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Assessment of Air and Noise Pollution from Industrial Sources in Ibadan, Southwest, Nigeria

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ABSTRACT

This study assessed air quality and noise parameters in Oluyole, an industrial zone in Southwest Nigeria. Twenty three sampling points were randomly selected in the industrial and residential areas, while four points control. The assessment was carried out for eight weeks each during rainy and dry seasons. A multi-gas monitor was used to determine sampling CO, SO_2, H_2S, and Hydrocarbon (HC), while a Personal Data RAM-1200 was used to measure suspended particulate matter (SPM). Noise levels were measured using a sound level meter, while the co-ordinates of sampling points were taken with a Garmin GPS. Data were subjected to descriptive analysis and one-way analysis of variance (ANOVA) to separate means. Selected air quality parameters varied significantly ($p<0.05$) for different locations and seasons. Residential and industrial areas showed significant variation in their levels of Noise, SPM and CO. SPM and H_2S levels were higher during dry season while Noise, CO and Hydrocarbon levels were higher during the wet season. Levels of Noise, SPM, H_2S and CO decreased with increasing distance from the industrial area but the reverse was the case for Hydrocarbon. Hence, there is a need for adoption of cleaner technologies by the industries and enforcement of environmental standards by regulatory agencies.

1. INTRODUCTION

Air pollution can be defined as the presence of pollutants, such as sulphur dioxide (SO_2), particle substances (PM), nitrogen oxides (NO_x) and ozone (O_3) in the air that we inhale at levels which can create some negative effects on the environment and human health (Turk and Kavraz, 2011). It can be classified into natural air pollution which includes wind-blown dust, volcanic ash, and gases, smoke and trace gases from forest fires, and anthropogenic air pollution which includes products of combustion such as nitrogen oxides (NO_x), carbon oxides (CO_x), sulphur dioxide (SO_2) (Oyekanmi et al., 2010). Pollutants that are pumped into the atmosphere and directly pollute the air are called primary pollutants while those that are formed in the air when primary pollutants react or interact are known as secondary pollutants (Agbaire, 2009).

Industrial pollution adversely affects human health, sometimes leading to chronic diseases of permanent nature. It is a serious threat to environmental health in many cities with a wide range of symptoms such as low birth weight, increased hospitalization, sudden infant death and high mortality (Brook et al., 2004). According to WHO, more than two million premature deaths each year can be attributed to the effects of urban outdoor and indoor air pollution and more than half of this disease burden is borne by the populations of developing countries (Mohammed, 2009). Chemicals found in polluted air could cause cancer, birth defects, brain and nerve damage and long term injury to the lungs and breathing passages in certain circumstances while long term exposure to high concentrations can cause severe injury or even death (Oyekanmi et al., 2010). Effects of air pollutants on structures include discolouration of buildings, while impairment of normal visibility often leads to disruptions in transportation system, death and stunted growth of crops, and acute toxicological effect in humans (Abdulkareem and Kovo, 2006). The costs of this burden of illness would include lost years of life and income, health care costs, and quality of life related costs. Beyond the toll on human health, there will also be corresponding impacts on domestic animals and food production (Bikkhu et al., 2009).

Studies have reported high concentrations of gaseous pollutants such as NO, CO, SO_2 and hydrocarbon above permissible limits. Rene (2008) measured high levels of particulate matter, CO, NO_2, SO_2 and Ozone above the environmental regulation limits in Vaal air shed of South Africa with warnings of serious health implications for residents, while Nkwocha and Egejuru (2008) revealed a strong association between air pollution indices and diseases such as cough, cold, bronchitis, sinusitis and phlegm among some school children in Nigeria with the strongest effect recorded among those below two years of age. Noise from industrial areas is often overlooked and has received very little attention over the years. In Nigeria, many industrial estates are located within the heart of towns and cities, while residential and commercial buildings might just find their way into industrial zones as a result of poor enforcement of town planning laws. Without strict environmental regulation and control laws in many developing countries, industrial noise sources can pose severe health risks (Nwobodo et al., 2004). The observed effects of noise on motivation, as measured by persistence with a difficult cognitive task, may either be independent or secondary to cognitive impairments (SRC, 2007). Homes, schools, hospitals and other structures found in industrial areas could be adversely affected by environmental noise. Depending on its duration and volume, the effects of noise on human health and comfort are divided into four categories; physical effects, such as hearing defects; physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers; psychological effects, such as disorders, sleeplessness and going to sleep late, irritability and stress; and finally effects on work performance, such as reduction of productivity and misunderstanding what is heard (Ozer, 2009). Similarly, Olayinka et al. (2008), found that the noise exposure level (LAeq) in minerals crushing mills, soft drinks bottling, beer brewing, bottling and tobacco making industries was above 85 dBA and noise level was well above 60 dBA recommended by World Health Organization in five selected processing and manufacturing industries in Ilorin, Nigeria.

