FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 4 No. 1, March, 2020, pp 226 – 234

ASSESSMENT OF NOISE FROM DIESEL GENERATORS USED IN GSM BASE STATIONS IN KANO METROPOLIS, NIGERIA.

***[1]Adam, B. M., [2]Abubakar, A. H., [3]Mohammed, M. U. and [4]Manu, H. I.**

[1]Department of Civil Engineering, Bayero University Kano
[2]Department of Environmental Management, Bayero University Kano
[3]Department of Geography, Bayero University Kano
[4]Gauff Consultants Nigeria Limited

*Corresponding authors email: elbasheer360@gmail.com

ABSTRACT
In Nigeria, most telecommunication companies use diesel generators to power their Base Transceivers Stations (BTS) due to erratic power supply to avoid failure in transmission of their services. This has resulted to noise pollution to man and the environment. This study investigated the compliance BTS in Kano Metropolis with the NESREA permissible limits. Twenty BTS were randomly selected and the sampling was carried out over a period of 5 days. For each of the Base Stations, three sampling points were established. Sampling was carried out at point source, 5m and 10m away from point source. Measurement of the Daytime and Night time noise levels and survey questionnaires were used to assess the socio-economic impacts of the generators on health and environment. The average noise levels of the BTSs measured ranged from 66.1dB–87.9dB for Daytime and 64.9dB–84.3dB for Night time which showed that the measured noise levels at the 20 stations in all the sampling points were above the NESREA limit of 55dB for Day Time and 45dB for Night Time. Findings from the survey analysis revealed that over 90% of the participants felt the surroundings of the Base Stations were not comfortable. Due to the health implications of the observed high noise levels and vibration from the Base Stations, it is recommended that NESREA should review the 10m setback by increasing the distance for base stations that will be sited in the future to avoid any threat to health. Adoption of environmentally friendly power sources was also recommended.

Keywords: GSM, Base Stations, NESREA, Power Sources

INTRODUCTION

Telecommunication is a major driver of socio-economic development of cities all over the world. Indeed, many cities in the developing countries of the world are currently expanding their telecommunication infrastructure especially in the area of Global System of Mobile Telecommunication (GSM). Installation of Telecommunication facilities involves construction of masts by the telecomm operators (Odunola *et al*., 2015). A mast is a free standing structure which supports antennas at a height where they can transmit and receive wave (Odunola *et al*., 2015). Mast is one of the fundamental telecommunication infrastructure needed for fast and efficient deployment of telecommunication services in any nation; and it is particularly important[1] because of its far-reaching impact on service delivery (Onuoha, 2016).

A base transceiver station (BTS) or Base Station is a tower or mast mounted with telecommunications equipment (e.g. antenna, radio receiver and transmitters) that enables the transmission of mobile signals (voice and data). At the bottom of each tower, there is a shelter with additional transmission equipment, air conditioning, battery racks and diesel generators for those that are off-grid or with unreliable electricity supply (Anayochukwu and Nnene, 2013).

In order to have optimal network coverage, most base stations are located in close proximity to the target users; the reason telecom operators also site their masts in residential neighborhoods (Michael *et al*., 2013). They are frequently found near or on shops, buildings, homes, schools, daycare centers and hospitals (Vini *et al*., 2010). According to Mobile Manufactures Forum and GSM Association, (2006) as cited by Bello (2010), base stations are sited in close proximity to inhabited areas because the farther the equipment is located away from the users, the poorer will be the quality of communication.

In Nigeria, diesel generators are commonly used to power base station sites round the clock. This is mainly due to limited availability of the national electricity grid, and therefore the task of providing uninterrupted power to satisfy minimum Quality of Service (QoS) requirements is difficult (Anayochukwu and Nnene, 2013). With the erratic power supply in the country, all the communication companies power their Base Transceivers Stations (BTS) with diesel plants all through the day in order to avoid failure in transmission in their services. These infrastructures have impacted on the surroundings both positively and negatively (Aderoju *et al*., 2013).

