Comparative analysis of Aircraft noise levels in ExxonMobil Nigeria Airstrip: Implication of potential impact on Residents in Eket Municipality

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Abstract

Measurements and analysis of aircraft noise level in ExxonMobil Airstrip, Eket, Akwa Ibom State have been carried out to determine the noise levels and its potential impact on the residents of the Area. The measurements were carried out for the period of twelve months between 8 a.m in the morning through 6p.m in the evening each day. Sound Level Meter (SLM), Model TEST 1350A (According to IEC651, ANSIS type) was employed to record the noise level. The measurements was also carried out during the take-off and landing of the aircraft. The results shows that the A-Weighted equivalent Sound pressure level ranges from 91.0-99.9 dB(A) which is against the WHO(2007) standard of (70 dB(A)) and other noise guideline. On the bases of this study, some measures have been proposed for abatement of aircraft noise level in the company under study, such as Government have to enact enabling law on noise pollution to help the residents to fight for their right

Keywords: Airstrip, Aircraft noise, noise levels, noise pollution, Eket residents

Introduction

Noise is defined as unwanted sound (Schmidt, 2005). Ambient noise or environmental noise is unwanted or harmful outdoor sound created by human activities, including noise emitted through means of transport (e.g. road traffic, air traffic noise) and noise from sites of industrial activity (Goines and Hagler, 2007).

In the face of unplanned traffic route control in a developing city like Eket Local Government Area(Thompson, 2017), the resultant health effects such as annoyance is mostly seen in the general health of the residents. It calls for concern from stakeholders and Government agencies that are responsible for planning the city. ExxonMobil Nigeria is a subsidiary company that carry their workers to offshore and other locations within and outside the company operational base in Eket. It is quite unfortunate that the company airstrip is sited within residential area and major business units. This causes the residents of the area to undergo serious health challenges due to the noise produced by the aircraft during takeoff and landing. Noise is considered a growing health threat and if left unchecked, could lead to hazardous conditions (Mutlin, Hardoy, and Satterhwaiite, 1992). Noise-induced hearing loss limits the ability to hear high frequency sounds and understand speech, which seriously impairs the ability to communicate. Hearing aids may help, but they do not restore your hearing to normal. It is of note that hearing loss is pervasive and also preventable. Exposure to loud noise is bound to kill the nerve endings in the inner ear and sustained exposure will result in more dead nerve endings. The resultant effect is permanent hearing loss that cannot be corrected by surgery or medicine. In 1999, the World Health Organization concluded that the available evidence showed that noise has been associated with cardiovascular health problems, and there is a relationship between long-term noise exposure above 67-70dBA and hypertension (Birgitta, Thomas and Dietrich, 1999). It is therefore imperative for the concerned authorities to look into adverse effect of this noise on the residents.
Conceptual Frame Work

Noise pollution

The words that are constantly heard in the media and academic circles are “Climate change and global warming”. These words are associated with studies based on carbon dioxide emissions and excessive heat. According to man-made thinking, generally, humans do not believe in noise impacts upon the total environment. They instead believe that fairly common atmospheric pollutants have more extreme consequences for the planet as opposed to noise (Fyri and Klaeboe, 2006). However, the noise problems of the past are incomparable to those of the modern society. A massive number of motor cars are constantly travelling through the cities and the countryside, while heavily laden trucks with diesel engines, which have been ineffectively silenced for engine and exhaust noise, weave about in the cities day and night (Schwela and Zali, 1999). In contrast to other population control measures, the control of environmental noise has been hampered by insufficient knowledge of its effects on humans. The effects of noise on people in developing countries are just as widespread as those in developed countries, and the long-term effects are the same. Even though noise pollution control is perceived as an extravagance, with the result that it has not been placed on the priority list of developed countries, exposure to harmful noise level is often greater in developing countries, on account of ineffectual planning and poor construction of buildings (Schmidt, 2005).

The most significant health problem caused by noise pollution is hearing loss. Loud noise deafens quickly extremely loud sounds, such as gunshot at close range, can cause immediate hearing loss. But even sound levels of only 85 decibels will cause some hearing loss after prolonged exposure (Hart, 1997). According to the National Institute of Health, 65 million people are exposed to noise levels that can hamper their work or disrupt their sleep, and 25 million risk health problems due to noise (Holmes, 1995).

