Original Research Article

Emission from Uyo Main Refuse Dumpsite and Potential Impact on Health

Abstract

This paper presentspotentialimpact on health of emission from landfill site on Uyo village road, Uyo local government area ofAkwa Ibom State, Nigeria. Three sampling points were assessed for particular matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), hydrogen sulphide H_2S, ammonia (NH_3), total volatile organic carbon (TVOC) and hydrogen cyanide (HCN) using highly sensitive digital portable meters. The data obtained were expressed in terms of air quality index.Air quality index indicates that the ambient air can be described as unhealthy for sensitive groups for NO_2, unhealthy for SO_2 and $PM_{2.5}$, and moderate for CO, respectively. H_2S, NH_3, TVOC, HCN, PM_{10} were not indicated in USEPA air quality standards.Itrecommended that stringent and proper landfill emissions management together with appropriateburningof wastes should be considered in the study area to ease the risks associated with these pollutants on public health.

Keywords: Landfill Emission, Air pollution,Air Quality Index, Impact on Health.

Introduction

Air quality report on dumped municipal solid waste around Nigerian cities has indicated that values exceeded their threshold limits relative tothe United StatesEnvironmental Protection Agency. This may bedueto precariousconservation of municipal solid waste together withunrestrained open air insituburning of waste, whose direct consequences on biodiversity and greenhouse effect cannot be overstressed. Barakat-Haddad, (2015), attributed mortalities to air pollution and the synergistic role they play in the development of respiratory diseases. Also, World Health Organization has acknowledged air pollution as anelementary health threat (WHO, 2014). The generation and poor conservation of municipal solid wastes in Nigerian citiescome with unfavorableassociated environmental and health consequence. Air Pollution associated with dumped municipal solid waste has become a major source of concern due toodour released and the emission of greenhouse gases like: sulphur, oxide of nitrogen and carbon monoxide as well as release of suspended particulate matter throughinsituburning.

Additionally, literature report indicated that insufficiencies in effective waste supervision of most developing nations had detrimental effect on human health and biodiversity with corresponding unfavorable consequences on keystone resources (Sharholy*et al.* 2008). The major routeof exposure to air pollution is by the process of inhalation (Barman *et al*, 2010). Nevertheless, air pollution can also cause eyes and airway irritation, nasal,anoxia, wheezing, coughing, and even lung and heart issues, which escalate risk to asthma and heart problem. However, in extreme cases it can result to mortality.The chronic exposure to air pollution can compromise the immune system and cause systemic cancer of the nervous, reproductive and respiratory systems.

Moreover,poisonous emission emitted during burning of waste, suspended particulates matter release contains anthropogenic substance which canirritate the nasal cavity or the lungs, carcinogenic, and cause poisons ranging from cold to other air-borne diseases (Bency*et al.* 2003). Also, people whose residence are adjacent to dumpsite are predispose to cardiovascular diseases (Nautiyal*et al*. 2007; Barakat-Haddad, 2015), likelungasthma, cancer, bronchitis, birth defect, and premature mortalities (Agwu and Ozeh, 2013). In another report on the relative aerobic microbial circulation of a dumpsitearound Nigerian cities indicated15% *Serratia*spp, 19% *Klebsiella*spp,37% *Escherichia coli*, 13% *Pseudomonas* spp, 8% of *Staphylococcus spp*, 7% of *Enterococcus spp*, with the slightest being 1% of *Salmonella spp*. (Odeyemi, 2012).

Uyo main refuse dumpsite in Uyo local government area is the site that was engulfed by major gully erosion many years ago, and was adopted by the Akwa Ibom State government as erosion control measures to reclaim the site. Today air quality around Uyo village road main refuse dumpsite is affected byfoul odours which is of interest to public health. Several health related issues have been reported by the residence living around the municipal solid waste dump site. In the present study, in view of the gravity of the situation, air quality index proposed by USEPA was used to assess the health risk for the purpose of determining the contamination level of emissions from landfill site and planning a management strategy accordingly.

Methods

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Location and climate of the study area

Uyo village road is located in Uyo local government area. Uyo is the capital city of Akwa Ibom State, Nigeria. It's situated at 5.03° North latitude, 7.93° East longitude and 196 meters

elevation above the sea level. The average annual temperature in Uyo is 26.4 °C. The rainfall here averages 2509 mm.

Method of investigation

Gaseous emissionsdata acquisition

Concentrations of air pollutants were measured at three (3) sampling points. Highly sensitive digital portable meters were used for the measurement of NO_2, SO_2, H_2S, HCN, NH_3, VOC, CO and SPMdetailing their ranges and alarm levels (Table 1).Table 2 shows the air quality index for priority pollutant. While Table 3 present air quality index levels and associated health impacts with their colour code. Air quality index is a ranking set by USEPA for evaluating health effects that can happen within a few hours or days after breathing polluted air. The air quality index for priority pollutant are categories ranging from good to hazardous. In the absent of air quality standards for landfill emissions on health, the results obtained in these studies were compared with the USEPA ambient air quality standards (air quality index).