While bio-electromagnetics experts are concerned primarily with possible adverse effects of the hand-held telephones (terminals), the general opinion seems to be considerably more concerned

about the base stations (Alicja *et al*., 2011). The World Health Organization (WHO) has recommended investigating the effects of exposure to emissions from mobile phone base stations to address public concerns (Hutter *et al*., 2005). The emissions and noise from generating set used to power the base stations 24-hours a day as a result of epileptic power supply situation of the country is a source of noise pollution (Daramola, 2013). Apart from the heat, vibration and noise accompanying generator operations, carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), and particulate matter are also released (Mbamali *et al*., 2012).

The NESREA Noise Standards and Control Regulations

The National Environmental Standard and Regulatory Enforcement Agency (NESREA) established a guideline of the permissible levels of noise at 55 decibels at daytime and 45 decibels at night time required in mixed residential (with some commercial and entertainment) environment in Nigeria as can be seen from Table 1.1

Table 1.1: Maximum permissible Noise Levels for general Environment

Facility	Noise Limits dB (A) (Leq)	
	Day	**Night**
Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites	45	35
Residential Buildings	50	35
Mixed residential (with some commercial and entertainment)	55	45
Residential + industry or small-scale production +commerce	60	50
Industrial	70	60

Source: The National Environment (Noise Standards and Control) Regulations, 2003

Time Frame duration used for Daytime is from 6.00a.m - 10.00p.m and Night time from 10.00p.m - 6.00a.m. The time frame takes into consideration human activities

The NESREA Standards for Telecommunications and Broadcasting Facilities

In 2011, National Environmental Standards and Regulatory Enforcement Agency (NESREA) Abuja issued out a regulation in the National Environmental (Standards for Telecommunications and broadcasting Facilities) Regulations, 2011). This states that; "In respect to the Guidelines on Technical Specifications for the Installation of Telecommunications Masts and Towers issued by the Nigerian Communication Commission (NCC) and relevant guidelines by the National Broadcasting Commission (NBC), and the National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, (2007) (NESREA Act, 2007) on the siting of BTS, the following guidelines should be adhered to;

BTS must have a minimum setback of ten (10) meters from the perimeter wall (fence) from residential/business premises, schools and hospitals to the base of the mast/tower; and

Where there is no perimeter wall (fence), a BTS must be at a minimum of twelve (12) meters from the wall of residential/business premises, schools and hospitals to the base of the mast/tower (The NESREA Standards for Telecommunications and Broadcasting Facilities, 2011).

