Effects of Generating Plant Noise on Humans and Environment

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Abstract-*Noise measurements were taken in the morning, afternoon, evening, and night to determine the extent of noise pollution all over the city. A calibrated sound level meter was used to measure the generating plant noise. The equivalent sound levels (Leq) were measured at 20 different locations, between 8 a.m and 10 p.m. High noise levels were observed throughout the town. The data obtained was analysed and the results then compared with world health organization standard. The noise equivalent level varied between 99.4 and 83.2 dBA. The results of the study established the fact that generator noise levels are more than the acceptable limit of 60 dBA, thatis the daytime government prescribed noise limit for residential and commercial areas. The reaction of the residents to generating plant noise was monitored with a total of 300 questionnaires. The results of the interview questionnaire revealed 97% of the people classified the noise in their street as very high while 3% says it is low. And also the respondents answered that noise bother them more in day and night while 11% of the respondents say it is only in the night only. The main outcomes of exposure to generating plant noise were loss of sleep, hearing loss, annoyance and disturbance.*

Keywords- *Noise, Annoyance-level, pressure level, pollution, exceedance-percentile, frequency.*

1. INTRODUCTION

Sound being the human sensation of pressure fluctuation in the air.Noise can seriously harm human health and interfere with people's daily activities at school, at work, at home and during leisure time. The United States Environmental Protection Agency describes noise as "unwanted sound" [1]. Noise is the unpleasant sounds which disturb the human being, physically, physiologically and causes environmental pollution by destroying environmental properties [1-3]. The most important measurement of noise is its loudness. This loudness depends on the physical sound pressure that is measured on the sensitivity of the human ear to it. According to Levitt[4], the sensitivity of the human ear depends on the frequency of the sound. Hearing losses are the most common effects of noise pollution. Mohammed [5] reveals that increasing noise pollution in the world as affected human being, animals, plants and even inert objects like buildings and bridges. Noise has become a very significant stress factor in the environment, to the level that the term noise pollution has been used to signify the hazard of sound which consequences in the modern day development is immeasurable.

According to Yılmaz et al. [6], Noise pollution is one of the major problem people facing in urban areas all over the world. As a result of increase in the number of cars and industrialization, noise pollution has also increased. Most of noises in urban areas are increasing every day as a result of more people moving to urban from rural settlements. Noise in cities, especially along main arteries, has reached up to disturbing levels. Residences far from noise sources and near silentsecondary roads are currently very popular. People preferto live in places far from noisy urban areas.Noise disrupts the tranquillity of the environment and can affect climate and human health negatively[7].Electricity generating plant, vehicle traffic noise and pressure, industrial noise, machinery noise, and construction noise are common sources of noise pollution that contributed directly to climate change.

It was observed at Ilorin metropolis, that generating plants of various designs and sizes are being used, and this resulting in high noise levels, thereby disturbing resident with the area. A comfortable environment is one in which there is little or no annoyance and distraction so that working or leisure tasks can be carried out unhindered either physically or mentally.Onuu [8], further explain that environmental noise has become a serious problem in many countries, and it is difficult to regulate by physical means alone.

The U.S. Department of Housing and Urban Development (HUD) recommends the following noise levels for residential areas, measured outdoors are shown in Table 1.

Table 1.HUD recommendation for outdoors noise

Noise Level	Standard
LAeq ≤ 49 dBA	Clearly Acceptable.
49 <LAeq ≤ 62 dBA (or LDN ≤65 dBA)	Normally Acceptable.
62 <LAeq ≤ 76 dBA (or 65 <LDN ≤ 75 dBA)	Normally Unacceptable
LAeq> 76 dBA (or 75 dBA<LDN)	Clearly Unacceptable.

2. MATERIALS AND METHODS

The procedure used in gathering and analysing the data is presented in Figure 1.

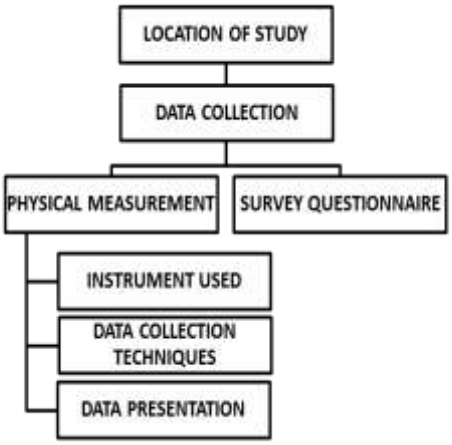

Figure 1: Methodology chart.

