Evaluation and Analysis of Noise Levels at High – Traffic Locations in Gusau, Nigeria

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ABSTRACT

The measurement of noise levels at high-traffic intersections of Gusau town is reported in this work. Five high-traffic locations tagged LOC-A, LOC-B, LOC-C, LOC-D and LOC-E were selected and evaluated at different periods of the day using an MS6700 IEC 651, ANSI.Si.4 Type-2 Sound Level meter. Result analyses indicates that LOC-C has the highest noise level with L_{NP} = 95 and TNI = 94, while LOC-B has the lowest noise level with L_{NP} = 82 and TNI = 67. These noise levels imply that Gusau metropolis has an unacceptable noise level, well above the globally recommended levels of 60-65 dB(A) and the national recommended level of 82 dB(A). The paper therefore makes recommendations on minimizing these intolerable noise levels with consequences for environmental and human health in the study location.

Keywords: Noise, noise pollution, noise level, Traffic noise, Gusau

I. INTRODUCTION

Noise may be defined psychologically as any sound undesired by the recipient. Noise is often referred to as unwanted sound, and is typically characterized by the intensity, frequency, periodicity and duration of sound (Talbott and Thompson 1995). Noise is also an acoustic, electric or electronic signal consisting of random mixture of wavelengths. Noise pollution being a byproduct of modern developments in technology is a major constraint on the quality of life in urban settlements. Population explosion and increasing human activities gives rise to noise pollution in many cities and urban areas of the world. In most urban areas, noise pollution is a result of unplanned settlements and is perceived as the least contaminant among all the environmental pollutions (Mansouri, Pourmahabadian and Ghasenkhani 2006). Noise pollution also has concomitant effects on public health (Shultz 1978; Passchier-Vermeer and Passchier 2000; Riediker and Koren 2004). Some specific works focused on the hazard of noise on cardiovascular health (Jarup Jarup, L., Dudley, M.L., Babisch, W. Houthuijs, D., Swart, W., Pershagen, G., Bluhm, G., Katsouyanni, K., Velanakis, M., Cadum, E. and Vigna-Taqlianti 2005; Belojevic, Jakovljevic, Stojanov, Paunovic and Ilic 2008) and hearing impairment (Passchier-Vermeer and Passchier, 2000; Uguwuanyi, Ahemeen and Agbeneden 2004), annoyance (Schultz 1978) amongst others. In fact, noise pollution can adversely affect future generations with socio-cultural aesthetic and economic consequences (Yilmaz and Ozer 2005). Factors responsible for noise pollution in the cities and urban areas include industrialization, uncontrolled use of electrical appliances such as television sets, musical

systems, public address systems, air and vehicular traffic, railway and commercial activities with various reports confirming road traffic as the predominant and most generalized noise in urban areas due to correlation with high vehicular traffic volume (Bisio 1996; Sa'adu, Onyeonwu, Ayorinde and Ogisi 1998; Ross, Kheibek, Clougherty, Ito, Matte, Markowitz and Eisl 2011). Braj and Jain (1995) reported on the traffic noise levels in New Delhi where commercial areas have the unacceptable noise levels followed by industrial and residential areas. Nejadkoorki, Yousefi, and Naseri (2010) reported a noise level figure of 70.9 dB (A) and 80.7 dB (A) for the city of Jazd in Iran.

Many people living in Nigeria are exposed to intra-city roads traffic noise on daily basis and the most vulnerable groups are intra-city taxi, articulated vehicle and other public transport drivers and commuters, motor traffic wardens, street traders and school children whose schools are situated in proximity to major roads and high-decibel epicentres like music concert venues and entertainment spots. In recent years, attention has been focused by researchers on the impacts of noise pollution on environmental sustainability and human survival in urban areas. Traffic and other concomitant noises has been noted to be severe in rapidly expanding cities and towns and regions in Nigeria such as the Southeastern States (Onuu 1992), Ilorin (Oyedepo and Saadu 2010), Ibadan city (Kupolati, Coker and Ogunbor 2010; Abolade and Adeboyejo 2013) and Akure (Fadairo 2013) and this is mostly attributable to poor transportation decisions and poor urban planning and management of these cities.