MATERIALS AND METHODS

The Study Area

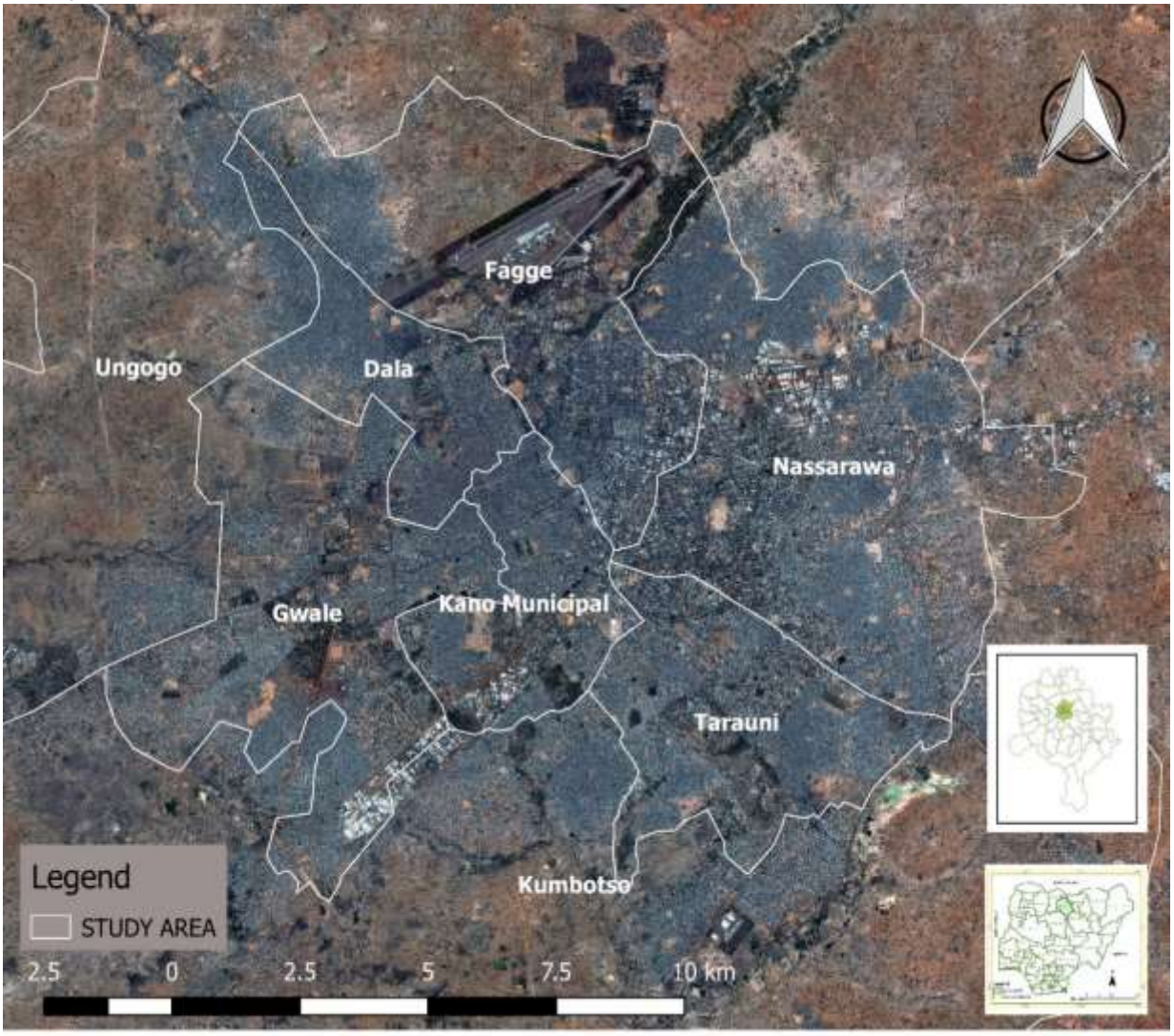

Fig. 1: Satellite imagery of Kano Metropolis (Source: Quickbird, 2014)

Kano Metropolis is located at the Central Western part of Kano State between latitude $11^0 59'59.57$ – $12^0 02'39.57^0$N of the equator and between longitudes $8^0 33'19.69$ – $8^0 31'59.69^0$E (Fig. 1.1). It lies in the northern part of Nigeria and is located some 840km away from the edge of the Sahara desert and 1,140km from the Atlantic Ocean. Its metropolis population is the second largest in Nigeria after [1]Lagos. The Kano Urban area covers 137sq.km and comprises eight Local Government Areas (LGAs) - Kano Municipal, Fagge, Dala, Gwale, Tarauni, Nassarawa. Kumbotso and Ungogo (El-Pateh, 2015).

Selection of Sites and Locations

Twenty Base Station sites in Kano metropolis were selected and sampled simultaneously over a study period of five days. Geographical coordinates of the base stations were recorded with the aid of a hand-held GARMIN GPSmap76CS instrument that was obtained from the Faculty of Earth and Environmental Sciences, Bayero University, Kano and the coordinates were then added as a layer over the map of the study area. The sites' locations were selected from the study area based on the following considerations:

Base stations not close to road junctions and other noise, vibration or air emission sources to avoid interference with the actual parameters to be measured;

ii. Compacted and dispersed settlements;

iii. Residential, Central business district areas and Social areas such as schools etc.

