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ASSESSMENT OF NOISE POLLUTION LEVEL OF TRANS- AMADI INDUSTRIAL LAYOUT, PORT- HARCOURT CITY RIVERS STATE, NIGERIA.

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ABSTRACT

Noise levels were evaluated using type II model IEC651 integrated digital sound level meter in selected industrial areas of Trans-Amadi and some commercial areas. The Leq values obtained exceeded the international permissible limit of 65 dB (A). Similar trend was observed in the studied commercial zones where the recommended permissible limit of 65 dB (A) (day-time) and 55 dB (A) (night-time) noise levels were all exceeded. The noise pollution level (Lnp) and the daily noise exposure (Lep,d) estimated exceeded their permissible levels. Noise contour was performed using computer software called surfer to show the various areas of high noise level and areas of low noise levels. The overall result show that the noise pollution level of Trans-Amadi industrial layout are high (unacceptable level), though it is similiar to results of work from similar environment nationally and internationally. This implies that the people working and living in the area of the study are exposed to relatively different degrees of environmental noise from industrial and commercial activities that can cause health issues.

Key words: Noise, Pollution, Exposure, Sound Pressure,

INTRODUCTION

Noise is defined as unwanted sound. Environmental noise has been defines by many authors as unwanted or harmful outdoor sound created by human activities (Anomoharan et al,. 2008, Defra 2003). Ebeniro and Abumere, (2003) , defined environmental noise as an unwanted acoustic signal or sound produced without regard to its adverse effects on both man and the environment. The rapid increase in industrialization, Urbanization, Communication systems and transportation systems (Rajiv and Yogesh, 2012), without corresponding increase in national electrical power supply has led to increase in noise pollution level due to the use of generators. Noise is becoming an increasingly health threat, yet unnoticed form of pollution (Avnish et al., 2010).

Environmental noise is any undesired, displeasing or harmful sound emanating from human activities such as transport system, industrial activities (Anomohanran et al., 2008). Most developed cities have adopted standards for noise exposure limits as a vital means of environmental policy to help alleviate the harmful effects off noise and increase the quality of life people (Srimanta, 2011). When the sound levels exceed the allowable limit, the environment is said to be noise polluted. The extent to

which a given noise is annoying depends on many factors such as pitch, irregularities, duration, rhthm or whether the noise has meaning for the particular observer (Okeke and George, 2012). The most important is the loudness which depends both on the physical sound pressure measured in decibels (db) and on the sensitivity of human ear which varies widely with frequency. The range of frequency the human ear responds to, is from 20 Hz to 20 KHz and it is called the audio frequency range. Below this range is the infra sound and above it is called the ultra sound.

Comprehensive noise pollution survey has been carried out in large cities (Alberola et al.2005, Avnish et al., 2010, Chauhan, 2008, Vidya Sagar and Nageshwara Rao, 2006, Oyedepo , 2012) and have clearly shown that exposure to high equivalent noise pressure levels can damage the sensory hair cells of the inner ear leading to irreversible hearing loss. Studies also showed that continuous exposure to heavy noise may result in high blood pressure and loss of sleep (Singh and Davar, 2004). Okeke and George (2015) stated that noise pollution is a by-product of urbanization and industrialization, vehicular traffic or increased vehicle in circulation and population commercial activities, intrusive sounds especially from the use of public address system by churches and so on.

Ochsner (2003), mentioned in her work that the loudness of noise and the period with which one is exposed determines the extent of damage to hearing. Noise level up to 85 dB and above are hazardous. Due to this most people are unaware of themselves losing their hearing ability until it gets to permanent hearing loss. Omubo-Pepple et al, (2010) in a survey carried in Port-Harcourt found out that public address system such as loudspeakers, religious activities are sources of noise. Nwafor and Menkiti (2015) measured noise level of Port Harcourt city and concluded that noise levels around the industrial areas exceeded national and international standards.

