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Assessment of Level and Characteristics of Aircraft Noise from Omagwa Airport on Surrounding Communities using Appropriate Metrics Analysis

Chioma Chinazaekpere Eze[1], Goodluck Prince Ogboeli[1], Ureh Annabel Oparaodu[2], Chibuogwu Lawrence Eze[3], Nwabuisi Paul Eze[4]

Institute of Geo-Science and Environmental Management, Rivers State University, Nkpolu Oroworukwo, Port Harcourt[1]
Faculty of Clinical Sciences, College of Medical Sciences, Rivers State University, Nkpolu Oroworukwo, Port Harcourt[2]
Institute of Pollution Studies, Rivers State University, Nkpolu Oroworukwo, Port Harcourt[3]
Department of Soil Science, Rivers State University, Nkpolu Oroworukwo, Port Harcourt[4]

ORCID id's: Eze Chioma Chinazaekpere - 0009-0003-5814-4875, Ogboeli Goodluck - 0009-0006-4920-0435, Oparaodu Ureh Annabel - 0000-0001-6604-029X, Eze Chibuogwu Lawrence - 0009-0008-7998-8758, Eze Nwabuisi Paul - 0009-0003-1229-7198
Corresponding Author: Chioma.eze@rsu.edu.ng

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Abstract— *Aircraft noise pollution is an increasing environmental concern, particularly for populations living near airports where repeated exposure to high-intensity and intermittent noise may negatively affect health, well-being, and quality of life. This study assessed the level and characteristics of aircraft noise generated by operations at Omagwa Airport, Rivers State, Nigeria, with emphasis on its impact on surrounding communities, especially Ipo. A field-based environmental monitoring design was adopted in line with ISO 1996-2:2007 standards. Noise measurements were taken using a Class 1 Digital Sound Level Meter (Kanomax Model 4431), while meteorological parameters were recorded using a Professional Weather Centre (PCE-FWS 20N). Aircraft operation data, including flight frequency and aircraft types, were obtained from Flightradar24. Noise levels were monitored between 08:00 and 17:00 hours and analyzed using acoustic indicators such as LA05, LA95, and intermittency (LA05 – LA95). The results showed an average of 12 aircraft overflights per day, with clear weekly variation; Monday recorded the highest activity (20 overflights), while Thursday recorded the lowest (8 overflights). Boeing aircraft dominated operations with 31 movements, reflecting the prevalence of larger aircraft types. Background noise levels in Ipo averaged about 35 dBA, while aircraft overflight noise ranged from 38.6 dBA to 70.5 dBA. Correlation analysis revealed strong positive relationships between overflight frequency and LA05 ($r = 0.86$) and intermittency ($r = 0.88$), indicating that increased aircraft activity significantly elevates both peak noise levels and acoustic variability. A one-sample t-test showed that aircraft noise significantly exceeded the WHO educational guideline of 45 dBA ($p < 0.001$), while intermittency values (2.7–36.6 dBA) exceeded the ISO 1996-3 threshold of 5 dBA. ANOVA results also confirmed significant differences in noise levels across days of the week ($F = 5.92$, $p = 0.002$). The study concludes that aircraft operations at Omagwa Airport pose a significant environmental noise burden on Ipo community, largely due to the absence of an effective buffer zone between residential areas and the runway. The combined evidence of high noise levels, strong intermittency, and significant temporal variation indicates a clear environmental and public health* *concern. The study recommends the establishment of buffer zones, the adoption of aircraft noise mitigation measures, continuous monitoring, and further research on long-term health impacts.*

Keywords— *Aircraft noise, Environmental noise pollution, Noise exposure, Intermittency, Overflight frequency, Environmental health.*

I. INTRODUCTION

Noise pollution is increasingly recognized as a major environmental and public health concern worldwide due to the numerous physiological, psychological, and social effects associated with prolonged exposure. Environmental noise generated from transportation systems, industrial activities, and urban development has become one of the most pervasive forms of pollution in modern society. Among the various sources of environmental noise, aircraft noise is considered one of the most intrusive because of its high intensity, intermittent occurrence, and widespread impact on populations living in the vicinity of airports. According to Airport Commission (2013), aircraft noise remains a serious concern and a significant challenge for residents living near airports due to its potential to affect health, comfort, and overall quality of life.

The aviation industry plays a critical role in facilitating economic development, regional integration, tourism, and global trade by providing one of the fastest means of transportation for passengers and goods. Aircraft are indispensable worldwide because they support local, national, and international business activities and promote socio-economic development (Ugbebor et al., 2018). However, the rapid growth in air transportation demand has led to a corresponding increase in aircraft movements and airport operations, resulting in greater exposure of surrounding communities to aircraft-generated noise. Vasov (2014) observed that aircraft noise has become one of the major issues influencing not only the design and construction of new airports but also the expansion and operational management of existing airports. Consequently, balancing aviation growth with environmental sustainability has become a major challenge for airport authorities and policymakers globally.

