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Assessment of the level of noise produced by sound generating machines in Lapai, Northern Nigeria

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ABSTRACT

An assessment of the level of noise produced by sound generating machines was carried out in Lapai, Niger State. Acoustical measurements were made in fifteen selected areas using a precision sound level meter model 2310 SL, IEC 651 type 2 with serial number 09837849 and factory calibrated with a resolution of 0.1dB. Measurements were made at intervals of 100cm from each source and a total of fifteen (15) machines were investigated to determine the noise generated and its level at each of these distances. Results show that the average ambient noise levels around these machines were lowest for source S3 which had between 46dB at 600cm and 78dB at 100cm and highest for source S5 which had between 94dB at 600cm and 122dB at 100cm.This result indicates that people working around source S5 are more exposed to noise and hence more prone to noise associated health effects. The results in S5 exceed the recommended noise level of 90dB for an 8 hour exposure by OSHA. A confirmatory analysis on annoyance, general discomfort and temporary hearing impairments indicated that people around these areas are already being ignorantly affected by these sources of noise.

Keywords: Assessment, Noise Level, Measurement, Noise Effects, health hazards, Lapai town.

INTRODUCTION

The World Health Organization (WHO) defines health as “A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.” This broad definition of health embraces the concept of well-being, and thereby renders noise impacts “health” issues. Noise effects, according to [1] can be separated into two broad categories: auditory (noise-induced hearing loss) and non-auditory (behavioural and physiological effects). Behavioural effects are those that are associated with activity interference such as interference with communication, rest or and sleep and learning; or that which produces annoyance. Physiological health effects include such things as cardiovascular disease and hypertension.

Most machines generate noise as a by-product during their operations. This increasingly results in environmental nuisance that affects human health and well being [2]. Unlike other pollutants, the control of environmental noise has been hampered by insufficient knowledge of its effects and lack of informative awareness by regulatory authorities. Noise pollution is a significant environmental problem in many rapidly growing urban centres. This problem is not properly acknowledged despite the fact that it is steadily growing in developing countries [3]. It is well established now that noise is an unjustifiable interference imposed upon human comfort, health and quality of life.

Noise is not easily understood by many as a physical pollutant. This is because the sensitivity of human ear gets automatically adjusted to the ambient level of sound so that slow increases in the ambient level is not easily observed. Noise therefore continues to do silent damage on those exposed to it in high dosage. Pollution itself is a by-product of some essential function or activity, it is therefore almost impossible to completely eliminate the pollutant, but it can be controlled. Most of the pollutants can be tolerated only up to a certain level, the level being dependent on the type of the pollutant. When the level of pollution continues to increase, it becomes necessary to know the amount by which the permissible limit has been exceeded so that their increase can be checked. In the case of noise pollution, measurement is essential because of the incapability of our auditory system to recognized slow changes [4].

In Nigeria, the problem of noise pollution is wide spread. Several studies report that noise level in metropolitan cities exceeds the standard limits [3]. The equivalent environmental noise level of 70 dB(A) Laeq, 24h has been recommended by WHO for industrial, commercial, shopping and traffic areas, indoors and outdoors areas to prevent impairments [5].

This paper assesses the noise level from various noise generating machines in Lapai town, Niger State, Nigeria with a view to ascertaining the level of exposure of people living or working around the premises where noise generating machines are installed and recommends some protective and proactive measures to minimize the hazards associated with high noise level.

Lapai is the headquarters of Lapai local government area in Niger State. According to [6] , it is located on longitude 9003'00"N and latitude 6034'00"E, and as at 2006, had a population of about 110,127 people [7] and an area of 3, 051Km2. It is bounded by Paikoro and Agaie local government areas of Niger State; the Federal Capital Territory(Abuja) and Kogi State.

The population of Lapai has been increasingly on the rise in the past six years due to the location of a State University in the town. This has led to mass influx of people into the town both for academic and commercial purposes. The study of noise in this area with this number of people is therefore very significant as its effects on the people can be known and suggestions proffered to reduce the associated health effects. Noise monitoring requires that people should be placed in a hearing conservation program if they are exposed to average noise levels of 90dB or greater during an 8 hour workday [8]. In order to determine if exposures are at or above this level, it may be necessary to measure or monitor the actual noise levels in the places where noise generating machines are used and to estimate the noise exposure received by residents during the periods of the machines' operations.