This work is focused on Gusau town with the primary objective of evaluating and analyzing the traffic noise levels of selected high-traffic locations and secondarily, to confirm or otherwise whether there is significant difference in noise pollution level (L_{NP}) in the locations surveyed during the test periods (i.e. day time and night time) and thirdly, to compare the traffic noise index (TNI) of these locations. In this work, reference data from the Federal Environmental Protection Agency (FEPA) (Abolade and Adeboyejo, 2013) are used as baseline data for measurements and comparisons. These data are tabulated in Table I.

TABLE 1
Nigeria's Standard noise level

Duration per day/hour	Permissible exposure limits (dB)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Source: FEPA, 1991 as cited in Abolade and Adeboyejo (2013)

II. METHODS AND MATERIALS

a) Study area

Gusau, an emerging urban area is the capital of Zamfara in Northwestern Nigeria. The town is situated at latitude 12° 09' 51"N and longitude 06° 40' 0"E. Since acquiring its new status as a State capital, Gusau has slowly, but steadily evolved into a melting pot of divergent cultures and influx of migrants from other cities of Nigeria. On the heel of the influx of people is the increased in volume of vehicular traffic with attendant noise pollutions. The field work was conducted in October 2012 at five selected locations known for high volume of vehicular crisscross daily. These locations are the arterial Lalan Roundabout, Gusau Hotel Roundabout, commercial areas of Tudunwada Road/Junction and Tudunwada Roundabout and Government House Roundabout

respectively. Designations of the selected locations are tabulated in Table 2.

TABLE 2
Designation of selected Locations

Designation	Location
LOC-A	Lalan Roundabout
LOC-B	Gusau Hotel Roundabout
LOC-C	Tudunwada Road/Junction
LOC-D	Tudunwada Roundabout
LOC-E	Government House Roundabout

a) Data collection

The instrument used for the field measurements consist of an MS 6700 precision-grade sound level meter (IEC 651 Type2), 1/2 inch electrets condenser microphone and 1/3 octave filter with frequency response of 31.5Hz to 8KHz. The measurement ranges are 30 - 80 dB, 40 – 90 dB, 50 - 100 dB, 60 - 110 dB, 70-120 dB, 80 - 130 dB giving a total of 6 ranges. The instrument is IEC standards-compliant. The measurements were made at street level (roads, roundabouts and junctions). The measuring instrument was comfortably held in hand with the microphone firmly pointed at the suspected noise source at an estimated distance of 1m away from any reflecting object. L_{Ai} (A-weighted instantaneous sound pressure level) measurements were recorded at interval of 30s for a period of 30min, giving 60 readings per sampling location. This procedure was carried out in the morning (7:30am - 8:00am), afternoon (1:30pm – 2:00pm), evening (3:30pm – 4:00pm) and at night (7:30pm - 8:00pm) giving a total of 240 readings for each location. From the readings, commonly used community noise assessment quantities like the exceedance percentiles L_{10}, L_{50} and L_{90}, the A-weighted equivalent sound pressure level, L_{Aeqi}, the day time average sound level L_D, the day-night average sound level L_{DN}, the noise pollution level, L_{NP} and the traffic noise index TNI were computed. These measurements are computed based on the following relationships (Sa'adu, Onyeonwu, Ayorinde and Ogisi 1998).

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

$$L_D = 10\log_{10}\left[\frac{1}{2}\left(anti\log\frac{L_{eqM}}{10} + anti\log\frac{L_{AeqA}}{10}\right)\right] \quad (2)$$

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

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

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

$$TNI = 4(L_{10} - L_{90}) + (L_{90} - 30) \quad (6)$$

Where L_{Ai} is the $i-th$ A- weighted sound pressure level reading in decibels. N is the total sum 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, and L_{AeqN} is the equivalent sound pressure level for the night measurement. L_{AeqN} L_N is night time noise level, L_D is daytime 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 and TNI is the traffic noise index.

III. Results and Discussion

The results of the field experimentation are tabulated in Table III (Appendix). From the noise level descriptors given in Table III, it can be deducted that people living around the study locations and by extension Gusau town are exposed to unacceptable noise levels from intra-city road traffic every day. A cursory look at Table III shows that the noise pollution level L_{NP} ranges from 82 dB(A) to 95 dB(A) and the traffic noise index TNI ranges from 67 dB(A) to 94 dB(A).

