Geospatial Assessment of Noise Pollution in Abuja Metropolis, Federal Capital Territory, Nigeria

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Abstract
As a part of everyday life, noise can influence human health, the quality of living and peace of mind. Noise is an environmental cause of health problems; as much as air quality is. Thus, noise is indeed a remarkable environmental hazard, and is consequently in the focus of intense scientific efforts, to date. The aim of this study is to evaluate noise pollution in Abuja metropolis and it was achieved by the following objectives: identify the various sources of noise in Abuja metropolis, measure the noise levels for both wet and dry seasons within Abuja metropolis as well as compare the measured noise levels for both wet and dry seasons within the temporal scope of the study, and compare the observed noise levels with established National and International standards. A noise meter Precision Gold (N09AQ) was used for the ambient noise level measurements. Seventy (70) noise sampling points were selected, five (5) each in a representative manner across 14 districts in the study area. Four daily sampling sessions: 7.30-8.30am, 12.30-1.30pm, 5.30-6.30pm and 10.30-11.30pm were maintained and the sampling was carried out for a whole week. The noise assessment was carried out in dry and in wet season. From the results of the assessment, the findings were that the weekly average dry season noise level 71.69dBA was slightly higher than that of the wet season 71.32dBA. Also, Jabi district recorded the highest average weekly noise level in both the dry season assessment (78.24dBA) as well as the wet season assessment (77.21dBA). Conversely, Maitama district with 66.14dBA recorded the lowest average noise level during the dry season assessment, while Central Business district with 66.53dBA recorded the lowest noise level for wet season assessment. Furthermore, the correlation result of the paired sample correlations between the average daily (day-night time) noise level of the dry and wet season was 0.967 and this indicates a very high positive correlation. The paired sample t-test result between the average daily (day-night time) noise level of the dry and wet seasons for the study area was 0.170, which indicates that there is no significant difference in the noise level of the study area between the wet and dry seasons. Furthermore, there was a less than 25% compliance with the regulatory noise limits of both the WHO and NESREA, as only 11.43% of the total sample points conformed to the WHO noise limits during the dry season and 24.29% conformed to the NESREA noise limits for the dry season sampling. Wet season sampling exercise showed a 12.86% compliance with the WHO regulatory limits and a 22.86% compliance limit with the NESREA standards. Based on these findings, it is recommended that Abuja city planning agencies create buffer zones by planting trees between residential neighbourhoods and major roads to act as barrier or insulation to sound propagation and reduce the intensity of traffic noise level before it reaches the residential buildings.

Key Words: *Noise; Environmental Hazard; Air Quality; Abuja Metropolis; Noise Assessment*

1. Introduction

Noise is an environmental pollution that is increasing very rapidly as a result of improvement in commercial, industrial and social activities (Anomohanran *et. al*., 2008; Bello *et al.*, 2022). This is because, noise is referred to as an undesirable sound which results from the activities of man (Anomohanran *et. al*., 2008). Nasir (2017) defined noise as any sound which exceeds the appropriate actual or presumed ambient noise level or which annoys or tends to disturb humans or which causes or tends to cause an adverse psychological or physiological effect on humans. Defra (2003) stated that the human hearing mechanism responds to changes in sound pressure in a relative rather than absolute manner. This is why a logarithmic scale called the decibel (dB) is used to measure sound pressure level (Defra, 2003). The weakest sound that the human ear can detect is referred to as the threshold of hearing and it corresponds to 0dB (Defra, 2003). On the other hand, the level of sound pressure that will cause pain to the ear is referred to as the threshold of pain and it corresponds to 120dB (Defra, 2003). A change of 3dB in sound level is just enough to make such a change noticeable (Defra, 2003). However, an increase of 10dB is perceived as doubling the loudness of the sound (Defra, 2003). In the measurement of sound, two weighting network namely the A and C network are employed (Alam, 2006). However, for environmental purposes, the measurement is made using an A-weighted scale (dBA) because this scale measures sound level in approximately the same way as the human ear (Alam, 2006).

Noise zone, according to (Nasir, 2017), means an area of generally consistent land use where the ambient noise levels are generally similar within a range of decibel. Noise is being recognized as serious environmental problem and one which must be addressed for sustained development policy which is designed to improve the quality of life of citizens (Nasir, 2017). Noise pollution is considered as one of the major environmental concerns today even though it is sad to admit that most people are unaware about the effects that it can cause (Nasir, 2017). As argued by WHO (2005) and Zannin et. al., (2006), noise is a dangerous agent which affects human health and the environment. Notwithstanding, it appears Nigeria does not pay significant attention to the seriousness of noise pollution and its dangerous environmental consequences. This is however not the case with other countries of the world where necessary actions are put in place to control and regulate this peril (FTA, 1995; Abumere et al., 1999; Anomoharan et al., 2006). Anomohanran et al. (2006) identifies lack of awareness, automobiles, commercial motorcycles, recording houses and the use of electric generators as some of the major factors responsible for most of the noise experienced in Nigeria.

Noise has been extensively studied in literature, some of these studies investigated noise pollution in a single workplace i.e. refinery (Wachusunder, 2004), textile factory (Bedi, 2006), quarry (Adie, 2012), integrated steel plant (Kerketta and Narayan, 2009), mining industry (Sensogut, 2007), mill (Kumar, 2008), construction site (Hamoda, 2008 and Alao and Avwiri, 2010) and cement factory (Mndene and Mkoma, 2012). Multiple workplaces i.e. steel pipe and air conditioning unit factory (Ahmed *et. al.*, 2001), sawmills, printing presses and corn mills (Boateng and Amedofu, 2004), concrete traverse, cement, iron and steel, and textile factories (Atmaca et. al., 2005);; noise in airport (Bello *et al.*, 2022), and fifteen industrial sites (Ali, 2011). The noise level reported by these studies with diverse machinery

and operating environment varies considerably. Generally, workplaces in the industrial sector have not only generated huge amounts of noise; they have equally witnessed enormous increase in number and diversification.

Noise pollution in Abuja, Nigeria, like in many other rapidly urbanizing cities, is a significant environmental and public health concern (Anomohanran, 2013). The capital city of Nigeria, Abuja, has experienced rapid population growth and urbanization, leading to increased vehicular traffic, industrial activities, construction projects, and commercial establishments, all of which contribute to elevated noise levels (Anomohanran, 2013). Enumerated are detailed background on noise pollution in Abuja, supported by data. This forms the basis to justify this research. According to official record by the National Bureau of Statistics (NBS, 2021), Abuja's population increased from around 776,298 in 2006 to over 3 million by 2020. This has resulted in the proliferation of residential, commercial, and industrial areas, leading to increased noise emissions (NBS, 2021). Furthermore, from a study that was conducted by the Abuja Environmental Protection Board (AEPB) in 2019, it was observed that traffic congestion on major roadways, such as the Nnamdi Azikiwe Expressway and Shehu Shagari way, significantly contributed to noise pollution levels exceeding acceptable limits. A research conducted by the Nigerian Conservation Foundation (NCF) as reported by Anomohanran in 2013 concludes (among other things that) noise complaints from residential areas near commercial districts, such as Wuse and Maitama, are common. A study by Ibekwe *et al.* (2016) highlighted the correlation between exposure to high levels of environmental noise in Abuja and increased prevalence of hypertension and sleep disorders among residents.