The issue of noise pollution is so important that United States' Federal Environmental Protection Agency recommended that; day–night noise pollution level (Lnd) greater than 70(dBA) can cause serious temporary or permanent hearing loss with time, 55< Ldn <70 (dBA) can cause sentence intelligibility, community complaints and annoyance, and Lnd = 55(dBA) is desirable outdoor noise level for residential neighbourhoods [9].

[10] provides daily noise exposure limits for workers in Nigerian industries as 90 dB(A) for 8 hour exposure but there is no known legal control measure over noise in the country. Measures therefore have to be taken to control the level of noise generated due to industrialization and acquisition of private noisy electricity generating machines which have become the last resort due to the dire need for electricity in the face of its irregular supply by the public power supply agencies.

Potential Health Effects of Noise Exposure

Exposure to noise is a potential challenge to individual and community health whether consciously or not. Sources of excess noise include vehicular traffic, aircraft, industry, and the use of generators in the home and/or workplace among others. The potential health impacts associated with exposure include annoyance, sleep disturbance, interference with communication, decreased school performance, increased levels of stress, and modification of social behavior. Chronic exposure to noise is associated with increased risk of hearing impairment, hypertension, and ischemic heart disease [11]

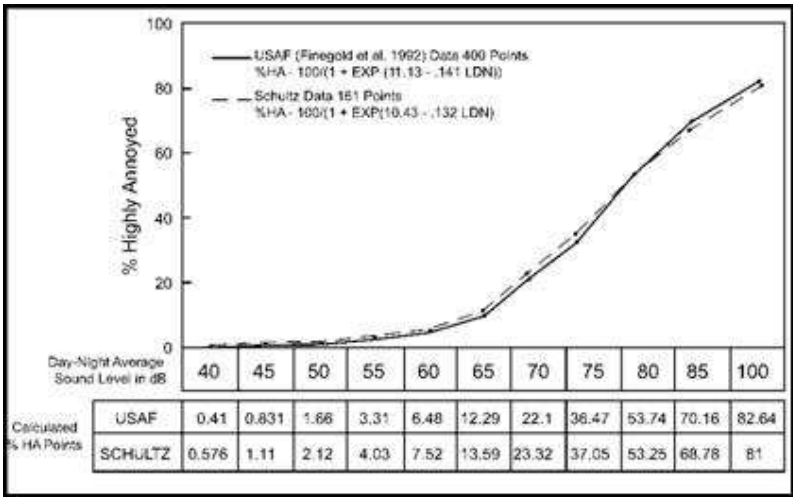


Fig. 1: Noise Level Vs Annoyance [13]

Community Annoyance

Social survey data have shown that individual reactions to noise vary widely for a given noise level. [9] and [12] in their studies have shown that attitudinal differences and personality are factors that affect individual annoyance to noise, and that the higher the sound level, the more annoying noise is likely to be. Nevertheless, as a group, people's aggregate response to other factors is predictable and relates well to measures of cumulative noise exposure such as day-night level. The most widely recognized relationship between noise and annoyance is shown in Figure 1.

Sleep Disturbance

The effect of noise on sleep is a long recognized concern. Historical studies of sleep disturbance were conducted mainly in laboratories; field studies also were conducted, in which subjects were exposed to noise in their own homes, using real or simulated noise. The data from these field studies show a consistent pattern, with considerably less percent of the exposed population expected to be behaviourally awakened than had been shown with laboratory studies. In 1997, the Federal Interagency Committee on Aviation Noise (FICAN) recommended a new dose response curve for predicting awakening, based on the results of the field studies described above. This curve is presented in Figure 2.

