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Noise pollution monitoring and health impacts from Nigerian busiest international airport

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ABSTRACT

The problem of urban traffic noise pollution is universal and in the past few decades it has become a major concern for both public and policy-makers. Muritala Mohammed airport is a typical example of this problem as it is the busiest in West Africa and located in the heart of Lagos metropolis with its operational routes passing over many densely populated suburbs. Noise due to Lagos airport was monitored simultaneously at 12 locations within the airport and 2 sites in the neighborhood of the airport for a period of five months. Measurements were performed for a period of 10 minutes at each location, repeated 3 to 5 times during peak and off-peak h to account for fluctuations at each location. This was done using the integrated CR-811 B type 1 model sound level meter placed at 1.7 m above the ground. In addition, means of central tendencies, regression analysis and noise mapping were employed to deduce further inter-relationships in the sampled locations. A structured open-ended questionnaire was used to obtain information about the perception of residents living around the airport. Findings indicated that the average diurnal and nocturnal airport noise values ranged from 52.30 to 81.30 dBA and 42.10 to 65.70 dBA respectively and therefore, violated the standard outdoor limits in most locations especially at the runway and apron sites. Based on the perception of the residents living around the airport regarding impacts of noise due to airport operations on their health; insomnia (68 %), hearing loss (21 %), headache (36 %) and disturbance on communication networks (17 %) were the major health impacts on the receptors. Therefore, windows for provision of noise abatement options in Lagos airport should be prioritized.

KEYWORDS

Airport; Diurnal; Noise; Nocturnal; Pollution; Urban traffic.

INTRODUCTION

Air transport represents a dynamic and fast growing industry that fits well with the dynamic needs of nowadays society. The process of upgrading existing local airports to international standard introduced by Federal Government of Nigeria in the last decades has deeply modified the structure of aviation at community level. However, aviation industry represents a source of environmental externalities, especially at local level as it interferes with human activities. The impact of emissions and noise pollution has always posed serious problems for dwellers located near airports. People who live close to airports suffer more than mere annoyance from noise

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emanating from ascending and descending aircrafts. In 1990, United States of America's law brought increasingly quieter engine technology but the projected continued growth of air travel threatens to cancel out these gains. Beyond annoyance, aircraft noise could have significant mental and physical health impacts on inhabitants who live below flight paths of commercial and private aircrafts.

Many studies have linked aircraft noise to stress, hypertension, sleep disturbances, work-related performance, learning and academic performance of pupils[1,2]. A report from European Commission[3] claimed that about 20 % (80 million) of population in European Union (EU) countries experience noise levels that are believed to have detrimental effects on human health. It also revealed that 42 % of EU population resides in so-called "grey areas", where noise pollution, if not hazardous to human welfare, is severe enough to cause occasional serious nuisance. The impact of aircraft noise on children's health was reported[4] and found higher systolic as well as diastolic pressure in children living near Los Angeles airport than those living far away. Similar study[5] found a relationship between chronic noise exposure and elevated neuro-endocrine and cardiovascular measures for children living near Munich's International Airport. Studies have also linked exposure to aircraft noise with deficits in learning. Evans and Maxwell[6] reported that first and second-grade school children chronically exposed to aircraft noise had poorer reading skills than children attending elementary school in a quieter neighborhood. The deleterious effect of noise pollution on rural environment and on wildlife in particular is well-documented[7,8]. What makes these findings particularly alarming is that our world will only get noisier.

In most developing countries such as Nigeria, data on personal or occupational noise exposures in aviation sector are largely unavailable. Therefore, a quantitative first-hand study of noise monitoring at Nigeria's busiest airport (Muritala Mohammed International Airport, Lagos and her neighborhoods) were conducted. Lagos is the former capital of Nigeria. It is recognized as the commercial, industrial and economic nerve center of the country. It serves as the country's main nodal point for all transport modes; air, water, road and rail. In addition, Lagos airport is the hub of national aviation activities as it handles over 80 % international departures and 45 % domestic connections[9], thus knowledge of noise levels monitoring at the airport and its impact on the surrounding suburbs are imperative.

RESEARCH METHODS AND MATERIALS

Field measurements

Equivalent continuous level (Leq) is the noise level of the fluctuating noise during a specific time interval which is equivalent to the established noise levels in the same interval, known Leq event noise[10]. Its unit is dB (A) and the equation for the Leq event-noise is written as;

$$\mathbf{Leq = 10\log\left[\frac{1}{n}\left(\sum_{i=1}^{n} 10^{0.1Li}\right)\right]} \quad (1)$$

Where, Leq = Level of equivalent noise; n denotes sample data of noise measurement; L_i means specified noise value measurement time interval.