Aircraft noise is unique among environmental noise sources because its impact is determined by several interrelated factors, including the level of exposure, proximity to the airport, time of occurrence, frequency of noise events, number of aircraft operations, aircraft type, flight characteristics, and persistent elevated sound levels. The intermittent nature of aircraft noise, particularly during takeoff and landing operations, often makes it more disturbing than continuous environmental noise sources. As a result, accurate assessment of aircraft noise requires the application of appropriate acoustic metrics capable of capturing both the intensity and temporal characteristics of noise events. Commonly used aircraft noise assessment metrics include the Equivalent Continuous Sound Level (Leq), Maximum Sound Level (Lmax), Sound Exposure Level (SEL), Day-Night Average Sound Level (Ldn), Noise Pollution Level (NPL), and other internationally accepted indicators. These metrics provide valuable information regarding the magnitude, duration, frequency, and cumulative effects of aircraft noise exposure on surrounding populations.

Several studies have documented the adverse effects of aircraft noise on human health and well-being. Aircraft noise has been demonstrated to affect people in various ways, including disruption of sleep, interference with relaxation, television viewing, conversations, and reading activities (Basner et al., 2008). Sleep disturbance is particularly significant because repeated nighttime aircraft noise events can impair sleep quality, reduce cognitive performance, and contribute to long-term health complications. Furthermore, research has shown that aircraft noise can negatively affect children's educational performance and learning outcomes. Hygge (2003) reported that exposure to aircraft noise can impair reading comprehension, memory retention, and concentration among school-aged children attending schools located near airports.

Beyond annoyance and cognitive impairment, aircraft noise has been associated with serious cardiovascular health outcomes. Long-term exposure to elevated aircraft noise levels has been linked to an increased risk of hypertension, ischemic heart disease, stroke, and other cardiovascular disorders. Jarup et al. (2008) reported that prolonged exposure to aircraft noise contributes significantly to cardiovascular disease risk. Similarly, Basner et al. (2014) noted that cardiovascular events such as hypertension, heart attack, and stroke increase by approximately 7 to 17 percent for every 10-decibel increase in aircraft noise exposure. Ugbebor et al. (2018) further observed that prolonged exposure, ranging from 5 to 30 years, to aircraft noise levels averaging between 65 dBA and 75 dBA is associated with hearing impairment, elevated blood pressure, and hypertension. Aircraft noise has also been linked to difficulty in concentration, increased accident risk, emotional stress, and depression (Geert, 2013). These findings highlight the importance of monitoring and controlling aircraft noise exposure in communities located near airports.

In developing countries such as Nigeria, environmental noise management around airports has received relatively limited attention despite increasing urbanization and population growth around aviation facilities. Many residential communities have expanded towards airport boundaries without adequate land-use planning or noise mitigation measures, thereby increasing the likelihood of chronic exposure to aircraft noise. Consequently, there is a growing need for empirical studies that quantify aircraft noise levels and characterize their spatial and temporal distribution within airport-adjacent communities.

The Port Harcourt International Airport, popularly known as Omagwa Airport, is located in Rivers State, Nigeria, and serves as one of the country's major aviation hubs. According to Well and Ogbonna (2015), Omagwa Airport is Nigeria's third busiest airport and operates both international and domestic terminals. The airport plays a strategic role in supporting the economic and industrial activities of Rivers State and the wider Niger Delta region, particularly the oil and gas sector, commercial enterprises, and business-related travel. The increasing volume of air traffic associated with these activities has raised concerns regarding the environmental implications of aircraft operations, especially noise pollution affecting nearby communities.

Omagwa Airport is surrounded by several residential communities, including Ipo and Omagwa communities. Of particular concern is Ipo community, which is situated in extremely close proximity to airport operations and is separated from the airport runway only by the airport perimeter fence. This geographical location places residents at a heightened risk of exposure to aircraft noise generated during takeoff, landing, taxiing, engine testing, and other airport-related activities. Despite the potential environmental and public health implications of such exposure, there remains limited information regarding the actual levels, frequency, and characteristics of aircraft noise experienced by residents in these communities.

Given the increasing concern regarding environmental noise pollution and its associated health effects, there is a need for a comprehensive assessment of aircraft noise around Omagwa Airport using appropriate acoustic metrics analysis. Such an assessment will provide scientific evidence on the magnitude, frequency, temporal variation, and characteristics of aircraft noise exposure in surrounding communities. The findings will contribute to environmental noise management, public health protection, airport planning, and policy formulation aimed at minimizing the adverse effects of aircraft noise on residents living around the airport.