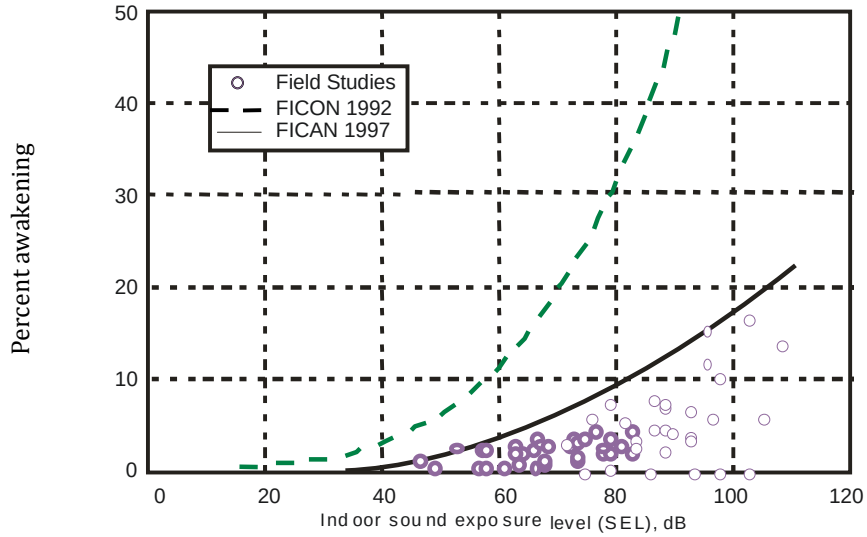


Fig.2 Recommended Sleep Disturbance Dose – Response Relationship [14]

Interference with Communication

One of the primary effects of noise is its tendency to drown out or "mask" speech, making it difficult or impossible to carry on a normal conversation without interruption. The sound level of speech decreases as distance between a raconteur and listener increases. As the level of speech decreases in the presence of background noise, it becomes difficult to hear. As the background level increases, the conversationalist must raise his/her voice, or the individuals must get closer together to continue their conversation.

The Effects of Noise on Children's Learning

So much attention has been given recently on the issue of the effects of noise on children and their learning. Research findings suggest that there are effects in the areas of reading, motivation, language and speech, and memory. One common theory for the causes of these problems is speech interference: if children who are learning to read cannot understand their teacher, they may develop reading problems. These problems appear to be aggravated in vulnerable populations, such as children for whom English is a second language.

Hearing Loss

Hearing loss is measured as "threshold shift". Threshold refers to the quietest sound a person can take notice of. When a threshold shift occurs, the sound must be louder before it can be heard - a person's hearing is not as sensitive as it was before the threshold shift. The natural decrease of hearing sensitivity with age is called presbycusis [12]. For hundreds of years it has been known that excessive exposure to loud noises can lead to noise-induced temporary threshold shifts, which in time can result in permanent hearing impairment, causing individuals to experience difficulty in understanding speech. A temporary threshold shift (TTS) usually precedes a noise-induced permanent threshold shift (NIPTS); i.e. after exposure to high noise levels for a short time or lower noise levels for a much longer time, a person's threshold of audibility is temporarily shifted to higher levels. After continuous noise exposure on an eight hour shift, such TTS can amount to over 20 dB [15]. However, as its name indicates, it is only temporary, and the ear recovers fully after several hours. If such exposures are repeated daily, or the ear is not allowed to recover, TTS can lead to a permanent threshold shift (PTS). [12] and [9] found that exposure to serious noise of sufficient intensity for long periods produces changes in the inner ear and seriously decreases the hearing ability and that these changes can range from only slight ear impairment to nearly total deafness.

Table 1: Examples of Long-term Effects Related to Noise Exposure [16]

Effect	Exposure type	Measure*	dB	Location of assessment
Hearing Impairment	Environmental	L_{aeq} (24 hr avg)	70	Indoors
	Occupational		75	
Hypertension	Environmental	L_{dn} (24 hr avg)	70	Outdoors
Ischemic Heart Disease	Occupational	L_{aeq} (24 hr avg)	<85	Indoors
	Environmental	L_{aeq} (24 hr avg)	70	Outdoors
Annoyance	Environmental	L_{dn} (24 hr avg)	42#	Outdoors
	Occupational	L_{aeq} (24 hr avg)	Industry <85 Office <55	Indoors
Performance	School	L_{aeq} (avg during school day)	70	Outdoors
	Occupational		70	
Disturbance of Sleep pattern	Sleep	L_{aeq}(overnight avg)	<60	Outdoors
Awakening	Sleep	SEL	55	Indoors
Sleep Quality	Sleep	L_{aeq}(overnight avg)	40	Outdoors
Mood Next Day (sleep disturbance)	Sleep	L_{aeq}(overnight avg)	<60	Outdoors

** Noise levels presented in this table are presented as an equivalent sound level (Laeq) measured over a period of time and day-night level (Ldn) which measures sound level over 24 hours with sound levels during the night. A sound exposure level (SEL) is the equivalent sound level of an event measured over 1 second.*
 # The dB level causing annoyance is approximately 12 dB lower for impulse noise.

