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ORIGINAL RESEARCH

Environmental Impacts of Municipal Solid Wastes in Yenagoa Metropolis, Bayelsa State, Nigeria

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ABSTRACT
Municipal solid wastes (MSWs) stream is becoming problematic due to the threat they posed to the environment, biodiversity and public health. Due to improper and/or insufficient management strategies unsegregated MSWs are burnt or left to undergo biological or physicochemical transformation, thereby producing foul odour that infringes on ambient air quality. In this study, the seasonal impacts of 7 waste dumpsites including control were assessed using portable air quality and meteorological metres. Result were reported as; temperature (dry: 31.33±0.98 - 33.76±1.00 and wet: 27.91±0.44 - 28.48±0.18 ^{O}C), relative humidity (dry: 57.24±7.16 - 61.84±5.66 and wet: 82.93±3.44 - 86.58±4.11%), wind speed (dry: 1.22±0.45 - 3.49±1.18 and wet: 0.73±0.07 - 5.25±0.06 m/s), and wind direction was predominantly South-West in both seasons. carbon monoxide (dry 0.18±0.03 - 1.23±0.10 and wet: 0.00±0.00 - 0.54±0.04 ppm), hydrogen sulphide (0.42±0.53 - 6.95±1.49 and 0.07±0.01 - 7.44±1.99 ppm), Oxides of Sulphur (0.01±0.00 - 0.81±0.08 ppm for both season), oxides of Nitrogen (dry 0.01±0.00 - 0.82±0.07 and wet: 0.01±0.00 - 0.33±0.04 ppm). Compared to the control values, results indicated higher anthropogenic impact of MSWs on ambient air quality with regards to seasonal variation. Consequent upon these findings, we urge the government and community leaders to intervene and educate inhabitants on the danger posed by anthropogenic activities arising from poor handling of MSWs.

KEY WORDS: *Air Quality, Anthropogenic activity, Municipal Solid Waste, Yenagoa Metropolis*

INTRODUCTION

The problems associated with poor management of municipal solid wastes (MSWs) has become a source of concern. There is swift population growth as a result of urbanization and industrialization of most developing nation (Lingan *et al*., 2014). Large waste streams are generated with a corresponding inappropriate, inefficient or inadequate management strategies. As such, poor MSWs handling has acquired an alarming status which has directly or indirectly infringed of vital environmental components especially air quality (Chatterjee, 2010), which could become a threat to the ecosystem.

The application of landfill as a means for disposing refuse has become a mainstay in many developing and industrialized nations (Oyelami *et al*., 2013), however it is has become more worrisome that this method has become a threat to biodiversity and public health due to substandard and inappropriate application (Adewole, 2005). Leachate of refuse originating from landfill can undergo several forms of transformations (Al Sabahi *et al*., 2009), which could be physical, biological or chemical; and consequently, results as major sources of air, water, and soil pollution (Christensen *et al*., 1998). Poor management of refuse in has been attributed human, economic, environmental and biological losses (Sharholy, 2008).

The global problem associated with municipal solid wastes (MSWs), and their associated management cannot be overemphasized. Over the past decades, in most developing country this problem has abruptly escalated due population explosion, urbanization and industrialization (Lingan *et al*., 2014), thereby acquiring an alarming status which is a threat to the environment and public health (Sharholy *et al.,* 2008; Chatterjee, 2010). In most developing countries, there are massive streams of MSWs with inappropriate or poor management strategies which results to environmental pollution (Angaye *et al*., 2015). It is worthy of note that environmental air pollution from dumpsites is inevitably linked to rapid global warming. This study therefore seeks to determine the associated environmental impact caused to urban dwellers around solid waste dumpsite in Yenagoa Metropolis

RESULTS AND DISCUSSION

Table 1 presents the spatial and seasonal of the dumpsites. Result showed that in dry season temperature ranged from 31.33±0.98 - 33.76±1.00 ^{O}C compared to values of the wet season (27.91±0.44 - 28.48±0.18 ^{O}C), with significant difference ($p<0.05$). Furthermore, with the exception of dumpsite in Kpansia market, there was no significant differences amongst temperature of sampling stations in dry season ($p>0.05$), as well and values of wet season. However, temperature was relatively higher in the dumpsites compared to the control ($p<0.05$). The highest temperature was indicated in the second station of the central dumpsite (CDS 2), in dry season. It was worthy of note that higher temperatures were recorded in dry season compared to wet season. With significant difference ($p<0.05$), the relative humidity of the dumpsites was lower in dry season (57.24±7.16 - 61.84±5.66%), compared to wet season (82.93±3.44 - 86.58±4.11%). This shows that temperature increases with decrease in relative humidity ($p<0.05$). Whereas, wind speed in the range of 1.22±0.45 - 3.49±1.18 m/s was reported in dry season, compared to 0.73±0.07 - 5.25±0.06 m/s values of wet season.