2.1 Material used

The sound level meter was used for the measurement of sound in various locations. The sound level meter is shown in Figure 2.

Figure 2: The external features of the digital noise meter.

2.2 Study Location

The study was conducted at 20 different locationsin Ilorin metropolis, the capital of Kwara State, Nigeria in May, 2013. The locations are Geri-Alimi, UnityChallenge, Post-office, Maraba, Sabo-Oke, Sango, Tanke, Gaa-akanbi, Offa Garage, Taiwo, Asa-Dam, Surulere, Agbo-oba, Oja-Oba, Oloje, Ipata, Mubo, Basin and Fate. The study area is located between latitudes 8° 30' 16'' N and longitudes 4° 34' 13'' E. This is an urban area that is mostly comprised of residential development, shopping complexes, offices and industries. Actual noise levels in the selected area have been measured and their maximum and minimum values were recorded.

2.3 Data collection

The two methods used in the data collection were byphysical measurement and survey questionnaire. Physical measurement was used to measure generating plant noise levels while the survey questionnaire involved data collection by using structured questions blended with some open-ended questions.

The noise meter was fixed at a low range of between 35 – 100 dB. The low range was chosen because it was found to correlate well with human response. The meter was adjusted to "A" weighting so as to determine the noise level. The "A" weighting network was used because it is most commonlyemployed for industrial and environmental studies.Therate of hearing loss tends to follow the "A"– scale in that one could tolerate higher levels of low frequency noise for a longer period without hearing impairment.The readings were taken by holding the instrument in such a way that the microphone was at a distance of 1.2m away from any reflecting surface and at 1.0m vertical distance above the ground level in both the living and working environments of the people in order to determine the noise levels to which the people are exposed to.Four readings were taken of 20 locations, with the aid of the sound level meter, at an interval of 30 seconds for a period of 1hourand the average for each location was recorded. The readings were taken between the hour of (8:00-9:00 am) in the morning, (1:00-2:00 pm) in the afternoon, (4:00-5:00 pm) in the evening, and (9:00-10:00 pm) in the night respectively.

2.4 Survey questionnaire

In order to know the opinion of the citizens from the area about how the generator noise levels have affected their daily life,and their attitude towards it, a questionnairewas developed. The survey questionnaire contained four different parts. The first part had three questions, where the interviewer was identified as to name, sex, age and date of survey. The second part had nine questions, where information about noise levels, major sources of noise and its effects on people's habit was obtained.

In the last part, with three questions, this is all about impacts of generating plant noise, and its effects on people on daily bases. A questionnaire has been applied on a one-to-one basis at selected location. A total of 300 questionnaires were processed.

3. DATA ANALYSIS

In this study, commonly used community noise assessment quantities like the exceedance percentiles L_{10}, and L_{90}, the A-weighted equivalent sound pressure level, L_{Aeq}, the daytime average sound level, L_D, the night time average sound level, L_N, the day-night average sound level, L_{DN}, the noise pollution level, $L_{NP,}$ were manually measured at each site separately using equations 1-5. These noise measures are defined as follows [9]:

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

$$L_D = 10\log_{10}\left[\frac{1}{2}\left(\text{antilog}\,\frac{L_{AeqM}}{10} + \text{antilog}\frac{L_{AeqA}}{10}\right)\right] \quad (2)$$

$$L_{DN} = 10\log_{10}\left[\frac{1}{24}\left(15\times\text{antilog}\frac{L_D}{10} + 9\times\text{antilog}\frac{L_{N+10}}{10}\right)\right] \quad (3)$$

$$L_N = 10\log_{10}\left[\frac{1}{2}\left(\text{antilog}\frac{L_{AeqE}}{10} + \text{antilog}\frac{L_{AeqN}}{10}\right)\right] \quad (4)$$