The factors responsible for the differences in noise levels in the locations surveyed include activities carried out at different hours of the day. For example, the morning rush hour when people and children transits to their normal businesses and schools. In addition, the presence of sources of intrusive noise gives rise to high value for morning measurements. The high noise pollution level L_{NP} and traffic noise index TNI at Tudunwada road/junction is due to the fact that the area is a commercial hub with attendant cacophony of noise from commercial activities in addition to high volume of traffic. A reconnaissance survey of the selected areas prior to the field work, to ascertain their suitability as test locations projected Tudunwada roundabout as the intersection with the highest traffic volume and by extension highest value of both L_{NP} and TNI. However, a week to the commencement of the field work, the municipality installed a programmable traffic lighting system which predictably reduced noise pollution through a reduction in honking of horns and speeds by unruly and impatient road users. The noise levels measured in a given location depends on a number of specific variables. It has been reported by some researchers that observed sound levels are mainly related to road traffic characteristics such traffic volume, vehicle horns, rolling stock and tyres, unruffled vehicle amongst others (Sa'adu, Onyeonwu, Ayorinde and Ogisi 1998; Amado and Jose 1998; Mansouri, Pourmahabadian and Ghasenkhani 2006). A close study of Fig. 1 reveals that there is variation in the noise levels with the period of the day and characteristics of the location. For example, at the Lalan roundabout, all periods of the day have almost the same noise pollution level with evening period (3:30 - 4:00pm) having the highest noise level of 87dB(A). This could be attributed to the fact that this location is an arterial route linking Zamfara, Katsina and Kaduna States through the Funtua-Zaria axis. The Gusau Hotel roundabout has the afternoon period (3:30 - 4:00pm) with highest noise level of 91 dB (A). This could be a result of mid-day rush and related activities. The Tudunwada road/junction is the only location having the highest noise level of 95 dB (A) and $L_{10} = 82$ during the morning period (7:30 - 8:00am). This location is situated close to populated residential areas. The noise level during the night period was also high due to evening rush and high traffic volume by residents returning to homes. The Tudunwada roundabout has the highest noise level of 89

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dB (A) during the evening period. The government House roundabout has the evening period with the highest peak noise level $L_{10} = 82$. In summary, the mean noise pollution level and the mean traffic noise index of Gusau town have highest figures during the evening period as shown in Fig. 3 and Fig. 4 respectively.

IV. Conclusion

The evaluation and analysis of the noise levels of five selected high-traffic locations in Gusau town is reported in this work. Evaluation and analyses of the various measurements collated revealed that traffic noise levels at the five selected locations are at unacceptable high levels. From these observations, it can be surmised that the cacophony of noise emanating from vehicular traffic is posing a health risk to the populace and this can negatively affect their physical and mental well-being as concurred by several researchers cited in the work. Considering the ongoing road and other infrastructural development in the study area at the time of this report, it can be projected that in no distant time the effect of noise could lead to audiological, cardiovascular and mental health crises among vulnerable road users. Based on the outcome of this work, the following recommendations are made.

V. Recommendation

The Government should build more road networks across Gusau town in order to ease traffic volume on some strategic road intersections such as those used in the present study (at the time of compilation of this report, the Government has embarked on a massive and unprecedented intra-city and intercity road constructions across all the local councils in the State).

There is the urgent need for intensive public enlightenment of vehicle drivers on the imperatives of maintaining vehicles for sustained roadworthiness. Impunity of vehicle drivers should be brought under control through implementation of relevant extant laws by the Nigerian road safety commission (Federal Road Safety Commission).

There is the need for enforcement of reductions, limitations or restrictions on traffic (types of vehicles, speed, hours of access, etc.) on certain roads in the city. This will mitigate the unbearable noise levels caused by jammed traffics and road rage.

There is the need for sustainable transportation and land planning (private vs public transportation, bus lanes, parking areas, and pedestrian areas) in Gusau town. Stiff competition on the use of available roads leads to road rage on daily basis.

The characteristics of well-planned road constructions (low-noise pavement, acoustic barriers etc) should be reflected in the ongoing massive road constructions across the state. In essence, integrated design principle should be reflected in the current road construction efforts as the absence of this process will results in poor road constructions.