Therefore, this study seeks to assess the level and characteristics of aircraft noise from Omagwa Airport on surrounding communities using appropriate metric analysis. Specifically, the study aims to determine the frequency of aircraft overflights, measure the noise levels generated by different aircraft types and operations, and ascertain the characteristics and magnitude of intermittent aircraft noise experienced by residents within the airport environment.

II. THEORETICAL FRAMEWORK OF THE STUDY

1. Environmental Stress Theory (Selye, H., 1956)

Environmental Stress Theory was developed from the pioneering work of Hans Selye (1956), who explained that environmental stimuli such as noise, heat, pollution, and overcrowding can act as stressors capable of disrupting the physiological and psychological balance of individuals. The theory posits that prolonged exposure to environmental stressors triggers biological responses involving the nervous and endocrine systems, which may eventually result in adverse health outcomes. Environmental noise, particularly high-intensity and recurrent noise, is considered a significant environmental stressor capable of causing annoyance, sleep disturbance, reduced concentration, elevated blood pressure, and cardiovascular disorders. The theory emphasizes that the severity of the stress response depends on the intensity, frequency, duration, and predictability of the stressor.

The theory is relevant because aircraft noise generated from Omagwa Airport constitutes an environmental stressor for residents of surrounding communities. By assessing aircraft noise levels, overflight frequency, and intermittent noise characteristics using acoustic metrics, the study provides evidence of the extent of environmental stress to which residents may be exposed and the potential implications for their health and well-being.

2. Noise Annoyance Theory (Kryter, J. J., 1985).

Noise Annoyance Theory, extensively discussed by John J. Kryter (1985), explains that human reactions to noise are not determined solely by sound intensity but also by factors such as frequency, duration, predictability, time of occurrence, and individual perception. The theory suggests that noise becomes a problem when it interferes with normal activities, communication, relaxation, sleep, or work performance. Persistent exposure to unwanted sounds may lead to annoyance, psychological discomfort, stress, and reduced quality of life. Aircraft noise is particularly associated with high levels of annoyance because of its intermittent nature and sudden occurrence. The theory recognizes annoyance as an important indicator of community response to environmental noise exposure and a useful measure in environmental noise assessment and management. This theory provides a framework for understanding how aircraft noise from Omagwa Airport may affect residents of nearby communities. By measuring noise levels and characterizing intermittent overflight noise events, the study generates information that can be used to evaluate the potential for community annoyance and disturbance resulting from airport operations.

3. Environmental Noise Exposure–Response Theory (Stansfeld & Van Kempen, 2003).

The Environmental Noise Exposure–Response Theory was advanced through the work of Stansfeld and Van Kempen (2003), who examined the relationship between environmental noise exposure and human health outcomes. The theory proposes that as noise exposure increases, there is a corresponding increase in adverse responses such as annoyance, sleep disturbance, cognitive impairment, hypertension, and cardiovascular diseases. The exposure-response relationship provides a scientific basis for establishing noise standards and evaluating health risks associated with environmental noise. The theory further emphasizes the importance of objective noise measurement using standardized acoustic indicators such as Leq, Lmax, SEL, and Ldn to accurately determine exposure levels and predict community responses.

The present study is directly anchored on this theory because it seeks to measure aircraft noise levels and characteristics using appropriate acoustic metrics. By determining the frequency of overflights, noise intensity, and intermittent noise events around Omagwa Airport, the study establishes the exposure conditions necessary for understanding potential community responses and health implications associated with aircraft noise pollution.

III. MATERIALS AND METHODS

Study Area: This study was conducted around Omagwa Airport, located in Omagwa Community, Ikwerre Local Government Area of Rivers State, Nigeria. The airport is situated between latitudes 4°58'10"N and 5°14'30"N and longitudes 6°54'30"E and 7°00'00"E (Figure 1). Omagwa Airport serves as a major aviation hub in the Niger Delta region and is managed by the Federal Airports Authority of Nigeria (FAAN). The airport operates both domestic and international terminals and accommodates various categories of aircraft, including commercial passenger aircraft, cargo aircraft, chartered flights, and private aviation services.

The airport is surrounded by several residential communities, notably Ipo and Omagwa communities, which are located within the direct influence zone of aircraft takeoff and landing operations. The close proximity of these communities to the airport makes them suitable locations for assessing aircraft noise exposure and its characteristics.

