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Assessment of Environmental Effects of Noise Pollution in Auchi, Nigeria

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*It is obvious that we are living in a noise-polluted environment. This pollution has been linked to a number of health related ailments such as depression, anger, weak concentration and hearing defects. Growing global population, increase in technological advancement and some human activities are major causes of this noise-related pollution. This study investigates environmental effects of noise pollution on man for possible mitigation strategies. Sound level meter (SLM) was used to obtain the level of noise pollution in decibel (dB). Selected noise-generating centres were used such as mosques, churches, markets, schools and household appliance-loudspeakers. Noise pollution variables (NPV) were mathematically-modelled and analysed using statistical metrics. Sound powers (SP), total power level (SPL) and total sound pressure level (SPL) were computed using empirical relationship. Reference power (RF) and pressure (RFP) values of 10^{-12} watt and 2.0 * 10^{-5} N/M^2 were computed. 230.65dB and 106.3 dB values of SWL were obtained. These values indicate serious health hazard because it is far above acceptable standard. The output of the resultant mathematical iterations indicates that the impact of noise pollution is a cumulative function of population increase, human activity and technological advancement at 1% and 5% level of significance. Generally, obtained results showed that the impacts noise pollution on man and his entire environment are obviously on the negative side. Hence, possible mitigation measures such as noise pollution regulatory policy enactment and design of noise absorbing structures are strongly recommended.*

Keywords: *noise, noise pollution, Sound, Environment, Man, decibel (dB), Mitigation, SPL*

1. Introduction.

The word "pollution" is very important and should not be trivialized because of its adverse impacts on man and his environment. The term "pollution" is one of the

major environmental problems. It is defined as the presence of impure, unwanted, and harmful substances present in an environment (Banrerjee, 2006). Generally, it also means the wrongful introduction of contaminants into the environment and its components. According to Park (2009), the key to man's health lies largely in his environment. In fact, much of man's ill health can be traced to the adverse environmental effects of pollutions such as: water pollution, soil pollution, air pollution and noise pollution (Banrerjee, 2006). The environment in which man lives is an integration of four components viz: atmosphere, Lithosphere, hydrosphere and biosphere. The atmosphere is the gaseous layer of the environment which comprises: seventy-eight percent (78%) of Nitrogen gas (N_2), twenty-one percent (21%), of Oxygen gas(O_2) three-tenths percent(0.3%) of carbondioxide (0.3%), six-tenths percent(0.6%) of Water vapour. The lithosphere which is also referred to as the geosphere is the solid earth and the interior layer of the environment [3]. The hydrosphere is the collection of the water bodies on earth (Akunbulire, 2007) .The biosphere is referred to as that particular zone of the earth where the interaction of other layers such as: the lithosphere, hydrosphere and the atmosphere exists (Akunbulire, 2007). However, man is responsible for the various forms of pollution through urbanization, industrialization and other human activities.

Noise pollution is one of the major pollutions which constitute problems to man and his environment. It is identified as the only environmental pollution or pollutants which does not leave any residues (Akunbulire, 2007). Furthermore, noise pollution may be defined as unwanted sound emitted from various sources into the atmosphere notwithstanding the adverse effects it may produce on living and non-living things (Banrerjee, 2006). It is regarded as slow poison which with time affects the health of man and his environment negatively. Several factors interfere with the amount of noise pollution both at rural and urban centers. A major challenge is the quantification of the noise impacts or effects on the population. Growth in terms of economic, social development and population increases the tendency towards increasing noise generation (Berglund, 1995). Considering the connectivity of vicinity, transport routes could result to an increase in noise volume generated. Noise is considered a growing health threat and if left unchecked could result to hazardous conditions (Bond, 1996). Noise is becoming an increasingly omnipresent, yet unnoticed form of pollution even in developed countries (Birgitta, 1999). Road traffic, jet planes, garbage trucks, construction equipment, manufacturing processes, and lawn mowers are some of the major sources of these unwanted sounds that are routinely broadcasted into the air (Kiernan, 1997; Hardoy, 1993).

Noise pollution testing has been viewed from various perspectives, while some argued that it should be a governmental initiative, others felt that the testing should be done according to the financial strength of the individual (Kisku, 2006). However, lack of interest in noise pollution analysis and testing has resulted in many environmental and health related problems. As result of this, this research study is focused on assessing and analysing the level and major sources of noise

pollution in view of developing rubost model for addressing the menace of noise pollution in Auchi and its environs.