The general noise level increases in towns as cities increases, mainly due to traffic. If a job entails concentration, the effect of noise on the worker will make the work much more tiring than if the job demands thought concentration. The effect of noise on the health of individuals, especially over a period of years, is an area of research that needs to be explored (Schmidt, 2005). Environmental noise pollution is a threat to the health and well-being of human-kind. It is more severe and wide-spread than ever before, and it will continue to increase in magnitude and severity on account of present societal trends namely population growth and urbanization. Its severity will intensify, in relation with the increase in the use of progressively more powerful, varied, and highly mobile source of noise. Noise levels will also continue to rise with sustained growth in highway, rail, sources of environmental noise (Schell, Gallo, Denham and Ravenscroft, 2006). Escape from human-induced sound is markedly more difficult today than a century ago, and within another half-century it may be all but impossible. One might well ask how human-kind arrived at the present state of affairs. Several causative factors would seem to be responsible (Schell, Gallo, Denham and Ravenscroft, 2006).

Aircraft noise

Aircraft operations garneted substantial noise in the vicinity of both commercial and military airports including vibration and rattle. The landing produce substantial noise in long low-altitude flight corridors. The noise is produced by the landing gear and automatic power regulation and also when reverse thrust is applied, all for safety reasons. In general, larger and heavier aircraft produce more noise than lighter aircraft. The main mechanism of noise generation in the early turbojet powered aircraft was turbulence created by the jet exhaust mixing with the surrounding air. This noise source has been significantly reduced in modern high by-pass ratio turbo-fan engines that surround the high-velocity jet exhaust with low velocity airflow generated by the fan. The fan itself can be a significant noise source, particularly during landing and taxing operations. Multi-bladed turbo-prop engines can produce relatively high levels of tonal noise. The sound pressure level from
Aircraft is typically predicted from the number of aircraft, the types of airplanes, their flight paths, the proportions of take-offs and landing and the atmospheric conditions. Severe noise problem may arise at airports hosting any helicopters or smaller aircraft used for private business, flying training and leisure purposes. Special noise problems may also arise inside airplanes because of vibration. The noise emission from future superjets is unknown (WHO, 2010).

A sonic boom consists of a shock wave in the air, generated by an aircraft when it flies at a speed slightly greater than the local speed of sound. An aircraft in supersonic flight trails a sonic boom that can be heard up to 50 km on either side of its ground track, depending upon the flight altitude and the size of the aircraft (Warren, 1972). A sonic boom can be heard as a loud double-boom sound. At high intensity it can damage property. Noise from military airfields may present particular problems compared to civil airports (Von Gieke and Harris, 1987). For example, when used for night-time flying for training interrupted landings and take-offs (so-called touch-and-go), or for low-altitude flying. In certain instance, vehicle (trucks), helicopters and small and large fire-arms.

**WHO Community Noise Guidelines**

Traffic is the most widespread source of environmental noise. Exposure to traffic noise is associated with a wide range of effects on human health and well-being. The World Health Organization (WHO) recognizes community noise, including traffic noise as a serious public health problem, promoting it to publish guidelines on community noise in 1999 (Birgitta, et al., 1999). These guidelines present noise levels above which a significant impact on human health and/or well-being is to be expected. In 2007 an extension of the guidelines was published (WHO, 2007), focusing on the health impacts of night-time noise. Table 1 presents the relevant guideline values for specific environments when multiple adverse health effects are identified for a given environment, the guideline values are set at the level of the lowest adverse health effect (the “critical health effect”).

**Table 1:** Selected values from the WHO community noise guidelines (WHO, 2007)

<table>
<thead>
<tr>
<th>Specific environment</th>
<th>Critical health effect</th>
<th>Day: L_{Aeq} (dB(A))</th>
<th>Night: L_{N}(dB(A))</th>
<th>Time base of exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day-time and evening noise</td>
<td>Serious annoyance,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor living area</td>
<td>day time and evening</td>
<td>55</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Moderate annoyance,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>day time and evening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dwelling indoor</td>
<td>Speech intelligibility and moderate annoyance,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>day-time and evening</td>
<td>50</td>
<td>35</td>
<td>16</td>
</tr>
<tr>
<td>School classrooms and pre-school indoors</td>
<td>Speech intelligibility, disturbance of information, extraction, message communication</td>
<td></td>
<td></td>
<td>During class</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School outdoor playground</td>
<td>Annoyance</td>
<td>55</td>
<td></td>
<td>During class</td>
</tr>
</tbody>
</table>
Hospital ward rooms

Indoor

Sleep disturbance, daytime and evening

Interference with rest and recovery

Hearing impairment

Hearing impairment

Hearing impairment

Body movement, awakening, self-reported sleep disturbance

During the night

Hospital, treatment room, indoor

Industrial, commercial and traffic areas

Music through earphones

Ceremonies and entertainment

Night-time noise

At the facade, outside

30

16

a*

70 dB(A)