$$L_{NP} = L_{Aeq} + (L_{10} - L_{90}) \quad (5)$$

Where L_{Ai} is the ith A-weighted sound pressure level reading dB,N is the total number of readings,L_{Aeq} is the A-weighted equivalent sound pressure level, $L_{AeqM}$is the equivalent sound pressure for the

morning measurement, L_{AeqA} is the equivalent sound pressure level for the afternoon measurement, L_{AeqE} is the equivalent sound pressure level for the evening measurement, L_{AeqN} is the equivalent sound pressure level for the night measurement, L_N is night time noise level, L_D is day time noise level, L_{10} is the noise level exceeded 10% of the time, L_{90} is the noise level exceeded 90% of the time,L_{NP} is noise pollution level, L_{DN} is day-night noise level.

4. RESULTS AND DISCUSSION

4.1 Noise Measurement Results

All the data were obtained on weekdays and under suitable meteorological conditions (no rain).Four readings each for each location were taken. The measurements that were taken at the 20 located points are given in Figure3 and4.Figure3 shows the maximum and minimum values obtained during the day, while Figure 4 shows the maximum and minimum values obtained during the night.

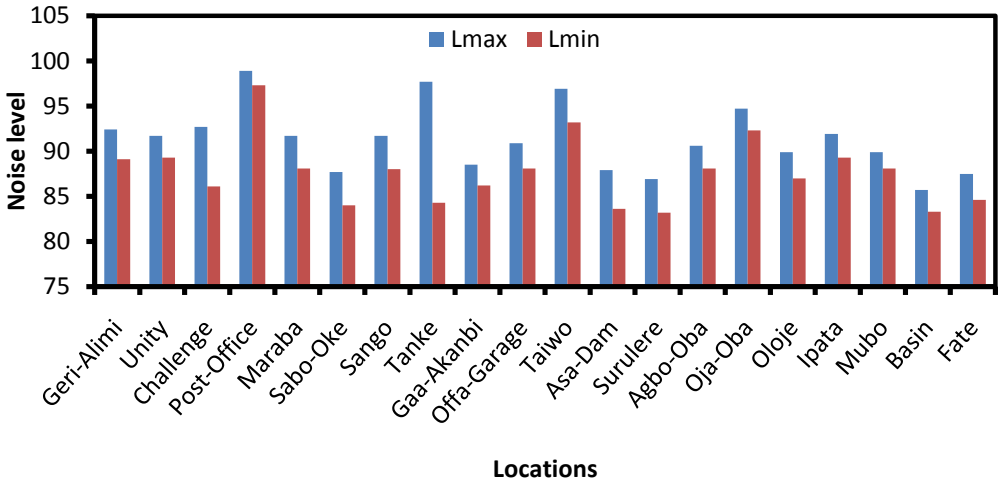

Figure 3: Shows day-time noise levels for measuring point

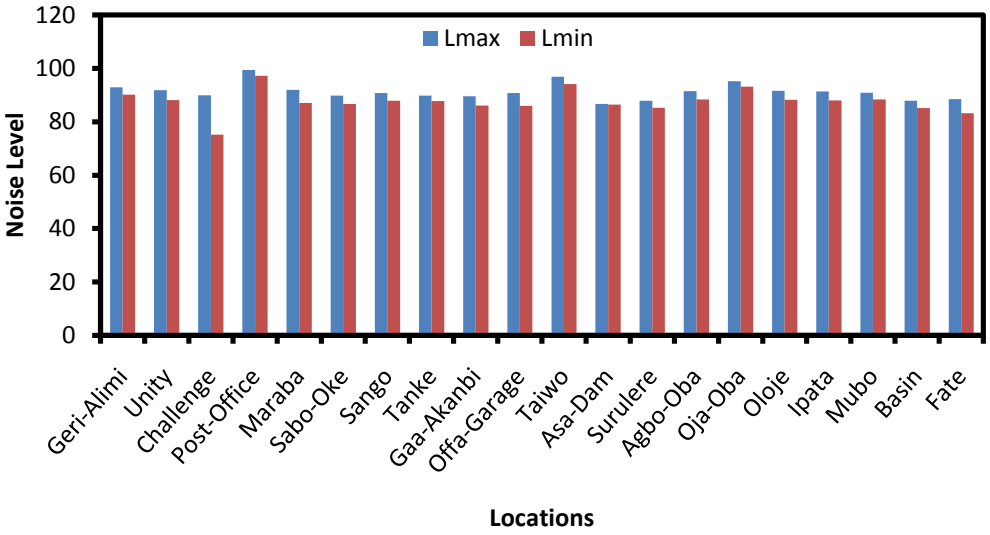

Figure4: Night-time noise levels for measuring point

From Figure3, the day Lmax values range from 85.7dB (A) at point 19 to 98.9dB (A) at point 4, while the Lmin values range from 83.2dB (A) at point 13 to 97.3dB (A) at point 4. From Table 2, the night Lmax values range from 86.7dB (A) at point 12 to 98.9dB (A) at point 4, while the Lmin values range from 83.2dB (A) at point 20 to 97.2dB (A) at point 4. An overview of the two tables revealed that the maximum values and the minimum values obtained have exceeded the governmental legislations for residential area.

The data were also used to evaluate noise descriptors in the form of L_{Aeq}, L_{10}, L_{90}, L_D, L_N, L_{DN} and L_{NP}. The locations are designated with numbers 1 to 20 in Table 2.The average noise descriptors were determined per location. From Table 2, location 4 and 11 has the highest values of L_{Aeq} (56 dBA), L_N (56 dBA), and L_{NP} (57 dBA), while location 4 has the highest L_{10} (99dBA), L_D (58dBA),L_{DN} (63dBA) and

L_{90} (98dBA). Location 11 has the second highest values of L_{10} (96dBA), L_{DN} (62 dBA), L_{90} (94 dBA) and L_D (56 dBA).

