

SPATIAL-TEMPORAL ANALYSIS OF NOISE POLLUTION FROM VEHICULAR TRAFFIC IN UYO METROPOLIS, NIGERIA

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Abstract

The study investigated the relationship between vehicular traffic and noise pollution in Uyo metropolis, Akwa Ibom State, Nigeria. Specifically, the study aimed at determining the spatial and temporal levels of noise pollution generated from urban traffic in Uyo metropolis. Through the use of noise dosimeter, data on the levels of noise pollution from vehicular traffic was obtained at eight (8) major transport routes, with high traffic density and the values compared to the ambient quality limit of WHO standards. The noise level readings was taken in the mornings, afternoons and evenings of Monday, Wednesday, Friday and Sunday respectively. Data on health implication of noise pollution was obtained through the use of structured questionnaires administered to 200 randomly sampled households along major streets selected for the study. The results show that 7 out of the 8 streets sampled for the study had all the weekday noise readings and most weekends exceeding the International Financial Agency and Environmental Protection Agency noise thresholds of 55decibels for residential and 70 decibels for

industrial and commercial areas. The study recommends the promulgation and implementation of a noise bill and empowerment of regulatory agency as major ways of solving the menace of noise pollution from vehicular traffic.

Introduction

Noise is derived from the Latin word “nausea” implying ‘unwanted sound’ or ‘sound that is loud, unpleasant or unexpected’. It is a by-product of urbanization and industrialization, which has been recognized as a major problem in urban areas with many adverse health effects in recent time (Zannin et al., 2003; Lisa and Louis, 2007; Nathaniel, 2007; Pathak et al., 2008). Recent studies indicate that vehicular traffic, railway and air traffic are the most important factors contributing significantly to noise pollution in urban areas (Oyedepo and Saidu, 2010; Sazegar et al., 2005) with vehicular traffic contributing about 55% of the total urban noise (Martin et al., 2006; Omidrain and Nouri 2009; Amrah et al., 2006). This informed why noise pollution from vehicular traffic is recognized as a major problem for the quality of life in urban areas all over the world. Noise pollution from vehicular traffic has been in the increase in the urban areas due to rising number of vehicles in the urban space and increase industrialization. Noise in cities, especially along main arteriars, has reached up an alarming and disturbing levels in recent time. It is therefore not unpopular to see residences far from noise sources and near silent secondary roads as people prefer to live in places far from noisy urban areas (Yılmaz and Özer, 1998).

Several studies (Payer, 2007; Dratva et al., 2010; Matheson, et al., 2010; Dino, et al., 2011) have been conducted to address the problem of noise pollution in many cities of the world, central to the findings of these studies are the scale of discomfort that noise causes in people’s lives (Butcha and Vos, 1998; Kura et al., 1999; Ali and Tamura, 2003; Marius et al., 2005). Depending on its duration and volume, the effects of noise on

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human health and comfort are classified into four categories: physical effects, such as hearing defects; physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers; psychological effects, such as disorders, sleeplessness and going to sleep late, irritability and stress; and finally effects on work performance, such as reduction of productivity and misunderstanding what is heard (Job, 1996; Evans and Hygge, 2000; Stansfeld et al., 2000; Passchier-Vermeer and Passchier, 2000; Quis, 2001; Marius, 2005). Noise is becoming an increasingly omnipresent, yet unnoticed form of pollution even in developed countries. Though noise pollution is a slow and subtle killer, yet very little efforts have been made to ameliorate it. Kiernan (1997) asserts that even relatively low levels of noise affects human health adversely; as it may cause hypertension, disrupt sleep and/or hinder cognitive development in children. The effects of excessive noise could be so severe that either there is a permanent loss of memory or a psychiatric disorder (Bond, 1996). Thus, there are many an adverse effects of excessive noise or sudden exposure to noise.