Air pollutions from industrial sources and their possible effects have been widely studied and this has improved the understanding of the link between air pollution and health effects thereby driving improvements of air quality in many countries. However, many challenges remain especially in the developing countries like Nigeria which are not heavily industrialised but still experience significant air pollutions in their cities. Many of these challenges include inadequate monitoring of air quality, high pollution index, scarce air pollution epidemiological research and weak enforcement of standards among others (Agbaire, 2009).

Table 1. Noise exposure limits for Nigeria (NESREA, 2009)

Facility	Maximum permissible noise limit (dBA)	
	Day	Night
Hospital, convalescence home, home for the aged, sanatorium and institutions of higher learning, conference rooms, public library, environmental and recreational sites.	45	35
Residential buildings	50	33
Mixed residential (with some commercial and entertainment)	55	45
Residential + industry or small-scale production + commerce	60	50
Industrial (outside perimeter fence)	70	60

Table 1 and Table 2 shows the National Environmental Standards Regulation Agency (NESREA) limits for noise and emissions. It specified the benchmark for noise level in various types of premises while indicating the acceptable limits for some air pollutants for long-term and short-term exposures rates.

The broad objective of this study was to evaluate the level of noise and some air pollutants, determine exceedance of ambient air quality standard and draw up management plan where necessary, while the specific objectives were:

- To evaluate the general level of some air pollutants in the study area.
- To determine seasonal variations in air qualities.
- To assess the level of noise pollution in the industrial estate.

- To establish the impact of industrial activities on ambient air qualities.
- To determine a possible exceedance of ambient air quality standards.

Table 2. National emission limits for some air pollutants

Pollutant	Emission limits (mg/m^3)	
	Long-term limits	Short-term limits
CO	1.0	5.0
HC (Total)	2.0	5.0
H_2S	0.008	0.008
SO_2	0.1	0.5
SPM	0.2	0.2
Pb	0.005	0.002
Hg	0.0003	-
O_3	0.1	0.2

2. METHODOLOGY

2.1 Site description

The study area, as shown in Figures 1 and Figure 2, was Oluyole industrial Scheme situated within Ibadan metropolis of Oyo state, Southwest Nigeria. Its geographical coordinates are Latitude 7º 21′ 19″ N and Longitude 3º 51′ 1″ E and covers about 1,926,600 m^2. Also located within the scheme are high and medium density residential areas, schools, clinics, places of religious and commercial centre. The Oluyole area of the metropolis has a population of about 282,585 according to the 2006 national population census.

The metropolis has a tropical wet and dry climate, with a lengthy wet season and relatively constant temperatures of about 32ºC throughout the year. The wet season runs from April through October, though a lull in precipitation is experienced in August which nearly divides the rainy season into two segments of wet season.

2.2 Sampling measurement

Twenty three randomly selected sampling points as illustrated in Figure 2, separated by at least 200 m covered the study area (industrial and residential) while the control area had four points, making twenty seven points altogether. The sampling design for the study area covered the industrial area with thirteen (13) points while the residential area had five (5) points on the east and west of the industrial area. Similarly, in the control (Government Residential Area devoid of Industrial Activities) within the metropolis, four randomly selected sampling points were assessed. The average value for repeated readings at each sampling point were recorded while assessment of noise and air quality parameters was carried out fortnightly for eight weeks during two periods of wet season (August to September) and dry season respectively (February to March). Concentrations of carbon monoxide (CO), sulphur-dioxide (SO_2), hydrogen sulphide (H_2S), and hydrocarbon (HC) were measured with an ITX Multi-gas Monitor while suspended particulate matter (SPM) was determined with a Personal Data RAM-1200 (Park Davis) and noise level dBA using a sound level meter (Extech Instruments 407730). Other parameters including air temperature, wind speed and wind pressure were determined by a portable weather station as a guide in the positioning of sampling equipment. Temperature and relative humidity were measured using a Pen monitor while wind speed and wind pressure were determined with a portable weather station and the coordinates of sampling points were taken with Garmin GPS. Iyaganku was selected as a control because of its serene environment.

Data obtained from the assessment were subjected to descriptive analysis and one-way analysis of variance (ANOVA) to separate means using the statistical package for social sciences (SPSS).