24

85 dB(A)

1

100 dB(A)

4

Materials and Method

Study Area

The research area is Mobil Producing Nigeria Unlimited, Eket Local Government Area of Akwa Ibom State, Nigeria. Eket is one of the largest cities in Akwa Ibom State. The city itself is an industrial city that in recent years has become a conurbation engulfing separate villages, it has a population of about 172,856, and the land size of 168.656km² (NPC, 2006). Eket is situated at 4.64°N latitude and 7.92°E longitude (Figure 3.1). Also Mobil Airstrip is situated at 4.647502(degrees)Latitude and 7.948844(degrees)Longitude

Materials

Instrument employed for the field measurements consisted of Sound Level Meter (SLM), Model TEST 1350A (According to IEC651; ANSIS.4 type, 1994) with condenser microphone, which has frequency range of 31.5Hz and measuring level range of 35 to 130dB(A). One 9-volt battery was used to power the instrument. Also, stopwatch was used to check the time. The instrument was calibrated by the internal sound level calibrators as specified or given by the instructional manual by the manufacturer before making measurements at each location. All the instruments employed comply with IEC standards (IEC, 1979) (Figure 2).

Methods

The methods used to study the aircraft traffic noise pollution in Mobil Producing Nigeria Unlimited, Eket Local Government Area of Akwa Ibom State, Nigeria were sampling location and the observation time, collection of data and analysis. A common community noise assessment model by Saadu, et al. (1998) and Microsoft excel were employed to analyse the data obtained.

Measurements

The measurements were carried out for the period of twelve months between 8 a.m in the morning through 6p.m in the evening each day. The instrument Sound Level Meter (SLM) was held comfortably in hand with the microphone pointed at the noise source from a distance of about 10 metres away from any reflecting source with the elevation of 20 metres. A-weighted instantaneous sound pressure level \( L_{\text{aI}} \) measurement were recorded from 8:00 am to 6:00 pm for twelve months during takeoff and landing of aircraft. Aircraft Traffic noise
measurements were carried out when the effects on noise sources of various factors such as rain, wind, storm, thunder were at minimal level.

Analysis
The model employed to analyze a common community noise assessment quantities such as Traffic Noise Index (TNI), exceeding percentiles $L_{10}$ and $L_{90}$, $A$-weighted equivalent sound pressure level ($L_{Aeq}$), and noise pollution level ($L_{NP}$) from the data obtained is given by the relations in equations 3.1 – 3.6 (Saadu, et al., 1998).

\[
L_{Aeq} = 10 \log_{10} \left[ \frac{1}{N} \sum_{i=1}^{N} \left( \frac{\text{anti } \log_{10} L_{Ai}}{10} \right) n_i \right]
\]

1

\[
L_{NP} = L_{Aeq} + (L_{10} - L_{90})
\]

2

\[
T_{NI} = 4(L_{10} - L_{90}) + (L_{90} - 30)
\]

3

where $L_{Ai}$ is the $A$-weighted sound pressure level reading in decibels, $N$ is the total number of the reading; $L_{Aeq}$ is the weighted equivalent sound pressure level, $L_{10}$ is the noise level exceeded 10% of the time (peak noise); $L_{90}$ is the noise level exceeded 90% of the time (background noise); $L_{NP}$ is the noise pollution level and Traffic Noise Index (TNI).

![Figure 2: Map of Eket Showing Traffic Noise Sampling Point](image-url)
Results and Discussion

Aircraft Traffic Noise Measurements
All the data were obtained on weekly basis for twelve months under good weather conditions. The data obtained were used to evaluate the mean noise descriptors in form of LAeq, L10, L90, LNP and TNI per location.
Table 2 Monthly Average of Noise Parameters.