Table 2: Occupational Safety and Health Administration (OSHA) Daily Occupational Noise Level Exposure[9]

	OSHA Maximum Allowable Noise Exposure									
Hours per day (constant noise)	8	7	6	4	3	2	1.5	1	0.5	≤0.25
Sound level dBA	90	91	92	95	97	100	102	105	110	115

MATERIALS AND METHODS

Sound level measurements were made around areas where sound generating machines were installed using a precision sound level meter, 2310 SL model, IEC 651 type 2 with serial number 09837849 and factory calibrated with a resolution of 0.1dB. Accurate and responsive, the Digital

Sound Level Meter measures sound in decibels and displays the reading on the LCD display that has a backlight button for easier viewing. Measurements were made at some distances from the source of the sound in steps of 100cm. A total of six readings each for maximum sound level ($L_{max.}$) and minimum sound level ($L_{min.}$) were recorded for 15 surveyed sites and the average sound level ($L_{av.}$) evaluated for each. Before carrying out the measurements, the background noise levels in the study areas were measured using the same precision sound level meter to ensure that the noise effects due to the generating sources were accurately determined. The "F/S" response time button was used for slow response measurements of comparatively stable noise and fast varying noise respectively, while the “Max/Min” button setting was used to measure the maximum/minimum noise level of sounds and updated continuously whenever a louder sound was detected. The reason for measuring the sound level at intervals of 100 cm was to determine at what distance the noise generating source could be placed so as to reduce the health risks on the inhabitants of the area. The choice of six measurements for each of the measurements was because the sources were installed to within six metres from the populace.

An oral interview was also conducted on the people exposed to such noise to determine their feelings.

RESULTS

The results obtained from these measurements represent the noise level obtained from five different categories of sound sources which were: Lister generators, LLG generators, Block moulding machines, Iron filling machines and grinding machines. The results are presented in figure 3.

A close look at the results shows that all the sound generating machines produced average noise levels in excess of 80dB at a distance of 100cm from the source.

In source S1, the average sound level was about 82dB at 100cm and decreased to about 74dB at 600cm from the source, a Lister Generator. Source S2 which represents noise level from another Lister Generator showed an average noise level range of between 83dB and 93dB at 600cm and 100cm respectively.

Sources S3 and S4 represent noise generated from LL5GF-4A Generators. The average values ranged from 46dB to 78dB and 58dB to 81dB at 600cm and 100cm respectively. S5, S6 and S7 show the average level of noise generated from brick making machines. S5 has a range of values from 94dB to 122dB while S6 and S7 have average noise level ranging from 70dB to 99dB and 76dB to 112dB at 600 and 100cm respectively.

Sources S8 to S11 show the noise level emanating from iron filing/cutting machines at various places within the town. The result indicated that the average noise level for S8 ranges from 64dB to 96dB,while that for S9 ranges from 64dB to 98dB. Similarly, the range of noise levels for S10 and S11 were respectively 61dB to 96dB and 80dB to 97dB at 600cm and 100cm.

Sources S12 to S15 shows the noise generated from grinding machines. The data shows an average noise level range of 85dB to 98dB for S12, 70dB to 97dB for S13, 76dB to 96dB for S14 and 79dB to 99dB for S15.

The interaction with people within the areas where these noises were generated revealed that they were not actually happy with the discomfort caused by the noise. But since it cannot be avoided, they have to have to accept it, especially as it is tied to their sources of income.

DISCUSSION

A critical look at the results as presented above shows that the range of values for each of the five categories of sound generators falls within the same limit with a deviation of ±10dB which could be as a result of the type of machines, age, settings, lubrication or a combination of one or more of these factors.

These machines were installed within six metres from workers in the area, thereby making them prone to exposure to the noise generated by these sources which in some cases exceeded the recommended levels as shown in tables 1 and 2. Ignorance and carelessness on the part of these noise prone people have increased the risk associated with such exposures and the need to monitor noise level in these areas has become imperative.