Arising from the negative impacts of noise pollution on human wellbeing, several initiatives have been taken by various countries to control noise level. For example, USA has taken initiative to create sites where human-caused noise pollution will not be tolerated (Geary, 1996). Similarly, the European Union (with more than 250,000 inhabitants) requires that 'noise maps' of big cities are drawn up by 2002 (New Scientist, 1998). To safeguard against ill effects of noise, the laws of Netherlands do not permit building of houses in areas where 24-hour average noise levels exceed 50dB. And in Great Britain, the Noise Act empowers the local authorities to confiscate the noisy equipment and fine people who create excess noise at night. Recently, several countries set standard limits for noise abatement. The standard guideline for the control of noise states that residential institutional and educational institutions should not be over 55dBA between 7am and 11pm and 45dBA between

11pm till 7am, while industrial and commercial exposure should not be over 70dBA all time (IFC,2007). In some places these standards are usually not complied with, especially in major urban centres, exposing people to the risk of noise discomfort. A report published by Stockholm University for the World Health Organization in 1995 concluded that noise levels outside dwellings should not exceed 55dB(A) to protect the majority of people from being seriously annoyed, and that 50dB(A) should be considered the maximum desirable.

Evidently, noise pollution has assumed alarming proportions affecting adversely the efficiency of various populations, mental health and general quality of life. Moreover, it is becoming a problem of law and order with the growing number of complaints to police and administration. Unless and until, measures are taken to control the level of noise, the quest for rapid urbanization and industrialization may complicate the problem so much that it becomes incurable. The fast growing vehicle population coupled with unplanned traffic route in Uyo metropolis in the recent years, has resulted in considerable increase in traffic on roads causing alarming noise pollution, with obvious socio-economic and attendant health implications. Study by Akpan (199) indicates that on the average a salon car in Uyo metropolis produces noise of the order of 70decibels and a heavy truck, 100 decibels. In spite of these alarming increase in vehicular traffic, no much empirical research has been conducted to ascertain the possible effects of increase level of noise pollution from vehicular traffic on the socio-economic life of humans in the metropolis. Again, while systematic evidence on the implications of noise pollution from vehicular traffic in developing countries is relatively scarce, a growing body of work on noise levels and its possible impacts on the health status of urban dwellers has been documented in many forms in developed countries (Sukuru, 2006; Lee and Fleming, 2002). Given this background, there is a need for a study of to identify the spatial-temporal effects of noise pollution on human health status from vehicular traffic to be carried out, as

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such study would provide an empirical and policy driven information on existing noise levels as it affects the health status of urban dwellers. Aside this, such study will further enrich the knowledge of policy makers, researchers and those in academic especially in development studies by providing vital planning inputs evolving policy towards control; aside drawing attention to the inadequacies of policy prescription as it affects diverse and vulnerable sections of the study area.

Against the aforementioned, this study investigated spatial-temporal levels of noise pollution from vehicular traffic in Uyo metropolis, Akwa Ibom State Nigeria, with the following specific objectives:

1. To identify the spatial-temporal patterns of noise pollution from vehicular traffic in Uyo metropolis
2. To determine the relationships between vehicular traffic and noise pollution levels on the one hand and, vehicular traffic concentration and noise pollution levels on the other hand in Uyo metropolis.
3. To identify the effects of noise pollution on the health status of households in Uyo metropolis.

Literature review

Literature on noise pollution from vehicular traffic are well documented, these include Singh and Mahajan (1990); Bhargawa (2001); Schade (2003); Haines et al (2003); Stansfeld et al (2005); Clark et al (2006); Adams et al (2006); Payer (2007); Dratva et al (2010); Matheson et al (2010); NPSE (2010); and Dino et al (2011) among others. Mounting evidence reveals that noise level in several metropolitan cities exceeds specified standard limits, which is responsible for rising incidence of deafness among urban households (Bhargawa, 2001). A study by Singh and Mahajan (1990) conducted in Delhi and Calcutta, found that the noise level is 95dB as against the ambient limit of 45dB. Even at the “calm” places, it does not fall below 60dB. Murli and Murthy (1983) also found

that traffic noise in Vishakhapatanam exceeds 90dB even in morning hours that acts as a source of nuisance. Bond, (1996) reports that 16% of people in Europe are exposed to 40 dB or more of traffic noise in their bedrooms at night compare with W.H.O.'s average estimates of 30 to 35 dB for undisturbed sleep.