Exposure to noise can lead to cumulative adverse health effects and also the quality of life enjoyed by people in most industrialized cities all over the world (Serkan et al., 2009). Depending on its duration and volume, the effects such a hearing impairment, physiological effects such as, sleeplessness , increased blood pressure, irregularity of heart rhythms and ulcers, psychological effects such as disorders, sleeplessness and irritability, stress and Human performance such as reduction of productivity and misunderstanding of what is heard (Evans and Hygge, 2000 and Ahmed et al., 2006).

Despite these adverse effects of noise pollution most people have not attributed any serious physiological impacts to it, though they may consider it as nuisance during sleeping hours may be due to lack of sound knowledge of its health implications. Practical actions to limit and control the exposure to environmental noise are therefore essential.

The aim of this study is to assess the noise pollution level of Trans-Amadi industrial layout Port Harcourt, Rivers State, Nigeria and this will be achieved through the following objectives.

1) To determine the spatial and temporal noise levels in selected sites of Trans-Amadi layout.
2) To estimate the daily personal noise exposure of workers
3) To determine the risk zones of the various selected sites.
4) To determine the noise burden of the workers/ environment of the selected city.

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MATERIALS AND METHOD

Study Area

The ambient noise monitoring was carried out in Trans-Amadi industrial layout area located within Port-Harcourt city of Obio-Akpor local government area of, Rivers state, Nigeria. The area lies between 4°48′55″ North latitude and 7°2′14″ East longitude. The area is characterized by diverse industries and commercial activities and is generally referred to as an industrial zone.