Study Population and Sample Size

For large populations, Cochran (1963) developed the equation (1.0) to yield a representative sample for proportions.

$$n_o = \frac{Z^2pq}{e^2} \quad (1.0)$$

Which is valid where;

n_0 is the desired sample size (when the population>10,000), Z is the standard normal deviate; usually set at 1.96 (or a~2), which correspond to 95% confidence level; p is the proportion in the target population estimated to have a particular characteristics; q equals 1-p (proportion in the target population not having the particular characteristics) and d is the degree of accuracy required, usually set at 0.05 level (occasionally at 2.0). The value for Z is found in statistical tables which contain the area under the normal curve.

Kano Metropolis has an estimated population of 3 million according 2006 population census by the National population commission of Nigeria. This population is however greater than one hundred thousand (>100 000), therefore, assuming p is 0.5 (maximum variability). Furthermore, we desire a 95% confidence level and ±5% precision. The resulting sample size is demonstrated in the equation (1.1).

$$n_o = \frac{Z^2pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 385 \text{ respondents} \quad (1.1)$$

Therefore, a total number of 400 questionnaires were distributed among those living within the base stations vicinity.

Noise Level Measurement

The noise levels was continuously measured and recorded by using a Digital/NL-21 Sound level with a measuring range of 40–130dB (A) and accuracy of ±1.5 dB (A). Figure 1.2 is a picture of the instrument.

Fig. 2: A Digital/ NL-21 Sound level meter

Noise levels were sampled by standing at point source (close to the generator exhaust) and at some distances (5m and 10m) away from the base stations. For each base station, the noise levels for both daytime and night time were measured using the handheld assessment method. This was done three times daily in terms of dB (A) and the average was recorded for that day. For the daytime measurements, readings was taken as early as 6:00am before the normal activities and vehicular movements start to avoid noise from traffic and commercial activities adding to the background noise levels. For the night time, the measurements were taken after 9:00pm as most activities generating noise would have been reduced to a minimal.

The sound level meter was calibrated before and after taking each measurement according to the user manual. The Sound Level Meter was held out at arm's length and placed between 1.2m – 1.5m above the ground with the microphone pointed towards the source of the noise to minimize sound reflecting off bodies using the instrument. The 'A' weighted network was used as it corresponds very closely to a persons' hearing sensitivity.

Questionnaire Survey

The empirical study was based on a sample survey of Kano Metropolis. 400 respondents (50 from each LGA) living within the vicinity of the selected base stations were chosen at random. The sample selection represented a cross-section of different gender, age groups, educational levels, occupation and marital status of respondents and therefore was representative for such an exploratory study.

RESULTS AND DISCUSSION

Table 2: Geographical locations of the selected Base station and their Characteristics

Site Number	Coordinates		Environment	Type
	Northing (N)	Easting (E)		
BS1	12° 00' 25.7"	008° 35' 56.8"	Commercial	Home
BS2	12° 00' 13.7"	008° 33' 49.9"	Commercial	Home
BS3	11° 59' 53.4"	008° 33' 58.7"	Residential	Home
BS4	11° 59' 10.7"	008° 33' 16.3"	Residential	Home
BS5	11° 59' 51.3"	008° 33' 38.0"	Residential	Home
BS6	12° 01' 48.9"	008° 34' 32.1"	Residential	Factory
BS7	12° 02' 11.1"	008° 34' 31.8"	Residential	Home
BS8	12°01' 12.6"	008° 32' 11.1"	Residential	Shops
BS9	11° 57'52.0"	008° 35' 21.4"	Residential	Home
BS10	11° 58' 03.8"	008° 53' 17.0"	Residential	Home
BS11	11° 58' 47.0"	008° 33' 35.5"	Commercial	Garage
BS12	11° 58' 45.1"	008° 33' 32.5"	Commercial	School
BS13	12° 00' 27.6"	008° 31' 59.8"	Commercial	Shops
BS14	12° 00' 41.4"	008° 31' 55.4"	Commercial	Secretariat
BS15	12° 00' 04.1"	008° 31' 36.9"	Commercial	Shops
BS16	11° 59' 22.3"	008° 30' 10.9"	Commercial	Shops
BS17	11° 57' 45.2"	008° 25' 57.4"	Residential	Homes
BS18	11° 58' 39.8"	008° 29' 26.7"	Social	Admin Block
BS19	11° 59' 05.7"	008° 29' 22.0"	Residential	Home
BS20	11° 58' 20.4"	008° 29' 23.7"	Residential	Home

