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Spatio-Temporal Analysis of Noise in Selected Areas of Oyo Township

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Abstract
Noise is an important environmental problem in major cities of tropical African countries with Nigeria not exempted. The study adopted a quantitative measurement of noise at selected sites having heterogeneous spatial characteristics. The data collected were analyzed using totals, means, t-test and a two-way ANOVA. The study showed that noise is a feedback mechanism stemming from myriads of urbanization and industrialization processes, poor urban planning, social functions, vehicular activities (hooting), household activities, hawking and other commercial activities of the recent times. The study also showed that noise level is functionally related to temporal and spatial characteristics of places. All these have resulted in vulnerability and exposure of the cities dwellers to noise related health impairment despite the presence of some health care centres. The immediate responses known to have followed excessive noise in these areas are hearing loss, sleeping disorder, annoyance, communication impairment, health related problems like cardiovascular diseases, temporary or permanent deafness and the likes. It is hereby recommended that adequate and timely environmental education be organized for people to have a change of attitude towards noise level reduction in particular and environmental pollution in general.
Keywords: Impairment, Vulnerability, Audiometry, Environment, Pollution, Hazard

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Introduction

An important factor for the quality of life in cities of the countries the Third World is related to the noise levels to which the population in them is subjected to. Several factors interfere with the level and amount of noise in cities of the Tropical African countries especially Nigeria. Noise in the words of Adejobi (2012) is considered as having a growing health threat, and if, left unchecked could result to hazardous conditions on the part of the vulnerable populations. It has been recognized as a major problem for the quality of life in urban areas all over the world because of the increase in the size of the cities, number of cars and industrialization. Noise in cities according to Ozer, Yilmaz, Yesil and Yesil (2009) especially along main transportation and commercial arteries, has reached an alarming levels of disturbance.

Noise as put by Babisch (2005); Lee and Fleming (2002) is not simply a local problem, but a global issue affecting everyone and calls for precautionary measures in an environmental planning situation. With the rapidity of urbanization and population growth, magnitude and harshness of noise has also continued to increase. The likely health effects of noise are abundant some of which according to Kumar, Panchal and Avtar (2015) are persistent, and medically or socially important. Human beings all over the world until their death reside in an environment and their survival depends largely on how enabled the environment is, once an environment is no more enabled, it becomes undesirable.

Therefore, from the foregoing, Alawode, Stephen and Adeyemi (2008) posit that noise is an unwanted pollutant introduced directly or indirectly into the environment usually exist at a range of 80 – 85dB level and at which sound becomes relatively painful and have deleterious effects possessing harm to living resources; and constitute hazard to human health and sea amenities. Most environmental sounds are made up of a

complex mix of many different frequencies with the audible frequency range normally considered to be 20 - 20,000 Hz for younger listeners with unimpaired hearing. However, our hearing systems are not equally sensitive to all sound frequencies, and to compensate for this various types of filters or frequency weighting have been used to determine the relative strengths of frequency components making up a particular environmental noise.

According to Berglund, Lindvall and Schwela (1999) noise has become an increasingly omnipresent, yet unnoticed form of pollution even in developed countries and it has always been an important environmental problem for man.

The effects of the noise are just as widespread and the long term consequences for health are the same. The most common effects of noise on the vulnerable population included health and social impacts of noise to include headache, lack of concentration and irritability to be the major health effects identified by Oloruntoba, Ademola, Sridhar, Agbola, Omokhodion, Ana and Alabi (2012) in their study conducted in the city of Ibadan where they equally submitted that noise had significant effect on job performance. Charlotta and Göran (2018) also stated that effects range from acute reactions to short-term loud noise, occurring within seconds or minutes from the initiation of a noise stimulus, to chronic effects of long-term exposure to more moderate noise levels, which may develop over years of exposure.

The study of Charlotta and Göran (2018) further reported annoyance, sleep disturbance, heart and circulation problems, reduced quality of life characterized by deteriorating physical and mental quality of life in people over 60 with exposure to road traffic noise and hearing loss among several others. Pathak, Tripathi, and Mishra (2006) also reported that noise is a major factor responsible for headache, hypertension, giddiness and lethargy and they further opine that people possessing higher education and income levels were more aware of the detrimental effect of noise on health.