As Payer (2007) observes, heightened public sensitivity to noise arose in many European cities during the latter half of the nineteenth century, and was derived in large part from the significant increases in traffic associated with urban industrialization. The influx of horse-drawn carts, pedestrians and cyclists, streetcars, railroads and automobiles to industrialising cities was a notable contributor in this regard, and the side effects of urban noise were being treated by medical health departments as an important health issue by the 1880s, in particular for their association with 'nervous behaviour'. Payer (2007,) attests:

Without doubt, noise was assigned a special position among urban nuisances for physiological reasons. Many argued that unlike other sensory organs, the ears could not be sealed and were therefore unprotected against all sorts of penetrating noises.

Whilst noise is often regarded as a nuisance associated with contemporary urban living (Schade, 2003), the issue is also widely recognised as a significant public health burden, particularly for its association with sleep deprivation, cognitive impairment (in children), high blood pressure, cardiovascular disease, and fatal heart in the transport literature. Dinno *et al.*, (2011,), for example, recognise that long-term noise exposure from rapid transit makes vulnerable those segments of society that the system principally serves; thus, school-age children, elderly people and people of low-income would necessarily be more vulnerable to these negative impacts. Dratva *et al.*'s (2010) research on road traffic-related noise exposure revealed that women reported significantly higher levels of noise

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annoyance and thus lower health-related quality of life than men. Children have also been recognised as particularly vulnerable to the negative health effects associated with traffic noise (especially aircraft noise), as exposure has been associated with cognitive impairment and issues with reading comprehension (see Clark *et al.*, 2006; Matheson *et al.*, 2010; Stansfeld *et al.*, 2005, and others), and the impact of aircraft noise is viewed as more significant than road traffic noise (Haines *et al.*, 2003).

Despite the wealth of studies that consider the impact of traffic noise on residents, Adams *et al.* (2006) observe that it is visual aesthetics not acoustic properties that dominate in urban planning policy and guidance. The importance of this issue within the UK, however, has arisen in the form of the *Noise Policy Statement for England* (NPSE) (2010), which recognises the adverse health and quality of life impacts associated with noise exposure (but does not elaborate as to the distributional effects associated with this type of impact); and the Mayor of London's (2004) *Ambient Noise Strategy*, that acknowledges the inequalities regarding noise exposure, such as for children and other disadvantaged groups. The literatures reviewed are significant in understanding different approaches that may be employed in the measurement of noise pollution from vehicular traffic. Central to the methodology employed by these scholars is the use of noise/sound measuring devices such as dosimeter or sonometer in the measurement of noise. Also the health implications of noise pollution from vehicular traffic were collected using focus group discussions, structured questionnaires and oral interviews. The data obtained were analysed using either descriptive or inferential statistics.

Materials and Methods

Purposive sampling technique was employed in the selection of eight (8) major streets/roads noted for high volume of traffic flow, high population density and residential and commercial activities in Uyo metropolis. Data on noise pollution (in decibels) from vehicular traffic along the selected

transport routes was measured through the use of noise sonometer (sound meter) Anoloque Cel 254 K2 at eight (8) points obtained at a height not less than 1.20 m and at a distance of 2-3m from noise sources as defined by Ramis et al. (2003), <http://poweracoustics.com> (2009), Piccolo et al. (2005) and Jamrah et al. (2005). Erroneous situations were prevented by calibrating the sonometer. Measurements were carried out in the mornings, afternoons and Evenings of Monday, Wednesday, Friday and Sunday. At each measurement point, noise values were recorded in five seconds by taking one noise value in every six seconds. The measurements of the noise levels were done under suitable meteorological conditions, that is, in the absent of wind and rain. Because transportation distances in the metropolis were short, the noise measurement intervals were also short. For this reason, values were obtained between: 7-10am; 12-3pm; and 4-7pm respectively. These periods were chosen as they represent peak periods when traffic density is higher than other hours.