From the foregoing, it is very evident that environmental noise pollution portends serious health threatening effects on human population and as such need to be studied for an urban settlement like the Abuja metropolis, which is the heart of the Federal Capital Territory hosting the major Federal Government institutions. Abuja also continuously experiences growth of its population as a result of year on year influx of migrants from other states of the country; mostly in search of greener pastures. This research work studied and analysed the noise pollution levels in the fourteen (14) districts of Abuja metropolis. An obvious gap that was identified from previous related studies is that of disregard for climatic seasonal influence (wet and dry season) in the effect of noise pollution of the population. This was covered by this study. Also, national and international standards was used as baseline against which to compare ambient noise levels.

2. Study Area

2.1 Location

Abuja, the study area is located between latitude 8º 55’ to 9º 05’ N and longitude 7º 23’ to 7º 34’ E. The area is 1180 feet (360 meters) above mean sea level. It shares boundaries with Bwari Area Council of the FCT to the North, Kuje Area Council, FCT to the South, Gwagwalada Area Council in the FCT to the West and Karu Local Government Area (LGA) in Nasarawa State to the East.

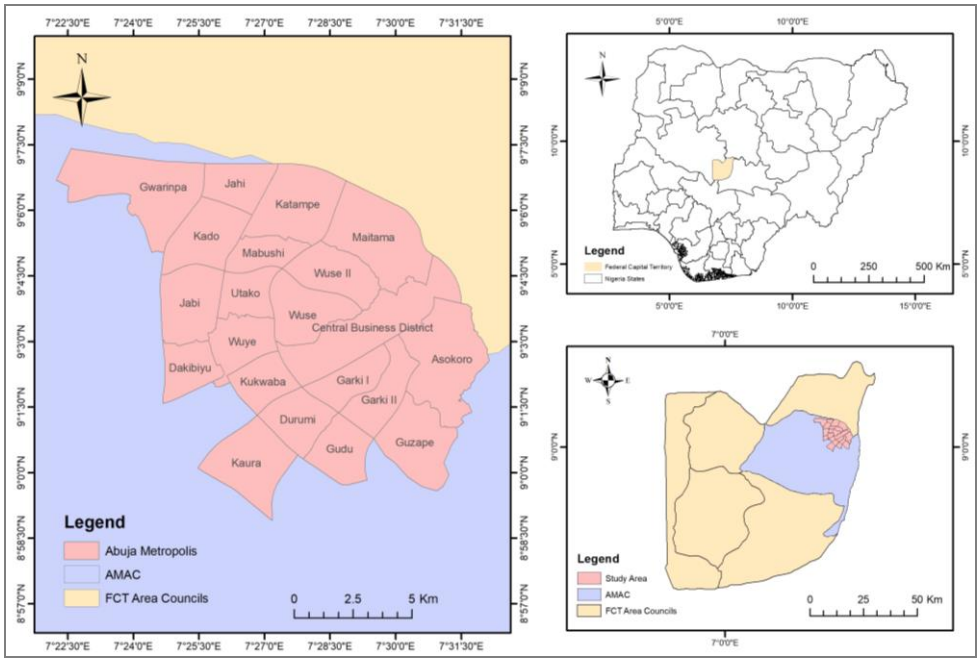

Figure 1: Location of Abuja Metropilise, FCT, Nigeria
Source: Author (2025)

2.2 Relief and Topography

According to Elevation.city (2019), Abuja has a minimum elevation of 438 m (1,437ft.), maximum elevation of 931 m (3,054 ft.) and an average elevation of 511.7 m (1,679 ft.). The terrain largely plain, however dotted with some aesthetically appealing granitic inselbergs like the Aso rock and mountain ranges like the Katampe hills.

2.3 Soil

The soils of the study area is generally deep well drained with few poorly drained soils; loamy sand surfaces over sandy loam to sandy clay loam and sometimes gravelly subsoils. In otherwords, the soil is shallow and moderately deep to deep well drained and some-what poorly to poorly drained soils; loamy sand to sand loamy and sometimes gravelly surfaces over sandy clay loam to sandy clay (Akpata et al., 2017).

2.4 Geology

The local geology of the study area comprise essentially of four geological class. These include; Coarse porphyritic biotite/biotite hornblende, Biotite-hornblende gneiss finely bonded, Muscovite/quartz-muscovite-schist, and Medium to coarse grained biotite granite. All of these belong to the Pre–Cambrian/Cambrian basement complex.

2.5 Climate

Abuja under Köppen climate classification features a tropical wet and dry climate (Köppen: Aw). The FCT experiences three weather conditions annually. This includes a warm, humid rainy season and a blistering dry season. In between the two, there is a brief interlude of harmattan occasioned by the northeast trade wind, with the main feature of dust haze and dryness. The rainy season begins from April and ends in October, when daytime temperatures reach 28°C (82.4°F) to 30°C (86.0°F) and night time lows hover around 22°C (71.6°F) to 23°C (73.4°F). In the dry season, daytime temperatures can soar as high as 40°C (104.0°F) and night time temperatures can dip to 12°C (53.6°F). Even the chilliest nights can

be followed by daytime temperatures well above 30°C (86.0°F). The high altitudes and undulating terrain of the FCT act as a moderating influence on the weather of the territory. The city's inland location causes the diurnal temperature variation to be much larger than coastal cities with similar climates such as Lagos. Rainfall in the FCT reflects the territory's location on the windward side of the Jos Plateau and the zone of rising air masses with the city receiving frequent rainfall during the rainy season from April to October every year.

2.6 Biodiversity

The study area is covered with Guinea savanna vegetation, precisely, southern Guinea savanna type. The Guinea savanna is the broadest of all types in Nigeria, covering the area which has 1000 mm to 1500 mm of annual rainfall where the rainy season last 6 months; as such, in many parts it is forested. There are numerous tree species in the Guinea savanna biome prominent among which are *Afelia Africana, Adansonia digitate, Daniella oliveri, Isoberlina doka, Terminalia macroptera, Lophira lanceolate, Mitragyna inermis, Hyphaene thebiaca*, and *Terminalia glaucens*. The dominant grass genera are *Androgon gayanus, Bekerpsis uniseta, Monocymbium ceresiiforne, Hyparrhenia, Panacium maximum, Andropogon pseudapricus, Pennisetum, Panicum* and *Imperata cylindrical* among many others (Areola et al., 1978; Simmons, 1982, Mallo, 1988; Ibrahim, 2010); botanical authorities are as cited in Mallo and Ochai (2009). The wildlife composition of the study area, like most guinea savanna areas comprise of mammals such as antelopes, patas monkey, bats etc. There are also reptiles such as snakes (python), frogs, alligator etc. Amphibians such as frogs and toads abound in the area. Worms such as earthworms are also a common sight within the study area which also has a very diverse collection of birds (both wild and domestic) such as cattle egret, vulture, pigeon, doves, hawks, eagles etc.