Ambient Noise levels

The results of noise level measurements carried out around the twenty base transceiver stations within Kano Metropolis, compared with the National Environmental Standards and Regulations Enforcement Agency (NESREA) stipulated limits. Measurements were made at point source, at 5m and 10m distances away from the generators. The measured day time noise levels in all the BTSs sampling points ranged between 76.8-86.4dB at point source and 72.9-79.7dB at 5m and 66.1-72.4dB at 10m as shown in Fig 1.3.

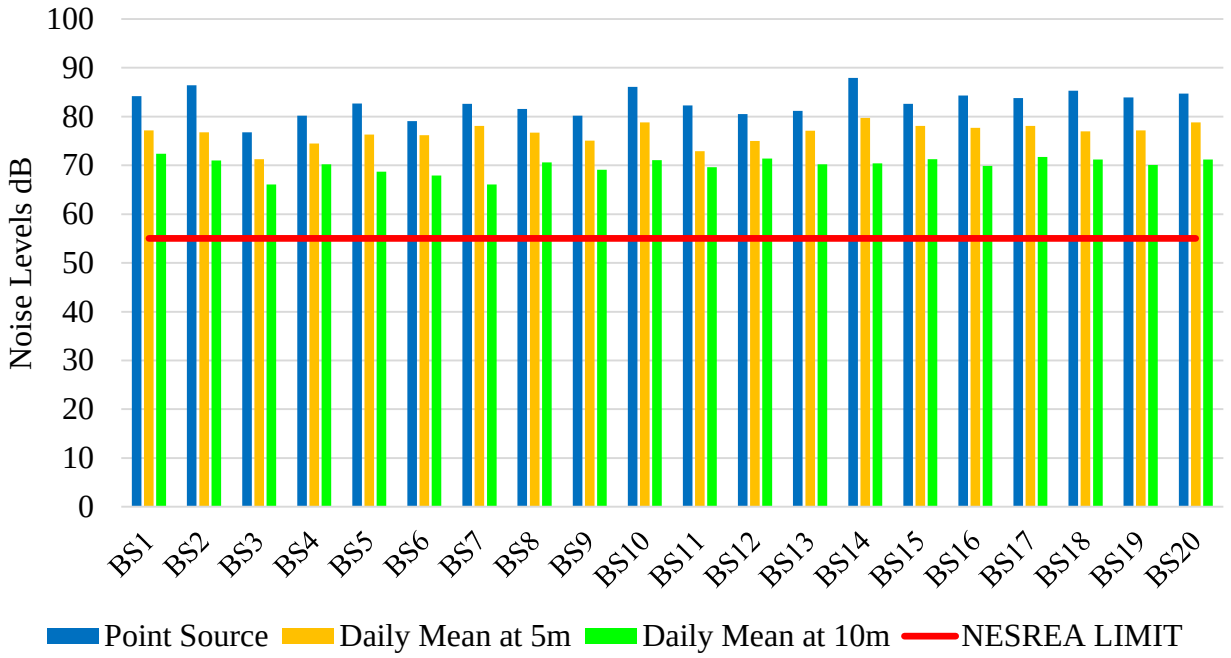

Fig. 3: Measured Day Time Noise Levels at Point Source and 5m and 10m away from point source

For night time noise level at point source, the measurements ranged between 75.6-84.3dB at point source and 72.3-79.4dB at 5m away and 64.9-71.8dB at 10m away from the generators respectively. This showed that there was a constant decrease in the levels of noise as the distance away from the generator increased.