From the foregoing, studies have affirmed that there were spatial and temporal variations in environmental noise with respect to land use, specifically the built urban environment and that when compared to guidelines for environmental quality and human health, adjusted noise levels in both areas exceeded the recommended values for residential and mixed-use development and are indicative of relatively intensive land use development (King, Roland-Mieszkowski, Jason, and Rainham, 2012). There is also variation in noise level under different dominant land uses for the three periods (morning, afternoon and evening hours) of the days (Baloye and Palamuleni, 2015). The study of Gozalo, Suárez, Montenegro, Arenas, Morillas and González (2020) also reported that urban variables related to street location, urban land use, street geometry, road traffic control, public and private transport were shown to be highly correlated with noise levels.

Measurement in some respect is only in terms of the volume generated which is always isolated from the spatial and temporal characteristics of the areas they represent. It is in view of this that this study is designed to investigate the response of noise level to spatial and temporal characteristics of Oyo township which is geographically located along traffic axis linking the North and Southern Nigeria.

Objectives of the Study

The study aims at analyzing the spatial and temporal pattern of noise in relation to different land uses in different parts of Oyo township bearing in mind the following specific objectives.

i. measure the noise levels in selected areas within the study that will give us the basis of comparing noise under different spatio-temporal conditions
ii. Compare the volume of noise generated in selected areas within the study area with recommended noise levels for various land uses and recommend suitable measures for mitigating the extreme noise impact.

The study however raised the following questions:

i. Does noise level in different areas of the city differ significantly with that recommended for the respective land uses?
ii. Are there any perceived differences in noise level across land uses in Oyo town?

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iii. Does noise generation have spatio-temporal explanations across the town?

Hypotheses

For the purpose of the present study the following hypotheses were formulated to guide the study.

i. There is no significant difference between noise level and land uses.
ii. There is no significant difference between noise level and time of the day.

Material and Methods

The research centered on the result of outdoor and sound level measurement carried out in November, 2020, at sixteen sampled locations: five of which represent residential land use; two representing educational land use; three representing transportation land use; and six of the selected points represent commercial land use. The data for the study were primarily sourced and include noise level measurement collected through the use of high precision ANSI 1.4 type digital sound level meter (DSLM) with a frequency range of 31.5Hz - 8Hz and noise level measuring range of 35 dB(A) – 130 dB(A). The instrument was calibrated by internal sound level calibrator to allow accurate sound level measurement. Measurements were made at road junctions, market central points, streets and passenger loading and parking points. Measurements were made in the morning (between 6.00 – 8.00am); afternoon (between 1.00 – 3.00 p.m) and evenings (between 6.00 – 8.00 p.m). Daily averages and mean daily averages noise levels measured across land uses and at different times of the day were computed for different land uses to serve as basis for comparison due to problems inherent in the basic arithmetic operations. Daily averages and mean daily averages was performed on the noise levels measured across land uses and at different times of the day as basis for analysis due to difficulty inherent in basic arithmetic operation.

Analysis

The data collected for the study were analyzed using daily averages and mean daily average of noise levels in respective locations selected for the study. Other analysis used in the study is inferential statistics in the form of standard deviation and comparative analysis with T-test to compare and evaluate the effects of land used type on noise level.

Table 1a: Permissible Equivalent Sound Exposure Levels (Beranek 1992).

Duration of Exposure (Hours)	OSHA	U.S. Army	U.S. Air Force	EPA
8	90	85	84	75 *
4	95	89	88	
2	100	93	92	-
1	105	97	96	-
0.5	110	101	100	-
0.25	115 **	105	104	-

Note: * The threshold for detectable noise-induced permanent threshold shift (NIPTS) at 4,000 Hz; exposures exceeding 75dB may cause NIPTS exceeding 5 dB in 100 percent of the population after cumulative noise exposure of 10 years.
** Ceiling on exposure level and duration (Extract from Lee and Fleming, 2002).