Data on vehicular traffic flow was obtained through traffic census. The counting was taken in three (3) time periods: 7-10am (morning); 12-3pm (afternoon) and 4-7pm (evening) of Monday, Wednesday, Friday and Sunday. Data on traffic concentration was derived by dividing the area of the selected roads by the total number of traffic flow per unit hour. While data on the selected road area was obtained from the Akwa Ibom State Ministry of Works, information on the effect of noise pollution on human health status was obtained through the use of structured questionnaire administered to 200 randomly sampled households within the eight (8) selected transport routes (25 questionnaire was administered to residents in each of the sampled streets/roads in the metropolis, thereby bringing the total number of questionnaire administered to 200). Descriptive statistics was employed in the data analysis.

Results and Discussion

Table 9.2.1.1 shows the tolerance limits for ambient noise emissions. The noise thresholds for residential areas should not exceeds 55decibels, while the allowable threshold for industrial and commercial areas are 70 decibels (USEPA, 1974).

Table 9.2.1.1: Noise sensitivity classification (level of risk exposure)

Db (A)	Sensitivity
55-60	Risk
60-65	Mediun Risk
65-70	High Risk
70-75	Dangerous
75-80	Highly Dangerous
80-85	Extremely Dangerous

Source: USEPA (1974)

Table 9.2.1.2: Spatial-temporal variations in noise pollution from vehicular traffic in Uyo metropolis

Location	MORNING (dBA)				AFTERNOON(dBA)				EVENING(dBA)			
	Mon	Wed	Fri	Sun	Mon	Wed	Fri	Sun	Mon	Wed	Fri	Sun
Barracks rd	71.4	70.5	78.5	50.3	72.6	67.8	78.7	48.6	70.1	67.4	75.2	48.6
Nwaniba	78.3	74.2	83.5	49.2	82.4	60.9	82.7	57.5	79.4	78.2	81.6	52.2
Oron Rd	80.2	78.1	82.6	52.3	81.5	75.0	80.2	54.8	82.4	81.5	80.6	54.4
Aka Rd	84.6	80.1	81.1	54.0	79.5	68.9	78.5	56.7	79.8	79.7	82.5	52.7
Abak Rd	81.8	75.9	82.3	53.2	79.8	64.6	84.0	53.4	80.4	80.1	83.2	58.2
IkotEkpene Rd	86.8	79.5	81.5	48.1	85.4	82.1	81.7	50.1	84.2	79.5	84.2	59.8
Ikpa Rd	82.5	77.5	81.3	48.2	79.1	74.3	77.2	48.3	81.3	71.5	80.4	56.1
Ibom Plaza	85.7	80.3	81.5	50.1	83.4	72.6	79.4	49.4	82.0	76.2	84.6	56.5

Source: Authors Field Survey (2017)

Table 9.2.1.2 also shows that all the weekday noise readings in Uyo metropolis greatly exceed the EPA standards of 55dBA and 70dBA for residential, industrial and commercial areas respectively. However, all the Sunday readings fall below the internationally accepted noise levels. Also,

all the weekday afternoon readings exceed the EPA noise level limit of 55dBA, while all Sunday afternoon readings, except along Nwaniba Road, were below the EPA standards. The possible reason for the high Sunday noise readings along Nwaniba Rd is that most of the major worships centers in the metropolis are located along this route. Again, all the weekday Friday readings at all the sampling locations were considerably high, exceeding the EPA limit for commercial and industrial noise levels. It can further be adduced that all the weekday and weekend evening, except along Abak Rd, Ikot Ekpene Rd and Ikpa Rd, which are relatively higher than the threshold limits of 55dBA readings, exceed the EPA noise limits for residential and commercial/industrial noise levels. Thus, it is abundantly clear that noise levels in all the 8 sampled streets/roads in Uyo metropolis have weekday readings that exceed the EPA standards of 55dBA for residential areas, and 70dBA for commercial and industrial areas, while most of all the weekend readings fall below the EPA threshold limits for residential and commercial areas.