2.7 Population

At the 2006 census, the city of Abuja had a population of 776,298, making it then the eighth most populous city in Nigeria. United Nations figures showed that Abuja grew by 139.7% between 2000 and 2010, making it the fastest growing city in the world. As of 2015, the city experienced an annual growth of at least 35%, retaining its position as the fastest-growing city on the African continent and one of the fastest-growing in the world (Wikipedia, 2023).

3. Methodology

3.1 Method of Data Collection

Before taking measurement on noise level, a reconnaissance survey was conducted for a period of not less than two (2) weeks. This was done to observe and explore the human and socio-economic activities dominant in the study area which generates noise. During the survey, sampling points were identified and coordinates taken with the GPS. This exercise was aimed at enabling the researcher to familiarize himself with the study area.

To carry out the noise level measurements, 70 sample points was selected. This culminated from 5 points selected in a representative manner across each of the 14 district in the study area. The Precision Gold (N09AQ) noise meter was kept and maintained at a standard height of 1.0 m above the ground for all the locations. Measurements was taken with the antenna pointing to the sound source. The instrument was set at the A-weighting network and the equivalent noise level (Leq.) which is the constant noise level that expands the same amount of energy over the same period. The sampling time for this noise assessment was

daily average, with four daily sampling sessions, which are: 7.30-8.30am, 12.30-1.30pm, 5.30-6.30pm and 10.30-11.30pm. The readings was recorded in decibel. The instrument was set at fast/slow mode to run continuously for one hour. This is because it is the recommended method from NESREA to obtain noise level pollution. The period of noise level measurement spanned for one week, so that the values obtained can represent the reality of noise pollution level. There was equally two season sampling – dry and wet season, to assess the seasonal influence on noise level.

3.2 Technique for Data Analysis

i. Measured Equivalent Noise Level (LD, LN, LDN)

The measured equivalent noise level was used as input data in the calculation of the day time noise level (LD), the night time noise (LN) and the day-night time noise level (LDN). These calculations was computed using equations 3.1, 3.2 and 3.3 as adopted by Anomohanran, (2010).

$$L_D = 10log\left\{\frac{1}{2}\left[\left(10^{\frac{LAeqM}{10}}\right)+\left(10^{\frac{LAeqA}{10}}\right)\right]\right\} \quad \text{Eqn. 1}$$

$$L_N = 10log\left\{\frac{1}{2}\left[\left(10^{\frac{LAeqE}{10}}\right)+\left(10^{\frac{LAeqN}{10}}\right)\right]\right\} \quad \text{Eqn. 2}$$

Where,
LAeq = The A-weighted equivalent sound pressure level
LAeqM = The equivalent sound pressure for the morning measurement
LAeqA = The equivalent sound pressure level for the afternoon measurement
LAeqE = The equivalent sound pressure level for the evening measurement
LAeqN = The equivalent sound pressure level for the night measurement
LD = Day time noise level
LN = Night time noise level

Thereafter, the results obtained from equations 1 and 2, was further computed into equation 3 to determine the day-night noise level (LDN) of Abuja metropolis. This was carried out by using equation 3.

$$L_{DN} = 10log\left\{\frac{1}{24}\left[\left(15 * 10^{\frac{LD}{10}}\right)+\left(9 * 10^{\frac{LN+10}{10}}\right)\right]\right\} \quad \text{Eqn. 3}$$

ii. Tables and Bar charts

Tables and bar charts were equally used to present and plot charts respectively of noise data on a daily basis across the dry and wet season sampling. Bar charts were further used in drawing an analogy between the noise levels at the respective sample points in each of the districts as compared with the regulatory standards as set by the WHO and NESREA.

iii. Paired Sample Student T-test

The paired sample student t-test was used to statistically compare the average weekly noise level of the dry and wet season for this study. This was to test the hypothesis that: the noise level of the study area does not vary with seasons (i.e, there is no significant difference

in the noise level of the study area between the wet and dry season).

iv. One-Way Analysis of Variance (ANOVA)

One-way ANOVA was used to test for variation in average ambient noise level; day time (LD), night time (LN) and day-night time noise level as dependent variable against the locations (14 districts in Abuja) as the independent variable. This was done for dry and wet seasons.

4. Results and Discussion

4.1 Sources of Noise in Abuja Metropolis

Table 1 shows the GPS locations and description of the seventy (70) noise sampling points across Abuja metropolis. These points were sampled across the fourteen (14) districts of the metropolis. These districts are: Central Business District (CBD), Garki, Wuse, Maitama, Asokoro, Kado, Durumi, Gudu, Utako, Jabi, Mabushi, Katampe, Wuye and Gwarinpa. The sampling points include: Grand square, Federal secretariat junction, Sahad stores, National hospital, Diplomatic zone opposite Egyptian embassy, Garki 2 market, Area 1 round about, UTC Area 10, Garki hospital, NNPC staff quarters, Wuse market, Berger junction, Banex plaza, Wuse general hospital, Estate in Cairo street Wuse II, Farmers market, Maitama round about, Habiba plaza, Maitama general hospital, Imani/Shell estate, Mogadishu barracks mammy market, AYA round about, Asokoro Shopping mall, Asokoro general hospital, Lakewood apartments, Ultra modern market, Katampe junction by next cash and carry, the capital hub, Deda hospital, Jab luxury homes, Durumi junction by Nnamdi Azikiwe expressway, Lasad super market, Medimax hospital, savanna estate, Gudu market, Tipper garage junction, Nwukpabi plaza, DIFF Medical Centre, and Hillview apartment.

Others are Utako modern market, Obafemi Awolowo way by Peace park, Leadership Newspaper office, Royal checksed specialist hospital, Lightwell garden estate, Jabi park, Airport junction, Jabi lake mall, NISA premier hospital, Jabi village, the amala place joint, Mabushi junction flyover, Saham plaza, Mobil filling station, Alterman paradise estate, Katampe mechanic village, flyover by katampe power station, AA rano fuel station, Peter hospital, De-Mes court apartment, Wuye modern market, Wuye junction by Nnamdi Azikiwe expressway, Quad plaza, Wuye pharmacy and stores, wetland estate, Tipper garage market, Gwarinpa round about, Irama Plaza, Gwarinpa general hospital and Gwarinpa estate 6th avenue. Table 1 show the districts in Abuja metropolis with the noise sample locations, sample codes, and the coordinates of the respective sample points. Figure 2 shows the spatial distribution of the noise sampling points across Abuja metropolis.

4.2 Noise Level Results for Abuja Metropolis

The equivalent day time noise level, night time noise level, and day-night noise level on a daily basis for the 70 sampling points for the sampling period (a whole week - Monday to Sunday) across wet and dry seasons was used to compute the measured equivalent day, night and day-night noise levels as presented in Table 2. The computations were done using Equations 1, 2 and 3.

4.3 Comparison between Dry and Wet Season Noise Level in Abuja Metropolis

The noise level of the dry and wet season for this study was statistically compared using the paired sample student t-test as shown in Table 5. This is to test the hypothesis that: The noise level of the study area does not vary with seasons (i.e, there is no significant

difference in the noise level of the study area between the wet and dry season). Significance level (α) used for the test is 0.05.