Event measurements were performed for 10 minutes using the integrated CR-811 B type 1 model sound level meter supplied from Cirrus Research Plc., United Kingdom. The instrumentation and calibration of equipment were performed in accordance with the manufacturer's recommended procedure[11] before measurement using the noise model calibrator to ensure accuracy and reliability. Interval time was set for 5 seconds and the measuring instrument was kept at 1.7 m above the ground for 24 h so that it can produce as many as 24 data consisting of 16 for day (06 to 22 h) and 8 for night (22.00 to 06.00). The measurements was done at 11 different locations within the airport and 2 areas of influence at the neighborhoods' (Figure 1) in the dry season months, from November (2008) to March (2009) in order to eliminate rain induced sounds. After sampling, Equivalent continuous level (Leq) data was retrieved for the calculations of L_{day} and $L_{night.}$

$$L_{day} = 10\log\left[\frac{1}{16}\left(10^{0.1L_1} + 10^{0.1L_2} + 10^{0.1L_3} + \cdots 10^{0.1L_{16}}\right)\right] \quad (2)$$

and,

$$L_{night} = 10\log\left[\frac{1}{16}\left(10^{0.1L_1} + 10^{0.1L_2} + 10^{0.1L_3} + \cdots 10^{0.1L_8}\right)\right] \quad (3)$$

Notes: $L_{day} = L_{eq}$ value for day (16 h) i.e. 06:00 to 22:00; $L_{night} = L_{eq}$ value for night (8 h): 22:00 to 06:00; L_1 to L_{24} = Leq value for every hour.