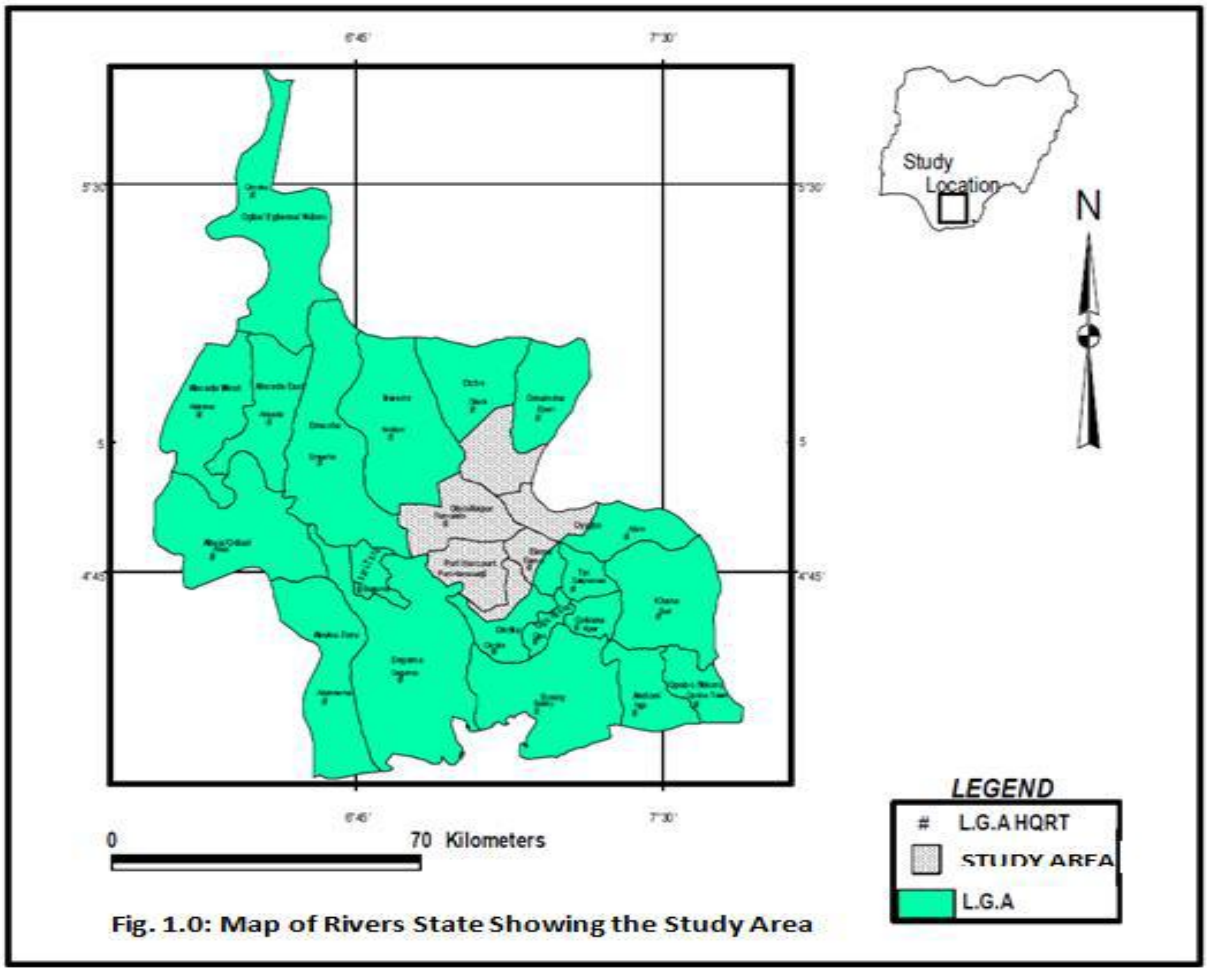

Fig.1: Map of the study Area

Port Harcourt metropolis is located in the Niger Delta, south-south geopolitical zone of Nigeria. The city, lies between longitudes 6055´E and 7055´ E, and latitude 4035´N and 5010´N (Figure 1).

Port Harcourt features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months of December and January truly qualifies as dry season months in the city. The harmattan, which climatically influences many cities in West Africa, is less pronounced in Port Harcourt. Port Harcourt's heaviest precipitation occurs during September with an average of 367 mm of rain. December on average is the driest month of the year; with an average rainfall of 20 mm. Temperatures throughout the year in the city is relatively constant, showing little variation throughout the course of the year. Average temperatures are typically between 25 °C - 28 °C in the city

The 2006 population census put the population at 1,255,387 and projected at 1,337,800 in 2009 (Nigeria population commission, 2006). In Port Harcourt metropolis, there are various land use patterns such as industrial, residential, commercial, road construction etc. There are a variety of road networks. These include highways of different categories, railways and waterways (seaport and jetties) and airports. The main industrial area of the city is Trans Amadi where there are clusters of industries that boost the economy of the state, while the residential areas include Port Harcourt Township known locally as "Town", G.R.A phases 1-5, Abuloma, Amadi-ama, Amadi Flats, and Borokiri.

Experimental Procedure

The measurement of sound pressure levels were made at street level (at busy road junctions, company premises, bus stops/parks , commercial areas and residential area using the noise level meter IEC 651 TYPE II, and the global positioning system (GPS) for location coordinate measurement. The instrument was automatically calibrated to the A-weighting network and the slow response was always used. The meter was held in hand with the microphone pointed at the suspected noise source at a distance of 1 m above the ground level and 1.5 m away from any reflecting objects. The sites were chosen to allow for a good comparison. Measurement were taken from June to August, 2016 under suitable meteorological condition. For each sampling location, the readings were taken at the precise moment after every one hour interval. For each hour, the sound pressure levels were recorded after every two minutes. The minimum and maximum sound pressure levels were recorded. These readings included the LAeq (A-weighted instantaneous sound pressure of the sound levels). From these readings commonly used community noise assessment quantities like equivalent noise level LAeq, noise pollution levels Lnp, and daily personal noise exposure LEP,d were computed using appropriate formula as shown below:

$$Leq = 10 \log_{10} \frac{1}{N} \sum anti \log \frac{LAi}{10}) \quad (1)$$

Where LAeq is the A-weighted equivalent sound pressure levels and LAi is the instantaneous sound pressure level at time , N is the time interval.

The noise pollution level is calculated using the equation:

$$Lnp = Leq + K\sigma \quad (2)$$

Where K is a constant with a value of 2.5 and σ is the standard deviation of the calculated LAeq values (Avwiri et al., 2007). σ is 7.4 dB for A-weighted noise level in ranking in which a variety of common noise are involved.