The results indicate that of the five categories of noise sources investigated, only S_3 , S_4 and S_1 produced an average noise of less than 90dB, even at 100cm distance from source as recommended by OSHA for an 8 hour exposure period. The other sources produced noise in excess of 90dB at 100cm from source. The implication is that anybody operating around this perimeter will be exposed to hazardous noise level.

The slight difference between the two Lister generators investigated could be attributed to their model, age and capacity as the one in the water factory was bigger and hence had a higher noise generating capacity.

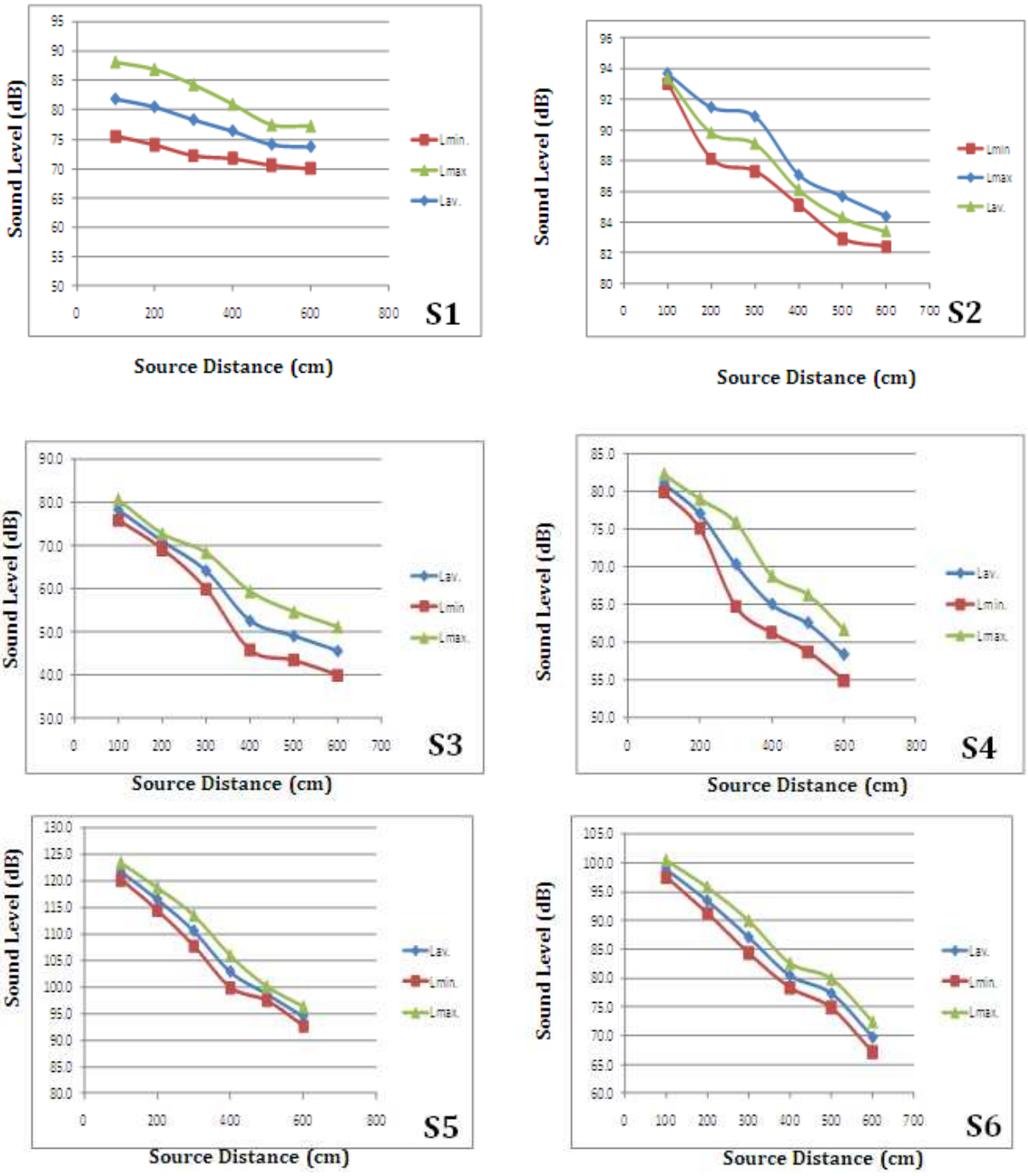
At 100cm of operation from the source, only people working in sources S9 and S10 will be exposed to noise above the OSHA limit, while at 2 meters from source the noise generated from sources S2, S6 and S8 could be harmful by the OSHA standard.