Table 1(b) Maximum permissible noise levels for general environment

	Column 1	Column 2	
	Facility	Maximum Permissible Noise Limit dB (A) (Leq)	
		DAY	NIGHT
A	Any building used as hospital, convalescence home, home for aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites	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

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Going by the values obtained in these areas, it was revealed that the entire areas selected to represent the residential land use are extremely noisy than the recommended noise level for habitation in these areas. The values obtained justified a greater affinity and propensity of producing hearing impaired people because throughout the morning hours, people in these areas are more exposed to noise from various sources. Apart from them being annoyed by the extreme noise levels in these areas, they are also subjected to hearing impaired related problems. Minimum daily average for all the location is put at 75.90 dBA which is higher than what human ear is capable to accommodate as seen in the tables recommending habitable noise level when compared with the WHO table shown above:

Result

In the study, the average noise level is higher when compare with recommended level of noise by the WHO for both the morning, afternoon and evening readings across all land uses.

The minimum noise level for the morning for the residential areas is 79.88 dB(A) which was generated in the afternoon in location N (Cele area) with an average of 80.15 dB(A) but a maximum noise level was 94.10 dB(A) generated in the morning in location P (Oroki junction area). Generally, comparing table 2 with recommended noise level shown in table 1 (a & b) for a typically developed society and Nigeria case, it is evidence based that all the sampled locations in the residential areas are noisy and the situation is rather more than annoying but capable of resulting in hearing impairment because the minimum average for all locations was 80.15 dB(A). Also for the afternoon, a minimum value of 75.58 dB(A) was generated in Araromi area and maximum value of 91.30 dB(A) was recorded in Sakutu area of the study. The situation is the same with what was obtained in the morning. It was also shown in the study that the evening was also equally noisier with a minimum value of 84.98 dB(A) obtained for sampled point located in Araromi area and a maximum value of 89.36 dB(A) recorded at Sakutu Area.

Table 2: Measured and Mean Noise Levels for Period of Day, Daily and Average Noise in study Areas

Period/ID No	Sampling Locations (Commercial Land use)						Sampling Locations (Educational Land use)	
	A	B	C	D	E	F	J	K
Morning	89.63	92.23	91.32	89.75	94.40	102.15	85.00	90.90
Afternoon	91.14	87.03	90.45	85.90	95.53	94.77	81.23	84.33
Evening	96.10	95.98	93.80	88.05	89.48	95.25	84.80	90.25
Daily Average	92.29	91.75	91.86	87.90	93.14	97.39	83.68	88.48
Period/ID No	**Sampling Locations (Residentiial Land use)**					**Sampling Locations (Traffic Land use)**		
	L	M	N	O	P	G	H	I
Morning	84.98	83.50	79.88	92.82	94.10	93.44	95.25	98.08
Afternoon	86.55	77.35	75.58	91.30	89.98	92.26	93.47	96.70
Evening	90.85	88.23	84.98	92.97	90.98	95.50	102.9	97.28
Daily Average	87.46	83.03	80.15	92.36	91.67	93.73	93.20	97.35

Source: Author's Field Survey, 9th November, 2020 – 22th November, 2020.

Noise Level Analysis in the Traffic Areas of the City

In the traffic areas of the city, noise is more critical and people are more exposed to the risks associated with extreme noise level problems. It was minimum in the morning in Town Hall round about area with 93.44 dB(A) recorded in Durbar junction in the morning hours and a maximum value of 98.08 dB(A) recorded in Isokun Ojongbodu area. In the afternoon, a minimum value of 92.26 dB(A) was recorded in Isokun Ojongbodu area and maximum value of 96.70 dB(A) recorded in Durbar junction. In the evening, a minimum value of 93.28 dB(A) was recorded in Isokun-Ojongbodu area and maximum value of 93.28 dB(A) was recorded in Owode (Lagos garage) samples location

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for the study. The traffic areas of the city generate more noise both in the morning, afternoon and evening as the average value generated are 90.30 dB(A) at Owode (Lagos Garage), 93.29 dB(A) at town hall roundabout and 93.39 dB(A) at Durbar junction. The value is relatively higher than recommended value that population need to be exposed to as seen in table 1. Findings from this study corroborates the submission of Ozer, Yilmaz, Yesil and Yesil (2009) that noise in cities especially along main transportation and commercial arteries, have reached an alarming levels of disturbance and that of Chigboh (2006) who submitted that noise generation can be peaked at road junctions and traffic arteries in cities and at airports.