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Table III: Noise level Descriptors in dB(A)

Location	Period of the day	L_{Aeq}	L_{90}	L_{50}	L_{10}	TNI	L_{NP}	L_D	L_N	L_{DN}
Lalan Roundabout	Morning	72	65	70	75	75	82			
	Afternoon	72	64	68	76	82	84	72		
	Evening	73	63	68	76	85	86			
	Night	73	63	68	76	85	86		73	79
Gusau Hotel Roundabout	Morning	75	71	73	78	69	82			
	Afternoon	75	67	70	79	85	87	75		
	Evening	78	68	72	81	90	91			
	Night	75	67	70	75	67	83		77	83
Tudunwada Road/junction	Morning	81	68	73	82	94	95			
	Afternoon	76	69	73	80	83	87	79		
	Evening	76	71	74	80	77	85			
	Night	80	72	76	82	82	90		78	85
Tudunwada Roundabout	Morning	75	70	74	78	72	83			
	Afternoon	78	72	76	80	74	86	77		
	Evening	79	71	76	81	81	89			
	Night	76	69	73	78	75	85		78	84
Government House Roundabout	Morning	75	71	74	80	77	84			
	Afternoon	75	71	75	80	77	84	82		
	Evening	78	71	74	82	84	89			
	Night	75	69	72	80	83	86		76	84
Mean	Morning	76	69	73	79	77	85			
	Afternoon	75	69	72	79	80	86	77		
	Evening	77	69	73	80	84	88			
	Night	76	68	72	78	78	87		76	83