Table 1: Noise Sampling Points (NSP) with their locational descriptions, sample code and coordinates

District	Locations	Sample Point Code	Coordinates	
			Latitude	Longitude
Central Business District (CBD)	Grand Square	NSP 1	9.053365°	7.478997°
	Fed. Secretariat Junc.	NSP 2	9.061536°	7.494978°
	Sahad Stores	NSP 3	9.052954°	7.491108°
	National Hospital	NSP 4	9.039296°	7.463172°
	Diplomatic Zone_Opp. Egyptian Embassy	NSP 5	9.036182°	7.467147°
Garki District	Garki 2 Market	NSP 6	9.020599°	7.490488°
	Area 1 Round About	NSP 7	9.029809°	7.468653°
	UTC Area 10	NSP 8	9.036410°	7.485547°
	Garki Hospital	NSP 9	9.033123°	7.484806°
	NNPC Staff Qtrs	NSP 10	9.040921°	7.499984°
Wuse District	Wuse Market	NSP 11	9.068925°	7.465106°
	Berger Junction	NSP 12	9.067781°	7.452302°
	Banex Plaza	NSP 13	9.083657°	7.469112°
	Wuse Gen. Hospital	NSP 14	9.062900°	7.469321°
	Estate_Cairo Street Wuse II	NSP 15	9.075030°	7.478625°
Maitama District	Farmer's Market	NSP 16	9.086075°	7.494111°
	Maitama Round About	NSP 17	9.084305°	7.490968°
	Habiba Plaza	NSP 18	9.103918°	7.492457°
	Maitama Gen. Hospital	NSP 19	9.086128°	7.481372°
	Imani/Shell Estate	NSP 20	9.087687°	7.491212°
Asokoro District	Mogadishu Barracks Mammy Market	NSP 21	9.050352°	7.539490°
	AYA Round About	NSP 22	9.049953°	7.526381°
	Asokoro Shopping Mall	NSP 23	9.035928°	7.520805°
	Asokoro Gen. Hospital	NSP 24	9.045641°	7.522948°
	Lakewood Apartments	NSP 25	9.051296°	7.511964°
Kado District	Ultra Modern Market	NSP 26	9.093127°	7.443288°
	Katampe Junction by Next Cash and Carry	NSP 27	9.087738°	7.439623°
	The Capital Hub	NSP 28	9.089526°	7.450119°
	Deda Hospital	NSP 29	9.100833°	7.450538°
	Jab Luxury Homes	NSP 30	9.108022°	7.451276°
Durumi District	Durumi Market	NSP 31	9.010872°	7.468576°
	Durumi Junction by Nnamdi Azikiwe Exp. Way	NSP 32	9.022825°	7.477732°
	Lasad Super Market	NSP 33	9.026703°	7.456774°
	Medimax Hospital	NSP 34	9.022819°	7.468080°
	Savanna Estate	NSP 35	9.007053°	7.470990°
Gudu District	Gudu Market	NSP 36	8.999380°	7.472015°

	Tipper Garage Junction	NSP 37	8.997428°	7.488429°
	Nwukpabi Plaza	NSP 38	9.007105°	7.474949°
	DIFF Medical Centre	NSP 39	8.992970°	7.473479°
	Hillview Apartment	NSP 40	9.011762°	7.484216°
Utako District	Utako Modern Market	NSP 41	9.066606°	7.445762°
	Obafemi Awo Way by Peace Park	NSP 42	9.068047°	7.440755°
	Leadership News Paper Office	NSP 43	9.075537°	7.442583°
	Royal Checksed Specialist Hospital	NSP 44	9.072011°	7.440877°
	Lightwell Garden Estate	NSP 45	9.062819°	7.445232°
Jabi District	Jabi Park	NSP 46	9.064971°	7.432821°
	Airport Junction	NSP 47	9.064480°	7.411025°
	Jabi Lake Mall	NSP 48	9.076567°	7.425757°
	NISA Premier Hospital	NSP 49	9.067507°	7.411516°
	Jabi Village	NSP 50	9.072770°	7.433692°
Mabushi District	The Amala Place Joint	NSP 51	9.085222°	7.439843°
	Mabushi Junction Flyover	NSP 52	9.077763°	7.455824°
	Saham Plaza	NSP 53	9.079663°	7.449990°
	Mobil Filling Station	NSP 54	9.086376°	7.457439°
	Alterman Paradise Estate	NSP 55	9.079882°	7.442549°
Katampe District	Katampe Mechanic Village	NSP 56	9.119701°	7.431656°
	Flyover by Katampe Power Station	NSP 57	9.112700°	7.479413°
	AA Rano Fuel Station	NSP 58	9.118169°	7.457487°
	Peter Hospital	NSP 59	9.122038°	7.431888°
	De-Mes Court Apartment	NSP 60	9.125585°	7.442980°
Wuye District	Wuye Modern Market	NSP 61	9.051083°	7.443614°
	Wuye Junction by Nnamdi Azikiwe Expressway	NSP 62	9.053656°	7.453191°
	Quad Plaza	NSP 63	9.050016°	7.435896°
	Wuye Pharmacy and Stores	NSP 64	9.055670°	7.444366°
	Wetland Estate	NSP 65	9.040732°	7.436063°
Gwarinpa District	Tipper Garage market	NSP 66	9.108555°	7.403608°
	Gwarinpa Round About	NSP 67	9.076906°	7.411762°
	Irama Plaza	NSP 68	9.117303°	7.419875°
	Gwainpa General Hospital	NSP 69	9.076934°	7.398716°
	Gwarinpa Estate 6th Avenue	NSP 70	9.121971°	7.379872°