In order of high noise descriptors, next to these two locations were sites 1 and 15. The average values of noise descriptors of these locations were: L_{Aeq} (52dBA), L_{10}(92dBA), L_{90} (91dBA), L_{NP} (53dBA), L_D(52dBA), L_N (52dBA),L_{DN}(59dBA) and L_{Aeq} (54dBA), L_{10} (94dBA), L_{90} (94 dBA), L_{NP} (54dBA), L_D(54dBA), L_N (55dBA), and L_{DN}(61 dBA) respectively. Locations 1, 4, 11 and 15 were commercial centre and passengers loading park respectively. The background noise levels (L_{90}) at these locations are higher than others locations. This was due to intrusive noise sources from human conversation due to commercial activities, traffic noise, radio player etc. The noise descriptors: L_N, and L_{Aeq} rise from morning and reach peak values in the afternoon and evening but descend in the night. The lowest noise descriptor values were recorded at location 6, 8, 9, 12, 13, 19, and 20 of $L_{Aeq,}$ L_{10}, L_{90}, L_{NP}, L_D, L_N,L_{DN}respectively. These locationsare residential areas with some little of commercial activities. Among the factors responsible for differences in noise levels in the centres surveyed include location site, presence of intrusive noise, traffic volume and commercial activities.

4.2 Questionnaire Results

Table 3 shows that 54% were male and 46% were female, and their ages was 20years and above, 50% were in the age group of 20-30 years old, 27% between 30-40 years old, 14% between 40-50years old and 9% were 50 years above.

The analysis in Table 4 indicates that a very large proportion of respondents in each age group are being affected by noise emanating from the generating plant noise. Majority of respondents with 97% across different age groups feel that traffic noise affects their activities. More than 54%respondentsacross different age-groups claim that noise originating from religious functions affects them. A relatively small proportion of respondents (3% across various age groups) acknowledge adverse effect of noise generated by construction and also equalproportion of respondents (3%) across different age-groups claim that noise originating from industries affects them.

Table 2: Noise levels descriptors computed for day and night in the study area

Location	L_{Aeq}	L_{10}	L_{90}	L_{NP}	L_D	L_N	L_{DN}
1	52	92	91	53	52	52	59
2	51	90	89	52	51	51	57
3	51	89	88	52	52	50	57
4	56	99	98	57	58	56	63
5	51	90	89	52	51	51	57
6	49	87	87	49	47	49	55
7	51	90	90	52	51	51	61
8	48	87	86	49	47	48	55
9	48	88	87	49	48	48	55
10	50	89	88	51	51	50	56
11	56	96	94	57	56	56	62
12	47	84	84	47	47	46	53
13	47	86	86	46	46	48	54
14	50	90	90	50	50	51	57
15	54	94	94	54	54	55	61
16	50	89	87	50	50	51	57
17	51	91	90	52	52	50	57
18	50	90	90	50	50	51	57
19	48	85	85	46	46	47	53
20	47	86	86	46	47	47	54