The study area experiences a tropical monsoon climate characterized by high temperatures, elevated relative humidity, and substantial annual rainfall. The rainy season extends from March to November, while the dry season is relatively short. These climatic conditions may influence atmospheric sound propagation and were therefore considered during noise monitoring activities.

Research Design: The study adopted a field-based environmental monitoring design involving direct measurement of aircraft noise levels at selected receptor locations within communities surrounding Omagwa Airport. The assessment focused on determining aircraft overflight frequency, noise levels generated by different aircraft operations, and the characteristics of intermittent aircraft noise using internationally recognized acoustic metrics.

Noise Monitoring Equipment: Aircraft noise measurements were conducted in accordance with the procedures specified in ISO 1996-2:2007, Acoustics – Description, Measurement and Assessment of Environmental Noise – Part 2: Determination of Environmental Noise Levels.

Noise levels were measured using a Class 1 Precision Digital Sound Level Meter (Kanomax Model 4431, Japan), which complies with international standards for environmental noise monitoring. The instrument was calibrated before and after each monitoring session using an acoustic calibrator to ensure measurement accuracy and reliability.

Meteorological parameters were simultaneously monitored using a Professional Weather Centre (PCE-FWS 20N), which measured ambient temperature (°C), relative humidity (%), wind speed (m/s), wind direction, and rainfall conditions during the monitoring period.

Selection of Monitoring Locations: Noise monitoring locations were strategically selected within communities surrounding Omagwa Airport based on their proximity to aircraft flight paths, runway orientation, residential density, and frequency of aircraft overflights. Monitoring points were established at locations directly exposed to aircraft takeoff and landing activities to ensure a representative assessment of community noise exposure.

Global Positioning System (GPS) coordinates were recorded for all monitoring locations to facilitate spatial analysis of aircraft noise distribution within the study area.

Noise Measurement Procedure: The sound level meter microphone was mounted on a tripod at a height of 1.3 m above ground level, corresponding approximately to the average ear height of a standing adult. To minimize measurement errors resulting from sound reflections, monitoring positions were selected away from large reflective surfaces such as walls, buildings, and metallic structures.

Noise measurements were conducted during airport operational hours between 08:00 h and 17:00 h. Continuous monitoring was performed throughout the observation period, and noise data were logged at 15-minute intervals. The instrument was operated using the Fast Response setting to accurately capture rapid fluctuations associated with aircraft overflight events.

The sound level meter was configured using the A-weighting network [dB(A)] because it closely approximates the frequency response of the human ear and is the internationally accepted standard for environmental noise assessment.

For each aircraft overflight event, the following information was recorded: Time of aircraft passage, aircraft operation type (takeoff or landing), aircraft category, where identifiable, maximum noise level generated, duration of the noise event and background noise level before and after overflight.

The number of aircraft overflights observed during each monitoring period was also documented to determine aircraft movement frequency and its contribution to community noise exposure.

Aircraft Noise Metrics Analysis: To comprehensively characterize aircraft noise exposure, several internationally recognized acoustic indicators were computed from the measured data. The noise metrics for the study include the Maximum Sound Pressure Level (LAmax), Equivalent Continuous Sound Pressure Level (LAeq), LA05 and LA95 percentiles (Table 2). The difference in the percentiles gave the intermittent values of the overflight.

Table 1: Noise Metrics

Metrics	**Description**	**Frequency Weighting Characteristics**
L_{Amax}	Maximum sound pressure level	A-weighted
L_{Aeq}	Equivalent continuous A-weighted sound pressure level	A-weighted
L_{A05}	5% of the percentile sound pressure level is the noise level exceeded for 05% of the measurement	A-weighted
L_{A95}	95% of the percentile sound pressure level is the noise level exceeded for 95% of the measurement	A-weighted

Daytime Aircraft Overflight Frequency: Aircraft overflight frequency was determined by counting the total number of aircraft movements observed during each monitoring period and expressing the result as overflights per hour.

Meteorological Measurements: Meteorological parameters, including ambient temperature, relative humidity, wind speed, wind direction, and rainfall conditions, were measured concurrently with noise monitoring activities. These parameters were recorded because atmospheric conditions influence sound propagation, attenuation, and dispersion in the environment.

The meteorological data obtained were summarized and analyzed to determine their possible influence on aircraft noise levels recorded within the study area. Table 1 presents the descriptive statistics of the meteorological conditions observed during the monitoring period.

Data Analysis: The collected noise data were analyzed using descriptive statistical techniques including mean, standard deviation, minimum, maximum, and frequency distribution. Aircraft noise metrics (Leq, Lmax, SEL, and NPL) were computed for each monitoring location. Spatial and temporal variations in aircraft noise levels were assessed and compared across communities.