2. Materials and methods

Noise levels measurements were taken at various locations, environments or sources such as: Markets, Religious centers (Churches and Mosques), Schools, events (wedding and birthday ceremonies) at Auchi and its environs. Noise data was collected with Sound level Meter of model TES-1350A, it ranges between 35-130dB (Niermann, 2006). The instrument has resolution and accuracy of 0.1dB and 1.5 dB respectively. It also consists of settings such as: fast/slow response, maximum hold function and AC/DC output. All these features are the essential functions of this noise or sound measuring instrument. The maximum hold function with the power switch on high mode was used in collecting the pollution raw data of the various locations. Collected data were analysed using statistical metrics of SSPS package. The output of sensitive analysis is shown in table 3. The values of the sound power (W) of the various locations were computed as shown in table 2 using the empirical expressions as follows:

$$SWL=10\log_{10}(W/W_{ref}) \quad (1)$$

$$SPL=20\log_{10}(P_i/P_{ref}) \quad (2)$$

The Sound pressures as shown in table 2 were computed by extrapolation. The threshold of hearing is zero (0) dB which is equivalent to the reference sound pressure value which is equal to $2x\ 10^{-5}\ N/m^2$ (Olokooba, 2005). However, a enchmark of $2x10^{-1}\ N/m^2$ for a noise level of 80dB was used to obtain the sound pressures values since the noise level values in table 1 are within the range of (98.8 -110.4) dB. Where, SWL is the sound power level which is taken to be equivalent to the values of the noise levels as shown in table 1. Total sound power levels and total sound pressure levels were also computed using the expressions as shown in equations 1 and 2. T he impact of noise pollution on man, environment, population and technological advancement is modeled as follows:

$$I=f_{(X)}+f_{(Y)}+f_{(Z)} \quad (3)$$

Where, I is the Impacts of noise pollution which is the dependent variable, X is a variable indicating the population factor, Y is the variable indicating the activity of man and Z is the variable indicating technological advancement or development.

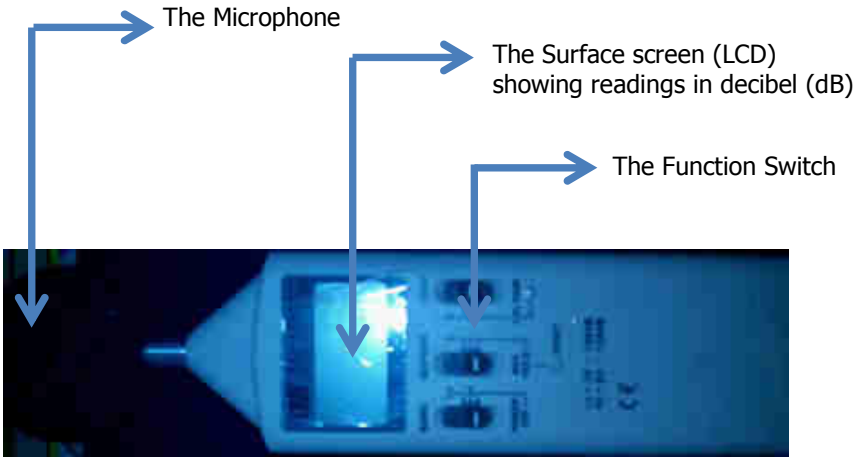

Figure 1. Sound level meter

3. Results and discussion

The results obtained in comparison with the World Health Organization (WHO) benchmark at various locations and sources confirmed that there is a drastic increase in the rate of noise pollution in Auchi and its environs (Park, 2009; Pachpande, 2005). Hence; noise pollution is evident in Nigeria and the world at large. Table 1 is the integration of sample data collected from different sources (domestic, industrial and traffic) of noise pollution. The lowest and the highest noise levels values of the various locations and sources as shown in table 1 were recorded as 98.8dB and 110dB respectively. Besides, the World Health Organization (WHO) guidelines for community noise recommended less than 30 A-weighted decibels (dB(A)) in bedrooms during the night for a sleep of good quality; less than 35 dB(A) in classrooms to allow good teaching and learning conditions, and for night noise less than 40 dB(A) of annual average (Lnight) outside of bedrooms to prevent adverse health effects from night noise. It has equally been submitted that a generally acceptable road traffic noise level (LD) for residential areas should be less than 55 dB(A) and for night, L_N should not be greater than 50 dB(A). An area with environmental noise level less than 55 dB (A) is usually considered as a comfortable environment with little or no annoyance so that no negative physical and mental influence would be caused to essential activities such as working, leisure and sleeping. Moreover, the acceptable noise level by the World health Organization (WHO) standard is obviously far less than the lowest noise level value (98.8dB) as shown in table 1. The implication is that noise pollution with respect to increase in population, increased human activities and technological advancements

have contributed greatly with time to the adverse effects or impacts on man and his environment.