Table 3. Sampling points in the study

S/N	Location	Latitude	Longitude
1	Residential area	N 06 º 35.489	E 003 º 22.331
2	Residential area	N 07 º 21.821	E 003º 51.460
3	Residential area	N 07 º 21.803	E 003 º 51.417
4	Residential area	N 07 º 21.832	E 003 º 51.348
5	Residential area	N 07 º 21.762	E 003 º 51.376
6	Industrial area	N 07 º 21.498	E 003 º 50.983
7	Industrial area	N 07 º 21.448	E 003 º 50.946
8	Industrial area	N 07 º 21.373	E 003 º 51.037
9	Industrial area	N 07 º 21.231	E 003 º 50.932
10	Industrial area	N 07 º 21.405	E 003 º 50.869
11	Industrial area	N 07 º 21.371	E 003 º 50.834
12	Industrial area	N 07 º 21.323	E 003 º 50.773
13	Industrial area	N 07 º 21.360	E 003 º 50.728
14	Industrial area	N 07 º 21.400	E 003 º 50.607
15	Industrial area	N 07 º 21.438	E 003 º 50.733
16	Industrial area	N 07 º 21.539	E 003 º 50.730
17	Industrial area	N 07 º 21.726	E 003 º 50.742
18	Industrial area	N 07 º 21.786	E 003 º 50.751

Table 3. Sampling points in the study (cont.)

S/N	Location	Latitude	Longitude
19	Residential area	N 07 º 21.802	E 003 º 50.674
20	Residential area	N 07 º 21.802	E 003 º 50.525
21	Residential area	N 07 º 21.901	E 003 º 50.251
22	Residential area	N 07 º 21.911	E 003 º 50.175
23	Residential area	N 07 º 21.916	E 003 º 50.117
24	Control area	N 07 º 21.900	E 003 º 50.253
25	Control area	N 07 º 21.900	E 003 º 50.253
26	Control area	N 07 º 21.900	E 003 º 50.253
27	Control area	N 07 º 21.900	E 003 º 50.253