Analysis of Noise Levels in the Educational Area of the City

For the purpose of this analysis, two areas of the city are selected. They are Oke-Oroki Area and Unique area. In the morning minimum noise of 85.00 dB(A) was generated in Unique area while a maximum of 90.90 dB(A) was in Oke-Oroki area of the city. The afternoon was comparatively lower in noise generation when compared with the morning hours as a minimum of 81.23 dB(A) noise is generated in Unique area of the city and maximum of 84.33 dB(A) was generated in Oke-Oroki area of the city. Similarly, the evening was characterized with a minimum noise value of 83.68 dB(A) at Unique area and a maximum value of 90.25 dB(A) at Oke-Oroki. Comparatively, Unique area of the city generates less noise than Oke-Oroki area of the city as shown by daily average of 83.68 dB(A) and 88.48 dB(A) in the table below: The lesser noise value in the afternoon may not be unconnected with the shift of activities in between the residential areas to places of work immediately after the morning hours and a return home after the working hours. See table 2 above.

Analysis of Noise Level in the Commercial Area of the City

Analysis of noise level in the commercial area revealed that minimum noise of 86.22 dB(A) was recorded in Ajegunle while the maximum noise of 100.05 dB(A) was recorded in Saabo market area. In the afternoon, minimum noise value of 82.34 dB(A) was equally recorded in Akesan market area while a maximum value of 91.56 dB(A) was recorded in Saabo market area. In the evening hour, a minimum noise value of 84.42 dB(A) was recorded in Akesan market area and maximum value of 93.44 dB(A) was recorded in Saabo market areas.

Comparatively, commercial area of the city is noisy than what human are expected to be exposed to and this may result in vulnerability of the people to excessive noise related diseases like brain disorder, cardiovascular diseases, deafness and several others that may be accompanied with premature death. See the table below for the above analysis.

Hypothesis Testing

Hypothesis 1: There is no significant difference between noises generated and land uses.

Table 8: Table testing the significance test between noises generated in commercial and residential areas of the city.

	Group 1	Group 2
Mean	83.6767	87.9033
SD	2.1212	3.3227
SEM	1.2247	1.9184
95% of mean	(78.41) - (88.95)	(79.65) - (96.16)
N	3	3
Paired t test Statistical Significance: True; P = 0.0384		
Calculated t Value = 4.9536; Critical t Value = 4.3027		

Source: Authors Fieldwork, Nov. 2020.

In testing if significant difference exists between noise level and land uses within the city, the entire study area is divided in accordance with land uses into residential on the one hand and commercial land uses on the other. Both transport and commercial stood

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for commercial because of increased activities within the city while residential and educational grouped as residential. Mean daily average noises generated at each point is computed and students t-test analysis used in comparing the means of the distribution from the above. A calculated value of t which is 4.9536 was obtained and then compared with the value of t at α level of 0.05 which is 4.3027. This value was statistically significant at a probability of 0.0384. This shows that the calculated value of t is greater than the table value. The implication of this is that the calculated value of t could not have arisen by chance of sample selection meaning that the calculation is significant at the specified level. Then the hypothesis set is hereby rejected and the alternative retained. Here, it was held that there is significant difference between noise level with varying land use types.

Hypothesis 2: There is no significant difference between noise generated and time of the day.

In testing this hypothesis, the noise value for different time of the day, morning afternoon and evening values were obtained for five selected areas. Afternoon value representing the peak of noise levels was compared with the morning value. The values are shown in the table below:

Table 1.0 Two-way ANOVA of Noise level measurement and Land use designate

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Mean	92.29	91.7467	91.7567	87.9	93.1367	97.39
SD	3.3848	4.4945	1.5712	1.9294	3.2168	4.1293
SEM	1.9542	2.5949	0.9071	1.1139	1.8572	2.384
95% CI of mean	(83.88 - 100.7)	(80.58 - 102.91)	(87.85 - 95.66)	(83.11 - 92.69)	(85.15 - 101.13)	(87.13 107.65)
N	3	3	3	3	3	3
Calculated F value = 2.578; Critical F value = 3.326						

Source: Author's Fieldwork November, 2020

From the table above where the means of the sample noise level computed are compared using the Analysis of Variance in testing the significant variation, a calculated F value of 2.578 was obtained and found to be lesser than the critical F value of 3.326 at 95% confidence limit signifying that the obtained value could have risen by chance of sample or measurement. This therefore makes the hypothesis of no significant difference to be retained. The implication therefore is that, there is no significant differences in noise level obtained at various time and areas under consideration.

