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Assessment of Environmental Noise Pollution in Selected Areas in Offa, Nigeria

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Abstract: *Many people do not understand noise as a form of physical pollution. As a result, it is critical to examine the environment where noise levels have increased using appropriate measuring and analytical tools to identify whether or not a genuine nuisance exists. The goal of this research is to uncover the rising levels of noise pollution in Offa, Kwara State, Nigeria. A sound level meter was used to monitor noise levels in nine different places. The investigation shows that the noise pollution levels measured at some areas in Offa exceeded the standard and set limit by the World Health Organisation (WHO) and Federal Environment Protection Agency (FEPA). The investigation shows that there was a significant increase in noise pollution in Owode market and Oja Ale as a result of high vehicular movement occasioned by congestion of road within the metropolis.*

Key words: *Noise, Decibel, Sound pressure, Noise level, Noise limit, Pollution*

1.0 Introduction

Noise is defined as an unwelcome and unpleasant sound. Sound is a rapidly varying pressure wave that travels through a medium. When sound travels through air, the atmospheric pressure changes on a regular basis. The frequency of sound is defined as the number of pressure variations per second and is measured in Hertz (Hz), which is defined as cycles per second. The intensity of noise is measured in decibels (Dai et al., 2005).

The decibel scale is logarithmic, meaning that a 10-decibel increase in noise intensity corresponds to a tenfold increase in noise intensity. The human perception of loudness follows a logarithmic scale as well; a 10-decibel increase is seen as nearly twice the volume. Thus, 30 decibels is ten times more intense than 20 decibels and sounds twice as loud; 40 decibels is one hundred times more powerful than 20 and sounds four times as loud; and 80 decibels is one million times more intense than 20 and sounds 64 times louder (Ighoroje et al., 2004). Hearing is a complex process that involves many parts of the ear working together to convert sound waves into information that the brain understands and interprets as sound.

1.1 Noise Pollution

Noise pollution is defined as any sound that is unwelcome or interferes with one's quality of life. Noise pollution occurs when there is a lot of noise in the environment. Sound

becomes unappealing when it interferes with normal activities such as working, sleeping, or conversing.

It is an underrated environmental problem because of the fact that we can't see, smell, or taste it. World Health Organization stated that "Noise must be recognized as a major threat to human well-being"

1.2 Source of Noise Pollution

1. Transportation systems are the main source of noise pollution in urban areas due to increase in number of vehicles.
2. Industrial noise – this is mainly caused by heavy industrial machines. Examples are Generators, Pneumatic equipment, Air conditioners, Pump, Fans, Turbines and Mills.

3. Neighborhood noise – this are noise form gadgets and household equipment. Examples are musical instruments or loudspeakers.

1.3 Effects of Noise Pollution

This following are the effect of noise pollution to human being (Garcia and Garrigues 1998).;

1. Hearing loss, productivity loss
2. High Blood Pressure/Hypertension
3. Stress related illness, Insomnia
4. Labored breathing, altered brain chemistry
5. Permanent damage in voice
6. Sleep Disturbances, Color Blindness
7. It can also cause memory loss/Forgetfulness
8. Severe depression and Panic attacks
9. Damage Physiological and Psychological health.
10. Annoyance and Aggression, Tinnitus
11. Miscarriages and abortions in women

1.4 Effect on Non-Living Thing

1. It causes cracks in Structure
2. Loud noise is very dangerous to buildings, bridges, Stones, Earth, Land and monuments.
3. It creates waves which struck the walls and put the building in danger condition.
4. It breaks of Glass, China clay, mud vessels due to sudden loud noise
5. It causes damage to furniture – ages faster
6. It cause damage to paintings and antique pieces

Noise levels below 85 dBA (decibels) are generally regarded safe, whereas noise levels exceeding 85 dBA induce hearing damage. The level (dBA) and time of exposure to the sound will inform you how hazardous the noise is, according to the Center for Hearing and Communication (Anomohanran et al., 2008). The louder the noise, the shorter the time it takes for hearing loss to occur. For comparison, the quietest sound a human can hear with normal hearing is 0 decibels, whereas regular breathing is 10 dBA. Rainfall has a decibel