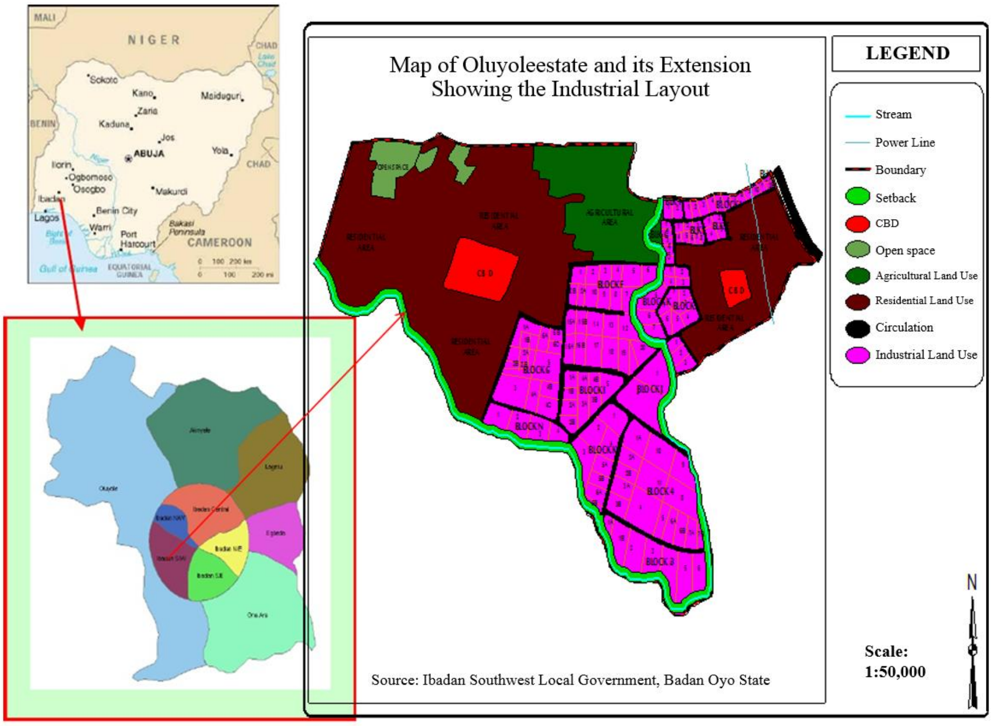

Figure 1. Map showing the study area

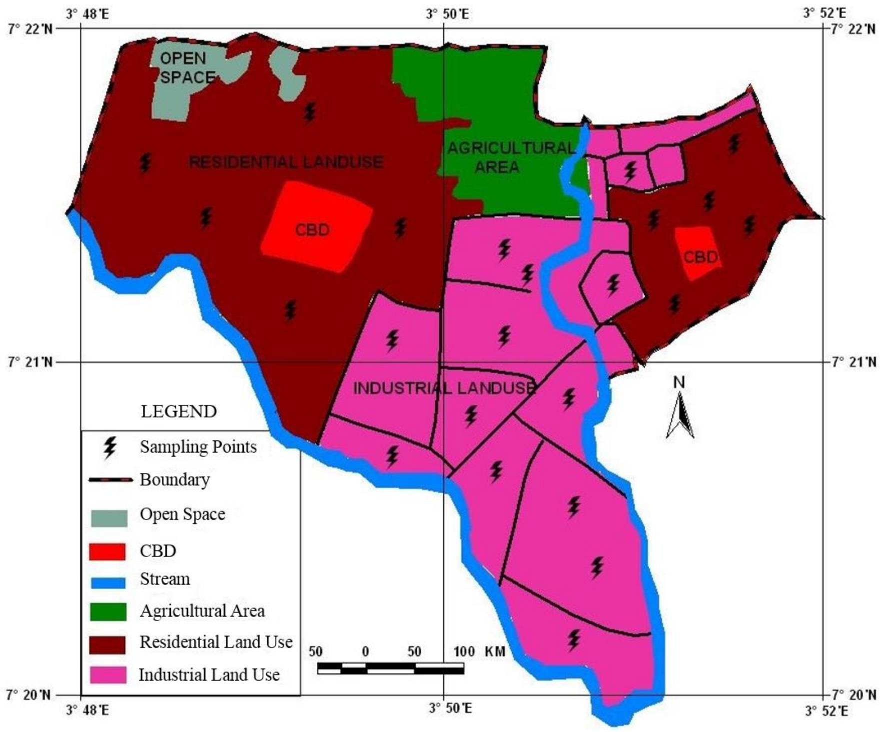

Figure 2. Map of study area showing land use and sampling points

3. RESULTS AND DISCUSSION

In the dry season, as illustrated in Table 4, within the residential area, noise level, SPM, CO and HC ranged between 46.19-68.47 dBA, 9.0-206 mg/m^3, 0.0-4.0 mg/m^3, and 0.0-6.0 mg/m^3 respectively, with mean values of 55.85 dBA, 48.91 mg/m^3, 1.23 mg/m^3 and 2.10 mg/m^3 respectively. CO was above the long-term exposure limit of 1.0 mg/m^3. HC level was generally above the 2.0 mg/m^3 long-term exposure limit while some sampling points had values as high as 7.5 mg/m^3 which is above the short-term exposure limit. SO_2 in the residential area was less than 0.001 mg/m^3 all through. This could be due to either a low level of sulphur release from production processes in many of the industries or due to dissolution, dispersion, mixing or any other atmospheric reaction leading to a low ground level concentration. Generally, the residential area is free from SO_2 and H_2S pollution at levels less than 0.01 mg/m^3.

For the industrial area, noise levels have a clustered range of 53.06-82.36 dBA with a mean of 66.98 dBA. In five of the sampling areas, the mean noise level was found with values as high as 273 dBA. SPM was low in places close to residential areas but measured up to as much as 721 mg/m^3 in the core industrial zone with a mean of 192.08 mg/m^3 and values ranging between 25-721 mg/m^3. The range of all values for CO was 0-8 mg/m^3 while the mean is 2.14 mg/m^3 which is higher than the long-term national emission limits. HC ranged between 0-6 mg/m^3 with a mean of 0.56 mg/m^3 while concentrations were above both short-term and long-term limit in a few parts of the industrial zone. SO_2 levels were generally below 0.01 mg/m^3, while hydrogen sulphide ranged between 0-11 mg/m^3 with a mean of 0.62 mg/m^3. Dispersion or fall out could be responsible for these low values. Meanwhile, in the control area, the noise level ranged between 38.72-46.48 dBA with a mean of 43.60 dBA, while SPM had a mean of 6.0 mg/m^3 and values that ranged between 2.0-11 mg/m^3. CO, H_2S and SO_2 levels were less than 0.01 throughout the sampling period of the season, but HC levels ranged between 0-5 mg/m^3 while the mean was 2.13 mg/m^3.