Daily personal noise exposure of a worker (LEP,d) : daily personal noise exposure of a worker is expressed in dB(A) using this formula;

$$L_{EP}, d = Leq(A) + 10 \log \frac{T}{T_O} \quad (3)$$

Where T= daily duration of a worker's exposure to noise (hours), T_o = 8 hours allowable exposure duration.

RESULTS AND DISCUSSION

This study was conducted in 16 different industries to assess the noise at the work environment and 6 commercial zones in order to determine the noise pollution levels and daily noise exposure of workers in those industries. Tables 1 and 2 shows the measured sound pressure levels of the industrial zone and commercial zone of the Trans-Amadi- industrial layout respectively with their noise pollution indices.

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Table 1: Results of the Sound pressure level in Industrial zone of the Trans –Amadi Industrial Layout with their Noise Pollution Indices.

S/N	Area Location	GPS Location	Sound Pressure Levels dB (A)		Average Noise Level dB (A)	LAeq dB (A)	Lnp dB (A)	LEP,d dB(A)
			Max.	Min.				
1.	$TREVI_1$	N4°48′37.9″	78.6	65.4	78.9			
2.	$TREVI_2$	E7°02′31.2″	80.8	74.7	81.8	76.0	98.32	76.96
3.	$TREVI_3$		65.5	62.6	67.3			
4.	Green $Field_1$	N4°48′42.9″	60.5	53.4	61.3			
5	Green $Field_2$	E7°02′27.4″	74.6	69.0	75.6	73.73	95.71	74.70
6	Green $Field_3$		84.2	71.2	84.3			
7	Light wave Nig. Ltd_1	N4°48′45.6″	55.9	52.0	57.4			
8	Light wave Nig. Ltd_2	E7°02′23.8″	60.2	59.6	62.7	60.87	80.84	61.84
9	Light wave $Nig.ltd_3$		61.3	56.0	62.5			
10	RCC_1	N4°48′45.0″	97.6	86.7	97.9			
11	RCC_2	E7°02′14.0″	82.8	74.5	83.4	86.93	110.80	87.90
12	RCC_3		77.9	77.2	80.4			
13	$RIVOC_1$	N4°48′43.8″	76.5	55.4	76.5			
14	$RIVOC_2$	E7°02′14.9″	70.2	70.2	73.2	77.93	100.53	78.50
15	$RIVOC_3$		82.3	79.3	84.1			
16	Delatire Bezons Night $Entrepose_1$	N4°48′38.8″	74.2	70.7	75.7			
17	$DBNE_2$	E7°02′18.2″	86.4	71.5	86.5	78.47	101.15	79.44
18	$DBNE_3$		72.2	66.3	73.2			
19	$Ponticeila_1$	N4°48′42.3″	79.1	57.6	79.1			
20	$Ponticeila_2$	E7°02′16.5″	55.6	50.2	56.8	67.63	88.68	68.55
21	$Ponticeila_3$		65.2	62.3	67.0			
22	Etalgate $Aluminium_1$	N4°48′30.4″	68.9	64.1	70.1			
23	Etalgate $Aluminium_2$	E7°02′50.2″	62.9	62.6	65.4	69.5	90.84	70.47
24	Etalgate $Aluminium_3$		70.5	69.3	73.0			
25	Baker $Hughes_1$	N4°48′50.3″	68.4	66.3	70.5			