Noise produced on the 8 sampled streets/roads varies spatially from risk levels to extremely dangerous level and poses serious danger to households residing within the metropolis. This kind of situation is found along Ikot Ekpene Rd, Oron Rd, Ibom Plaza, Aka Rd, Abak Rd and Ikpa road respectively where the noise levels produced by vehicular traffic along these roads reaches up to 75-85db(A) during the day. It could, therefore, be concluded that noise poses severe nuisance on the well-being of the people residing or working in and around these locations as they are at a very high risk of noise related ailments like temporary or permanent deafness, high blood pressure, headaches, auditory fatigue, temporary and permanent lessening of hearing ability, sleep disorders, and can even contribute to learning problems in children. There is a gradual increase in noise levels readings from Monday through Wednesday and Friday and a significant decrease in the readings on Sunday. Specifically, there is a general increase in the noise levels mostly on Monday and Friday, while

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Sunday records the least noise levels both in the morning, afternoon and evening readings.

Table 9.2.1.3: Temporal features of noise levels from vehicular traffic in Uyo metropolis

Street	Morning(7-10am)		Afternoon(12-3pm)		Evening(4-7pm)	
	TFV	MNL	TFV	MNL	TFV	MNL
Abak Rd	1974	67.68	1173	66.93	887	47.80
Aka Rd	2556	71.30	3012	70.88	1638	53.00
Barrack Rd	1099	73.30	840	72.88	542	54.13
Ikot Ekpene Rd	1675	74.95	2630	70.90	1771	73.73
Ikpa Rd	2918	73.30	1316	70.45	984	55.38
Nwaniba Rd	2719	73.98	2037	74.83	2832	55.88
Oron Rd	2622	72.38	2051	69.73	2711	52.00
Ibom Plaza	3451	74.40	3120	71.20	3567	53.83

Source: Fieldwork (2017)

Where: TFV= Traffic Flow Volume and MNL:Mean Noise Levels

Table 9.2.1.4 shows the relationships between vehicular traffic flow on the one hand and vehicular concentration and the mean noise levels in Uyo metropolis on the other hand. One would have expected that the noise emitted during heavy traffic congestion would be higher than periods with free traffic flow. Contrarily, it is evident from the table that more noise is produced during free traffic flow than does in congested period. It could be said that there is a proportional relationship between the volume of vehicular traffic flow and the mean level of noise generated. Thus it is revealed that increase in the volume of free traffic flow results to a corresponding increase in noise levels. The highest mean noise level is 83.30 dB(A) and this is produced during free traffic flow with increase traffic volume in Ibom Plaza compared to the mean noise level of 81.24dB(A) produced during high traffic concentration. The noise levels

in a free traffic flow is generally higher than the levels in higher traffic concentration in all sampled locations except at sampled points 3, 6 and 7 with higher mean noise levels during periods of high traffic concentration.

Table 9.2.1.4: Relationships between vehicular traffic and noise pollution levels in Uyo metropolis

Street	Traffic Flow	Mean Noise Level	Traffic Conc.	Mean Noise Level
Barracks	4282	67.11±1.32	344	65.31±2.11
Nwaniba	7588	78.30±3.14	474	74.72±3.01
Oron Rd	7384	71.01±6.50	462	75.45±3.32
Aka Rd	7206	83.54±1.21	450	77.26±6.40
Abak Rd	6903	75.25±3.51	535	71.11±0.26
Ikot Ekpene Rd	6076	73.67±4.31	380	79.07±5.04
Ikpa Rd	5218	69.11±6.21	580	76.45±2.05
Ibom Plaza	10,138	89.30±8.01	634	85.21±4.20

Source: Fieldwork (2017)

The possible reason for the low noise levels produced during a congested traffic situation is that during such situation, a long queue usually exists and vehicles invariably move very slowly. This means that at a higher concentration, speed is low and flow is consequently small. At a certain limits of flow and concentration, speed will simultaneously be zero. Also, concentration has a maximum values called jam concentration, C_j when vehicles move in a bumper to bumper fashion. Therefore, between the limits of zero and jam concentration, C_j , the flow must have at least one maximum. It should also be noted that under a condition of high traffic concentration, two things resulting from rapid fluctuation in flow, speed and concentration are visible. First, the situation is always characterized by frequent stopping and starting as drivers drive in a bumper to bumper mode or the vehicle remains in a fixed position steaming, thus enhancing further congestion, which probably results in low noise levels compared to

