ASSESSMENT OF AIR POLLUTION IN A SEMI-URBAN INDUSTRIAL CLUSTER

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ABSTRACT
This study assessed the air pollution in a semi urban industrial cluster in Nigeria with special focus on the cement industry. The major pollutants considered in this research were Suspected Particulate Matter (SPM), Oxides of Nitrogen, Sulphur di Oxide (SO2), Carbon Mono Oxide (CO), Lower Explosive Limit (LEL), Hydrogen Sulphide (H2S) and Noise. Industrial Scientific ITX 6 multi-gas analyzer, Land Duo Emission Analyzer, Handheld Aerosol Monitor Model 1055 and Quest Sound Level Meter, Model 2400 were used in the analysis. Also, empirical investigation, as well as reconnaissance surveys were carried out by the administration of well-structured residential and industrial question forms. The result of the analysis showed that there was a 3.1% reduction in the level of SPM measured with lower value than the required limit for 8 hours exposure. Reduced levels of CO and CO2 were observed from the average readings taken from 2014 and 2015 with 24.81% and 31.4% reduction in the average reading respectively for two consecutive years. Noise level detected at the several locations varied from 49.8 to 69.6 dB. The outcome of the research showed that appropriate measures must be put in place by industries to reduce air pollution now and in the foreseeable future.

Key words: Pollution, Cement Industry, noise level, Suspected Particulate Matter, Industrial Scientific multi-gas analyzer

1. Introduction

Air pollution is a global problem with serious health effect. This may be as a result of a deliberate or accidental release of harmful substances in liquid, solid or gaseous states into the environment causing serious damage to human health and the ecosystem at large [1]. [2] asserts that the presence of one or more than one pollutants in a quantifiable amount as to cause injury to living things or leads to irritability or discomfort and loss of properties is termed pollution. There are different types of pollution which depends on the state of matter of the pollutant.
It is generally alleged that about 10%-15% of wastes produced from industrial activities are regarded as being hazardous, and it is increasing at a rate of 2-5% per year [3]. Air pollution has potentially harmful or nuisance effects on human beings, animals, plants, their biological communities, habitats and on the soil [4]. The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution [5]. Epidemiological studies suggest that more than 500,000 people die each year from cardiopulmonary disease linked to breathing fine particle air pollution [6]. Transportation an integral component of nation’s growth [7] and industrialization are the major contributor to the problem solid waste [8] and air pollution. Automobiles release bye products resulting from the incomplete combustion of fossil fuel. Due to the fact that these urban centers are densely populated with very high vehicular traffic there are elevated levels of waste products of combustion engines in the atmosphere, also fast development of these areas has a direct effect on the human population, leading to higher vehicular activities and hence the amount of released pollutants.

Correspondingly from the industry, typical gaseous emissions to air from cement manufacturing plants include nitrogen oxides (NOx), sulphur dioxide (SO2), carbon oxides (CO and CO2) and dust (Pregger et al., 2009; Egyptian Environmental Affairs Agency EEAA, 2005). The key environmental emissions are nitrogen oxides (NOx), sulphur dioxide (SO2) and grey dust [9].

Across board, pollution can be classified into different levels which are local, urban, regional continental and global. For the purpose of this study, on the urban level of pollution in Nigeria with major focus on air pollution. Interestingly, in the advent of recent research, environmentalists like [10] have tried to link the relationship between environmental damage and industrial growth in developing countries. Also, Braden, [11] discovered, small scale industries tend to often fail to employ new more efficient technology maybe because of cost and this affects their activities and
waste disposal techniques, due to their number in most clusters, they tend to cause harm to the environment. Accordingly, [12] asserts that there are numerous environmental challenges in Nigeria created through man’s activities such as harnessing natural resources which openly or incidentally create complications for man and the environment. Cement is an extremely important construction material used for housing and infrastructural expansions and developments and a key to economic growth [13-14]. The longer a pollutant remains in the atmosphere, the longer the effect related with that pollutant will persevere. Some climate imposing pollutants stay in the atmosphere for prolonged periods of time even as much as decades or centuries after they are released, this implies that today’s emissions will possibly affect the climate far into the future [15]. Hence, this research assessed the level of air pollution in an industrial cluster with special focus on an industrial cluster in a semi urban area.

2. Methodology

Atmospheric analysis of the air at various distances from Portland cement Company was taken using portable gas analyzers and the results analyzed. This analysis was carried out during the dry season so as to prevent disruptions by rainfall. The results were collated and analyzed against past findings and the Federal Ministry of Environment (FME) standards and limits. This is to ascertain the trend in pollution in the area considered. The major pollutants considered in this research are: Suspected Particulate Matter (SPM), Oxides of Nitrogen, Sulphur di Oxide (SO₂), Carbon Mono Oxide (CO), Lower Explosive Limit (LEL), Hydrogen Sulphide (H₂S) and Noise.