26	Baker Hughes$_2$	E7°02′36.3″	73.2	68.8	74.7	75.17	97.37	76.14
27	Baker Hughes$_3$		79.9	70.0	80.3			
28	Coca-Cola$_1$	N4°48′51.7″	86.7	80.4	87.7			
29	Coca-Cola$_2$	E7°02′35.1″	74.7	71.4	76.5	79.1	101.87	80.07
30	Coca-Cola$_3$		72.1	66.0	73.1			
31	Halliburton$_1$	N4°48′56.9″	81.8	80.1	83.9			
32	Halliburton$_2$	E7°02′32.2″	71.9	70.2	74.4	77.67	100.23	78.64
33	Halliburton$_3$		72.6	71.0	74.7			
34	Schlumberger$_1$	N4°48′58.9″	70.8	70.2	73.3			
35	Schlumberger$_2$	E7°02′31.7″	72.7	68.3	74.2	76.87	99.31	77.84
36	Schlumberger$_3$		80.6	79.8	83.1			
37	Mclatex Nig. Ltd $_1$	N4°49′7.2″	70.3	66.1	71.8			
38	Mclatex Nig. Ltd $_2$	E7°02′27.1″	71.2	70.4	73.7	75.23	97.43	76.15
29	Mclatex Nig. Ltd $_3$		78.4	72.0	80.2			
40	Edward Nig. Ltd1	N4°49′10.5″	80.7	80.4	83.2			
41	Edward Nig. Ltd2	E7°02′26.1″	88.4	87.0	90.9	85.07	108.68	86.04
42	Edward Nig. Ltd3		80.1	74.2	81.1			
43	Pabod Breweries $_1$	N4°49′35.8″	71.8	64.7	72.6			
44	Pabod Breweries $_2$	E7°02′17.9″	73.4	70.2	75.2	71.67	93.34	72.64
45	Pabod Breweries $_3$		65.1	63.2	67.2			
46	Deluchi$_1$	N4°48′57.0″	81.0	80.2	83.5			
47	Deluchi $_2$	E7°02′51.1″	74.2	72.8	76.7	78.63	101.33	79.60
48	Deluchi $_3$		75.4	63.6	75.7			
				Average		**75.65**	**97.91**	**76.59**
				WHO	**Standard**	**65**		

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Table 2: Results of the Sound pressure level in Commercial zone of Trans-Amadi Industrial Layout with their Noise Pollution Indices

S/N	Area Location	GPS Location	Sound Pressure Levels dB (A)		Average Noise Level dB (A)	Leq dB (A)	Lnp dB (A)	LEP, d dB(A)
			Max.	Min.				
1.	Slaughter Mkt $_1$	N4°48′48.1″	76.8	59.6	76.9			
2.	Slaughter Mkt $_2$	E7°02′38.0″	70.3	70.0	72.8	72.60	94.41	73.57
3.	Slaughter Mkt$_3$		66.3	62.9	68.1			
4.	Rivoc Road Str. Mkt$_1$	N4°48′36.1″	74.7	55.7	74.7			
5	Rivoc Road Str.Mkt$_2$	E7°02′19.0″	80.3	72.9	81.1	73.73	95.71	74.70
6	Rivoc Road Str.mkt $_3$		63.9	59.7	65.4			
7	Kojo auto service $_1$	N4°48′33.2″	71.8	58.3	72.1			
8	Kojo auto service $_2$	E7°02′25.3″	63.0	60.1	64.8	68.23	89.38	69.20
9	Kojo auto service $_3$		65.7	64.0	67.8			
10	Nipost $_1$	N4°48′39.4″	81.8	81.4	84.3			
11	Nipost $_2$	E7°02′36.2″	80.2	77.3	82.0	79.27	102.06	80.24
12	Nipost $_3$		69.4	69.0	71.5			
13	Aggrey motor park 1	N4°48′43.5″	72.7	66.4	73.7			
14	Aggrey motor park 2	E7°02′41.2″	73.4	71.1	75.5	71.50	93.15	72.47
15	Aggrey motor park 3		64.9	53.9	65.3			
16	GTC$_1$	N4°48′38.1″	78.9	64.6	79.1			
17	GTC $_2$	E7°02′44.5″	67.4	67.1	69.9	71.00	92.57	71.97
18	GTC $_3$		61.5	60.1	64.0			
				Average WHO(dB)		**72.7255**	**94.55**	**73.69**

The average instantaneous noise level within the industrial zone ranges from 56.8 to 97.9 dB (A). The equivalent continuous noise level (LAeq) calculated ranges from 60.89 to 86.93 dB (A) while the noise pollution level (Lnp) estimated in industrial zone ranges from 80.84 to 110.80 dB(A). The minimum and maximum sound pressure level (SPL) measured around commercial zone of the industrial layout ranges from 53.9 to 81.4 dB (A) and 61.5 to 81.8 dB (A) respectively. The equivalent noise level (LAeq) and the noise pollution level (Lnp) ranges from 68.23 to 79.27 dB(A) and 89.38 to 102.06 dB(A) respectively.