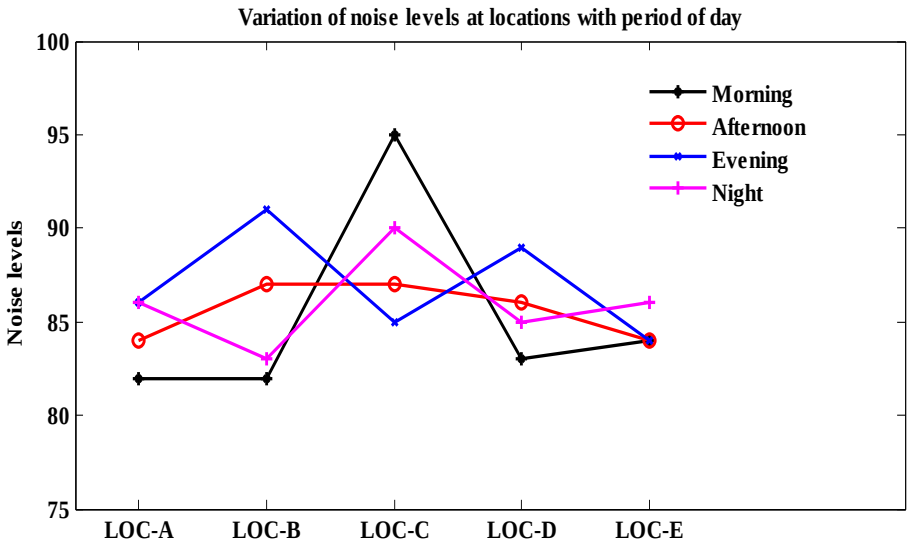

Fig. 1: Variation of noise levels at locations and period of day

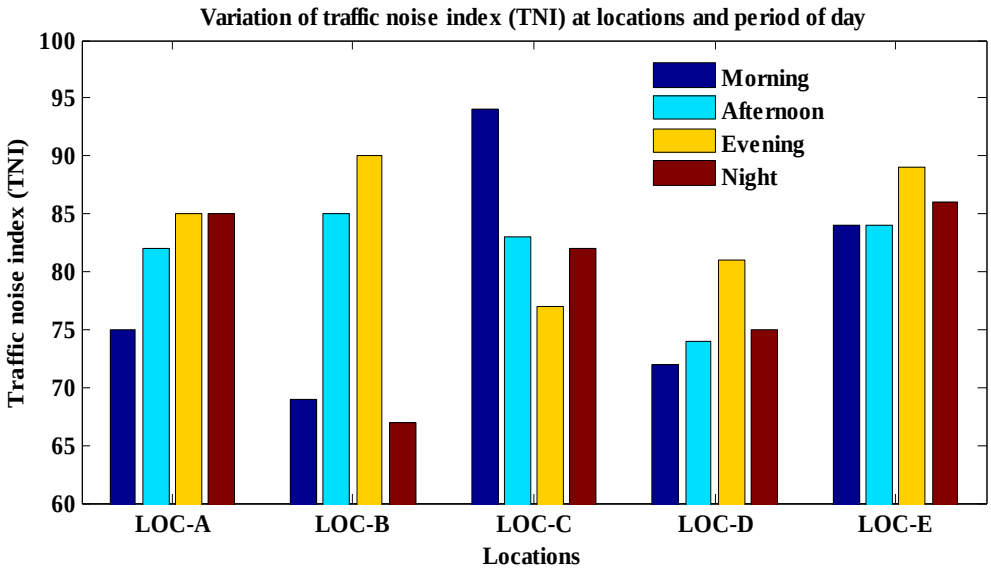

Fig. 2: Variation of TNI at locations and period of day

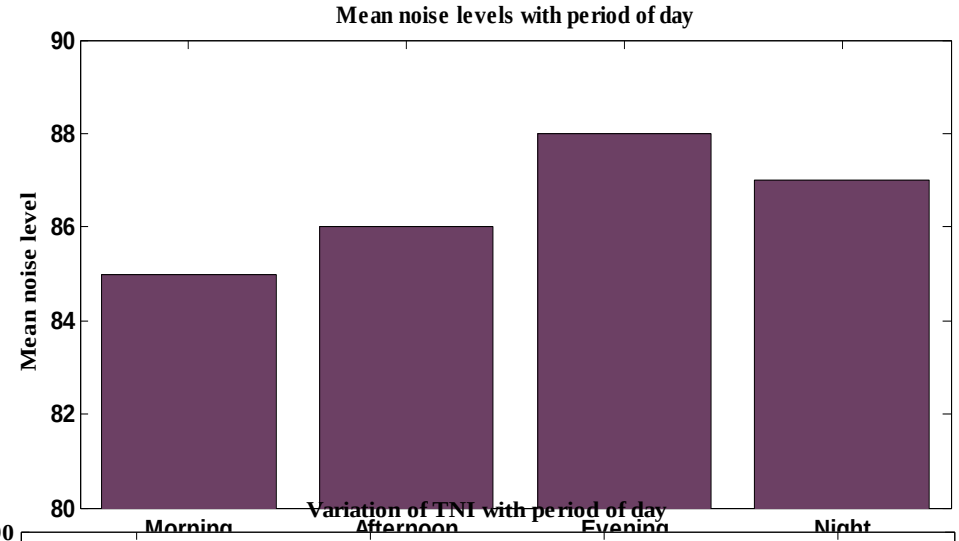

Fig. 3: Mean noise levels of Gusau with period of day

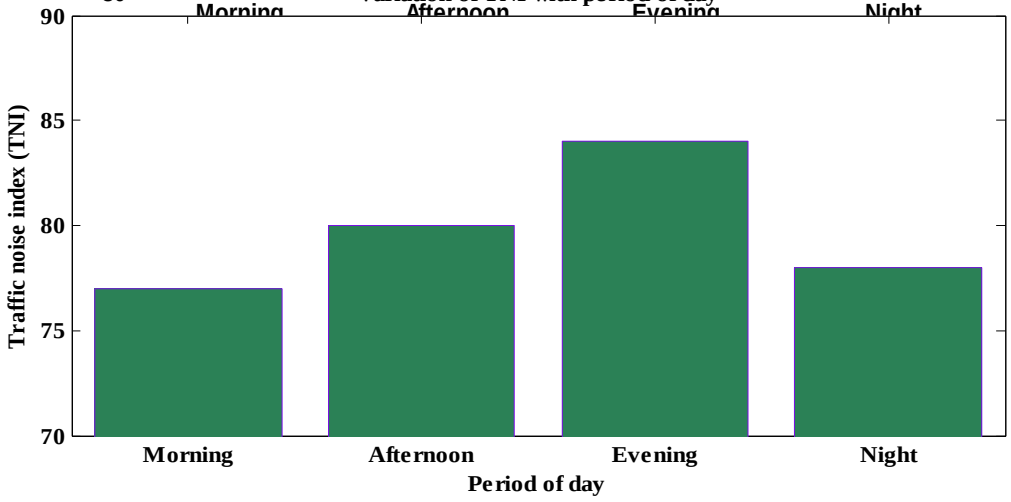

Fig. 4: Mean TNI of Gusau with period of day