level of 50, while an average discussion has a decibel level of 60. Something like shouting in someone's ear or thunder at 120 decibels would be above the level of safety at 110.
Many surveys have been conducted in many cities around the world to address the problem of noise pollution (Singh & Daver 2004, Li et al. 2002, Morillas et al. 2002, Zannin et al. 2002, Alberola et al. 2005, Lebiedowska 2005, Pucher et al. 2005, Tansatcha et al. 2005), and (Ali & Tamura 2003; Marius et al. 2005) have demonstrated the level of annoyance caused by noise in people's lives
Existing evidence that noise pollution has a harmful influence on human health has prompted research to better understand and address noise pollution issues (Georgiadou et al. 2004).
The effects of noise on human health and comfort are divided into four categories based on its duration and volume: physical effects, such as hearing loss; physiological effects, such as increased blood pressure, irregular heart rhythms, and ulcers; psychological effects, such as sleeplessness and going to bed late, irritability, and stress; and finally effects on work performance, such as decreased productivity and misunderstanding what is heard.
Noise levels in cities can be studied in three ways: traffic and transportation; industrial operations; and sport, marketing, and entertainment facilities (Dursun et al. 2006).
In compared to other pollutants, the control of ambient noise has been impeded by a lack of established standards and limited information of its impacts on humans. In many rapidly urbanizing locations, noise pollution is a significant environmental issue.
Noise has long been recognized as a potential threat to one's health, communication, and pleasure of social life. It's turning into an unacceptable intrusion into people's comfort, health, and quality of life. Noise pollution is a widespread concern in Nigeria. Several studies have found that noise levels in major cities surpass established standards. In a research conducted in Makurdi, Nigeria, Ugwuanyi et al. (2004) discovered that noise pollution levels in the city were about 3 dB(A) to 10 dB(A) above the recommended upper limit of 82 dB(A) (A).
Anomohanran et al. (2008) also discovered a peak noise level of 100 dB at a road junction in Abraka, Nigeria (A).

This noise level is higher than the recommended level for commercial and residential areas, which is 60 decibels (A). Ighoroje et al. (2004) looked at the amount of noise pollution in a few industrial areas in Benin, Nigeria. The average ambient noise level at sawmills, electro-acoustic markets, and food processing industrial zones was found to be greater than 90 decibels (A). This noise level is significantly higher than the safe noise level of 60 decibels (A).

2.0 Material and Methods

This research is based on the results of outdoor sound level measurements carried out in July 2021 at 10 different locations (2 commercial centers, 3 road junctions & busy roads, 1 passengers loading parks, 2 high density areas and 2 low density areas) in Offa metropolis, Kwara State. Table 1 shows the locations selected for the noise level measurements in Offa metropolis. Figure 1 shows an overview of Offa metropolis showing the locations of noise measurements for this study.

Table 1: Location selected for the noise level measurement in Offa metropolis.

S/NO	DESIGNATION	DESIGNATION NUMBER
1	OSUNTE AREA	001
2	ATAN OBA AREA	002
3	OLOHUNKUSHE AREA	003
4	OWODE MARKET	004
5	IDI AGBON AREA	005
6	AMUYO AREA	006
7	ANILELERIN AREA	007
8	OMO OWO AREA	008
9	OJA ALE AREA	009
10	RONDO AREA	010

Sound Level Meter was used to carry out this research. The sound level meter was incorporated with a softwares designed by SplendApp. The measurements were taken at street level (road junctions, parks, market and residential areas). The instrument was carefully held with the microphone pointing towards the suspected noise source at a distance not less than 1 meter away from the source of the noise. L_{Ai} (A-weighted instantaneous sound pressure level) measurements were taken at interval of 15 seconds for a period of 15 minutes, having 60 meter readings. Morning readings were taken between 8:00am and 8:15am while evening readings were taken between 5:00pm and 5:15pm for each location. Commonly used community noise assessment quantities like the exceedence percentiles (L_{10} and L_{90}), the A-weighted equivalent sound pressure level L_{Aeq}, daytime average sound level (L_D), the noise pollution level (L_{NP}) and the traffic noise index(TNI) were computed.

The data are computed as follows (Saadu et al., 1998):

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

$$L_D = 10\log_{10}\left[{}^{1}/_{2}\left[antilog\frac{L_{AeqM}}{10} + antilog\frac{L_{AeqE}}{10}\right]\right] \quad (2)$$

$$L_{NP} = L_{Aeq} + (L_{10} - L_{90}) \quad (3)$$

$$TNI = 4(L_{10} - L_{90}) + (L_{90} - 30)$$

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 (dB (A)), L_{AeqM} is the equivalent sound pressure for the morning measurement (dB (A)), L_{AeqE} is the equivalent sound pressure level for the evening measurement, 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, TNI is the traffic noise index.

3.0 Results and Discussion

The measurements were made when the impacts of variable elements on the noise sources were minimal (e.g., wind speed, rainfall, etc.). All of the data was collected on weekdays and under ideal weather conditions, i.e., no rain. For a period of 15 minutes, measurements were taken every 15 seconds, yielding 60 meter readings in the morning and 60 meter readings in the afternoon each location. The information was utilized to assess noise descriptors such as L_{Aeq}, L_{10}, L_{90}, T_{NI}, L_{NP}, and L_D.