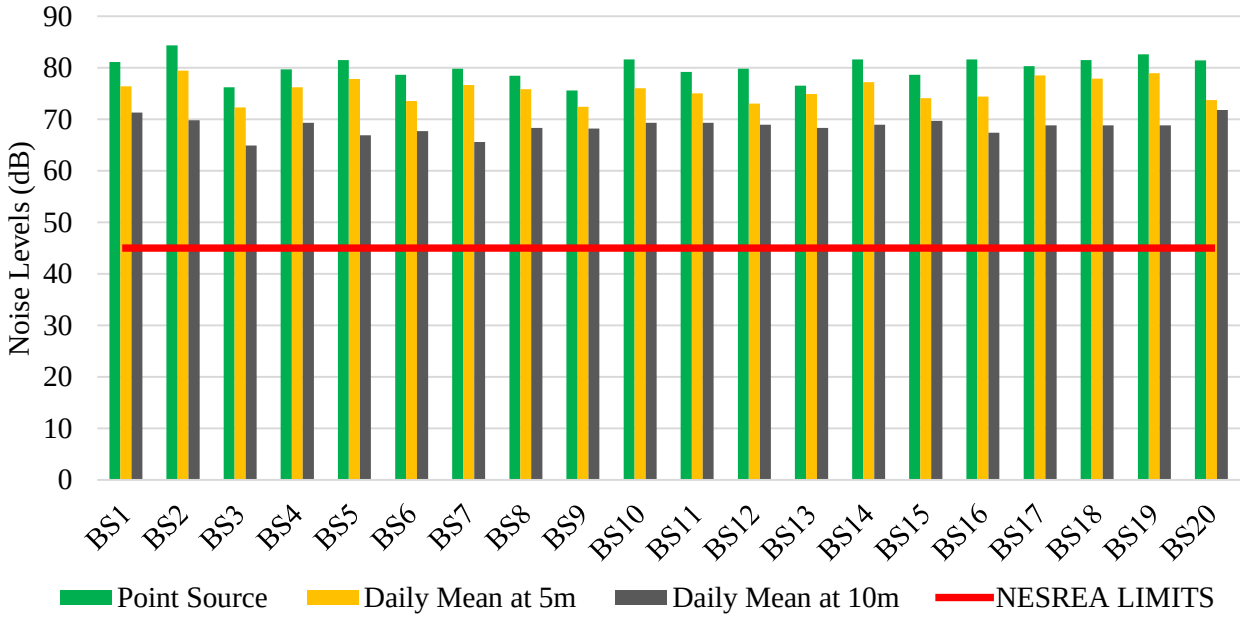

Fig. 4: Measured Night Time Noise Levels at Point Source and 5m and 10m *away from point source*

The noise levels varied from one BTS to another and the variation may depend on type of generators used, for instance A.C generators or D.C generators, model, size, maintenance culture and age etc. Although, the day time noise levels measured at the Base Stations were found to be higher than that of night time, this was as a result of the likely sources of increased noise levels from power generating sets used in factories, noise influenced by light or heavy traffic, noise from commercial and artisan activities and other social activities.

Comparing these noise levels from the result with the National Environmental Standards and Regulations Enforcement Agency (NESREA), it was discovered that all the noise levels measured at the BTSs were higher than the NESREA permissible noise limits of 55 dB for day time and 45dB for night time as shown in Figures 1.3 and 1.4.