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periods with free vehicular flow. The increase in noise levels during free traffic flow could be directly related to the engine, transmission, exhaust, and suspension of the vehicles during high traffic flow, which is greatest during acceleration, and during engine braking. Frictional noise from the contact between tires and pavement during acceleration contributes significantly to overall traffic noise and is generally greatest at high speed and during quick braking. Poor vehicle maintenance is a contributing factor to this noise source.

At periods of heavy concentration, traffic noise and vehicular vibrations which are concerned with ride comfort becomes paramount on the urban environment. Traffic noise is both annoying and disturbing as it penetrates through the interior buildings disturbing concentration at work and conversation. The level of noise from vehicular traffic as revealed from field observation in Uyo metropolis is influenced by the speed of the vehicles, the density of the traffic (Table 9.2.1.3) and the nature of the surface which the vehicle is operated.

The sampled respondents leaving along the major streets sampled were asked to rank their perception of the possible health implications of exposure to high noise levels on their health status as evidenced in Table 9.2.5. From the respondents ranking, it was revealed that several respondents complained of hearing impairment, sleep disturbance, interference with spoken communication and mental disturbance as the major effects of exposure to noise levels beyond the recommended threshold levels of 55dB(A) for residential and 70dB(A) for commercial and industrial areas. This corroborates findings by Evans and Hygge (2000); Stansfeld et al., (2000); Passchier-Vermeer and Passchier (2000); Quis, (2001); and Marius, (2005) that exposure to excessive noise levels has the tendency of causing hearing defects; sleeplessness, misunderstanding what is heard, and increase blood pressure amongst others. Given the nature of the road surface in Uyo metropolis, the intensity of noise might increase beyond human tolerance limit which

could manifests in severe human health challenge. According to Esin (2009; 2000), noise pollution has adverse effects on man and his environment including land, structures, domestic animals, wild life and ecological systems.

Table 9.2.1.5: Health implication of noise pollution from vehicular traffic in Uyo metropolis

Effects	Ranking
Sleep disturbance	2
Cardiovascular disturbance	7
Hearing impairment	1
Interference with spoken communication	3
Mental disturbance	5
Impaired task performance	4
Negative social behaviour	6
Hearing loss in foetus/new-born	8
Others	9

Source: Fieldwork (2017)

Concluding Remarks/Recommendation

The study has shown that vehicular traffic contributes significantly to the total noise levels produced in Uyo metropolis. It was also revealed that noise levels tend to be greatest a free flow traffic situation than in a congested situation. The study has further revealed that the noise production from vehicular traffic determined by a number of factors: the number of vehicles passing per unit time; the constancy of flow -vehicles tend to be noisier in stop-and-go traffic; and the speed of traffic flow - noisiest at high speeds and the type of vehicles in the stream and their level of maintenance among others. Again, it was revealed from the study that increase noise pollution from vehicular traffic impact negatively on

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the health status of households in Uyo metropolis. Based on these, it is recommended that there is urgent need to evolve proper approaches to address the issue of noise and protection of human and environmental health in Uyo metropolis in particular and Nigeria in general. It is recommended that the National Assembly should pass a Noise Abatement bill making it mandatory for all states and local government of the federation to enact similar law to combat noise pollution aggressively in all the major cities/towns in Nigeria. The survey indicates that noise affects individuals in several ways. It results in improper communication, sleeplessness and reduced efficiency. Though the psycho-somatic effects (annoyance and depression) are also common yet the extreme effects e.g. deafness and mental breakdown are not ruled out. There is also the need for public enlightenment, education and sensitization on the potential hazards and human health effects associated with noise pollution. This is indeed very germane because many are still ignorant of the fact that there exist any relationship between noise pollution and their health status.

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