Source: Field Survey, 2023

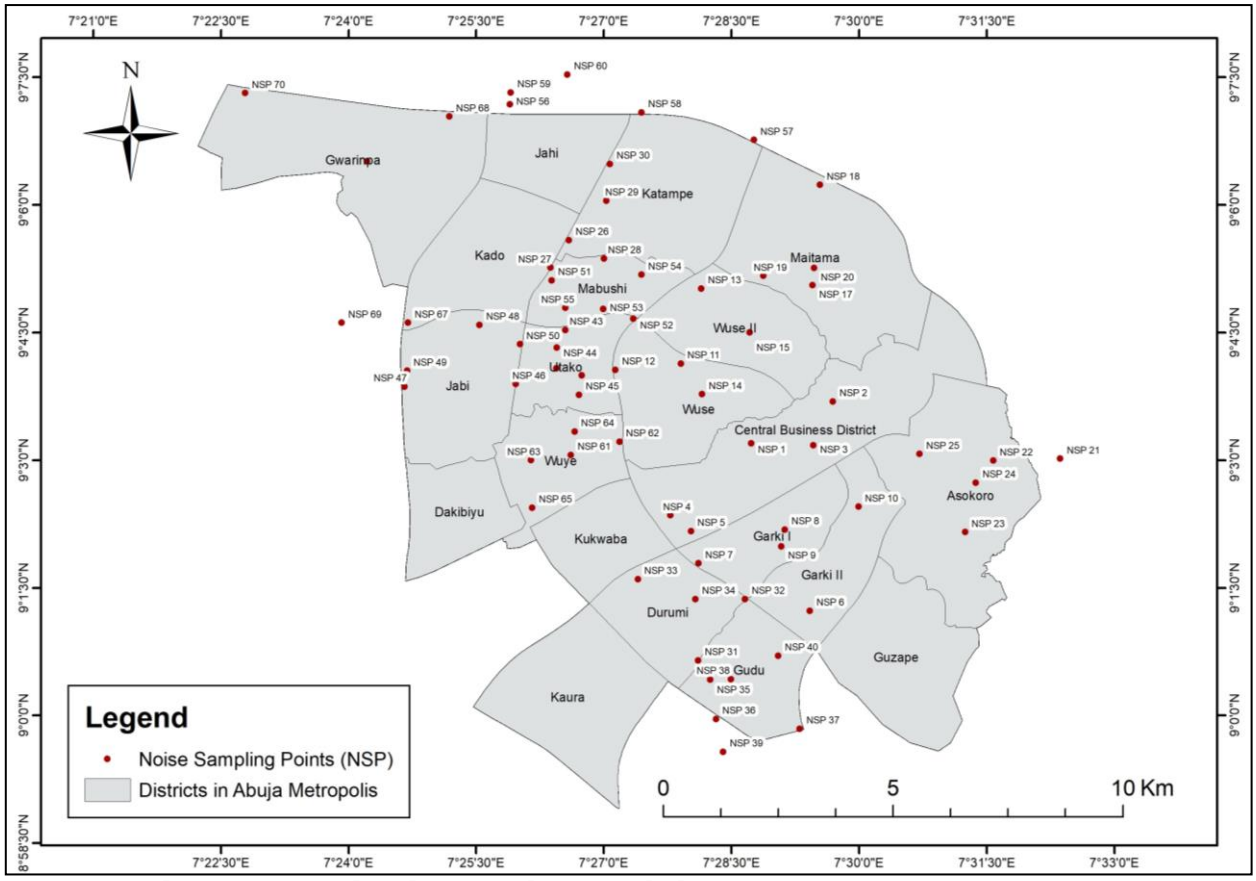

Figure 2: Abuja Metropolis Showing the Sampled Noise Points

Table 3 presents the data for the paired sample student t-test analysis. Table 4 is the result of the paired sample statistics, while 5 is the paired samples correlations results.

From the result of the paired sample correlations between the average daily (day-night time) noise level of the dry and wet season, the correlation was 0.967 (See Table 6) which indicates a very high positive correlation.

The paired sample t-test result between the average daily (day-night time) noise level of the dry and wet season for the study area is 0.170 (See Table 5). Since the p-value is not less than 0.05, we accept the null hypothesis and conclude that the noise level of the study area does not vary with seasons. In other words, there is no significant difference in the noise level of the study area between the wet and dry season.

4.4 Comparing Abuja Noise Level with the Standard

The noise level of Abuja metropolis was compared with regulatory standards (National Environmental Standards and Regulations Enforcement Agency – NESREA and the World Health Organisation – WHO) to satisfy one of the major study objectives. For NESREA (representing the local standard), the regulatory limit used was the Maximum Permissible Noise Level for General Environment – Regulation 2(1) D (Residential + industry or small scale production + commerce) which is 60dBA. While for WHO, which is the international standard, the Guideline Value for Outdoor living Area Limit (2011) which is 55dBA was used. Below are charts showing the graphical comparism of the ambient noise levels of the respective districts (14) in Abuja metropolis with the local and international standards.

Table 2: Weekly average noise level for Dry and Wet Season with Average Day time, Night time and Day-Night time noise across the sampling points

District	Sample Point Code	Weekly Average Noise Level for DRY SEASON						Weekly Average Noise Level for WET SEASON					
		L_D (dBA)	L_N (dBA)	L_{DN} (dBA)	Mean L_D (dBA)	Mean L_N (dBA)	Mean L_{DN} (dBA)	L_D (dBA)	L_N (dBA)	L_{DN} (dBA)	Mean L_D (dBA)	Mean L_N (dBA)	Mean L_{DN} (dBA)
Central Business District (CBD)	NSP 1	73.40	61.42	72.96	65.44	58.12	67.12	71.60	60.99	71.40	65.48	57.52	66.53
	NSP 2	81.18	71.42	81.41				79.18	71.42	80.21			
	NSP 3	68.60	66.13	73.14				69.25	64.13	71.79			
	NSP 4	59.65	55.13	62.67				61.44	54.28	62.90			
	NSP 5	44.39	36.49	45.42				45.92	36.76	46.35			
Garki District	NSP 6	80.76	75.13	83.11	70.13	66.08	74.62	79.38	72.85	81.14	70.41	64.70	73.77
	NSP 7	81.33	74.28	82.91				79.75	71.99	80.77			
	NSP 8	84.42	69.28	83.18				84.29	67.13	82.76			
	NSP 9	50.82	56.42	62.39				53.25	55.99	62.17			
	NSP 10	53.32	55.28	61.52				55.38	55.56	62.03			
Wuse District	NSP 11	85.38	81.56	88.84	70.29	68.83	75.78	84.22	76.85	85.93	69.61	66.34	73.95
	NSP 12	84.84	81.13	88.43				82.30	77.70	85.26			
	NSP 13	75.00	78.85	85.00				72.85	76.70	82.87			
	NSP 14	56.75	53.30	60.83				58.84	53.14	61.34			
	NSP 15	49.50	49.29	55.80				49.82	47.29	54.34			
Maitama District	NSP 16	60.67	55.99	63.52	65.54	54.83	66.14	63.19	53.85	64.04	66.50	54.64	67.20
	NSP 17	80.41	73.42	82.05				79.58	73.42	81.48			
	NSP 18	72.89	65.85	74.45				73.63	70.28	77.65			
	NSP 19	61.92	42.79	60.24				63.50	40.70	61.61			
	NSP 20	51.81	36.08	50.45				52.60	34.94	51.22			
Asokoro District	NSP 21	72.73	60.70	72.26	67.02	57.23	67.61	75.20	61.42	74.35	68.99	57.33	69.38
	NSP 22	84.58	80.56	88.16				83.57	81.56	88.40			