Table 3: Responses on the Socio-economic impacts of the Base Stations

Section C: Noise Pollution		**Frequency (387)**	**Percentage (%)**
15.	Do you know what noise pollution is?		
	Yes	328	84.8
	No	59	15.2
	Total	**387**	**100**
16.	Is there any problem of noise pollution in your area?		
	Yes	371	95.9
	No	16	4.1
	Total	**387**	**100**
17.	Does any particular noise annoy you on a daily basis apart from the noise from the Base Station generators?		
	Yes	153	39.5
	No	234	60.5
	Total	**387**	**100**
18.	Do you experience discomfort by vibration in your area?		
	Yes	376	97.2
	No	11	2.8
	Total	**387**	**100**
19.	Are you aware that there are regulations regarding the level of noise and vibration?		
	Yes	206	53.2
	No	181	46.8
	Total	**387**	**100**
20.	If you had the opportunity of relocating to another area, will you be willing?		
	Yes	311	80.4
	No	76	19.6
	Total	**387**	**100**

1. Do you know what noise pollution is?

The response for this question showed that 84.8% of the respondents were aware of what noise pollution is. 15.2% said they do not know what noise pollution was but were briefed on what Noise pollution is.

2. Is there any problem of noise pollution in your area?

Noise pollution causes the greatest concern among residents and they felt it as the most likely to have harmed their health with 371 (95.9%) of respondents saying there is a problem of noise pollution. An additional 16 (4.1%) of the respondents said they experience no problem of noise pollution.

3. Does any particular noise annoy you on a daily basis apart from the noise from the Base Station generators?

When asked if there was any noise that was a source of annoyance apart from the noise from the diesel generators in the base stations, 153 (39.5%) respondents said there was a mysterious humming noise and rumbling sound especially in the night as a result of wind hitting the masts making a particular noise which was a source of disturbance. However, 234 (60.5%) of the respondents said '**No**' meaning there was no other noise source.

4. Do you experience discomfort by vibration in your area?

The results indicated that 339 (87.6%) of respondents experienced discomfort by vibration coming from the generators and 48 (12.4%) said they were comfortable and when asked further, it was discovered that they actually live far from the base stations and don't feel the effect of the vibration.

5. Are you aware that there are regulations regarding the level of noise and vibration?

As presented in Table 1.3, 206 (52.3%) of all respondents reported that they are aware of the regulations regarding the level of noise and vibration, and approximately 47% of all respondents reported that they were not aware of such regulations.

6. If you had the opportunity of relocating to another area, will you be willing?

311 (80.4%) of the respondents reported that they had considered relocating to another area and are willing to relocate because they were concerned about the environment or their health. Some may argue that by choosing not to relocate, residents are making a conscious decision to accept the risks of base station operations. However, the results of this study highlighted the underlying complexity of such decisions. 76 (19.6%) of the respondents reported that they were not willing to relocate because the benefits of staying is worth it. Interviews offered additional insight into this surprising result. One of the residents explained why he continued to live in the area, and spoke about the feeling of community that was important to him;

"We like living here because the life is easy and we have our businesses here…when we relocate, we have to pay for everything. Here we know each other, when we don't have anything we just go to the next house and we can borrow."

Others wrote about their personal and cultural connections to the area,

- *"I was born and bred here and so were my parents and their parents before them. We have nowhere else to go and we are used to live in the metropolis."*
- *"My ancestors died here…so here we stay."*

It was clear that the cultural and personal connections played an important role in the decision- making process. Additionally, the lack of alternative economic opportunities, particularly for those without higher education or specialized training, limited the choices available to them and their families.

CONCLUSION

The average noise levels of the BTSs measured ranged from 66.1dB–87.9dB for Daytime and 64.9dB–84.3dB for Night time which showed that the measured noise levels at the 20 stations in all the sampling points were above the NESREA limit of 55dB for Day Time and 45dB for Night Time. Findings from the survey analysis revealed that over 90% of the participants felt the surroundings of the Base Stations were not comfortable and complained of high disturbances due to noise or vibrations.