Table 1. Data for Sources of Noise pollution and their equivalent noise levels for a duration: $t \geq 5$ minutes (300 Seconds)

S/No.	Location/Sources	Noise levels (dB) Ranges	Average Noise Levels (dB)
1	Market	97.7-119.7	108.7
2	Church(Religious Center)	98.7-107.5	103.1
3	Traffic	93.4- 123.5	108.5
4	Mosque	100.2-103.5	101.9
5	Generator	100 – 120	110.0
6	Cutting Machine	102.6	102.6
7	Drilling Machine(Micro-Industry)	101.6	101.6
8	Barbers' Clipper	98.8	98.8
9	Standing Fan	102.4	102.4
10	Ceiling Fan	93.6-119.8	106.7
11	Schools	100-102.5	101.3
12	Loud-Speaker	101.5 -104.8	103.2
13	Church Marriage Ceremony(Event)	100.9-119.9	110.4
14	Birthday(Event)	82.3- 115.2	98.8
15	Pepper Grinding Machine	93.4-123.5	108.5
16	Block Moulding Machine	93.7- 123.7	108.7

Field work, 2016

The values of total sound power and total sound pressure levels of 230.65dB and 106.38dB were obtained respectively. These values pose a great hazard to man's health and the global environment. Moreover, the value of the calculated standard deviation (S.D) is 3.99 which connote an acute state and high level of noise pollution in Nigeria and its various localities. Conclusively figures 2 reveals the magnitude of the noise levels at the various locations/sources as shown in table 1. The values of the horizontal axis represent the various locations/sources as numbers (1-16) while figure 3 is a representation of the sample data in table 1in respect of the average noise levels in decibel (dB) and their corresponding percentages. It also shows that the locations/sources such as: markets, traffic, generator, grinding machine, block moulding machine have the higher percentages of noise pollution which is seven percent (7%). Hence, the higher the percentage of noise levels, the greater the impacts on the health of man and his environment.

Table 2. Sources of Noise Pollution and their equivalent Sound Power & Sound Pressures

S/No.	Location/Sources	Average Noise Levels (dB)	Sound Power (W)	Sound Pressure (N/m^2)
1	Market	108.7	7.4×10^{-2}	2.7×10^{-1}
2	Church	103.1	2.0×10^{-2}	2.5×10^{-1}
3	Traffic	108.5	7.1×10^{-2}	2.7×10^{-1}
4	Mosque	101.9	1.5×10^{-2}	2.5×10^{-1}
5	Generator	110.0	1.0×10^{-1}	2.8×10^{-1}
6	Cutting Machine (for Aluminum)	102.6	1.8×10^{-2}	2.5×10^{-1}
7	Drilling Machine (Micro-Industry)	101.6	1.4×10^{-2}	2.5×10^{-1}
8	Barbers' Clipper	98.8	7.6×10^{-3}	2.5×10^{-1}
9	Standing Fan	102.4	1.7×10^{-2}	$2,6 \times 10^{-1}$
10	Ceiling Fan	106.7	4.7×10^{-2}	2.7×10^{-1}
11	Schools	101.3	1.3×10^{-2}	2.5×10^{-1}
12	Loud-Speaker	103.2	2.1×10^{-2}	2.5×10^{-1}
13	Church Marriage Ceremony (Event)	110.4	1.1×10^{-1}	2.8×10^{-1}
14	Birthday (Event)	98.8	7.6×10^{-3}	2.5×10^{-1}
15	Pepper Grinding Machine	108.5	7.1×10^{-2}	2.7×10^{-1}
16	Block Moulding Machine	108.7	7.4×10^{-2}	2.7×10^{-1}

Table 3. Deviations from the mean values and determination of the Standard Deviation

S/No.	Location/Sources	Average Noise Levels (dB)	Deviations (d) Mean (X)=104.7dB	d^2
1	Market	108.7	4.0	16.00
2	Church(Religious Center)	103.1	-1.6	2.56
3	Traffic	108.5	3.8	14.44
4	Mosque	101.9	-2.8	7.84
5	Generator	110.0	5.3	28.09
6	Cutting Machine(for Aluminum)	102.6	2.1	4.41