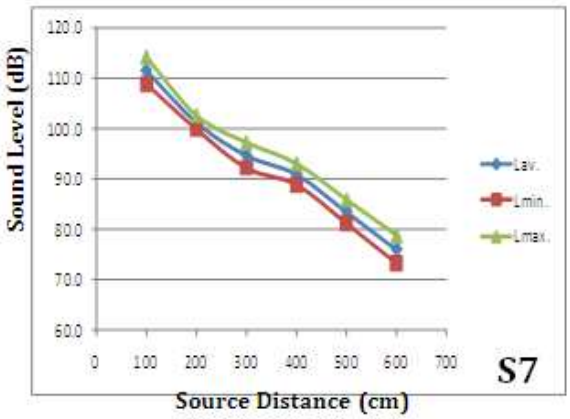
The noise level observed at 300cm from sources S11, S12, S13, S14 and S15 also exceeded the OSHA benchmark. This means people should not operate within 300cm distance from these sources for adequate safety, especially those whose operations would not be affected by so doing.

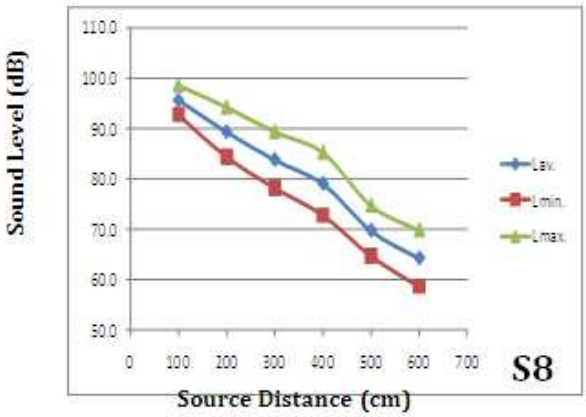
The noise from source S7 exceeded the OSHA standard at 400cm while source S5 produced the highest noise of all the sources assessed. This source had an average noise level of 122dB at 100cm, and even at 6 metres, an average noise level of 95dB was recorded.

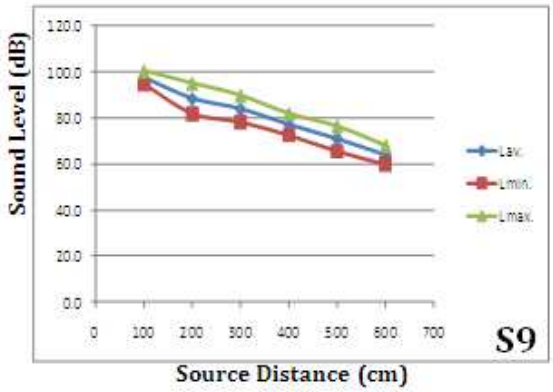
From the interview conducted on the people operating within these noise range, it was discovered that all of them complained of serious discomfort and temporally hearing difficulties

which according to them disappears after sometime. They however, failed to understand the cumulate effects.