The average noise descriptors were determined per location. Table 2 shows the daily average values of noise descriptors for all the sites surveyed. The sites are designated with numbers 001 to 010.

Table 2: Average Noise Descriptors at Study Locations

LOCATIONS	LOCATION NUMBERS	L_{10}(dB (A))		L_{90}(dB (A))		L_{EQ}(dB (A))		TNI(dB (A))		LNP(dB (A))		L_D(dB (A))
		M	E	M	E	M	E	M	E	M	E	
OSUNTE	001	80	80	68	65	75.89	75.98	86	95	87.89	90.98	75.94
ATAN OBA	002	73	77	54	61	67.3	72.51	100	95	86.30	88.51	70.64
OLOHUNKUSHE	003	79	81	65	65	76.74	77.32	91	99	90.74	93.32	77.04
OWODE MARKET	004	83	85	63	73	75.73	81.65	113	91	95.73	93.65	79.63
IDI AGBON	005	78	81	60	72	74.19	77.89	102	78	92.19	86.89	76.42
AMUYO	006	80	80	65	67	75.55	76.54	95	89	90.55	89.54	76.07
ANILELERIN	007	71	75	60	68	72.67	76.44	74	66	83.67	83.44	74.95
OMO OWO	008	78	78	65	66	75.01	74.71	87	84	88.01	86.71	74.86
OJA ALE	009	80	81	62	65	75.51	76.87	104	99	93.51	92.87	76.24
RONDO	010	66	73	52	60	64.65	67.64	78	82	78.65	80.64	66.40