Table 4. Variation in the values of air parameters during dry season

Parameter	Locations		
	Residential	Industrial	Control
T (^OC)	34.45± 0.30^b	35.60± 0.21^a	28.19± 0.33^c
RH (%)	62.08±1.42^b	54.44±1.22^c	77.63±1.29^a
WS (m/s)	7.23 ±0.43^a	7.47±0.36^a	5.37± 0.38^b
WP (mm Hg)	1.51±0.38^a	1.29±0.21^{ab}	0.39± 0.18^b
NOISE (dB)	55.85±0.83^b	66.98±0.93^a	43.60±0.61^c
SPM (mg/m^3)	48.91±5.28^b	192.08±26.68^a	6.00±0.52^c
CO (mg/m^3)	0.80±0.21^b	2.14±0.31^a	0.00±0.00^b
H_2S (mg/m^3)	0.00±0.00^b	0.62±0.31^a	0.00±0.00^b
SO_2 (mg/m^3)	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
HC (mg/m^3)	2.10±0.29^a	0.56±0.20^b	2.13±0.38^a

Values in the same row and with different superscript are significantly different at $p<0.05$

In the rainy season, as shown in Table 5, noise levels ranged between 52.50-81.90 dBA with a mean of 62.15 dBA, while SPM ranged between 5.0-100 mg/m^3 with a mean value of 35.56 mg/m^3. CO was found to be within the range of 0.0-8.0 mg/m^3 with a mean of 2.88 mg/m^3, while HC level ranged between 0.0-3.50 mg/m^3 with a mean of 1.34 mg/m^3. H_2S and SO_2 levels were not detectable.

Noise levels in the industrial area ranged between 62.50-89.60 dBA with a mean of 75.96 dBA. Moreover, SPM ranged from 6.0-521 mg/m^3 with an average value of 107.52 mg/m^3, while CO ranged between 0.00-10 mg/m^3 having a mean of 6.10 mg/m^3. Hydrocarbon level was within 0.00-4 mg/m^3 with a mean value of 1.55 mg/m^3, while SO_2 and H_2S levels were very low and almost undetectable.

Noise levels within the control area was in the range of 45.2-62.7 dBA with an average of 54.81 dBA, while the measured level of the suspended particulate matter was in the range of 16-54 mg/m^3

with a mean value of 28.36 mg/m^3. The measured level of CO in the area falls within the range of 0-7 mg/m^3 with a mean value of 1.94 mg/m^3, while the hydrocarbon level was between 0-3 mg/m^3 with an average value of 0.88 mg/m^3. Similarly, H_2S and SO_2 levels were below detectable limits.

Table 5. Variation in the values of air parameters for wet season

Parameter	Locations		
	Residential	Industrial	Control
T (^{O}C)	29.10±0.28^b	30.61±0.17^a	30.51±0.21^a
RH (%)	68.18±1.23^a	61.54±0.80^b	61.70±0.61^b
WS (m/s)	8.67±0.29^b	9.82±0.27^a	8.59±0.52^b
WP (mm Hg)	1.90±0.15^b	2.41±0.13^a	1.85±0.26^b
NOISE (dB)	62.15±0.95^b	75.96±1.03^a	54.61±1.07^c
SPM (mg/m^3)	35.58±3.44^b	107.52±16.32^a	29.55±2.53^b
CO (mg/m^3)	2.88±0.3475^b	6.10±0.43^a	2.05±0.46^b
H_2S (mg/m^3)	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
SO_2 (mg/m^3)	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
HC (mg/m^3)	1.34±0.17^{ab}	1.55±0.16^a	0.85±0.21^b

Values in the same row and with different superscript are significantly different at $p<0.05$.

Seasonal variation as shown in Table 6 indicated a significant variation ($p<0.05$) in noise levels during the dry (55.85±0.82, 66.98±0.97 and 43.60±0.61) and wet season (62.15±0.95, 75.96 ±1.03 and 55.23±1.23) at all locations. The level of SPM within the Residential and Industrial areas was significantly higher ($p<0.05$) during the dry season (48.91±5.28 and 192.08±26.68) than the wet season (35.58±3.44 and 107.52±16.32) except for the control area with reverse situation.

Also, there was a significant variation ($p<0.05$) in CO concentrations during the dry (0.80±0.21, 2.14±0.32 and 0.00±0.00) and wet season (2.89±0.35, 6.10±0.43 and 2.13±0.54) at all three locations. Meanwhile, there was no significant variation ($p>0.05$) in the values of H_2S except in the Industrial area in wet season. A similar situation was recorded for SO_2 concentrations. However, the values of HC varied significantly ($p<0.05$) among locations during both dry and wet seasons.

The comparison of air pollutant levels with permissible limits, as shown in Table 7, the noise level in residential areas during both wet and dry seasons were found to be above 50 dBA which is the standard limit stipulated by NESREA while that of the control area was not above limit. There was exceedance during the dry season in the industrial area with values above 70 dBA while the mean value during the wet season was not above the standard limit. Generally, noise levels were higher during the dry season.