7	Drilling Machine (Micro-Industry)	101.6	-3.1	9.61
8	Barbers' Clipper	98.8	-5.9	34.81
9	Standing Fan	102.4	-2.3	5.29
10	Ceiling Fan	106.7	2.0	4.00
11	Schools	101.3	3.4	11.56
12	Loud-Speaker	103.2	-1.5	2.25
13	Church Marriage Ceremony (Event)	110.4	5.7	32.49
14	Birthday (Event)	98.8	-5.9	34.81
15	Pepper Grinding Machine	108.5	3.8	14.41
16	Block Moulding Machine	108.7	4.0	16.00
				$£\delta^2$=238.57

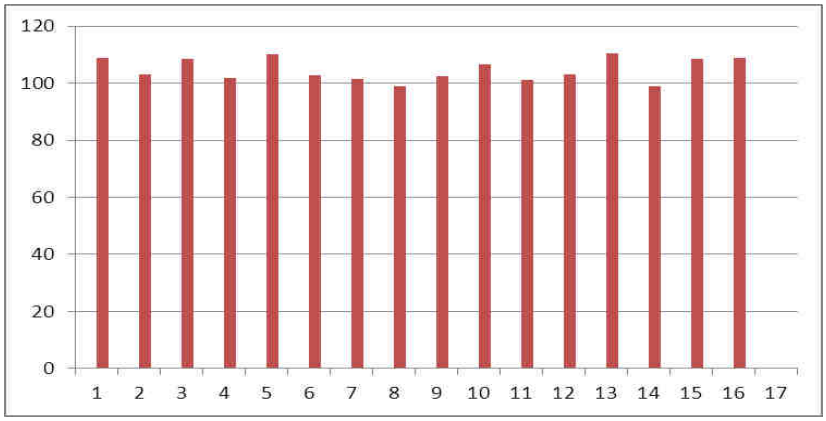

Figure 2. Noise levels in decibel (dB) versus Locations/Sources

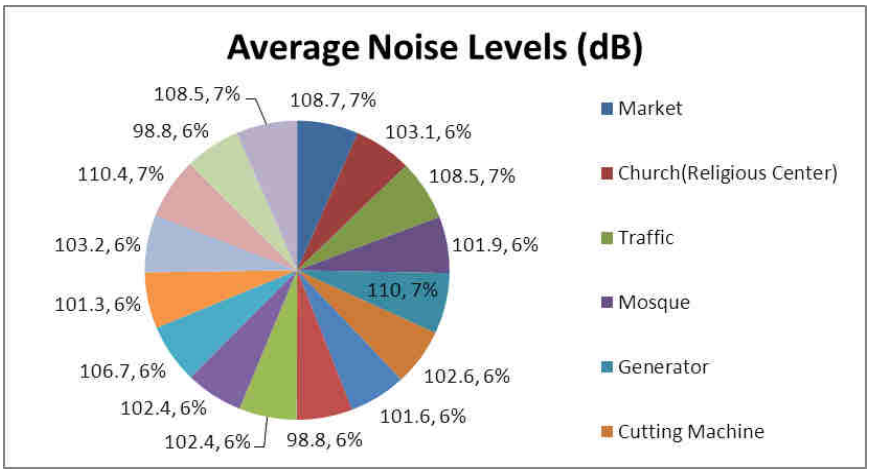

Figure 3. Showing the Average Noise levels (dB) and their Percentages

4. Conclusion

It is deduced from the research paper that noise pollutio is one of the major problems facing man and his environment. It is also important to know that the impacts of noise pollution with time is a cumulative problem. From the data collected at locations/sources such as: market, religious centers, home appliances, industrial machines and events (wedding and birthday ceremonies); it is convincing that the range of noise levels (98.8dB -110.4dB) as revealed in table 1 is more than enough to cause annoyance, sleep disturbance, reduced efficiency in work places, hearing impairment which further affects intelligibility and effective communication. The inexorable fact remains that noise pollution can not be completely avoided with respect to increase in population, increased activities and technological advancements; coded as variables (X,Y and Z) but can be mitigated, if proper cautions and laid down guidelines against noise pollution are strictly obeyed. It is noteworthy that variable Z, is perfectly elastic as it can be modified to counter the problems of noise pollution. Besides, government, employers, schools and other should enact laws that will inculcate people on the necessity to abide by the acceptable noise levels. Noise Monitoring and Control Agencies (NMCA) should also be established and empowered to regulate noise pollution in developing nations. Hence, all of the above put together and constituted will help to attenuate the gross impacts of noise pollution on man and the environment; making man healthy and the environment friendly.

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