Table 3: Respondents' Profile

Variables	Options (Year)	Frequency of Occurrence	
		N	%
Age	20-30	150	50
	30-40	82	27
	40-50	42	14
	Above 50	26	9
		300	100
Sex	Male	163	54
	Female	137	46

Table 4: Disturbance category by age group

Source of Noise	Age Group									
	20-30		30-40		40-50		Above 50		Total	
	N	%	N	%	N	%	N	%	N	%
Traffic Noise	146	97	82	100	42	100	26	100	296	97
Industrial Noise	4	3	3	4	3	7	-	-	10	3
Generating plant Noise	150	100	82	100	42	100	26	100	300	100
Construction Noise	4	3	3	4	3	7	-	-	10	3
Religious place Noise	84	56	38	46	26	62	13	50	161	54

Table 5: Effect of generating plant noise on different age groups.

Plant noise effect	Age Groups									
	20-30		30-40		40-50		Above 50		Total	
	N	%	N	%	N	%	N	%	N	%
Hearing loss	150	100	82	100	42	100	26	100	300	100
Annoyance	150	100	82	100	42	100	26	100	300	100
Blood pressure	-	-	-	-	2	5	10	38	12	4
Loss of sleep	150	100	82	100	42	100	26	100	300	100
Stomach ailments	10	7	7	9	3	7	5	19	25	8
Disturbance	150	100	82	100	42	100	26	100	300	100
Stress	118	79	55	67	26	62	22	85	221	74
Total	150	100	82	100	42	100	26	100	300	100

In another question, the subjects have classified the noise in their environment as "high" and "low". Figure 5 shows that 97% of the respondents experienced high level of generator noise in their resident and 3% experienced low noise level. Figure 6 shows that about 79% of the respondents have affirmed that they had been living at their resident for years, while 21%had been living at their resident for months. The respondents have been asked "what time does noise bother them more". For this question, Figure 7 shows that 89% of the respondents said there are bothered by noise bother them in the day and night and 11% answered that noise bother them more in the night. The majority of the respondents have answered that they sometimes felt annoyed by generating plant noise in his/her environment.

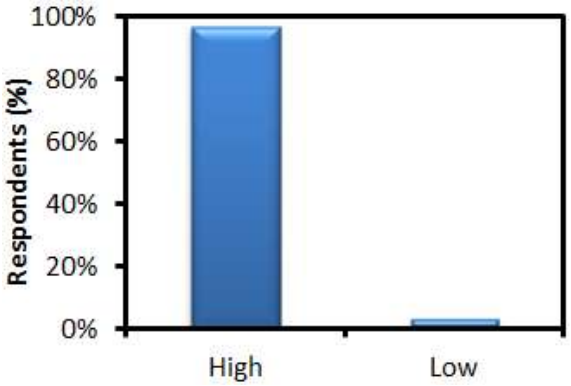

Figure 5:Respondent for generating plant noise.

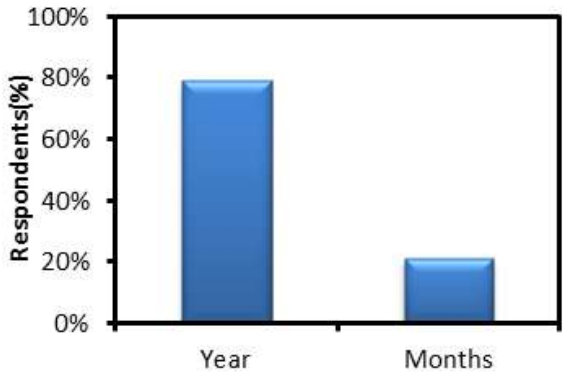

Figure 6:Respondents residence time.