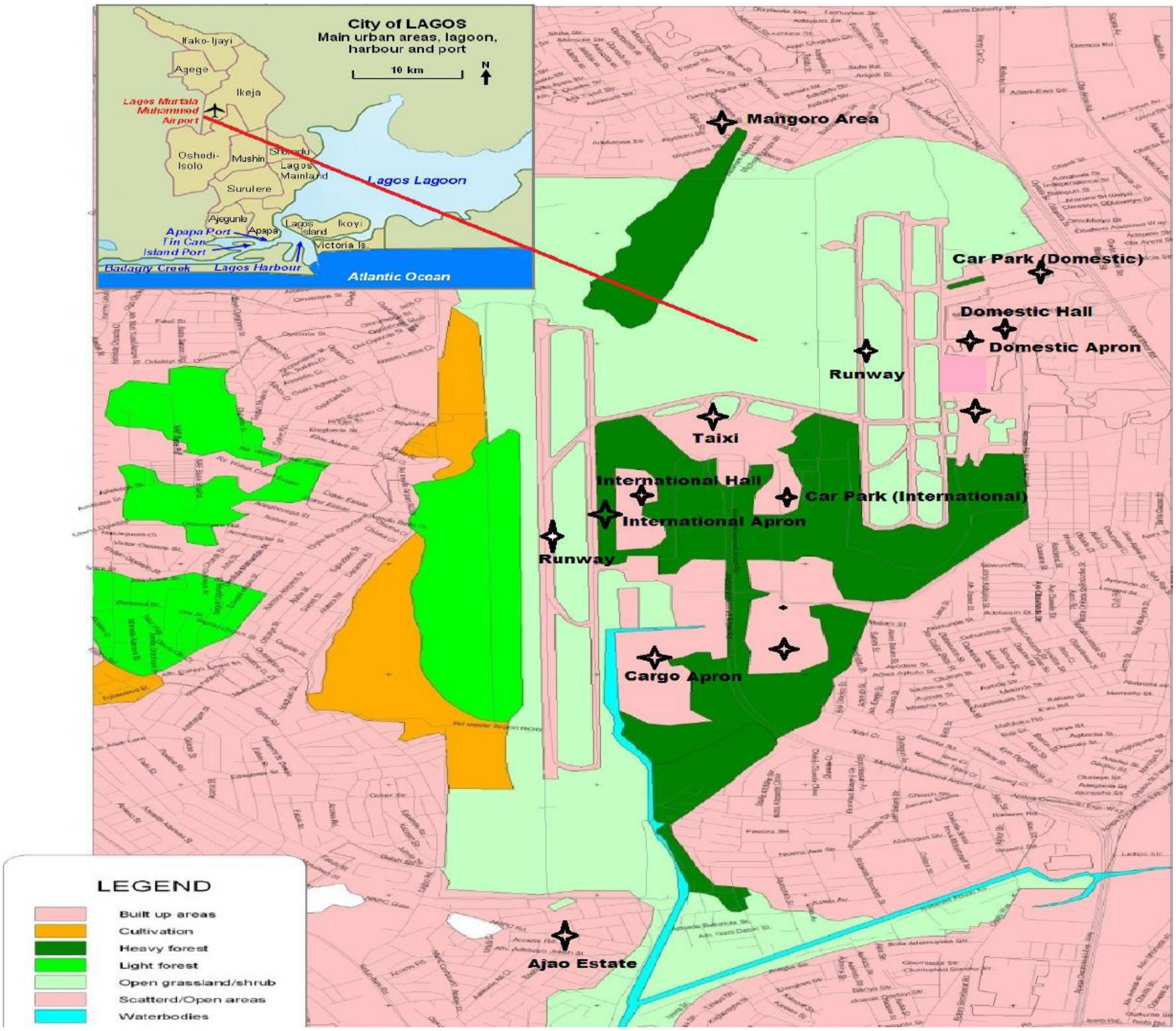

Figure 1: Location map for the study

The data was further statistically analyzed using Microsoft Excel package to determine the degree of variance between the day and night noise levels. To evaluate the propagation of the noise path within the study area, a noise mapping was performed using Surfer-12 software to develop contour map. Data input to the software includes; sources and receptor coordinates, measured values, study area attributes.

RESULTS AND DISCUSSION

Diurnal noise measurements (TABLE 1) ranged from 52.30 to 73.70 dBA while the median and mean values stood at 59.30 and 61.21 dBA respectively. Similarly, the nocturnal measurements (TABLE 1) ranged from 42.10 to 65.10 dBA, while median and mean values were 47.90 and 50.40 dBA respectively. Overall, the Leq average sound levels at night-times were found to be lower than the diurnal values. Similarly, average L_{day} violated the 70 dBA guideline limit[12] for Commercial / Industrial areas at three locations vis-à-vis Runway (81.30 dBA), International (73.70 dBA) and Domestic Aprons (71.10 dBA). However, for the L_{night} measurements, the Runway (63.40 dBA), International (65.70 dBA) and Domestic Aprons (64.80 dBA) had values that were within the 70 dBA World Health Organization (WHO) standard[12]. The areas with high noise concentrations

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were further confirmed in Figure 2 which described the mapping and propagation patterns of noise in the study sites.

Specifically, different diurnal and nocturnal noise levels established at the various study locations within the airport are displayed in TABLE 1. For instance, the noise level measured at the Runway (81.30), international (73.70 dBA) and domestic aprons (71.10) accounted for the highest during diurnal measurements. While the least diurnal noise level was observed at the air force apron (52.30 dBA). Equally, same scenario was recorded for nocturnal measurements, the study sites with high noise level thresholds were international (65.70 dBA) and domestic apron 64.80 (dBA) as well as runway with 63.40 dBA. Leq_{-night} had their least values at domestic cargo apron (42.10 dBA) and domestic car park (42.70 dBA) probably due to less activity in the nocturnal periods. Conversely, noise levels at the domestic and international aprons were among the highest in both diurnal and nocturnal periods because the airport apron has several peculiarities compared to other workplaces in the airport. It is the place where operations of "turn around" such as toilet service, baggage loading and off-loading, fuelling and so on are carried out to provide assistance to aircrafts. High value of noise levels registered at the Runway during day time could be due to increased anthropogenic activity as well as the fact that the Runway is where the aircrafts gather enough momentum to fly and such uses the nosiest gear. However, the apron result was in agreement with previous study of L_{day} and L_{night} noise levels at an international airport in Indonesia[13].

The results also revealed that the daytime and night-time noise levels exceeded the satisfactory indices of WHO for L_{day} (55 dBA) and L_{night} (45 dBA) measurements for community noise in outdoor residential living environments (TABLE 2). These communities; Ajao estate and Mangororo are situated about 1 km away from the landing and take-off ends respectively.