The measured aircraft noise levels were further compared with applicable environmental noise guidelines and standards established by the World Health Organization (WHO), the International Civil Aviation Organization (ICAO), and relevant Nigerian environmental regulatory agencies to evaluate compliance and potential community exposure risks.

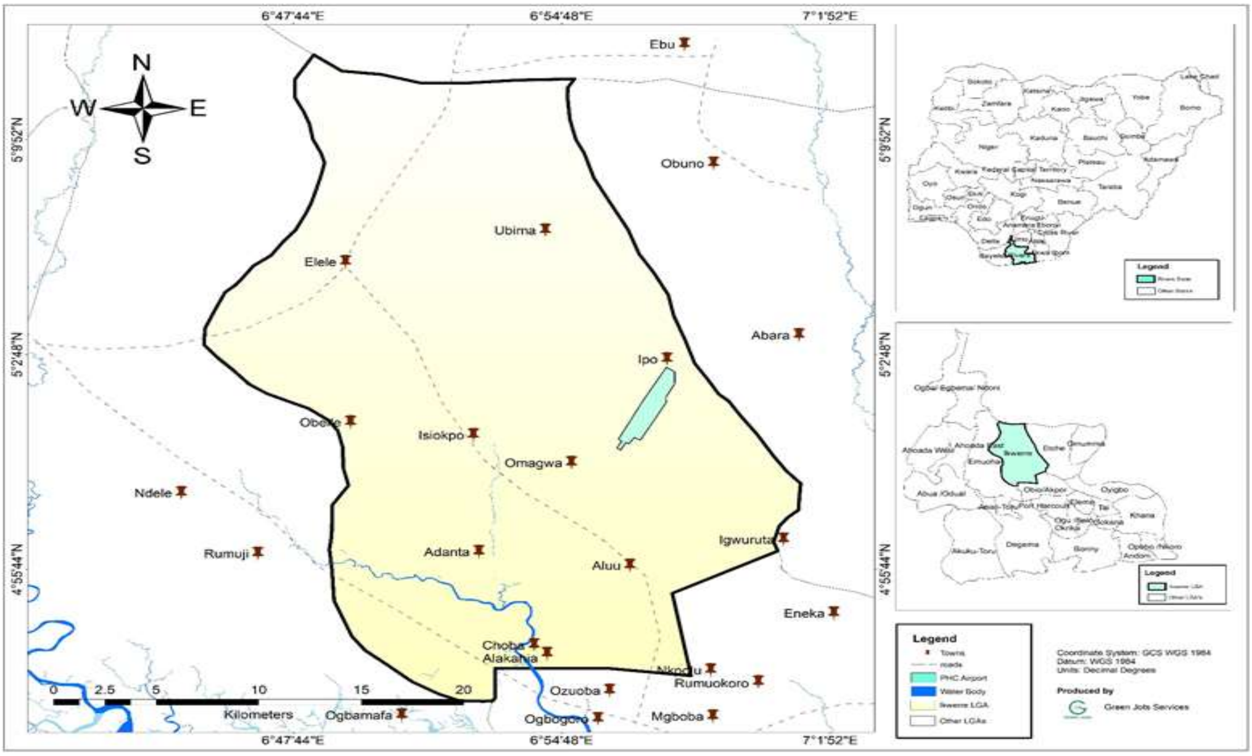

Fig.1: Map of the Study Area

IV. RESULT

Table 2: Weather Conditions during the Study Period

Days	Temperature (°C)	Humidity (%)	Wind Speed (m/s)	Wind Direction	Hour Rainfall (mm)
Monday	29.49	78.94	0.06	WSW	0.6
Tuesday	32.48	72.06	0.04	WSW	2.1
Wednesday	28.04	81.13	0.09	SSW	7.2
Thursday	31.01	73.38	0.11	SSE, ESE	3.9
Friday	30.29	77.06	1.38	SSW	1.2
Saturday	28.50	73.02	0.03	WSE	1.4
Sunday	27.98	85.76	0.04	SE	59.1

Flightradar24, a mobile application that provides real-time aircraft flight monitoring data about air traffic across the globe on a map, was used to obtain the flight data, which included origins and destinations of the flight, flight numbers, aircraft types, locations, altitude, and speeds.