The average equivalent noise level (LAeq) and the noise pollution level (Lnp) estimated in industrial zone is 75.65 dB (A) and 97.91 dB (A) respectively while the equivalent noise level (LAeq) and noise pollution level (Lnp) estimated in commercial zone of the Trans-Amadi industrial layout is 72.72 dB (A) and 94.55 dB(A) respectively. The average noise pollution level (Lnp) during the day period of industrial zone and commercial zone are higher than the permissible limit of 65 dBA as prescribed by ISO (1996) and WHO (1999) respectively as shown in figure 2. This may be due to the movements of heavy duty trucks within a working premises, cement and granite stone mixing machine, power plants. Workers daily exposure was also determined in the industrial zone and commercial zones. The daily noise exposure (Lep,d) of workers estimated in the industries surveyed is within the maximum exposure limits of 85 dB recommend by Federal Environmental Protection Agency (FEPA, 1989) and Occupational Safety and Health Act (OSHA, 1996). As at the time of this measurement, the highest and lowest average equivalent continuous noise level in industrial zone were 87.98 dB(A) and 73.0 dB(A) respectively while for commercial zone , the maximum and minimum average equivalent continuous noise level are 79.27 dB(A) and 68.23 dB(A) respectively. The daily noise exposure of the public around the commercial zone ranges from 69.20 to 80.24 dB (A) with an average value of 73.69 dB (A).

The noise levels exceeded the 65.0 dB (A) criterion recommended by World Health Organization (WHO, 1999) but are within 85.0 dB (A) recommended by FEPA and OSHA. United kingdom, Belgium, Italy, Canada France and Denmark allows 90 dB (A). Japan, Sweden, Germany, Norway also allows 85 dB (A). These limits are allowed for halving rates of 3dB (A) and working schedules of 8 hours per day. OSHA allows 90 dB (A) for 8 hours/d with the halving rate of 5 dB(A) (Bedi, 2006), as well as in some African countries including Sudan (Yousif, 2006). Workers in these industries generally work for more than 8 hours per day and 6 days per week that is (48 hrs/wk) and are exposed at high noise.

In Figure 2, the equivalent noise levels (LAeq) and noise pollution level (Lnp) exceeded the WHO(1999) permissible limit in all the industries studied except in Light wave Nig. Limited which recorded lower values. These high noise levels recorded in both industrial zones and commercial areas are in agreement with the works of Nwafor and Menkiti (2015) which had almost similar equivalent noise values and the little disparity is believed to be due to varying distances from the source of noise within a company. Also the result of this work is higher than the result obtained by Omubo-Pepple et al (2010) and Okeke and George (2015) respectively, which was carried out within Port-Harcourt metropolis. Such high level of noise not only hinders the communication between the workers but its long term exposure may also result in health hazards especially, permanent hearing threshold shift. The hazardous nature of industrial noise in Nigeria lead credence to the formulation of permissible levels by Federal Ministry of Environment formally known as federal environmental protection agency (FEPA) to which an employee may be exposed. The FEPA noise exposure limits guideline for Nigeria is shown in Table 3.

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Table 3: FEPA Noise Exposure Limit Guidelines