<table>
<thead>
<tr>
<th>Month No.</th>
<th>Time interval</th>
<th>Distance</th>
<th>LAeq dB(A)</th>
<th>L10 dB(A)</th>
<th>L90 dB(A)</th>
<th>LNP dB(A)</th>
<th>TNI dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>92.8</td>
<td>97.6</td>
<td>85.9</td>
<td>104.5</td>
<td>102.7</td>
</tr>
<tr>
<td>02</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>91.0</td>
<td>96.5</td>
<td>84.2</td>
<td>103.2</td>
<td>103.4</td>
</tr>
<tr>
<td>03</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>99.6</td>
<td>104.1</td>
<td>90.9</td>
<td>112.8</td>
<td>113.7</td>
</tr>
<tr>
<td>04</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>92.1</td>
<td>97.5</td>
<td>85.8</td>
<td>103.8</td>
<td>102.6</td>
</tr>
<tr>
<td>05</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>98.0</td>
<td>102.3</td>
<td>90.1</td>
<td>110.2</td>
<td>108.9</td>
</tr>
<tr>
<td>06</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>97.1</td>
<td>94.8</td>
<td>86.5</td>
<td>105.4</td>
<td>89.7</td>
</tr>
<tr>
<td>07</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>99.3</td>
<td>103.5</td>
<td>90.1</td>
<td>112.7</td>
<td>113.7</td>
</tr>
<tr>
<td>08</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>92.9</td>
<td>97.8</td>
<td>85.5</td>
<td>105.2</td>
<td>104.7</td>
</tr>
<tr>
<td>09</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>99.9</td>
<td>103.8</td>
<td>90.1</td>
<td>113.6</td>
<td>114.9</td>
</tr>
<tr>
<td>10</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>91.5</td>
<td>96.6</td>
<td>84.3</td>
<td>103.8</td>
<td>103.5</td>
</tr>
<tr>
<td>11</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>99.2</td>
<td>103.5</td>
<td>90.5</td>
<td>112.2</td>
<td>114.5</td>
</tr>
<tr>
<td>12</td>
<td>8:00 a.m.-6:00pm</td>
<td>10 metres away</td>
<td>98.1</td>
<td>102.4</td>
<td>90.0</td>
<td>110.5</td>
<td>109.6</td>
</tr>
</tbody>
</table>

Discussion
From the survey, the A-Weighted equivalent pressure level ranges from 91.0-99.9 dB(A), L10 ranges from 94.8-104.1 dB(A), L90 ranges from 84.2-90.9 dB(A), LNP ranges from 103.2-113.6 dB(A) and TNI ranges from 89.7 – 114.9 dB(A) (figure 1). The result obtained showed that the noise level as exceeded the noise standard given by WHO 2007 (figure 2). The results also shows that as aircraft landing increases, the noise pollution level also increases and further trigger danger on the residents of the area. During the survey, it was also discovered from the research that there is always a pre-maintenance of aircraft in this airport, though the measurements was not done during this maintenance, but it can be predicted if on normal circumstances, where the aircraft has not undergone any maintenance, yet the noise level exceed the standard, it means that as the aircraft undergoes pre-maintenance, the noise level will as well increase as the aircraft engine is steaming high.
The problem is not really the aircraft noise from the Mobil Airstrip but the danger of the noise on the residents of the area and the modality put in place to ensure that the residents of the area are safe from this ugly situation.

**Implication of the Findings on Eket Residents:**

The aircraft noise frequently exceeds the guideline levels published by WHO and those exposed to this noise consequently suffer an array of adverse health effects. These include socio-psychological responses such as annoyance, sleep disturbance, and physiological effects such as cardiovascular diseases (heart and circulatory problems) and impacts on mental health (impaired cognitive functioning).

The noise level detected in Exxon Mobil Nigeria in Eket range from 91.0-99.9 dB(A). This result shows that the residents of the area are potentially undergoing health effects both short-term and long-term. On these effects, it is very essential for citizens to be aware of the ugly situation and relocate their homes from such vicinity because of the health implication.

**Conclusion**

This work has shown some facts about aircraft noise in Exxon Mobil Nigeria in Eket. The A-Weighted equivalent pressure level ranges from 91.0-99.9 dB(A), L10 ranges from 94.8-104.1 dB(A), L90 ranges from 84.2-90.9dB(A), LNP ranges from 103.2-113.6dB(A) and TNI ranges from 89.7–114.9dB(A) (figure 1). The result obtained showed that the noise level as exceeded the noise standard given by WHO 2007 (figure 2). The results also shows that as aircraft landing increases, the noise pollution level also increases and further trigger danger on the residents of the area. Therefore, it is important to address it immediately because it may be difficult and expensive to control then. So, proper awareness and the WHO standard should be put into consideration.

**Recommendations**

Exxon Mobil Nigeria was brought for the benefits of Eket people in terms of development and employment. However, the location where the company is sited does not really help the residents of the area, because it has created another problem to people instead of solving their problem. It is therefore recommended that:
1. Mobil should relocate the homes of those that encompasses them and also pay them the environmental impact assessment by mean of compensation.
2. Government have to enact enabling law on noise pollution to help the residents to fight for their right.
3. Recommend that Eket L.G. A should set out by laws on the distance where residents should built to the airstip
4. Mobile company should adequately maintain and repair the aircraft on time to avoid noise pollution.
5. That modern noiseless aircraft should be used by mobile oil company.

References


Thompson, E,E (2017). Measurements and Analysis of Traffic Noise in Eket