	NSP 23	70.81	63.71	72.25				74.87	63.85	74.69			
	NSP 24	58.01	46.46	57.54				60.11	46.07	59.61			
	NSP 25	48.99	34.70	47.85				51.22	33.76	49.83			
Kado District	NSP 26	83.28	76.56	84.92	69.82	64.99	72.98	84.51	73.70	84.34	71.66	63.85	73.66
	NSP 27	83.03	73.28	83.19				83.87	71.56	83.33			
	NSP 28	77.16	71.99	79.80				78.03	73.70	81.11			
	NSP 29	54.03	56.42	62.59				55.48	56.28	62.67			
	NSP 30	51.58	46.72	54.38				56.41	44.01	56.84			
Durumi District	NSP 31	80.85	74.85	82.89	65.26	60.10	68.24	83.63	73.13	83.59	67.11	57.79	67.70
	NSP 32	81.65	75.85	83.87				81.46	74.28	82.77			
	NSP 33	64.26	60.85	68.15				63.55	55.99	64.74			
	NSP 34	50.10	45.48	53.04				52.13	42.66	52.67			
	NSP 35	49.42	43.45	53.23				54.76	42.88	54.75			
Gudu District	NSP 36	84.32	80.13	87.53	68.84	64.51	72.03	84.12	76.42	85.38	69.71	62.57	71.69
	NSP 37	79.95	75.70	83.25				78.00	74.42	81.66			
	NSP 38	71.87	66.56	74.30				72.47	64.56	73.67			
	NSP 39	53.19	51.85	58.53				56.13	51.71	59.55			
	NSP 40	54.87	48.29	56.56				57.85	45.72	58.18			
Utako District	NSP 41	83.83	75.42	84.82	70.44	62.15	71.49	85.33	74.13	84.95	70.30	60.63	71.22
	NSP 42	83.99	75.85	85.10				81.37	73.85	82.53			
	NSP 43	78.32	71.28	79.97				76.82	72.56	79.97			
	NSP 44	56.52	50.44	58.52				59.20	53.28	61.40			
	NSP 45	49.54	37.75	49.06				48.78	29.33	47.23			
Jabi District	NSP 46	86.33	78.70	87.76	75.71	70.08	78.24	83.19	67.56	82.49	76.29	66.71	77.21
	NSP 47	82.67	79.13	86.32				80.76	76.70	83.99			
	NSP 48	72.44	69.56	76.75				76.99	67.28	77.73			
	NSP 49	61.56	53.72	62.76				61.70	49.57	61.17			
	NSP 50	75.53	69.28	77.59				78.81	72.42	80.66			
Mabushi District	NSP 51	73.86	67.85	75.89	69.72	63.41	71.81	71.11	62.70	71.96	70.45	59.25	70.70
	NSP 52	84.54	78.13	87.27				81.59	70.42	82.22			
	NSP 53	76.61	70.99	78.93				81.22	72.42	81.96			

	NSP 54	60.70	55.16	63.13				67.12	53.85	67.00		
	NSP 55	52.87	44.94	53.83				51.21	36.85	50.38		
Katampe District	NSP 56	79.62	75.42	82.86	69.61	65.06	72.78	80.96	74.99	83.01	70.82	64.00	72.56
	NSP 57	84.48	78.28	86.79				80.26	71.85	81.40		
	NSP 58	75.76	70.87	78.47				81.91	73.85	82.82		
	NSP 59	54.68	52.31	59.63				58.21	52.86	60.86		
	NSP 60	53.50	48.43	56.16				52.74	46.43	54.70		
Wuye District	NSP 61	80.06	72.56	81.29	71.31	65.62	73.65	82.03	68.56	81.32	72.07	61.96	72.54
	NSP 62	81.73	76.56	84.25				80.73	73.42	82.04		
	NSP 63	71.09	64.85	73.28				71.25	60.42	71.15		
	NSP 64	67.74	64.57	71.70				72.64	63.70	73.85		
	NSP 65	55.91	49.57	57.74				53.72	43.72	54.34		
Gwarinpa District	NSP 66	82.93	77.28	85.24	69.27	62.72	71.15	81.52	74.42	82.98	69.53	60.26	70.32
	NSP 67	81.85	77.85	85.20				80.47	75.28	83.00		
	NSP 68	66.72	60.87	69.12				68.80	60.14	69.61		
	NSP 69	54.56	45.75	55.13				57.01	43.32	56.29		
	NSP 70	60.29	51.85	61.04				59.84	48.14	59.72		

Source: Field Survey, 2024

Table 3: Weekly Average (Day-Night) noise level for Dry and Wet Season

District	Dry Season Day-Night Noise Level (Dry Season L_{DN} dBA)	Wet Season Day-Night Noise Level (Wet Season L_{DN} dBA)
Central Business District (CBD)	67.12	66.53
Garki District	74.62	73.77
Wuse District	75.78	73.95
Maitama District	66.14	67.20
Asokoro District	67.61	69.38
Kado District	72.98	73.66
Durumi District	68.24	67.70
Gudu District	72.03	71.69
Utako District	71.49	71.22
Jabi District	78.24	77.21
Mabushi District	71.81	70.70
Katampe District	72.78	72.56
Wuye District	73.65	72.54
Gwarinpa District	71.15	70.32
Average	**71.69**	**71.32**

Source: Authors' Computation (2025)

Table 4: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Dry Season L_{DN}	71.6886	14	3.45974	.92465
	Wet Season L_{DN}	71.3164	14	2.96688	.79293

Source: Author's Computation using IBM, SPSS (2025)

Table 5: Paired Sample T-Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Dry Season L_{DN} – Wet Season L_{DN}	.37214	.95845	.25616	-.18125	.92553	1.453	13	.170

Source: Authors' Computation using IBM, SPSS, (2025)

Table 6: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Dry Season L_{DN} and Wet Season L_{DN}	14	.967	.000

Source: Author's Computation using IBM, SPSS (2025)

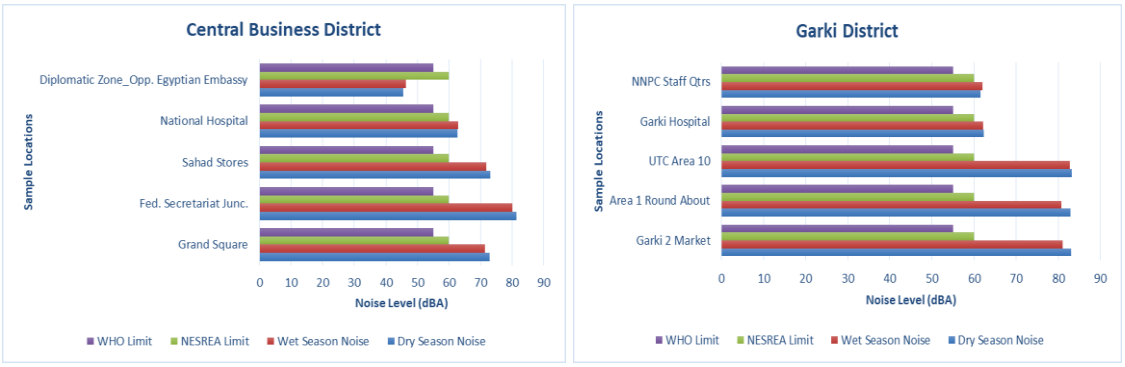

Figure 3: Mean Dry and Wet season Noise Level at CBD & Garki District with Regulatory Limits

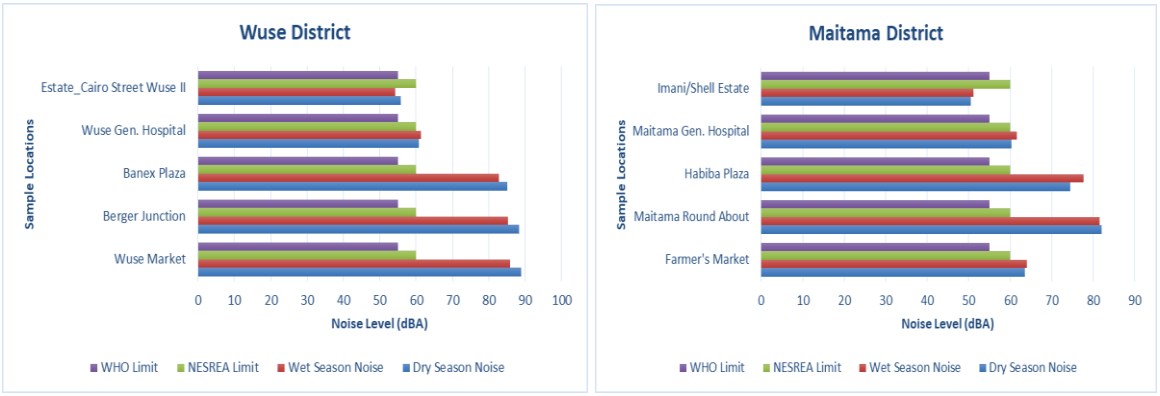

Figure 4: Mean Dry and Wet season Noise Level at Wuse & Maitama District with Regulatory Limits