RECOMMENDATIONS

In the face of the continued insufficient national power supply, the development of cost effective and environmentally friendly alternative power sources (renewable power sources) should be provided. On the other hand, the regulatory authorities responsible like NESREA should strictly enforce the penalties for violating the standard for siting of these base stations and should take active measures and develop keen interest in enforcing the laws that are guiding the location of these stations or mandate operators to comply with environmental standards and also review their 10m setback by increasing the distance where the noise from the base stations are above the standard to avoid any threat to health.

REFERENCES

Aderoju, O. M., Ibrahim, M., Onuoha, H. U., Adebowale, R. K, and Oke, A. B (2013) Assessment of the Level of Noise from Base Transceivers' Station using Geospatial Techniques: In Abuja Municipal Area Council. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) Volume 7, Issue 4 (Nov. - Dec. 2013), PP 30-39 www.iosrjournals.org.*

Alicja, B., Elżbieta, G., Agata, S., Piotr, P., Paweł, M., Wiesław, S. and Marek, Z. (2011) Subjective Complaints Of People Living Near Mobile Phone Base Stations In Poland. *International Journal of Occupational Medicine and Environmental Health 2012; 25 (1):31–40 DOI 10.2478/s13382-012-0007-9.*

Anayochukwu, A. V. and Nnene, E. A. (2013) Measuring the Environmental Impact of Power Generation at GSM Base Station Sites. *Electronic Journal of Energy & Environment Vol. 1, No. 1, April, 2013.*

Bello, M. O. (2010) Effects of the Location of GSM Base Stations on Satisfaction of Occupiers and Rental Value of Proximate Residential Property. *Published by Canadian Center of Science and Education. Vol. 3, No. 4; November 2010*.

Cochran, W. G. (1963) Sampling Techniques, *2nd Ed New York: John Wiley and Sons, Inc*.

Daramola, J. (2013) Geographic Information System - A tool for Sustainable Development of the Nigeria Environment: Global System for Mobile Communication Mask Perspective. *Journal of Environmental Research and Development Vol. 8 No. 1, July-September 2013.*

El-Pateh, S. J. (2015) Assessment of Air Quality of some Road Inter-Sections in Kano Metropolis. *Master's Dissertation to the Department of Civil Engineering, Bayero University Kano. pp. 36.*

Hutter, H. P., Moshammer, H., Wallner, P. and Kundi, M. (2005) Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med 2006; 63:307–313. doi: 10.1136/oem.2005.020784*.

Mbamali, I., Stanley, A. M. and Zubairu, I. K. (2012) Environmental, Health and Social Hazards of Fossil Fuel Electricity Generators: *A Users' Assessment in Kaduna, Nigeria*. *American International Journal of Contemporary Research Vol. 2 No. 9; September 2012*.

Michael, A. O., Nnaemeka, B. E. and Matthew, T. O. (2013) Locational Effect of GSM Mast on Neighboring Residential Properties' Rental Values in Akure, Nigeria. *Academic Journal of Interdisciplinary Studies Vol. 2 No 3*.

National Environmental (Standards for Telecommunications and Broadcasting Facilities) Regulations, S. I. No. 11 of 2011.

National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, 2007 No 25.

National Environmental Standards and Regulations Enforcement Agency [NESREA] (2016).

National Environnemental (Noise Standards and Control) Régulations, S. I. No. 35 of 2003.

Odunola, O. O., Jelili, M. O. and Asani, M. A. (2015) Telecommunication Mast Location and It's Health Implication for Residents in Ogbomoso, Nigeria. *Civil and Environmental Research Vol.7, No.9, 2015 www.iiste.org*.

Onuoha, R.A (2016) Communication Mast and the Legal Framework for Planning Control in Nigeria: Problems and Prospects. *AJLC Volume 6 Number 1 (2016) 25-36 ISSN-2045-8401*.

Vini G. K., Lennart, H., Joris, E., Alicja, B. Michael, C., and Mikko A. (2010) Epidemiological evidence for a health risk from mobile phone base stations. *International Journal of Occupational and Environmental health Vol 16, 2010- Issue 3.*