Similarly, Table 8 illustrates that during the dry season, there was exceedance in the level of suspended particulate matter for long and short-term exposure limits in all locations, while there was exceedance in CO and HC for short-term exposure limit in both residential and control area. The levels of SO_2 and H_2S with values below 0.001 mg/m^3 did not exceed both standards, while in the industrial area the level of suspended particulate matter and H_2S exceeded standards for both long and short-term exposure limits. CO and HC showed exceedance only for long-term exposure limit. SO_2 levels were less than 0.001 mg/m^3 which does not exceed exposure limits.

For the wet season, the level of suspended particulate matter exceeded limits for both long-term and short-term exposures in all location, but CO, HC and H_2S levels only exceeded long-term exposure standards in all locations, whereas the level of SO_2 was generally not above standard with a mean value of 0.001 mg/m^3.

This study showed that industrial activities contributed significantly to the noise level in the surrounding residential areas, making it higher than the permissible limit. Noise levels within the industrial area were above the permissible limit during dry season. Industrial noise impact was found to decrease with increasing distance from the industrial area, which means that there is an inverse relationship between distance and industrial noise pollution in surrounding residence. There was also an exceedance of permissible noise limit in the control area during the dry season, and this could be attributed to frequent honking from trucks venturing into the area. Exceedance in permissible noise level in the study area poses a serious threat to the health and general well-being of the residents. Ozer et al. (2009) revealed a very high noise level in some areas of Tokat city, Turkey which includes public structures, hospitals, schools and houses with noise levels over 75 dB, while Osemeikhian and Anomohanran (2006) recorded noise levels above 90 dBA in Warri, Nigeria. High noise levels may predispose residents of this study area to health problems such as noise-induced hearing loss, tinnitus, insomnia and headache, as reported by Bisong et al. (2004) that members of the community that are exposed to 105.8±9.24 dBA of noise level suffered from noise-induced hearing loss, tinnitus, insomnia and headache. There is a special concern for the children attending the various schools located very close to the industrial area as it could be a serious source of distraction among other effects. Similarly, Kankal and Gaikwad (2011) concluded that residential areas and vulnerable institutions and hospitals face noise levels which are much higher than the acceptable limit. The level of SPM in the residential, industrial and control areas was far above both short and long-term permissible limits. In a similar development, Ideriah and Stanley (2008) observed that the concentrations of SPM were found to exceed permissible limits at all locations while Assimakopoulos et al. (2008) discovered that SPM were found at levels above the specified limits in different areas of usage in Athens. It was observed that SPM level in the residential area decreased with increasing distance from the industrial area meaning there is an inverse relationship between the distance from the industrial area and level of SPM and this implies that industrial activities are the main sources of SPM. The inverse relationship between distance and pollutant concentration observed in this study agrees with the findings of Nwaogu and Onyeze (2010), where mean values of all the air quality indices decreased as the distance from the flaring site increased while Al-Salem and Khan (2008) also noted that distance and winds are the strongest influencing parameters for the disposal of gaseous pollutants.

Carbon monoxide level was above long-term exposure limit in all areas in both seasons. Meanwhile, short term exposure limit was exceeded only in the industrial area in wet season. The higher level of CO in the wet season could also be attributed to less dispersion and mixing. Ideriah and Stanley (2008) reported a CO value between 1-5 mg/m^3 which is in line with the results of this study while high levels of pollutants were further attributed to vehicular emission and domestic activities which is also similar to the situation in the area of study. CO combines ten times more readily with haemoglobin than oxygen. Therefore people exposed to it for long hours could experience dizziness and fatigue more often. CO is a poisonous gas having a life time of two to four months in the atmosphere and affects the oxygen carrying capacity of haemoglobin (Ideriah and Stanley, 2008). People who already have ailments like asthma, bronchitis or other respiratory diseases could have their conditions worsened by this situation. Exceedance of permissible limits was found in all measured parameters in the industrial, residence and control areas except for SO_2.

The health of people working and living in the area could be negatively impacted by a high concentration of air pollutants. Kowalska et al. (2006) found that measured concentrations of airborne particulate and gaseous pollutants in the Katowice Conurbation (0.035 mg/m^3 and 0.049 mg/m^3 of SO_2 and SPM respectively) influenced daily mortality pattern among the inhabitants of the region while the largest impact was seen in relation to the elderly and the case of cardiovascular mortality and SO_2 remained the most powerful determinant among the examined air pollutants. The effects of long-term exposure to ambient PM apply to cardiopulmonary mortality and probably to lung cancer also (WHO, 2004). Peng et al. (2008) revealed that a 10 mg/m^3 increase in PM2.5-PM10 was associated with 0.36% increase in cardiovascular disease admissions on the same day while Yang et al. (2008) found CO and SO_2 to be significantly associated with chronic obstruction pulmonary disease (COPD).