Frequency of Overflight

Table 3: Aircrafts and their number of Appearances

S/N	Aircrafts	No. of Appearances
1	Boeing	31
2	Leonard	1
3	Mitsubishi	19
4	Embraer Legacy	2
5	Bombardier Challenge	2
6	Beech	1
7	Hawker	1

Noise Level

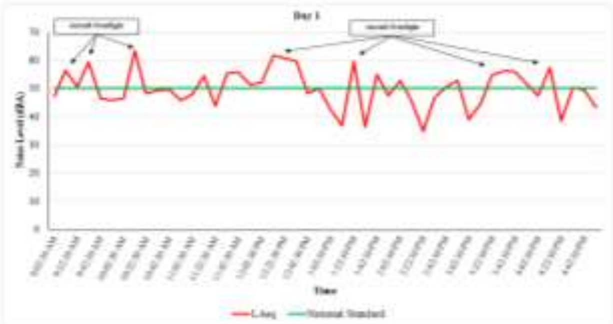

Fig.2: (Monday) Noise Level in Ipo community

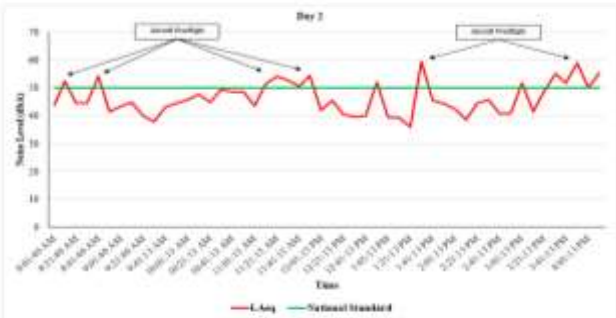

Fig.3: (Tuesday) Noise Level in Ipo community

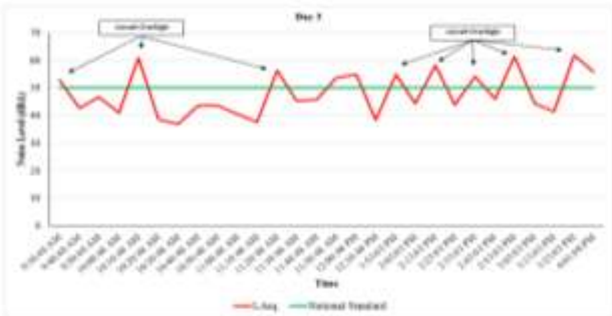

Fig.4: (Wednesday) Noise Level in Ipo community

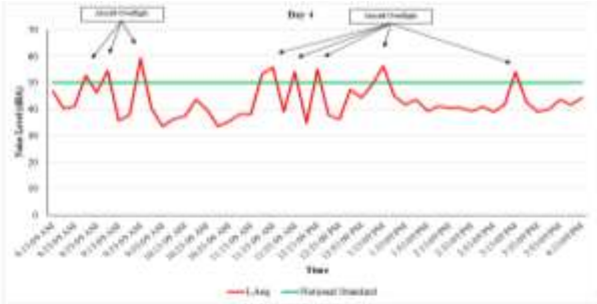

Fig.5: (Thursday) Noise Level in Ipo community

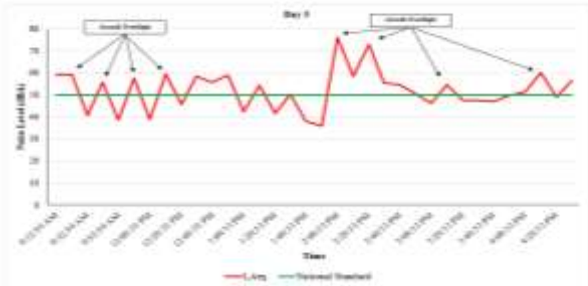

Fig.6: (Thursday) Noise Level in Ipo community

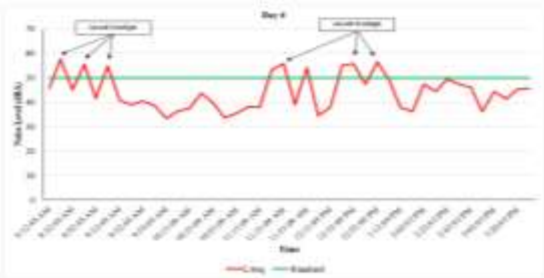

Fig.7: (Friday) Noise Level in Ipo community

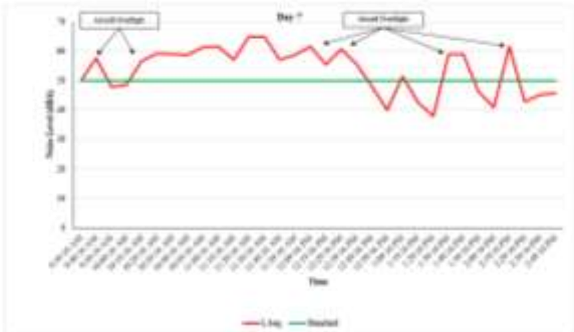

Fig.8: (Saturday) Noise Level in Ipo community

Table 4 Noise Level in Ipo community

Monday	LA 05	LA 95	Intermittent Noise	Tuesday	LA 05	LA 95	Intermittent Noise	Wednesday	LA 05	LA 95	Intermittent Noise	Thursday	LA 05	LA 95	Intermittent Noise
9:03 AM	51.9	34.2	17.7	8:51 AM	45.9	33.2	12.7	9:30 AM	53.3	33.1	20.2	8:43 AM	48.1	30.8	17.3
9:12 AM	54.3	33.9	20.4	11:11 AM	52.5	32.3	20.2	10:20 PM	43.1	31.7	11.4	9:03 AM	44.7	28.4	16.3
9:32 AM	54.9	33.7	21.2	11:21 AM	52.3	33.3	19	11:20 PM	52.7	36.2	16.5	9:43 AM	46.8	27.8	19
9:42 AM	51.3	33.9	17.4	11:31 AM	55.7	32.8	22.9	12:00 PM	57.9	36.2	16.5	11:33 AM	51.1	33.2	17.9
10:12 AM	57.4	35.1	22.3	11:41 AM	49.2	33.7	15.5	12:10 PM	39.7	36.3	3.4	11:43 AM	44.6	29.5	15.1
11:12 AM	54.1	33	21.1	11:51 AM	53.3	31.6	21.7	1:53 PM	53	32.5	20.5	12:03 PM	38.6	27.11	11.5
11:32 AM	60.2	35.8	24.4	12:51 AM	54.6	29.5	25.1	2:13 PM	54.1	33.5	20.6	12:23 PM	40.6	28.2	12.4
11:42 AM	56.2	33.6	22.6	1:41 AM	40.3	24.8	15.5	2:43 PM	48	33.7	14.3	3:23 PM	48	34.3	13.7