The highest level of wind speed was recorded in Etegwe during the wet season, while the lowest value was in Opolo market of the same season. In dry season, with the exception of Mopol base, Kpansia and CDS 2 which was statistically similar to the control, there was no significant difference in terms of wind speed values of the dumpsites ($p>0.05$). In wet season, there was significant difference in wind speed values including the control ($p<0.05$). In dry season, wind direction was predominantly South-West, as only Kpansia market and the control station recorded wind speed in a North-East direction. Similarly, in wet season wind speed was predominantly South-West with dumpsites in Etegwe and Kpansia market indicating wind direction in a North-East manner

Table 2 presents the results of pollutant gases associated with the dumpsites. With exception of dumpsites in Kpansia market that was not statistically different from the control ($p>0.05$), Carbon monoxide (CO), was higher and in the range of 0.18±0.03 - 1.23±0.10 ppm during the dry season. On the other hand, except the CDS 1 and 2 the concentration of CO was significantly lower ($p<0.05$) in wet season and was in the range of 0.00±0.00 - 0.54±0.04 ppm. Notwithstanding, compared to the control highest level of CO was indicated during the dry season in the central dumpsite (CDS 1 and 2), and lowest in Etegwe and Kpansia Market during the wet season ($p<0.05$). With exception of dumpsites in Etegwe, CDS 1 and 2, there was no significant difference ($p>0.05$) in the concentration of Sulphur oxides (SO_X). Notwithstanding, SO_X ranged from 0.01±0.00 - 0.81±0.08 ppm in dry season with a similar trend in wet season. However, with exception of Etegwe and Kpansia market in wet season there was significant difference in SO_X concentrations of the dumpsites ($p<0.05$)

Results also showed that Oxides of Nitrogen (NO_X) was in the range of 0.01±0.00 - 0.82±0.07 ppm during the dry season. There was no significant difference amongst the sampling stations except for the central dumpsites 1 and 2 ($p>0.05$For wet season, NO_X was lower compared to dry season in the range of 0.01±0.00 - 0.33±0.04 ppm. Furthermore, with exception to CDS 1 and 2, there was no significant difference amongst the sampling stations for both dry and wet seasons as presented in Table 2 ($p<0.05$). For levels of hydrogen sulphide (H_2S), values within the ranged of 0.42±0.53 - 6.95±1.49 ppm was reported during the dry season compared to wet season in the range of 0.07±0.01 - 7.44±1.99 ppm. Furthermore, for dry season with exception to Etegwe and Kpansia market, there was significant difference in H_2S concentration ($p<0.05$). Comparatively, in wet season the central dumpsite show significant difference

Table 1: Spatial and seasonal distribution of Meteorology in some Municipal Solid Waste Dumpsites of Yenagoa Metropolis

Sampling Stations	Coordinates		Dry Season				Wet Season			
	Latitude	Longitude	Temperature (°C)	Relative Humidity (%)	Wind Speed (m/s)	WD	Temperature (°C)	Relative Humidity (%)	Wind Speed (m/s)	WD
Mopol Base	N04° 57′ 46.7″	E006 22′ 01.6″	32.03±1.37cd	57.26±6.74b	3.49±1.18e	SW	27.91±0.44a	83.79±4.36d	3.57±0.35e	SW
Etegwe Bridge	N04° 56′ 57.8″	E006° 21′ 23.6″	31.73±2.22cd	58.51±7.55b	2.80±1.92dcdc	SW	27.97±0.68a	84.36±4.13d	5.25±0.06f	NE
Opolo Market	N04° 56′ 57.8″	E006° 20′ 08.2″	32.31±1.21d	57.24±7.16b	1.22±0.45ab	SW	27.96±0.16a	86.58±4.11d	0.73±0.07a	SW
Kpansia Market	N04° 55′ 30.4″	E006° 19′ 04.2″	31.33±0.98c	61.84±5.66bc	2.38±0.15de	NE	28.48±0.18ab	82.92±3.44d	2.34±0.14cd	NE
Central Dumpsite 1	N04° 51′ 50.2″	E006° 51′ 54.5″	33.66±0.97d	50.61±2.84a	1.75±0.19bc	SW	28.41±0.42a	83.98±5.39d	1.84±0.06bc	SW
Central Dumpsite 2	N04° 51′ 28.4″	E006° 15′ 58.3″	33.76±1.00d	49.12±4.00a	3.09±0.70de	SW	28.22±0.16a	84.17±4.24d	3.56±0.02e	SW
Control	N04° 56′ 55.5″	E006° 20′ 26.0″	29.35±0.29b	64.55±0.32c	3.21±1.43e	NE	28.21±0.67a	84.19±3.54d	4.62±0.23f	SW