Table 6. Variation in the values of air parameters for dry and wet seasons

Parameter	Residential (dry season)	Residential (wet season)	Industrial (dry season)	Industrial (wet season)	Control (dry season)	Control (wet season)
T (^{O}C)	34.42±0.30^{a}	29.096±0.28^{b}	35.60±0.22^{a}	30.61±0.17^{b}	28.19±0.33^{b}	30.52±0.26^{a}
RH (%)	62.08±1.42^{b}	68.175±1.23^{a}	54.44±1.22^{b}	61.54±0.80^{a}	77.63±1.29^{a}	61.31±0.72^{b}
WS (m/s)	7.23±0.432^{b}	8.665±0.29^{a}	7.47±0.36^{cb}	9.82±0.27^{a}	5.37±0.38^{b}	8.71±0.62^{a}
WP (mm Hg)	1.51±0.38^{b}	1.8962 ±1.45^{a}	1.29±0.21^{b}	2.41±0.13^{a}	0.39±0.18^{b}	1.92±0.31^{a}
NOISE (dB)	55.85± 0.82^{b}	62.15±0.95^{a}	66.98±0.97^{b}	75.96±1.03^{a}	43.60±0.61^{b}	55.23±1.23^{a}
SPM (mg/m^{3})	48.91±5.28^{a}	35.58±3.44^{b}	192.08±26.68^{a}	107.52±16.32^{b}	6.00±0.52^{b}	28.75±2.67^{a}
CO (mg/m^{3})	0.80±0.21^{b}	2.89±0.35^{a}	2.14±0.32^{b}	6.10±0.43^{a}	0.00±0.00^{b}	2.13±0.54^{a}
H_2S (mg/m^{3})	0.00±0.00^{a}	0.00±0.00^{a}	0.62±0.31^{a}	0.00±0.00^{b}	0.00±0.00^{a}	0.00±0.00^{a}
SO_2 (mg/m^{3})	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
HC (mg/m^{3})	2.10±0.30^{a}	1.34±0.17^{b}	0.56±0.20^{b}	1.55±0.16^{a}	2.13±0.38^{a}	0.72±0.20^{b}

Values in the same row and with different superscript are significantly different at $p<0.05$.

Table 7. Noise level in comparison with permissible limits of NESREA

Facility	Maximum permissible limit (dBA)	Mean value for wet season (dBA)		Mean values dry season (dBA)	
		Residential	Control	Residential	Control
Residential buildings	50	55.85	43.6	62.15	54.81
Industrial area (Outside perimeter fencing)	70	66.98		75.96	

Table 8. Air pollutant concentrations in comparison with permissible limits of NESREA

Pollutant	Long-term limits (mg/m^{3})	Short-term limits (mg/m^{3})	Dry season			Wet season		
			Residential (mg/m^{3})	Industrial (mg/m^{3})	Control (mg/m^{3})	Residential (mg/m^{3})	Industrial (mg/m^{3})	Control (mg/m^{3})
SPM	0.20	0.20	48.91	192.01	6.00	35.58	107.52	28.38
CO	1.00	5.0	1.23	2.13	2.14	2.88	6.10	1.94
H_2S	0.008	0.008	0.00	0.62	0.00	0.00	0.00	0.00
SO_2	0.10	0.50	0.00	0.00	0.00	0.00	0.00	0.00
HC (Total)	2.00	5.00	2.10	0.56	2.13	1.34	1.55	0.88

4. CONCLUSIONS

Emissions released from industries located in the industrial scheme contributed significantly to the ground level concentration of H_2S, PM, and noise in surrounding residential areas while exceedance of exposure limits by NESREA was recorded for all parameters except in SO_2. Seasonal variation played an important role in the difference between ground level concentrations of pollutants. The presence of industries contributed significantly to high ground level concentrations of air pollutants in the surrounding and distant residential areas therefore reductions in air pollution will be of significant benefits to both living and non-living resources in and around the metropolis.

There is the need for air quality monitoring on the part of a relevant government agency while the residence should be enlightened on the inherent danger posed by air pollution and how to seek redress though they may rather feel that the industries are important to them regarding economic opportunity.

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REFERENCES

Abdulkareem AS, Kovo AS. Urban air pollution by process industry in Kaduna, Nigeria. Assumption University Journal of Technology 2006;9:172-4.

Agbaire PO. Air pollution tolerance indices (APTI) of some plants around erhoike-kokori oil exploration site of delta state, Nigeria. International Journal of Physical Science 2009;4:366-8.