As a result of aircrafts landing and take-offs sound levels above WHO standards for the day and night at the communities were often exceeded. This shows that these could be risk zones and that the noise levels can cause physiological and psychological problems both to human and animals around those vicinities[14]. High day-night noise level means that even after work, residents could still be exposed to high noise level which can lead to sleep disturbance and annoyance amongst other health problems[15]

TABLE 1: Average day and night noise level at different location in the study area

S/N	Location	Coordinates		Noise level equivalent (dBA) L_{day}	Noise level equivalent (dBA) L_{night}
		Easting	Northing		
1	Runway	535222	727310	81.30	63.40
2	Taxi way	535417	727393	59.90	48.70
3	International Apron	535483	727163	73.70	65.70
4	Domestic Apron	536906	728360	71.10	64.80
5	Air force Apron	536862	728073	52.30	44.10
6	Tank farm	536789	726356	56.00	49.70
7	Car park (International)	535123	725765	59.70	44.50
8	Car park (Domestic)	536768	728358	60.40	42.70
9	International hall (Departure)	535090	725980	54.30	44.50
10	Domestic hall (Departure)	536715	728422	56.30	46.70
11	Mangororo (Landing area end)	536272	730300	58.90	47.60
12	Ajao Estate(Take-off area end)	530336	724206	57.60	48.20
13	Domestic Cargo Apron	535702	728438	54.30	42.10
14	International Cargo Apron	533808	726418	61.20	52.41
	Range (dBA)			52.30 - 81.30	42.10 - 65.70
	Mean (dBA)			61.21	50.36

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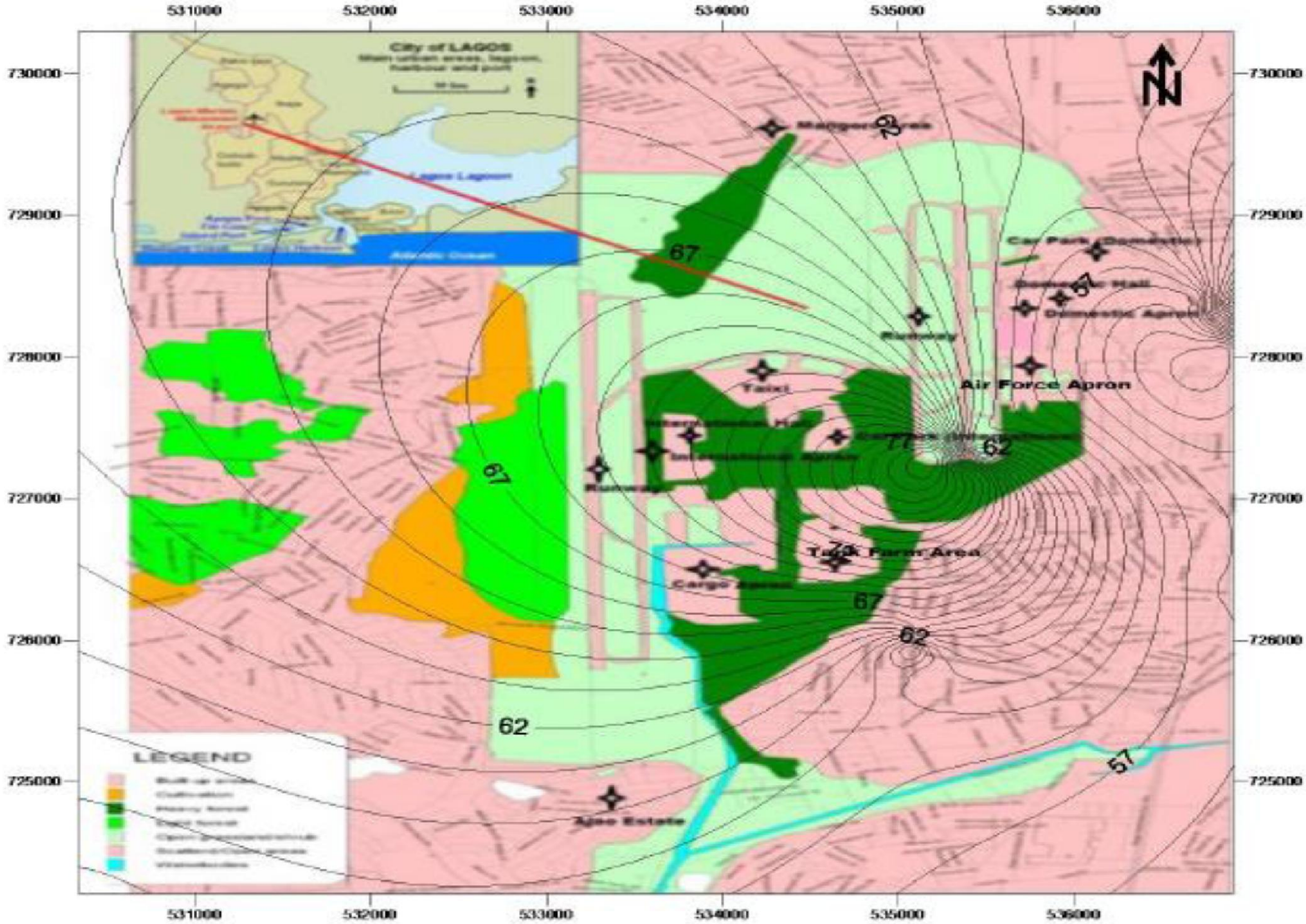