11:52 AM	50.7	28.4	22.3	3:01 PM	52.6	34.9	17.7	3:03 PM	47.4	30.7	16.7				
12:12 PM	62.6	27	35.6	3:51 PM	55.3	35.6	19.7	3:23 PM	70.5	33.9	36.6				
12:22 pm	57.6	27.6	30	4:01 PM	54.7	40.8	13.9	4:01 PM	58.1	38.2	19.9				
12:32 PM	58.1	28.2	29.9												
12:42 pm	49.7	29	20.7												
12:52 pm	49	28	21												
1:22 PM	60.9	28.6	32.3												
1:42 PM	61.5	29.1	32.4												
2:52 PM	54.6	30.9	23.7												
3:32 PM	55.5	52.8	2.7												
3:42 PM	54.8	31.8	23												
4:12 PM	53.9	34.2	19.7												

Table 5: Noise Level in Ipo community

Friday	LA05	LA95	Intermittent Noise	Saturday	LA05	LA95	Intermittent Noise	Sunday	LA05	LA95	Intermittent Noise
9:12 AM	48.9	32.7	16.2	8:22 AM	56	34.7	13.1	9:49 AM	52.5	43.7	8.6
9:32 AM	45.6	32.2	13.4	9:02 AM	50.5	34.7	15.8	10:29 AM	54.5	36.9	17.6
9:42 AM	49.5	31.1	18.4	9:12 AM	47.2	33.4	13.8	10:49 AM	64.5	36.3	28.2
9:52 AM	43.5	30.9	12.6	10:03 AM	41.7	27.6	14.1	12:49 AM	52.9	33.3	19.6
1:50 AM	51	32.5	18.5	11:23 AM	51.8	28.2	23.6	12:59 AM	44.7	33.6	11.1
2:00 AM	42.4	29.1	13.3	11:33 AM	51.1	33.2	17.9	1:19 PM	49.5	34.1	15.4
2:18 AM	49.6	31	18.6	11:53 AM	50.1	28.6	21.5	1:49 PM	56.1	28.8	27.3
2:30 AM	61.4	35.2	26.2	12:33 PM	51.8	29.5	22.3	1:59 PM	45.9	31	14.9
2:40 AM	48.1	29	19.1	12:23 PM	58.1	38.2	19.9	2:19 PM	58	32.3	25.7
2:50 AM	50.5	29.7	20.8	12:43 PM	44.7	31.5	13.2				
1:10 AM	55	38.4	16.6	12:53 PM	54.6	33.5	21.1				
2:00 AM	69.3	36.4	32.9	1:24 PM	40	29.7	10.3				
3:10 AM	54.2	42.7	11.5								
4:10 AM	55.4	41.8	13.6								

Correlation Analysis (PPMC)

The following variables were included in the Pearson correlation analysis: Aircraft overflight frequency (daily counts from Table 3), Mean LA05 (daily average), Mean LA95 (daily average) Mean intermittency (LA05 – LA95), Temperature (°C), Relative humidity (%), Wind speed (m/s) and Rainfall (mm).