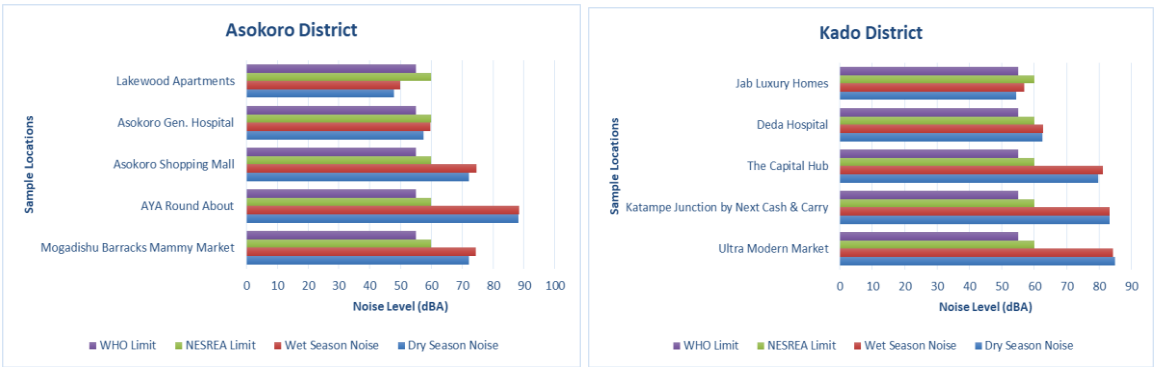

Figure 5: Mean Dry and Wet season Noise Level at Asokoro && Kado District with Regulatory Limits

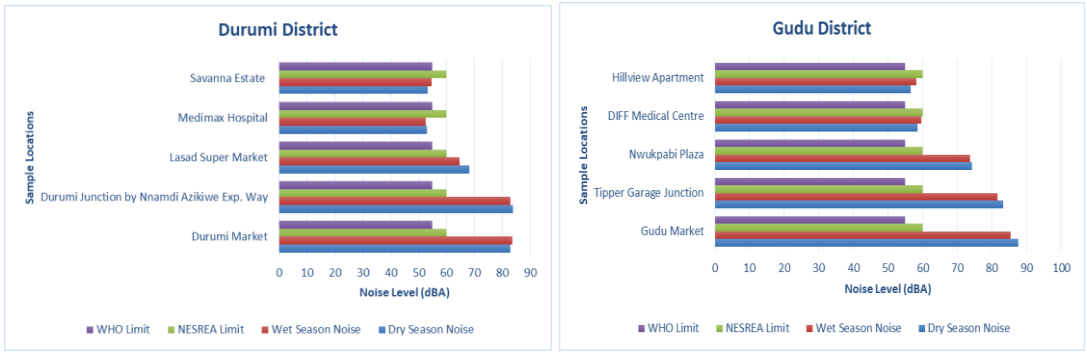

Figure 6: Mean Dry and Wet season Noise Level at Durumi & Gudu District with Regulatory Limits

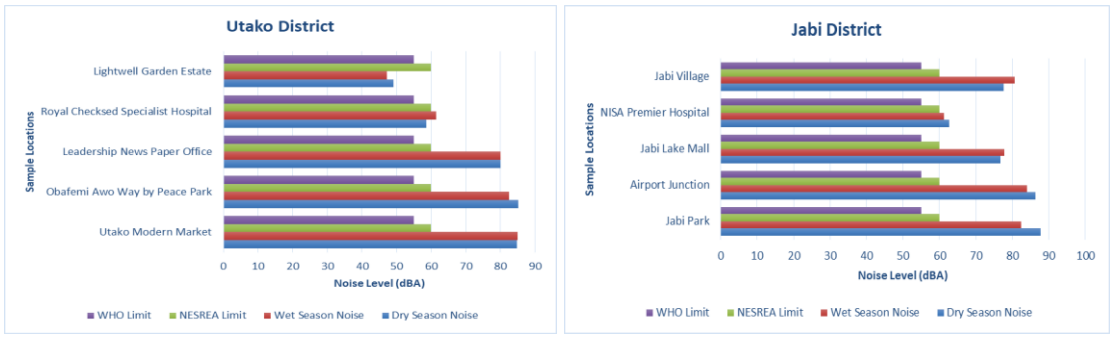

Figure 7: Mean Dry and Wet season Noise Level at Utako & Jabi District with Regulatory Limits

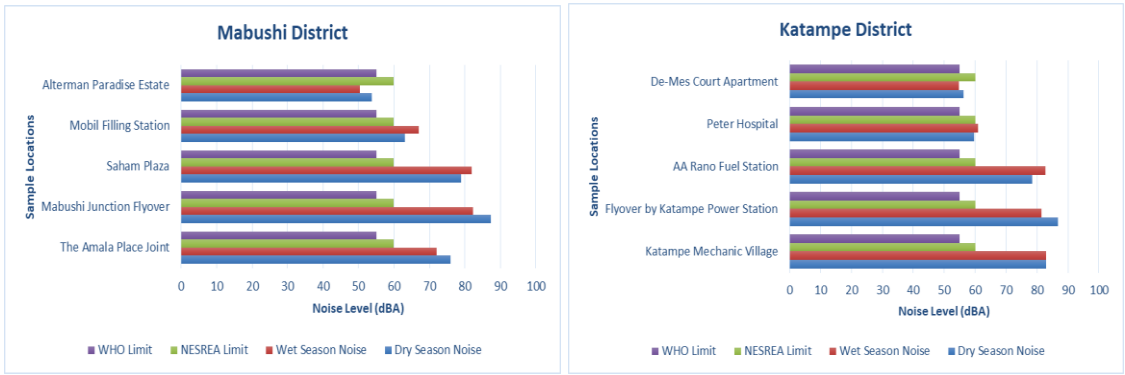

Figure 8: Mean Dry and Wet season Noise Level at Mabushi & Katampe District with Regulatory Limits