Figure 2: Noise contour map around the airport

TABLE 2: Guidelines values for community noise in specific environments

S/N	Specific Environment	Critical Health effect(s)	Noise Level dB(A)
1	Outdoor living area	Serious annoyance, day and evening.	55
		Moderate annoyance, day and evening	50
2	Dwelling, indoors	Speech intelligibility and moderate annoyance, day and night.	35
	Inside bedrooms	Sleep disturbance, night-time	30
3	Outside bedrooms	Sleep disturbance, window open (outdoor values)	45

Public perceptions to airport noise

To improve on the understanding of implications of the noise level measurement reported above, an open-ended questionnaire were administered to 180 residents residing in the two communities (Ajao estate and Mangororo area) monitored in order to obtain first-hand information regarding their perception on impacts of noise emanating from the airport. Thereafter, the feedbacks from the questionnaire would serve as basis for policy makers to design effective strategy to tackle noise pollution.

Main inferences from the questionnaires indicate that eight were void while 172 were used. Residents (respondents) ages were between 18 to 30 years (20.9 %), 31 to 40 years (40.1 %), 41 to 50 years (26.2 %) and 51 years and above (12.8 %). The living duration of the residents were ≤ 5 years (50 %), 5 to 10 years (18.6 %), 11 to 15 years (14 %), 16 to 20 years (10.5 %) and ≥ 2 years (7.0 %). Residents of the two neigbourhoods also complained about the impacts of aircraft noise on their health; sleeping disturbances (68 %), hearing impairments (21 %), headache (36 %) and distortion in communication networks (17 %). Other information from the questionnaires (TABLE 3) revealed that 68 % of the residents are aware of noise pollution due to airport activities. Interestingly, just 9 % of the respondents were not aware of the physiological and psychological impacts of airport noise on human health. This implies that residents in the two neigbourhoods may be residing as the last resort or due to ulterior motives such as proximity to work places and so on.

TABLE 3: Community perception of noise pollution

Questions	Yes (%)	Does not know (%)
Airport noise awareness	68	32
Dangers of airport noise to human health	91	9
Knowledge of abatement options	29	71
Knowledge on use of ear muffler	34	66
Use of hands to shield ears during excessive airport noise	52	48
Have you ever complain to enforcement /regulatory agencies	3	97

In addition, only 29 % of the respondents had knowledge regarding abatement options of noise pollution due to airport activities while 34 % have adopted the use of ear muffler as mitigation option especially during aircraft take-offs and landings. Conversely, only 3 % of the respondents have ever complained about the impacts of noise due to airport activities to the relevant authorities. So many reasons such as lack of public trust and "will" for the government could account why 97 % of the respondents have never formally complained to the state. The negative effect of aircraft noise, in particular around airports, is alarming. More and more people suffer not only from annoyance, but recent studies indicate that intermediate and high noise levels also contribute to physiological and psychological effects that in extreme cases can cause severe health problems.

CONCLUSIONS

Though, the aircraft industry has launched an ambitious plan to reduce the noise emission levels from aircraft by as much as 20 dBA. Even if this goal is attained, the reduced noise levels will have little or no influence on the overall noise concentration around airports. This is because of increase in passenger's volume especially in the developing nations where aircrafts is becoming an acceptable and avoidable means of transport. By the result of this study, mean noise diurnal levels around the airport were more prominent in three locations vis-à-vis Runway (81.30 dBA), International (73.70 dBA) and Domestic Aprons (71.10 dBA). While, the average nocturnal noise had Runway (63.40 dBA), International (65.70 dBA) and Domestic Aprons (64.80 dBA) respectively. Based on public perception of inhabitants of the suburbs around the airport, in particular Mangororo and Ajao estate about noise emanating from the airport, obtained information were sleeping disturbances (68 %), hearing impairments (21 %), headache (36 %) and distortion in communication networks (17 %). In addition, most residents were apathetic to report the noise impacts to concerned authorities. However, control and handling of the problem of noise at the airport can be organized through noise restraint at the respective source; on the propagation path and on humans. To reduce noise impacts, it is therefore recommended to the airport managers to plant noise muffle trees with wide fissures around the airport. Equally, daily, monthly, seasonal and yearly sampling of noise levels around the airport should be encouraged.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors

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