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

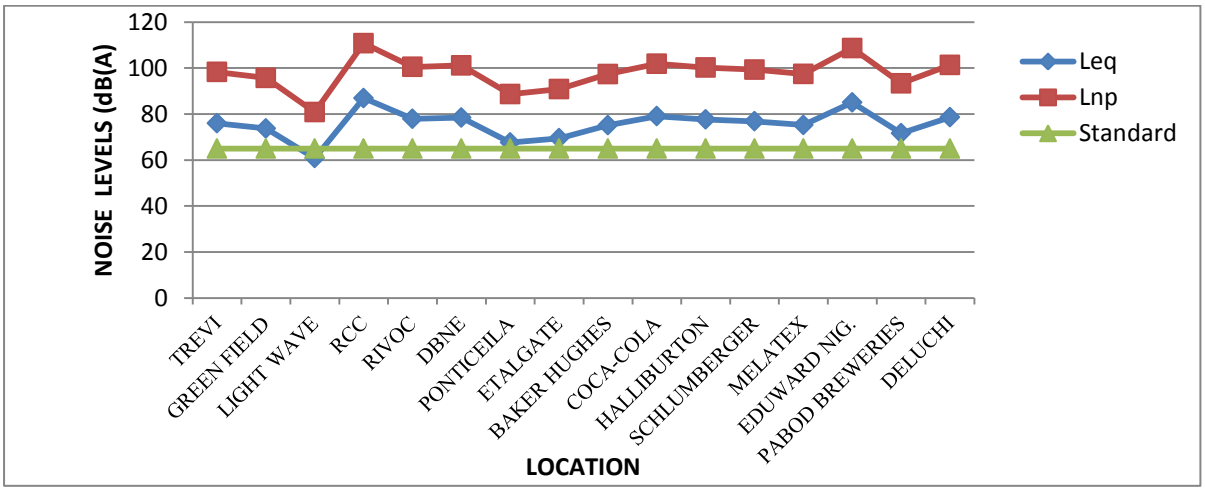

Fig.2: Comparison of Noise level, noise pollution with the FEPA standard for 10 hours of Exposure

Noise contour map was created using the data obtained in Table 1 with the aid of software package called surfer 11. Figure 3 shows the noise contour map of the industrial zones while Figure 4 shows the noise contour map of the commercial zone. The contour maps give the distribution of constant noise levels of industrial and commercial zones of the Trans-Amadi industrial layout. From Figure 3 and 4 one can easily identify areas that are prone to high level of noise. From figure 4, Nipost area (N4 4839.4 and E702'36.20) and Rivoc Road market geographically located at N44836.1 and E70219.0) are prone to high level of noise which can be attributed to the heavy traffic noise from vehicles horns, engine , speedy vehicles and traffic volume involving improper stoppages.