Data expressed as mean ± Standard Deviation, difference alphabetical subscript indicates significant difference. WD means wind direction

Table 2: Spatial and seasonal distribution of Air quality in some Municipal Solid Waste Dumpsites of Yenagoa Metropolis

Sampling Stations	Dry Season				Wet Season			
	CO (ppm)	SO_X (ppm)	NO_X (ppm)	H_2S (ppm)	CO (ppm)	SO_X (ppm)	NO_X (ppm)	H_2S (ppm)
Mopol Base	0.47±0.14b	0.02±0.01a	0.17±0.15ab	1.93±0.60b	0.02±0.01a	0.31±0.09c	0.01±0.00a	0.14±0.03a
Etegwe	0.91±0.20cd	0.21±0.16b	0.03±0.01b	0.42±0.53a	0.01±0.00a	0.01±0.00a	0.01±0.00a	0.07±0.01a
Opolo	0.49±0.19b	0.03±0.01a	0.01±0.00a	1.95±0.52b	0.25±0.04bc	0.35±0.06c	0.01±0.00a	0.33±0.07a
Kpansia	0.02±0.01a	0.01±0.00a	0.18±0.09ab	0.20±0.03a	0.01±0.00a	0.01±0.00a	0.01±0.00a	0.19±0.04a
CDS 1	1.23±0.39d	0.81±0.08f	0.46±0.47c	5.00±1.11c	0.54±0.04bc	0.81±0.08f	0.23±0.16abc	5.88±0.44d
CDS 2	1.18±0.14d	0.71±0.15e	0.82±0.07d	6.95±1.49e	0.31±0.10bc	0.62±0.04d	0.33±0.04bc	7.44±1.99e
Control	0.02±0.01a	0.01±0.00a	0.01±0.00a	0.01±0.00a	0.01±0.00a	0.01±0.00a	0.01±0.00a	0.01±0.00a

Data expressed as mean ± Standard Deviation, CO: Carbon monoxide, H_2S: Hydrogen sulphide, SO_X: Oxides of Sulphur, NO_X: Oxides of Nitrogen, VOC: Volatile organic carbon

($p<0.05$) compared to other dumpsites.

Our finding is comparable with other investigation. The assessment of meteorological and air quality of Eneka dumpsite in Port-Harcourt had the following values. For meteorology, temperature ranged from 33.5 – 36.8°C, with relative humidity of 53.2 – 67.30%, wind speed was 1.10 – 2.4 m/s, with wind direction predominantly south-west. Air quality values were 0.30 – 0.40 for nitrogen, 0.03 – 0.06 for carbon dioxide, 0.00 – 4.00 for carbon monoxide, 1.00 – 2.00 for ammonia and < 0.01 for sulphur dioxide and methane gas (Ezekwe *et al*., 2016). Another study by Weli and Adekunle (2014), showed that the values of air quality in Rumuolumeni dumpsites of Port Harcourt were reported as; sulphur dioxide (0.67 mg/m^3), methane (0.06 mg/m^3), VOC (2.28 mg/m^3), Ammonia (0.12 mg/m^3) and Hydrogen sulphide (0.19 mg/m3).

Assessment of air quality of some dumpsites in Delta state showed that SPM ranged from 773 to 801 µg/m^3, carbon monoxide and carbon dioxide ranges from 133.7 - 141.6 ppm and 401 - 404.5 ppm respectively. Oxides of sulphur and Nitrogen were between the range of 21.0 - 27.3 and 27.7 - 37.1 ppm respectively. Other pollutant gases were reported as 14.7 to 19.5 ppm for ammonia, 2310 - 2771 ppm for methane and 3.4-7-7 ppm for hydrogen sulphide (Rim-Rukeh, 2014). As reported by Njoku (2015), air quality of dumpsites in Abakiliki of Ebonyi state had the following values; Ammonia ranged from 0.047 – 0.070 ppm, carbon monoxide (1.74 - 1.90 ppm), hydrogen sulphide (0.03 – 0.07 ppm) and oxides of Nitrogen was 0.05 – 0.12ppm. result showed that there was significant difference ($p<0.05$) in the concentration of CO, H_2S and NO_2 compared to ammonia ($p<0.05$).