Al-salem SM, Khan AR. Comparative assessment of ambient air quality in two urban areas adjacent petroleum downstream/upstream facility in Kuwait. Brazilian Journal of Chemical Engineering 2008; 25:683-5.

Assimakopoulos VD, Saraga D, Helmis CG, Stathopoulou OI, Halios CH. An experimental study of indoor air quality in areas of different use. Global NEST Journal 2008;10:192-200.

Bhikkhu V. Negative Impacts of Industrialization Along Lumbini Road, Nepal. Lumbini institutions. Birgitta, Berglund and Lindvall, H: A Draft Document of Community Noise. 2009.

Bisong SA, Umana AN, Onoyom-ita V, Osim EE. Hearing acuity loss of operators of food grounding machine in Calabar, Nigeria. Nigerian Journal of Physiological Sciences 2004;19:20-7.

Brook RD, Franklin B, Cascio W, Hong Y, Howard G, Lipsett M, Luepker R, Mittleman M, Samet J, Smith SC, Tager I. Air pollution and cardiovascular disease: a statement for healthcare professionals from the expert panel on population and prevention science. American Heart Association 2004;109:2655-71.

Ideriah JK, Stanley HO. Air quality around some cement industries in Port Harcourt, Nigeria. Scientia Africana 2008;7:27-34.

Kankal SB, Gaikwad RW. Studies on noise and air quality monitoring at Shirdi (Maharashta), India. Advances in Applied Sciences Research 2011;2:63-75.

Kowalska M, Zejda JE, Hubicki L, Osrodka L, Krajny E, Wojtylak M. Effect of ambient air pollution on daily mortality in Katowice Conurbation, Poland. Polish Journal of Environmental Studies 2006;16:227-32.

Mohammed IN. Risk Assessment in Air; Qualitative Analysis for Industrial Process [dissertation]. University of Technology, Malaysia; 2009.

National Environmental Standard Regulations Agency (NESREA). Federal Republic of Nigeria Official Gazette; National Environmental Regulations. 2009;96:1299-389.

Nkwocha EE, Egejuru RO. Effect of industrial air pollution on the respiratory health of children. International Journal of Environmental Science and Technology 2008;5:509-16.

Nwaogu LA, Onyeze GOC. Environmental impact of gas flaring in ebocha-egbema, Niger-Delta. Nigerian Journal of Biochemistry and Molecular Biology 2010;25:25-30.

Nwobodo ED, Ighoroje ADA, Marchie C. Noise induced hearing impairment as an occupational risk factor among Nigerian traders. Nigerian Journal of Physiological Sciences 2004;19:14-9.

Olayinka OS, Abdullahi SA. An overview of industrial employees' exposure to noise in sundry processing and manufacturing industries in Ilorin metropolis, Nigeria. Industrial Health 2008;4:123-33.

Osemeikhian JEA, Anomohanran O. Day and night pollution study in some major towns in Delta State, Nigeria. Ghana Journal of Science 2006;46:47-54.

Oyekanmi A, Obidairo K, Ekop G, Medupin C. EMS 311: Air and noise pollution, school of science and technology, National Open University [Internet]. 2010 [cited 2017 Nov 15] Available from: http://nouedu.net/sites/default/files/2017-03/ESM%20311.pdf

Ozer S, Hasan Y, Murat Y, Pervin Y. Evaluation of noise pollution caused by vehicles in the city of Tokat, Turkey. Science Research and Essay 2009;4:1205-12.

Peng RD, Chang HH, Bell ML, McDermott A, Zeger SL, Samet JM. Coarse particulate matter, air pollution and hospital admissions for cardiovascular and respiratory diseases among medicare patients. Journal of the American Medical Association 2008;299:2172-9.

Rene GT. An Air Quality Baseline Assessment for the Vaal Airshed in South Africa [dissertation]. University of Pretoria; South Africa: 2008.

Spire Research and Consulting (SRC). Air Pollution- China's Public Health Danger. 2007. p. 1-11.

Turk YA, Kavraz M. Air pollutants and its effects on human health: the case of the city of Trabzon. In: Moldoveanu A. editor. Advanced Topics in Environmental Health and Air Pollution Case Studies. Croatia: In Tech Europe; 2011. p. 251- 68.

Yang Q, Chen Y, Krewski D, Burnett RT, Shi Y, McGrail KY. Effect of short-term exposure to low levels of gaseous pollutants on chronic obstruction pulmonary disease hospitalization. Environmental Research 2008;1(99):99-105.

World Health Organisation (WHO). Systematic review of health aspects of air pollution in Europe [Internet]. 2004 [cited 2017 Nov 15]. Available from: http://www.euro.who.int/__data/assets/pdf_file/0003/74730/E83080.pdf?ua=1