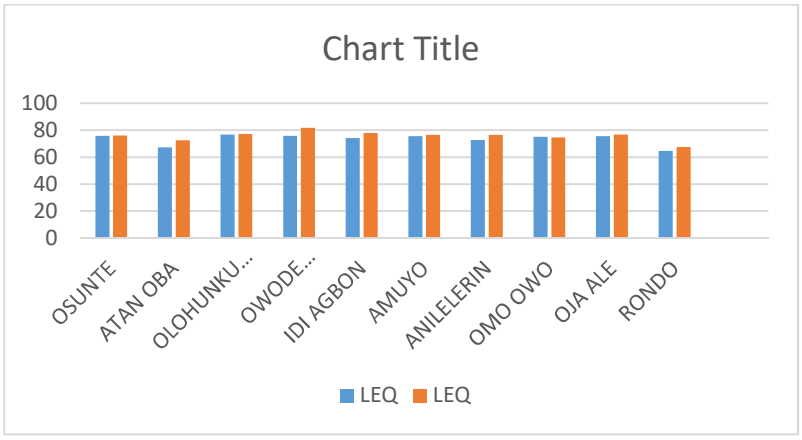

Fig 1: Graph showing the morning and evening equivalent sound pressures

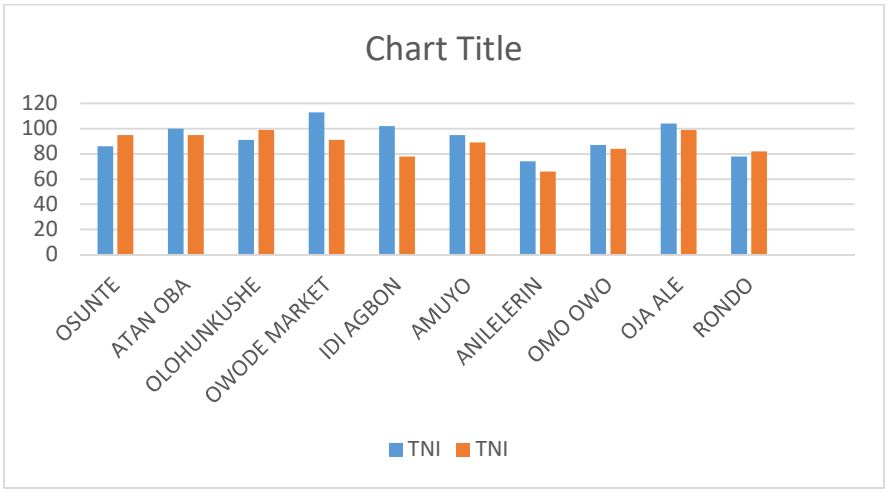

Fig 2: Graph showing the morning and evening Traffic Noise Index Values

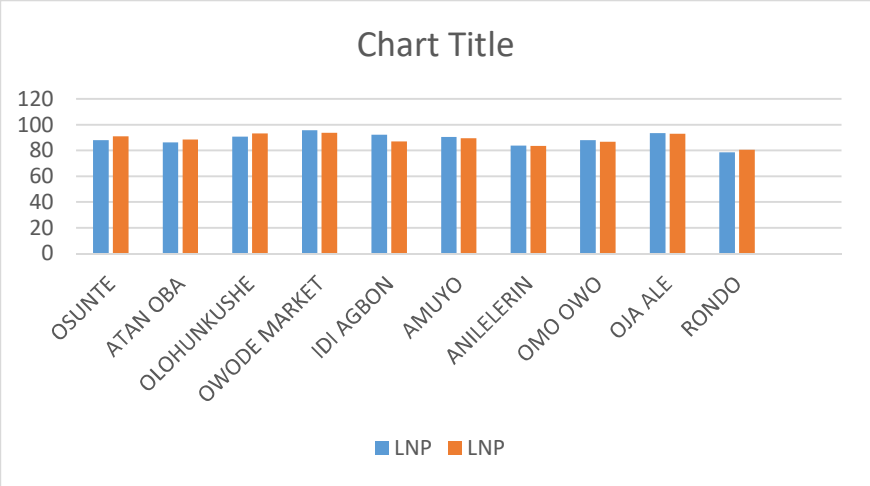

Fig 3: Graph showing the morning and evening Noise Pollution Level

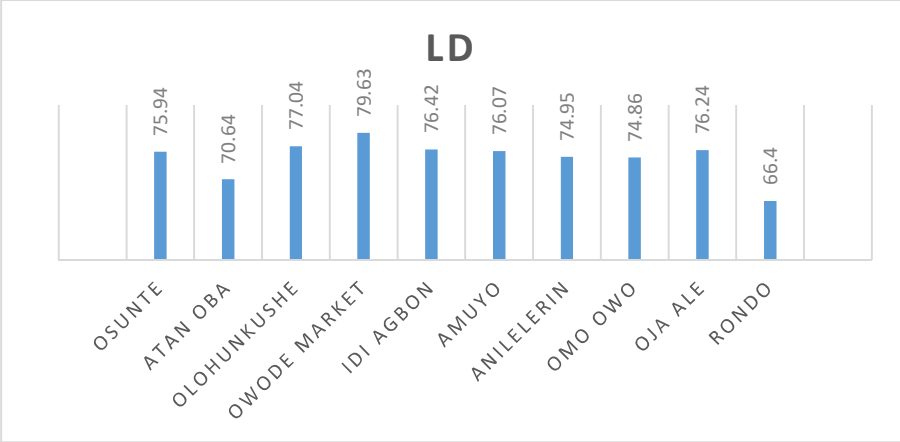

Fig 4: Graph showing the Daylight Average Sound Level

From Table 2, location 003 has the highest morning Leq (76.74dB (A)) and highest TNI in the evening (99dB (A)). This is so because most of the residents in the area are car owners and move to and from their various workplaces within the period the measurements are taken, thereby creating more traffic. Location 004 has the highest evening Leq (81.65dB (A)), highest morning LNP (113dB (A)) and second highest evening LNP (91dB (A)) because it is a market square where there is always high noise level. Location 009 has the second highest morning TNI (104dB (A)), highest evening TNI (99dB (A)), the second highest morning and evening LNP (95.51dB (A) and 92.87dB (A) respectively) because it is also a market that is situated near an expressway. Of all the locations considered for this research work, location 010 has the least morning and evening Leq (64.65dB (A) and 67.64dB (A) respectively) and second least morning and evening TNI (78dB (A) and 82dB (A) respectively) and the least LNP both in the morning and evening (78.64dB (A) and 80.64dB (A)). Among the factors responsible for differences in noise levels in the centers surveyed include location site, presence of intrusive noise, traffic volume, commercial activities etc.

In conclusion, location 004 is found to be the noisiest in the town because of the presence of market and Load Park and commercial centers. In these locations, apart from traffic noise, other intrusive noise sources include noise from record players, loud speakers, hawking and human conversation which contribute majorly to the environmental noise pollution.

Most of the countries have come up with permissible noise standards keeping in view the alarming increase in environmental noise pollution, Table 3 shows Table 4 shows the official gazette by National Environmental (Noise Standard) Regulation where 55dB (A) is the maximum permissible noise level for mixed residential areas. The World Health Organization (WHO) has also suggested a standard guideline value for average outdoor noise levels of 55 dB (A), applied during normal daytime (16 hours) in order to prevent significant interference with the normal activities of local communities, and is considered as serious annoyance, while a value of 50 dB as moderate annoyance. Table 5 shows the WHO Guidelines values for community noise listing also critical health effects ranging from annoyance to hearing impairment.

