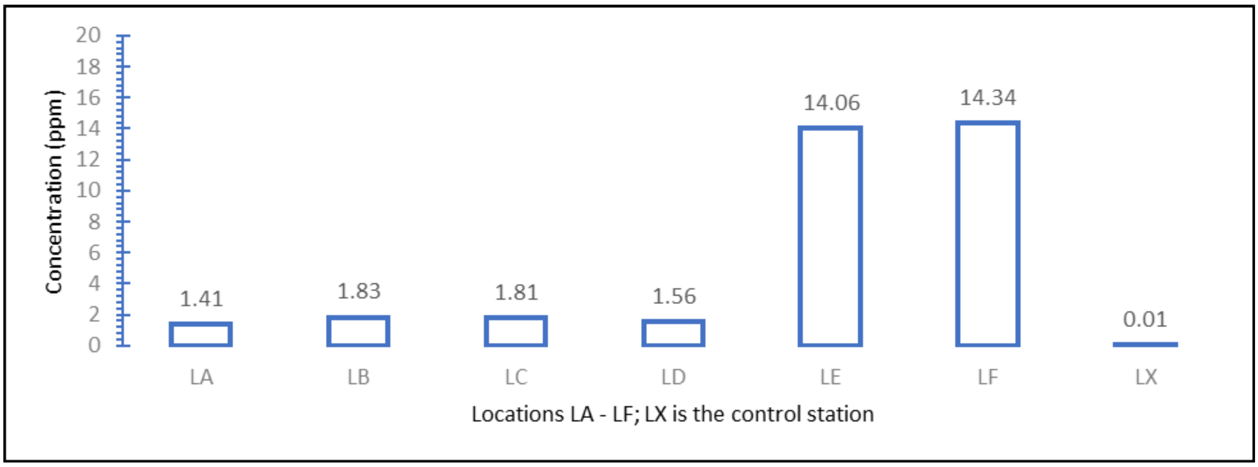

Figure 2. Spatial variation of H_2S gases associated with the dumpsites

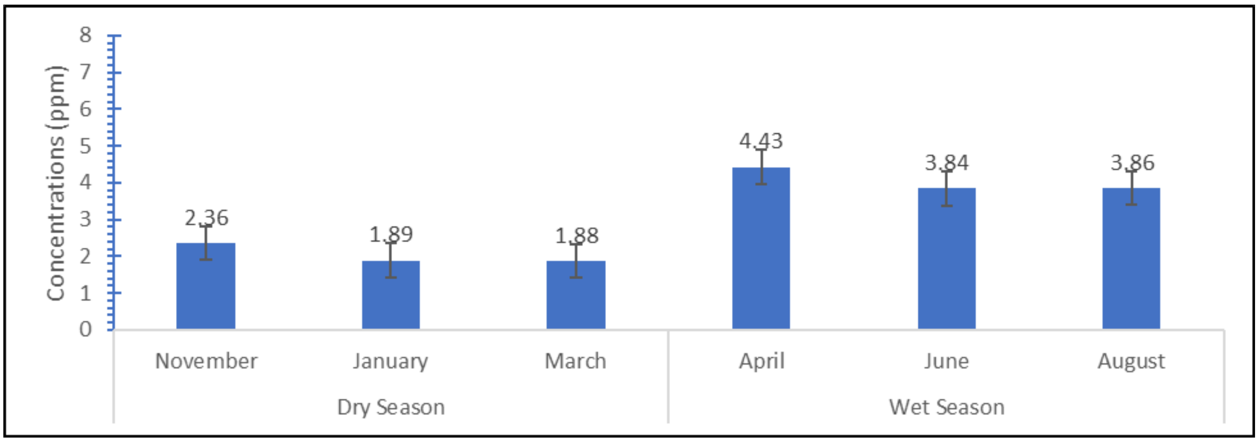

Figure 3. Seasonal variation of H_2S gases associated with the dumpsites

Table 1. Health Risk assessment of Hydrogen Sulphide

	Median Mean Scenario		Geometric Mean Scenario		
	Dry Season	Wet Season	Dry Season	Wet Season	
LA					
LB					
LC					
LD					
LE					
LF					
Keys					
Safe [0-50]	Moderate [51 -100]	Unsafe for sensitive group [101 -150]	Unhealthy [151 – 200]	Very Unhealthy [201 – 300]	Hazardous [>300]

due to its greenhouse effects. Consequently, the sequestration of H_2S has become necessary. We therefore recommend the gasification of H_2S for power generation, as a waste to wealth policy. In addition, dumping of wastes close to public places should be prohibited following the provision modern or sanitary landfills. Furthermore, effective legislations and policies should be enacted to ensure the reduction, reuse and recycling of waste stream.

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