Sound Level (dB)
Source Distance (cm)
Lav.
Lmin.
Lmax.
S7


Sound Level (dB)
Source Distance (cm)
Lav.
Lmin.
Lmax.
S8


Sound Level (dB)
Source Distance (cm)
Lav.
Lmin.
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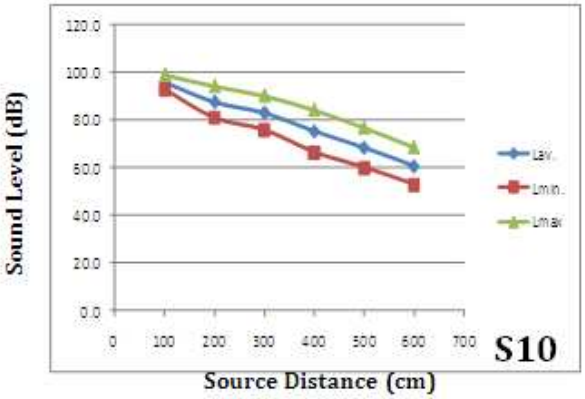
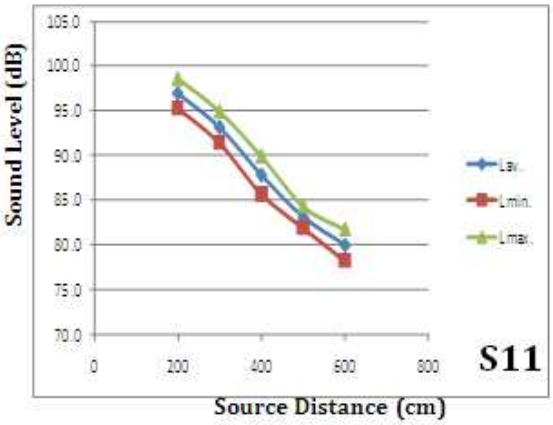
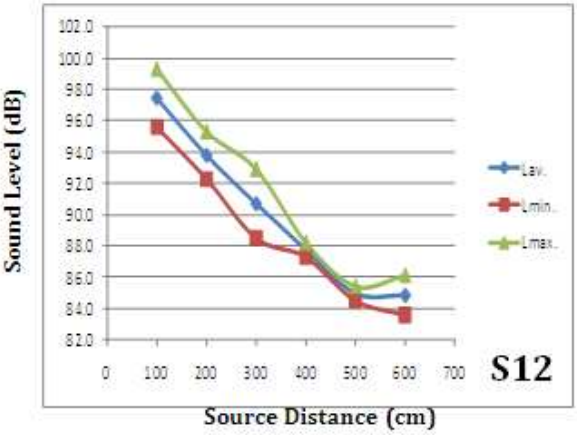
S9