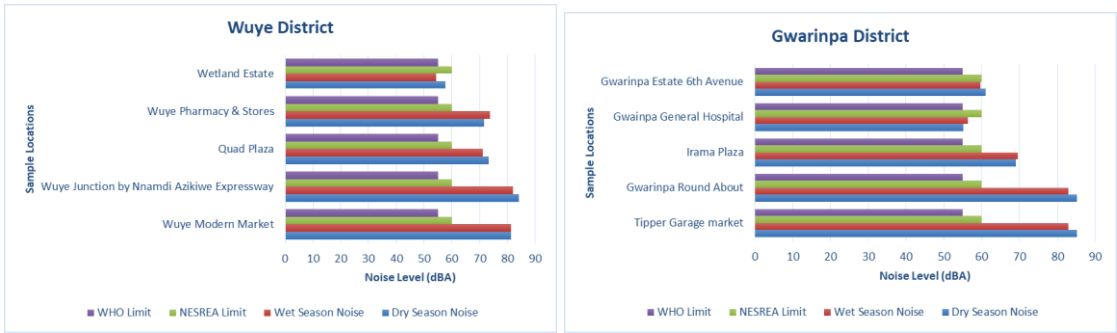

Figure 9: Mean Dry and Wet season Noise Level at Wuye & Gwarinpa District with Regulatory Limits

Table 7: Level of Conformance of Noise with Acceptable Regulatory National and International Limits

		Dry Season		Wet Season	
S/No.	Districts	WHO Limit	NESREA Limit	WHO Limit	NESREA Limit
1.	Central Business District (CBD)	1/5	1/5	1/5	1/5
2.	Garki District	0/5	0/5	0/5	0/5
3.	Wuse District	0/5	1/5	0/5	1/5
4.	Maitama District	1/5	1/5	1/5	1/5
5.	Asokoro District	1/5	2/5	1/5	2/5
6.	Kado District	1/5	1/5	0/5	1/5
7.	Durumi District	2/5	2/5	2/5	2/5
8.	Gudu District	0/5	2/5	0/5	2/5
9.	Utako District	1/5	2/5	1/5	1/5
10.	Jabi District	0/5	0/5	0/5	0/5
11.	Mabushi District	1/5	1/5	1/5	1/5
12.	Katampe District	0/5	2/5	1/5	1/5
13.	Wuye District	0/5	1/5	1/5	1/5
14.	Gwarinpa District	0/5	1/5	0/5	2/5
	Total Frequency	**8/70**	**17/70**	**9/70**	**16/70**
	Percentage Compliance	**11.43%**	**24.29%**	**12.86%**	**22.86%**

Source: Author's Computation

From table 7 above, of the 70 points sampled, only 8 points (11.43%) conformed to the WHO noise limits during the dry season and 17 points conformed to the NESREA noise limit for the dry season sampling. Wet season sampling exercise showed a 12.86% (9 points) compliance with the WHO regulatory limit and a 22.86% (16 points) compliance limit with the NESREA standard. This therefore means that across both seasons, there is less than 25% compliance with the regulatory noise limits of both the WHO and NESREA. Thus, for hypothesis iii, we accept the null hypothesis and conclude that the noise level of Abuja metropolis does not conform to acceptable National and International regulatory standards.

The above conclusion agrees with Anomohanran (2013) which inferred that only 29% of the Abuja city possess satisfactory noise level quality. Also, the work done by Ibekwe et al, (2016) found out that the night noise levels are satisfactory but the day and day-night levels are above the recommended tolerable values by WHO and therefore urgently call for awareness and legislative regulations. Furthermore, in the 2024 study carried out by Ekom et al, titled: Assessment of noise level from selected highways and motor parks in the Federal Capital Territory (FCT), Abuja, they found out that all noise level parameters at the sample locations exceeded NESREA permissible limits of 65dB limits and the WHO limit of 75dB. The implication of the above is that ambient noise level in Abuja metropolis is at a point where it largely peaks above regulatory limits. This is not a good sign especially for human habitation especially at the receptor points within the metropolis.

The ambient noise level of Abuja metropolis portend serious implications on the wellbeing of people working and living in the metropolis and its environs due to frequent exposure to noisy environment. Many studies have reported the adverse effects of excessively high noise level on human health among which are hearing loss, sleep disturbances,

increased stress levels and cardiovascular problems, such as hypertension and heart disease (Basner et al., 2014; Ibekwe et al., 2016). It was also reported that it could impair concentration, hinder productivity, affect cognitive performance in both adults and children and cause annoyance thereby reduce the overall quality of life (Gupta et al., 2018). Sorensens et al. (2011) noted that a 10dB increase in chronic exposition of noise in humans increases the risk of cardiovascular accident (CVA) by 14% and systolic blood pressure appreciation by 0.26mmHg. This was confirmed by Erikson et al. (2012) who stated that a persistent noise level ≥50dB is associated with the risk of cardiovascular disease.

5. Conclusion and Recommendation

From the findings in this study, the following conclusions are made:

a) Firstly, the weekly average dry season noise level recorded a mean value across the entire district of 71.69dBA while the wet season assessment averaged 71.32dBA. This can be interpreted to mean that the average noise level in the dry season is slightly higher than it is in the wet season.

b) Jabi district recorded the highest average weekly noise level in both the dry season assessment (78.24dBA) as well as the wet season assessment (77.21dBA). Conversely, Maitama district with 66.14dBA recorded the lowest average noise level during the dry season assessment, while Central Business district with 66.53dBA recorded the lowest noise level for wet season assessment.

c) The correlation result of the paired sample correlations between the average daily (day-night time) noise level of the dry and wet season was 0.967 and this indicates a very high positive correlation.

d) The paired sample t-test result between the average daily (day-night time) noise level of the dry and wet season for the study area was 0.170 (See Table 4.19). Thus, it was concluded that there is no significant difference in the noise level of the study area between the wet and dry season.

e) Across both dry and wet seasons, there is less than 25% compliance with the regulatory noise limits of both the WHO and NESREA. From the 70 points sampled, 8 points (11.43%) conformed to the WHO noise limits during the dry season and 17 points conformed to the NESREA noise limit for the dry season sampling. Wet season sampling exercise showed a 12.86% (9 points) compliance with the WHO regulatory limit and a 22.86% (16 points) compliance limit with the NESREA standard.

Based on the research findings earlier discussed in this study, the following recommendations are made:

i. In areas where noise levels were identified to be high like Jabi district, Abuja city planning agencies should create buffer zone by planting trees between residential neighbourhoods and major roads to act as barrier or insulation to sound propagation and reduce the intensity of traffic noise level before it reaches the residential buildings. This will improve the quality of life in residential neighbourhoods in the city. Also, other identified noise generation sources, like industries and plazas with noisy generators, should have installed noise barriers (fence) which will serve as a measure to protect people living or working close to these noise generation sources.

ii. The identified areas like Jabi, whose daily activities confine them to high noise level, there should be at least 10 hours of recovery time. This can be achieved through the dissemination of noise effects on the health of the people through awareness campaigns by

NESREA and the Abuja Environmental Protection Board (AEPB).

iii. Motorists should be compelled to make use of designated parking car spaces to guard against indiscriminate parking along the road which will in turn create traffic congestion and cause an increase in the ambient noise level.

iv. Application of speed limits for vehicles driving around residential areas as well as zones where healthcare facilities are located. In other words, government should pay adequate attention to traffic noise management in residential neighbourhoods due to its adverse effects on people. They should also legislate on noise pollution from vehicular traffic within residential neighbourhoods.

v. There should be a 24-hour continuous noise level monitoring in the entire FCT to check the level of noise pollution specifically in the face of the growing population being experienced.

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