Discussion of Finding

From the study, it is revealed that land use type determines level and amount of noise generated in the study areas of the city. Some land uses generate more noise than other activities going on in them. The commercial areas are known to generate more noise than the residential and other areas of the city. Activities in these areas are daily and that the noise is much higher in commercial areas during the day than what were experienced in the mornings and evenings. In the residential areas, differences perceived in noise level cannot be ascribed a temporal explanation. This is in line with the findings of King et al (2012), Baloye and Palamuleni (2015) and Gozalo, et al (2020) who reported that urban variables related to street location, urban land use, street geometry, road traffic control and public and private transport were shown to be highly correlated with noise levels.

The study further revealed that high noise levels were continuous and spatially distributed within the study area. Though noise being an environmental problem produced from sources like traffic (light/heavy vehicle), road transportation and motorists sound, loud speakers from barbing saloons, music centres, religious and non-religious source and mobile trading, hooting of horns of mobile movement, marketing activities and several other sources of noise which in turn pollute the entire environment of the study area. Noise is not only undesired and disturbing to the biotic component of our

environment but also pose serious threat to humans and livestock due its chronic effect which is on a long term difficult to trace. It is worrisome, therefore, that no part of the city is spared of noise including Education and Residential areas where set values recommended by World Health Organization (WHO) and other regulatory agencies standards are often times exceeded.

Conclusion

Whether consciously or unconsciously, vast majority of the people of the areas within the city under study contribute immensely to the present state of noise pollution in our environment because of the daily activities going on in them. Often neglected is the fact that noise pollution adversely affects both humans and livestock in no small measure and leads to irritation, loss of concentration, loss of hearing and other severe health implications. This study is of particular importance because it allows us to identify the sources of noise pollution and once identified, the reasons for increased generation could better be assessed. In the same vein, efforts could then be made to reduce the undesired level of noise from the generating sources.

Recommendations

- Enforcement of laws and regulations, continuous check of noise limit, and ensure strict adherence and compliance with acceptable levels that will be set by Government and agencies designate that are not exceeded for whatever reason(s).
- Once statutory regulations have prescribed noise level, the public should be sensitized and mandated to complain to the noise regulatory body designated for violation of the noise level limit by any noise.
- Environmental Protection Agency, Ministry of Environments at the states and federal levels, Agencies and departments should enforce strict compliance in respect of noise level for land use types and set barriers for respective land uses in Nigeria cities.
- In addition, Federal Ministry of Health should collaborate with Environmental Agencies to set limitation for Noise levels across the country and provides orientation services to Nigerians on implications of exceeding specified noise levels.
- Different areas and cities in Nigeria should also be demarcated into noise limits and noise requirement for each zone be made to reflect what noise level is assigned for each area.
- Also, orientation service which should include exposing people to the negative health implications accompanying undesired noise level in the present and in the future should be embarked upon.
- It is high time that everyone should be alive and responsive to curb hazards associated with noise that has remained unbearable and constitute itself as silent killer. The following management techniques are recommended to help reduce noise pollution: a growing hazard of the present millennium.
- Certain study limitations may affect the generalizability of the results. First, noise levels were measured in a neighborhood and within a limited time period. Increasing the number of study areas to include additional land-use types would provide a deeper understanding of the relationship between environmental noise and land use characteristics.
- Second, an extended sampling could investigate the potential for seasonal variation on noise levels and the attendant health implications.

Abbreviations: DSLM - Digital Sound Level Meter; dB(A) – Decibel per Area; ANOVA – Analysis of Variance; WHO – World Health Organization

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