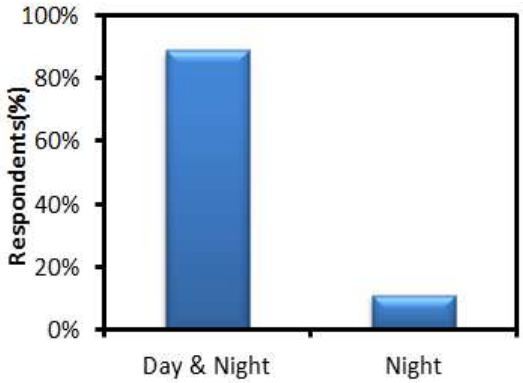

Figure 7:Noise disturbance time.

We can visualize (Table 5) that generating plant noise causes disturbance, hearing loss, blood pressure/hypertension, stress, stomach ailments, and annoyance to individuals under its umbrella. Majority of sample respondents exposed to generator noise pollution report occurrence of annoyance, disturbance, loss of sleepand hearing problem. About 100% reported the hearing loss, disturbance, loss of sleep and also equal number reported annoyance. The survey data shows that the effect of noise is not similar among various age groups.

Generally, growing agebears more effect of generator noise pollution. For example, the rising proportion of sample respondents in higher age groups (40years above) acknowledges annoyance, sleeplessness, blood pressure/hypertension, stress, stomach ailment and hearing loss effect. A very large proportion of respondents feel that noise interferes with inter-personal communication and causes annoyance. Extreme effects such as mental, stomach ailments and blood pressure were acknowledged by one third of survey population.

4.3 Discussions

Noise pollution in big cities is a growing problem due to the fact that the urban environment is becoming increasingly crowded and busy. In this study, the measured noise levels were generally high; LAeq, ranged between a maximum of 99.4 dBA and a minimum of 83.2dBA.

The environmental sound levels measured at a given location depend on a number of specific variables. Ugwuanyi[10], Paqrvathi, [11] and Oseji, [12] have

found that the observed sound levels are mainly related to homeappliance (television and music system), road traffic noise, public address system, generating sets, railway and air traffic noise etc. [10]. Several studies have demonstrated that the urban conditions of a given area are also a very important factor influencing the environmental noise levels. There is variation in the noise levels with the period of the day and the nature of the location. From the study carried out, it is observed that there is high noise pollution levels (LNP) in the daytime (7:00 am–3:00 pm) compared with the night-time (8:00 pm–10:00 pm), these always happen mostly in commercial areas. In residential areas where the majority of the residents are always at home after working day hours, the noise level at night is always high compared to day period as a result of the residents gone for their daily work or business in the day.

Considering the criteria from HUD, only 7 locations representing 35% out of the 20 locations surveyed, can be classified as clearly acceptable, while the remaining locations representing 65% can be classified as normally acceptable. A widely accepted scientific fact is that living in black acoustic zones, where the equivalent sound level is higher than 65 dBA put an urban population in a high risk status for numerous subjective effects of noise, including psychological, sleep and behavioural disorder.

Table 7 shows that 100% of the respondents in each age group believed that the noise emanating from generators affect their hearing. Nearly 89% of subjects believed that noise bothered them more in the day and night and 11% in the night.The study also revealed that the most unpleasant noise was generating plant and motor traffic followed by religious centred, then by industrial layout, and construction noises.

Interesting results have also been obtained regarding generator noise levels (high and low) are used to determine the level of noise. If the sources are analysed separately, it is noticeablethat among the subjects who felt annoyed by the noise in his/her home, 97% pointed out the traffic noise was the main source of annoyance, 100% the generating plant noise.Thestudy showed that generating plant noise has negative impacts on human health [10, 11].

5. CONCLUSION

This study explores the sources of noise in Ilorin metropolis, effects, reactions and suggestions for controlling the excessive noise caused by generating plant.It hasalso been revealed that Ilorin is a fast growing metropolis and the generating plant noise pollution has reached a non-acceptable level, as pointed out from the results obtained. Table 6 revealed that the generator noise has become one of the major sources of environmental pollution and will require urgently solutions. These were confirmed from the results of the questionnaire interview conducted on the effect of noise pollution on human being. This investigation reveals that noise level at measuring point is higher than the recommended level of 60 dB(A) for commercial and residential areas by World Health Organization(WHO). Hence, the present status of noise pollution in Ilorin metropolis poses a severe health risk to the residents.

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