Table 1: Equipments used for the research

| EQUIPMENT USED               | PARAMETERS ANALYSED |
|------------------------------|----------------------|
| Land duo emission analyzer   | CO, NO, CO₂, NOx, O₂ |
### 2.1 Data Collection and Sampling Method

Additionally, residential assessment forms were administered to the residents as well as industrial assessment forms which were administered to the major factories in the vicinity with special focus on cement manufacturing industry. The residential assessment form was to seeking public opinion on the industrial activities causing pollution in their vicinity and how this pollution affects the quality of their lives, the frequency of these emissions and any other information that may be useful in the assessment of the pollution levels. The industrial assessment forms were distributed to these factories and was aimed at determining the products, as well as by-products from their manufacturing processes, the percentage of these wastes categorized as gaseous, the amount pollutants recycled and infrastructure put in place to limit the emissions of toxic gaseous wastes.

### 2.2 Data Analysis

The data collated from the questionnaires were analyzed using The SPSS software and Microsoft Excel.

### 3.0 RESULTS AND DISCUSSION

#### INDUSTRIALIZATION AND POLLUTION

The result of the analysis showed that the percentage of cement producing company in the industrial cluster considered was 79% while steel production was 17% (Figure 1). This was as a result of the abundance of the required raw material for cement production.
Figure 1: Types of industries in the study area

Based on the respondence the availability of industries in the study area has contributed immensely to air pollution. The industrial assessment form showed that waste (solid, liquid and gas) were being discharged daily, weekly or monthly based on the production schedule. Figure 2 showed that 84% of the industries considered release industrial waste on a daily basis.

Figure 2: Frequency of waste disposal
The implication of this is that there will be a high concentration of these pollutants in the environment. It is a known fact that air pollution to a very large extent has health implications.

![Health related issues](image)

**Figure 3: Health related issues**

The result of the distributed question forms indicated that 36% of this industrial waste leads to breathing irritability while 35% indicated that it leads to skin irritations see Figure 3. The degree of irritability was as a result of the proximity to the industry as most respondence that lived far away from the industrial clusters were not really affected. Oral investigation showed that government efforts towards the reduction of waste have been tailored towards water and solid waste while air waste (pollution) has been neglected. Also there should be a strict rule to restrict residential buildings in industrial estates or zones due to the health implication. The result of the analysis showed that 21% of the respondence lives very close to the industrial cluster, based on the survey conducted it can be concluded that most factory workers tends to live very close to industrialized zone due to the reduced cost of transportation not considering the health impact as a result of pollution (Figure 4).
3.2 Spartio Temporal Assessment of the Level Of Air Pollutant In The Industrial Cluster

During sampling, the major pollutants detected at various locations around the industrial cluster and neighboring settlement were nitrogen oxides (NOx), sulphur dioxide (SO$_2$), carbon oxides (CO and CO$_2$) and Suspended Particulate matter (SPM) as seen in table 2 and figure. Suspended Particulate matter and CO$_2$ were prevalent pollutants observed during the sampling period. It should be noted however that all the pollutants detected were well within the Federal Ministry of Environment (FME) Limits. EPA’s health-based national air quality standard for SO$_2$ is 0.03 ppm (measured on an annual average) and 0.14 ppm (measured over 24 hours) Table 3. Emissions of SO$_2$ also can damage the foliage of trees and agricultural crops. Together, SO$_2$ and NO$_2$ are the major precursors to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility.

EPA’s health based national air quality standard for CO is 9 parts per million (ppm) [measured over 8 hours].
Table 3:

|   | Location          | SO₂ ppm | H₂S ppm | LEL ppm | CO ppm | NOₓ ppm | NO ppm | SPM |
|---|-------------------|---------|---------|---------|--------|---------|--------|-----|
| 1 | 6.907280N 3.208760E | <0.1    | <1      | <1      | 1      | <0.01   | <0.01  | 28  |
|   | 145 feet          |         |         |         |        |         |        |     |
| 2 | 6.905110N 3.207490E | <0.1    | <1      | <1      | <1.0   | <0.01   | <0.01  | 26  |
|   | 133 feet          |         |         |         |        |         |        |     |
| 3 | 6.909570N 3.209440E | <0.1    | <1      | <1      | <1.0   | <0.01   | <0.01  | 24  |
|   | 101 feet          |         |         |         |        |         |        |     |
| 4 | 6.902440N 3.205370E | <0.1    | <1      | <1      | <1.0   | <0.01   | <0.01  | 26  |
|   | 102 feet          |         |         |         |        |         |        |     |
| 5 | 6.889730N 3.205390E | <0.1    | <1      | <1      | 1      | 0.1     | 0.01   | 26  |
|   | 116 feet          |         |         |         |        |         |        |     |
| 6 | 6.889340N 3.202610E | <0.1    | <1      | <1      | <1.0   | <0.01   | <0.01  | 28  |
|   | 136 feet          |         |         |         |        |         |        |     |
|   | LIMITS            | 0.6     |         | 20-Oct  | 0.1    |         |        |     |

The noise level at the different locations considered is as shown in figure 5. There exists a linear relationship between the noise levels at the locations considered. The noise level tends to increase as the distance increases. This is as a result of the fact that transit stops are major sources of noise pollution.
Figure 5: Noise concentration

Correspondingly, the oxygen concentration increases as the distance increases while no specific relationship was established between the CO2 concentrations across boards. The concentration of the two pollutants was still within the specified range Figure 6.

Figure 6: Concentration of O2 and CO2
Figure 7: Comparative assessment of the pollution level

From the analysis, there is a slight reduction in the measured level of SPM (Suspended Particulate Matter). From the values in the Figure 7, it can be deduced that there was a 3.1% reduction in the level of SPM measured. SPM was detected in all the locations, and it was lower than the FME limits of 150 mg/m³ -500 mg/m³ for 8 hour exposure. Particulate matter is the term for solid or liquid particles found in the air. Some particles are large or dark enough to be seen as dust, soot or smoke. Others are so small they can be detected only with an electron microscope. Because particles originate from a variety of mobile and stationary sources (stone crushing, diesel trucks, woodstoves, power plants, etc.), their chemical and physical compositions vary widely. Particulate matter can be directly emitted or can be formed in the atmosphere when gaseous pollutants such as SO₂ and NOₓ react to form fine particles.
Also, there is a reduction in the measured noise levels; this could be as a result of the prevailing conditions such as traffic conditions as at when measurements were taken and the distances from the factory. There was a 24.1% reduction in the average noise levels measured from both years. Noise level detected at the several locations around the Lafarge cement plant and immediate settlements varied from 49.8 to 69.6 dB.

The noise levels in all the locations assessed were within allowable noise levels of 85 to 90 dB, for 8hrs exposure approved by the FME (Federal Ministry of Environment). The noise level detected varied with distance. Reduced levels of CO₂ were observed from the average readings taken from 2014 and 2015. There exists a reduction of 31.4% in the measured average readings from both years. Conversely, there was no increment or reduction in the average oxygen (O₂) levels measured in both 2014 and 2015, around the cement factory. The oxygen levels in the air were adequate and within FME limits.

The average levels of carbon monoxide (CO) measured in 2014 and 2015 show that there is a decrease of CO levels in the area. There is a 24.81% reduction in the measured levels of CO in the area. H₂S was observed in very trace amount in some of the locations behind the factory. It wasn’t observed in the previous year due to the locations where the tests were taken. LEL wasn’t observed in most of the reference points and the only point that had it, did so in very trace and negligible amounts. NOₓ was detected in trace amounts and a value of 0.1 was recorded and is within the FME limits.
3. Conclusion

During sampling, the major pollutants detected at various locations around the industrial cluster and neighboring settlement were nitrogen oxides (NOx), Sulphur dioxide (SO$_2$), carbon oxides (CO and CO$_2$) and Suspended Particulate matter (SPM).

Suspended Particulate matter and CO$_2$ were prevalent pollutants observed during the sampling period. It should be noted however that all the pollutants detected were well within the Federal Ministry of Environment (FME) Limits.

Reduced levels of CO$_2$ were observed from the average readings taken from 2014 and 2015. There exists a reduction of 31.4% in the measured average readings from both years. Noise level detected at the several locations around the Lafarge cement plant and immediate settlements varied from 49.8 to 69.6 dB. There exists a reduction of 31.4% of CO in the measured average readings from both years. From the results obtained from the air quality tests carried out and compared with the average values of research by [16] there is a slight reduction in the presence of air pollutants. This may be as a result of stack height installed and air pollution control devices put in place.

RECOMMENDATION

There is a need for the government to put adequate measures and check on industrial waste with special focus on air pollution which is often times neglected. Industries should control air pollution wind dynamics to a large extent for a safe and green environment.

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