Sound Level (dB)
Source Distance (cm)
Lav.
Lmin.
Lmax
S10


Sound Level (dB)
Source Distance (cm)
Lav.
Lmin.
Lmax.
S11


Sound Level (dB)
Source Distance (cm)
Lav.
Lmin.
Lmax.
S12

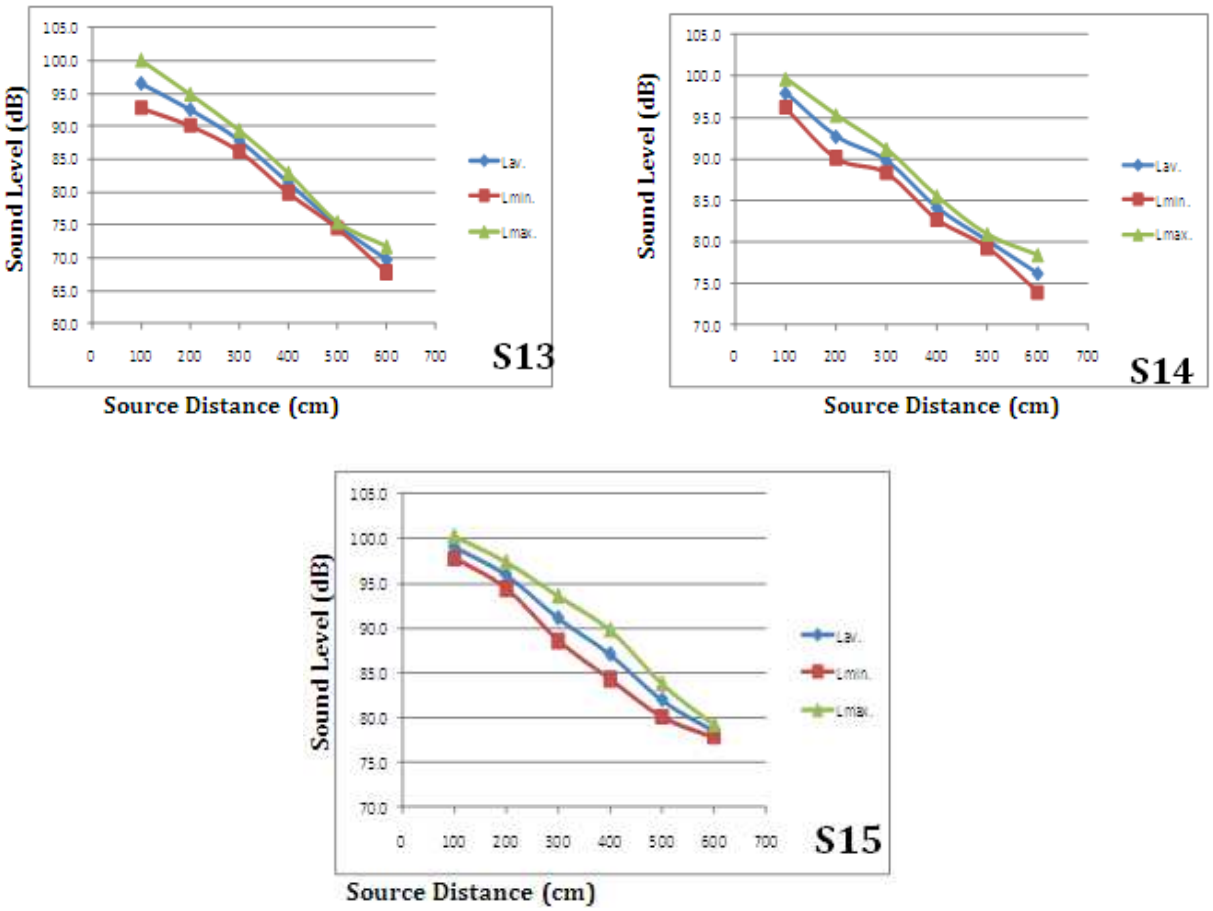


Figure 3: Graphs of Sound Level versus Source Distance for the Investigated Sources.

S 1: *Lister Generator at the Police Barracks Canteen, Lapai.*
S 2: *Lister Generator at the Jantabo Sachet Water Industry, Lapai*
S 3: *LL5GF-4A Generator, High Court, Lapai.*
S 4: *LL5GF-4A Generator, Emir's Palace Road, Lapai.*
S 5: *Block Molding Machine, State Low-cost, Lapai.*
S 6: *Block Molding Machine, Beside Catholic Church, Lapai.*
S 7: *Block Molding Machine, Along Bida Road, Near Water Board.*
S 8: *Iron Filling/Cutting Machine, Beside Lapai Garage Entrance Gate.*
S 9: *Iron Filling/Cutting Machine, Inside Lapai Garage.*
S 10: *Iron Filling/Cutting, Machine Comprehensive Health Centre Gate, Lapai*
S 11: *Iron Filling/Cutting Machine, Behind Kobo Campus, IBB University, Lapai.*
S 12: *Grinding Machine, Opposite Soje Filling Station, Along Minna Road, Lapai.*
S 13: *Grinding Machine, Around Minna T- Junction, Lapai.*
S 14: *Grinding Machine, Inside Badeggi Market, Lapai.*
S 15: *Grinding Machine, Around Emir's Palace Roundabout.*

CONCLUSION

The study assessed the noise level in selected industrial work places and homes in Lapai, Nigeria. Iron filling and cutting machines, Food Processing machines, block moulding machines and generators were considered. People work around some of these areas for an average of 8 hours daily except for those exposed to generator induced noise whose exposure level varies from 1hr to 5hrs daily depending on the availability of public power supply. The average ambient noise levels in these workplaces were found to be in the range of 46dB at 600cm and 78dB at 100cm for source S3 which was the lowest. This is enough to cause annoyance, sleep disturbance and reduced performance in children. Similarly, source S5 had 94dB at 600cm and 122dB at 100cm which could in addition, cause hearing impairment. The results also showed that people working in the block moulding industries in the surveyed areas were more exposed to noise and hence more prone to noise associated health effects.

Recommendations

Based on the above findings, it is recommended that the distance between workers and the noisy electrical generating machines must be greater than 600 cm. Those working with grinding machines, block moulding machines and iron filling machines should always wear ear pads to reduce the auditory effects of noise on them. The noise generating machines should also be relocated to places far away from densely populated areas to reduce large scale effect of noise on others.

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