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Results and discussion

Table 4 presentsresults of landfill air quality measurements in the study area compared with the USEPA ambient air quality standards (air quality index).

NO_2 were in the range of 0.2 – 0.3 ppm which was above the permissible limit of USEPA ambient air quality standards. In terms of air quality index rating the air quality for NO_2 at the three-sampling point SP1 to SP3 was unhealthy for sensitive groups. This means that members of sensitive groups around the dump site may experience health effects.

NO_2 is associated with unfavorable consequences on human health. (HPA, 2011) reported that, at high concentrations, nitrogen dioxide (NO_2) acts as an irritant of the airways and exposure can yield inflammation and bronchoconstriction (narrowing of the lungs) and can influence the immune cells in the lungs, increasing vulnerability to respiratory infections. Asthmatics individuals are most vulnerable, although levels of NO_2 may also produce effects on the lung function of non-asthmatics individuals. As a result, emissions of NO_2 from active well-managed landfill sites should not significantly impact local air quality and consequently the health of those living near the landfill site. Proper control of emissions and strict regulation of landfill sites should ensure that emissions do not result in an exceedance of ambient Air Quality Objectives as set in (USEPA, 2016) air quality strategy.

The concentration of SO_2 was found in the range of 0.1 – 0.2 ppm which was above the permissible limit of USEPA ambient air quality standards. In terms of air quality index rating the air quality for SO_2 at the three-sampling point SP1 – SP3 was unhealthy. This implies that everyone around the dumpsite may begin to experience health effects. Members of sensitive groups may experience more serious health effects.SO_2 can affect the respiratory system and the functions of the lungs, and causes irritation of the eyes. Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Hospital admissions for cardiac disease and mortality increase on days with higher SO_2 levels. When SO_2 combines with water, it forms sulfuric acid; this is the main component of acid rain which is a cause of deforestation.Regulation of landfill sites and pollution control measures should limit SO_2 emissions. Nevertheless, provided the site is appropriately managed and regulated, it is unlikely that emissions from landfill sites will significantly affect local air quality.

The results of carbon monoxide (CO) were in the range of 4.0 – 7.0 ppm which was above the permissible limit of USEPA ambient air quality standard. In terms of air quality index rating the air quality for CO at the three-sampling point SP1 – SP3 was moderate. This means that air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution around the dumpsite. Carbon monoxide enters the bloodstream through the lungs and binds chemically to hemoglobin, the substance in blood that carries oxygen to cells. In this way, carbon monoxide reduces the amount of oxygen reaching the body's organs and tissues. People with cardiovascular disease, such as angina, are most at risk from carbon monoxide. These individuals around the dumpsite may experience chest pain and more cardiovascular symptoms if they are exposed to carbon monoxide, particularly while exercising.

The concentration ofhydrogen sulphide (H_2S) was found in the ranged of 0.1 – 0.2 ppm but was not indicated in the permissible limit of USEPA ambient air quality standards. H_2S is produced in landfill sites when high sulphate bearing materials like gypsum and plasterboard are mixed with biodegradable waste. The composition of the waste material and the design and management of the site will determine the amount of H_2S produced and concentration in landfill gas can vary considerably.

At low concentration, hydrogen sulphide may cause irritation to the mucous membranes of the eye and respiratory tract. Exposure to high concentrations results in depression of the central nervous system, loss of consciousness and respiratory paralysis (HPA, 2009b).

The concentration of NH_3 was found in the ranged of 2.0 – 4.0 ppm but was not indicated in the permissible limit of USEPA ambient air quality standards.Ammonia can lead to damage of terrestrial and aquatic ecosystems through deposition of eutrophying pollutants and through acidifying pollutants. Precursor to secondary PM and therefore contributes to the ill-health effects caused by PM_{10} and $PM_{2.5}$.

The concentration of the $PM_{2.5}\mu$m particulate matter ranged from 49 - 63 $\mu g/m^3$ which were above the permissible limit of USEPA ambient air quality standard. In terms of air quality index rating the air quality for $PM_{2.5}$ at the three sampling point SP1 – SP3 was unhealthy. This means that everyone around the dumpsite may begin to experience some unfavorable health effects, and members of the sensitive groups may experience more serious effects.The concentration of $PM_{10}\mu$m particulate matter ranged 84 – 92 $\mu g/m^3$ but was not indicated in the permissible limit of USEPA ambient air quality standards.

Both fine and coarse particles can accumulate in the respiratory system and are associated with numerous health consequences. Coarse particles can aggravate respiratory conditions such as asthma. Exposure to fine particles is associated with a number of serious health effects, including premature death. Unfavorable health consequences have been associated with exposures to PM over both short periods such as a day and longer periods such as a year or more. When exposed to PM, people with existing heart or lung diseases such as asthma, chronic obstructive pulmonary disease, congestive heart disease, or ischemic heart disease are at increased risk of premature death or admission to hospitals or emergency rooms. The elderly also is sensitive to PM exposure. They are at increased risk of admission to hospitals or emergency rooms and premature death from heart or lung diseases. When exposed to PM, children and people with existing lung disease may not be able to breathe as deeply or vigorously as they normally would, and they may experience symptoms such as coughing and shortness of breath. PM can increase susceptibility to respiratory infections and can aggravate existing respiratory diseases, such as asthma and chronic bronchitis, causing more use of medication and more doctor visits.