Compared to the control values, the temperature of the dumpsites was very higher with low relative humidity ($p<0.05$). This is not farfetched as it is a typical characteristic of dry season coupled with the incidence of open air insitu burning of MSWs. Higher values for temperature with corresponding low relative humidity as well as higher wind speed has been recorded in dry season data compared to wet season (Uba, 2015). The meteorological condition of an area play vital role in the fate of pollutants (Cossu and Reiter 1996; Weli and Adekunle, 2014; Uba, 2015). For instance, the study of Weli and Adekunle (2014), indicated that temperature and relative humidity influences the levels of pollutant gases like nitrogen dioxide, ammonia and hydrogen sulphide. The wind speed of the study area was significantly high above calm wind speed limits (0.51 - 1.8m/s) as described by Pillay *et al*., (2011).

The spatial concentrations of pollutant gases like carbon monoxide, hydrogen sulphide, oxides of sulphur and nitrogen of the central dumpsite MSWs dumpsites were significantly higher in dry season compared to wet season as well as in the central dumpsite compared to other dumpsites close to residential area. These findings are in tandem with the study of Uba (2015), who recorded significantly high values of carbon monoxide, hydrogen sulphide and suspended particulates in dry season compared to wet season. High levels pollutant gases can cause bronchial constriction, pulmonary resistance, irritation of the mucous membrane, vision impairment red eyes, etc (ATDSR, 2001; Uba, 2015). Exposure to oxides of sulphur (especially Sulphur dioxide), concentration below 2.6 mg/m^3 exposure to SO_2 can cause acute bronchial constriction, nasal irritation, pulmonary resistance, and airway reactivity. It can further cause acute metabolic deviation and vision impairment by irritating the mucus membrane.

CONCLUSION

This study investigated the seasonal impacts of meteorological condition and emission of pollutant gases around MSW in Yenagoa metropolis. Generally, results show some degree of seasonal variation in metrology and air quality. Generally, the dumpsites recorded higher concentration of pollutants than control, especially in the central dumpsite. Although dumpsites closer to residential area recorded mild level of contamination, but it is also an indication of some levels of anthropogenic activities amongst the populace. In order to mitigate the adverse effects posed by MSW dumpsites, the emission of pollutant gases in the central dumpsite should be sequestrated to reduce their greenhouse effects by converting them to sources of clean and renewable energy. In addition, the populace should desist from uncontrolled insitu burning of MSW. It is also recommended that the levels of pollutant gases and other contaminants around MSW in Yenagoa and other sensitive areas of Bayelsa state should be monitored on regular bases. The populace should be sensitized on the adverse effects of indiscriminate and unsafe disposal of MSW.

MATERIALS AND METHODS

Study area

The Niger Delta Region is a wetland located on the southernmost part of Nigeria. Its flood plain is made up of three basic rivers, which are tributaries to the Atlantic Ocean. These tributaries are River Nun in Bayelsa State which is Central, and flanked to the West and East by Rivers Forcardos in Delta and Orashi in Rivers State respectively. This study was carried out in some waste dumpsites of Yenagoa Metropolis. Yenagoa is the capital of Bayelsa State whose population estimate was over 300,000 as at 2006 (NPC, 2006). Bayelsa state is a wetland and tropical rainforest climate, with two prevailing seasons. The dry season is usually windy and dusty with no rainfall and ranges from November – March. On the other hand, wet season (April - October), is rainy with annual mean rainfall ranging from 2000mm inland to over 4000mm coastward, with relative humidity between 80 to 90%. In addition, average temperature ranges from 25°C - 28°C.

Sampling

Data on ambient air quality and meteorology of the dumpsites was collected in two seasons (dry and wet season), in the second week of the month in a post-monthly manner from November 2016 through September 2017. range. The sampling was carried out in seven stations including control. The sampling stations were dumpsites in; Mopol base of Akenpai, Etegwe bridge of Tombia Junction, Opolo Market, Kpansia Market, and two sampling points (CDS 1 and CDS 2), in the Central Dumpsites located at the outskirt of Yenagoa.

Air quality and Meteorology

Air quality and meteorological parameters monitored are as followed: The sampling stations were geo-referenced using Germin etrex GPS (Taiwan). Meteorological parameters like; wind speed, temperature, relative humidity and Wind direction was measured using portable hand-held Kestrel meteorological meter (4500NV-USA). For other pollutant gases like; Carbon monoxide (CO), Hydrogen sulphide (H_2S), Oxides of Sulphur (SOx) and Nitrogen (NOx), portable multiprobe AEROQUAL metre was used (Aeroqual Limited Auckland-New Zealand-Series 300).

Statistical analysis

All results are 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 difference in alphabets were used to establish significant difference.

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