Table 3: FHWA noised standards (Oyedepo, 2012)

S/No	Land use	Noise Level L_{10}	Description of land use category
1	A	60dB (A) (Exterior limit)	For parts and open places
2	B	70dB (A) (Exterior limit)	Residential area, Hotels, Schools, Libraries, Hospitals etc.
3	C	75dB (A)	Developed areas
4	D	55dB (A) (Interior limit)	Residential areas, Hotels, Libraries etc.

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

$$L_{Aeq} \leq 49 \text{ dB (A)} \text{— clearly acceptable}$$

$$49 < L_{Aeq} \leq 62 \text{ dB (A) (or } L_{DN} \leq 65 \text{ dB (A))} \text{ — normally acceptable}$$

$$62 < L_{Aeq} \leq 76 \text{ dB (A) (or } 65 < L_{DN} \leq 75 \text{ dB (A))} \text{ — normally unacceptable}$$

$L_{Aeq} \leq 76$ dB (A) (or 75 dB (A) $< L_{DN}$) — clearly unacceptable (Dhananjay and Prashant, 2007)

The result of this study shows that noise levels (L_{10}) in all the locations surveyed (ranges from 66–80 dB (A)) are higher than the recommended values by FHWA (i.e., 60 dB (A)). Out of 10 locations surveyed, only 3 locations have noise level higher than 75 dB (A),

Table 4: Maximum Permissible Noise Levels for General Environments [FGN GAZETTE] (Oyedepo and Saadu 2010)

	Column 1	**Column 2**	
	Facility	**Maximum permissible noise limit Leq (dB (A))**	
		DAY	NIGHT
A	Any building used as hospital, convalescence home, home for the aged, sanatorium, home for higher learning, conference room, public library, environmental or recreational centres	45	35
B	Residential buildings	50	35
C	Mixed residential (with some commercial and entertainment)	55	45
D	Residential + Industry or small scale production + commerce	60	50
E	Industrial (outside perimeter fence)	70	60

Above noise levels are weighed average in the facility over the hours defined for night and day below,

Time frame: used duration

Day -6:00am-10:00pm

Night -10:00pm-6:00am

Table 5: WHO guideline for community noise (Mansouri et al. 2006)

Environment	**Critical health effect**	**Sound level (dB (A))**	**Time (hours)**
Outdoor living areas	Annoyance	50-55	16

Indoor dwellings	Speech intelligibility	35	16
Bedrooms	Sleep disturbance	30	8
School classrooms	Disturbance of communication	35	During class
Industrial, commercial and traffic areas	Hearing impairment	70	24
Music through earphones	Hearing impairment	85	1
Ceremonies and entertainment	Hearing impairment	100	4

4.0 Recommendation

In this work, transport infra-structures have been recognized as major sources of noise in Offa town. Hence, technical actions on the transport systems can produce interesting results. Possible technical controls include:

(i) Changes in road profiles,
(ii) Low noise pavements (porous or porous elastic) type,
(iii) Effective repairs to the silencers and vehicle suspensions restrictions on
(iv) Traffic (types of vehicles, speed, hours of access etc.)
(v) Building of acoustic barriers along the sides of heavily travelled highways running through residential areas.

Noise generated as a result of citizen's behaviour (driver, music player, hawker etc.) can be controlled by regular education of the drivers. Another step that can be taken to minimize noise pollution is preparation of noise map. The noise map that has baseline data for town planners, engineers and other professionals and researchers for the planning and execution of their projects. Most of the cities in Nigeria have not presented noise pollution maps.

5.0 Conclusion

In this study, comprehensive assessment of environmental noise levels has been carried out in Offa town. Ten (10) selected areas were surveyed for noise pollution levels. The result of this study shows that at locations near the busy roads/ road junctions, commercial centers and passengers loading parks, the equivalent noise level, background noise level and peak noise level are higher compared to station near low density residential areas. This investigation reveals that noise levels at all the locations surveyed exceeded the recommended limit of 60dB (A) by values of 6–25 dB (A). Hence, the present status of noise pollution in Offa town poses a severe health risk to the residents. Furthermore, productivity can be affected by the discomfort and irritation being caused by the pollution, both in public service and private sectors. In addition, the research shows that some areas tend to reach the threshold of pains and lead to permanent loss of hearing and death.

Attention has to be given to the challenges noise pollution pose on human health by full implementation of general and statutory policies.

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