The concentration of total volatile organic (TVO) compounds was found in the ranged of 0.456 – 2.341 mg/m^3 but was not indicated in the permissible limit of USEPA ambient air quality standards. Respiratory, allergic, or immune effects in infants or children are associated with man-made volatile organic compounds and other indoor or outdoor air pollutants (Mendell, 2007). Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, vomiting, nose bleeding, fatigue, dizziness.

The concentration of hydrogen cyanide was found in the ranged of < 0.1 mg/m^3 but was not indicated in the permissible limit of USEPA ambient air quality standards. Inhalation hydrogen cyanide exposure include; mild to moderate and severe effects. Mild to moderate consequences include headache, confusion, anxiety, dizziness, weakness and loss of consciousness. Severe effects include coma, seizures, and dilated pupils (mydriasis) (NIOSH, 2011).

Conclusion

The findings of this study in general revealed that high risks are associated with public health near the dumping sites. Air quality index indicates that the ambient air can be described as unhealthy for sensitive groups for NO_2, unhealthy for SO_2 and $PM_{2.5}$, and moderate for CO, respectively. H_2S, NH_3, TVOC, HCN, PM_{10} were not indicated in USEPA air quality standards. The results recommend that stringent and proper landfill emissions management together with close burning management of wastes should be considered in the study area to ease the risks associated with these pollutants on public health. Further monitoring of the dump site is recommended as well as research by biomedical expert to make public the rigorous unfavorable consequences that landfill emissions might induce in humans, particularly individuals in vulnerable populations.

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Table 1: Gaseous Emissions and Noise Measuring Instruments

Parameter	Equipment	Range	Alarm levels
SO_2	SO_2 Crowcon Gasman S/N: 19648H	0-10ppm	2.0ppm
NO_2	NO_2 Crowcon Gasman S/N: 19831N	0-10ppm	3.0ppm
H_2S	H_2S Crowcon Gasman S/N: 19502H	0-50ppm	10ppm
CO	CO Crowcon Gasman S/N: 19252H	0-500ppm	50ppm

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NH_3	NH_3 Crowcon Gasman S/N: 19730H	0-50ppm	25ppm
HCN	HCN Crowcon Gasman S/N: 19773H	0-25ppm	5ppm
SPM	Haz-Dust TM 10µg/m^3 particulate monitor	0.1-200 10µg/m^3	+1-0.0210µg/m^3

Table 2: Air Quality Index for Priority Pollutant

Category	**QAI**	**$PM_{2.5}$**	**CO**	**SO_2**	**NO_2**
		($\mu g/m^3$) 24-hour	(ppm) 8-hour	(ppm) 1-hour	(ppm) 1-hour
Good	0 - 50	0.0 – 12. 0	0.0 – 4.4	0 - 0.035	0 – 0.053
Moderate	51 – 100	12.1 – 35.4	4.5 – 9.4	0.036 – 0.075	0.054 – 0.100
Unhealthy for Sensitive Groups	101 – 150	35.5 – 55.4	9.5 - 12.4	0.076 – 0.185	0.101 – 0.360
Unhealthy	151 – 200	55.5 – 150.4	12.5 - 15.4	0.186 – 0.304	0.361 – 0.649
Very Unhealthy	201 – 300	150.5 – 250.4	15.5 - 30.4	0.305 – 0.604	0.605 – 1.249
Hazardous	301 - 500	250.5 – 500.4	30.5 – 100.4	0.605 – 1.004	1.250 – 2.049

Source: USEPA 2016

Table 3: Air Quality Index Level and Associated Health Impacts

AQI Level of Health Concern	**Meaning**	**Colour Code**
Good	Air quality is considered satisfactory, and air pollutant poses little or no risk	Green
Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Yellow
Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Orange
Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Red
Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.	Purple
Hazardous	Health alert: everyone may experience more serious health effects.	Maroon

Source: USEPA 2016

Table 4: Landfill Air Quality Measurements

Sampling Points	**NO_2 ppm**	**SO_2 ppm**	**H_2S ppm**	**CO ppm**	**NH_3 ppm**	**CH_3O_3 (ppm)**	**TVOC mg/m^3**	**HCN ppm**	**$PM_{2.5}$ $\mu g/m^3$**	**PM_{10} µg/m3**
SP_1	0.3	0.1	0.2	5.0	4.0	0.521	2.341	<0.1	49	84
SP_2	0.2	0.2	0.1	7.0	2.0	0.555	0.456	<0.1	52	86

SP_3	0.3	0.2	0.2	4.0	3.0	0.601	0.625	<0.1	63	92
Mean	1.77	0.17	0.17	5.33	3.0	0.92	1.14	<0.1	75.7	87.3