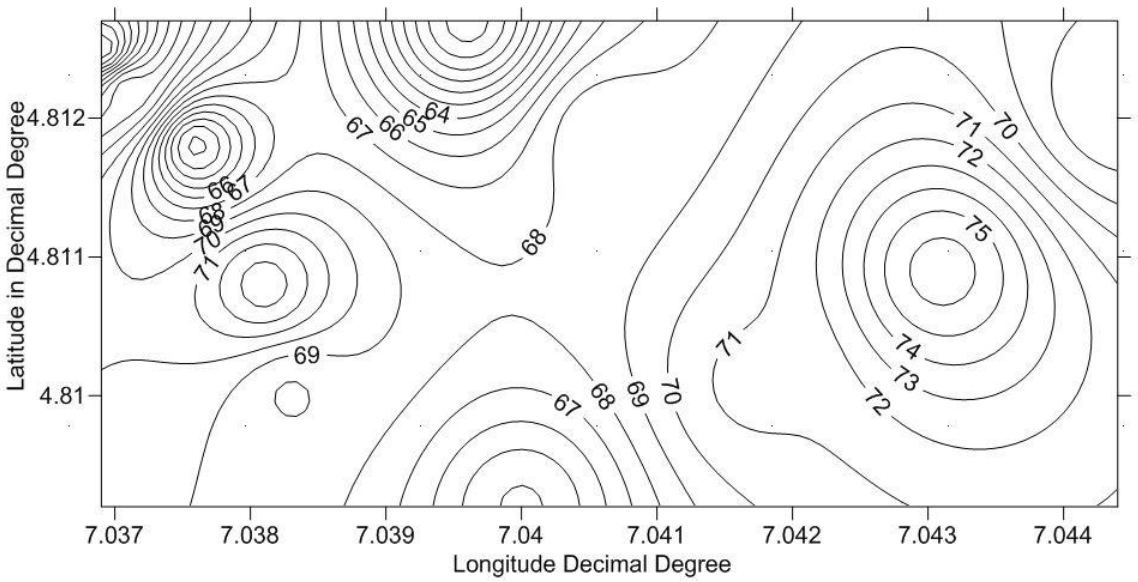

Fig. 3: Noise Contour map of industrial zones

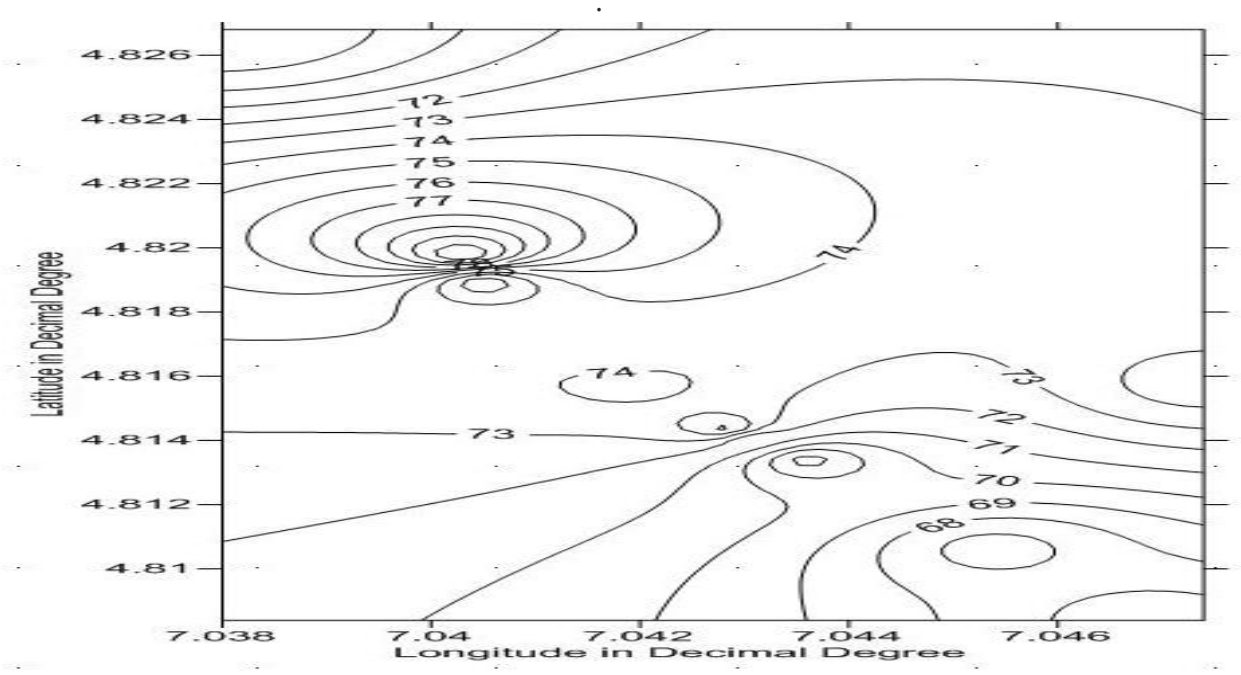

Fig. 4: Noise Contour map of the Commercial zone

The data obtained in this study clearly indicates that the industrial workers and the general public in these area of study are exposed to high unacceptable noise level which could be interfering with a number of vital activities and may even affect health. The continuous exposure of the citizenry to these levels of noise for a long time may impair their hearing or cause noise induced hearing loss, which may be permanent or temporal. This implies that in the nearest future, people who do business or live in these areas may go deaf apart from other health problems like insomnia.

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The equivalent noise levels (Leq), noise pollution level (Lnp) and daily noise exposure of workers estimated in both industrial zone and commercial zone differs significantly from one location to the other and were also higher than the prescribed international standard, though they are within the national standard. It is therefore recommended that there should be a functional agency that should ensure compliance with noise exposure limit standard for a particular period of time and people should be intimated on the hazardous effect of noise pollution and the need for protecting themselves from noise either by always wearing protective equipment or by increasing the distance from the source of the noise.

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