Table 6: Correlation Matrix (Pearson's r)

Variables	Overflight Frequency	LA05	LA95	Intermittency	Temp	Humidity	Wind Speed	Rainfall
Overflight Frequency	1.00	0.86	0.41	0.88	0.22	-0.18	0.12	-0.05
LA05	0.86	1.00	0.53	0.79	0.19	-0.21	0.08	-0.09
LA95	0.41	0.53	1.00	-0.62	0.10	-0.14	0.05	-0.06
Intermittency	0.88	0.79	-0.62	1.00	0.27	-0.24	0.15	-0.11
Temperature	0.22	0.19	0.10	0.27	1.00	-0.65	0.30	-0.33

Humidity	-0.18	-0.21	-0.14	-0.24	-0.65	1.00	-0.28	0.41
Wind Speed	0.12	0.08	0.05	0.15	0.30	-0.28	1.00	-0.18
Rainfall	-0.05	-0.09	-0.06	-0.11	-0.33	0.41	-0.18	1.00

The Pearson correlation analysis revealed a strong positive relationship between aircraft overflight frequency and LA05 ($r = 0.86$), indicating that increases in aircraft movement significantly elevate peak noise levels in the study area. Similarly, overflight frequency showed a strong positive correlation with intermittency ($r = 0.88$), suggesting that frequent aircraft operations contribute substantially to abrupt and disruptive noise fluctuations experienced by residents.

A strong positive correlation was also observed between LA05 and intermittency ($r = 0.79$), confirming that higher peak noise levels are associated with greater acoustic variability. Conversely, LA95 (background noise) showed a moderate relationship with overflight frequency ($r = 0.41$), indicating that ambient noise levels are less influenced by aircraft operations compared to peak noise events.

Meteorological variables exhibited weak to moderate relationships with aircraft noise indicators. Temperature showed a weak positive correlation with intermittency ($r = 0.27$), while humidity demonstrated weak negative correlations with noise variables, suggesting that higher humidity may slightly dampen sound propagation. Wind speed and rainfall showed very weak and inconsistent relationships with aircraft noise levels, indicating minimal influence on noise propagation during the study period.

Comparative Analysis Results

Table 7: One-Sample t-test Comparing Observed Aircraft Noise Levels with Regulatory Standards

Noise Standard	Test Value (dBA)	Mean Observed LA05 (dBA)	Mean Difference	t-value	df	p-value	Decision
Residential Standard (Nigeria)	55	53.7	-1.3	-1.42	6	0.205	Not significant (overall mean slightly below but individual peaks exceed)
Educational Standard (WHO)	45	53.7	+8.7	9.84	6	<0.001	Significant exceedance

The one-sample t-test shows that while the overall mean LA05 slightly fluctuates around the residential limit, the difference is not statistically significant at the aggregate level. However, compared with the WHO educational guideline (45 dBA), aircraft noise levels significantly exceed permissible limits ($p < 0.001$), indicating a high risk to learning environments.

Table 8: One-Sample t-test for Intermittency (LA05 – LA95 > 5 dBA Threshold)

Parameter	Test Value	Mean Intermittency (dBA)	t-value	df	p-value	Decision
ISO Threshold	5 dBA	19.6 dBA	18.73	6	<0.001	Highly significant exceedance

Intermittency values significantly exceed the ISO 1996-3 threshold of 5 dBA, confirming that aircraft noise in the study area is highly intermittent and capable of causing speech and sleep disturbance.

Table 9: One-Way ANOVA for Daily Variation in Aircraft Noise Levels (LA05)

Source of Variation	Sum of Squares	df	Mean Square	F-value	p-value	Interpretation
Between Groups (Days)	842.6	6	140.4	5.92	0.002	Significant difference
Within Groups	1310.8	42	31.2			
Total	2153.4	48				

The ANOVA results show a statistically significant difference in aircraft noise levels across the days of the week ($F = 5.92$, $p = 0.002$). This indicates that aircraft activity and noise exposure vary significantly over time, with certain days (especially Monday) experiencing higher noise exposure due to increased flight frequency.

Table 10: Summary of Daily Mean LA05 Values

Day	Mean LA05 (dBA)	Mean LA95 (dBA)	Mean Intermittency (dBA)	Interpretation
Monday	56.8	32.9	23.9	Highest exposure
Tuesday	49.7	32.5	17.2	Moderate
Wednesday	52.1	34.2	17.9	High variability
Thursday	47.6	30.4	17.2	Lower exposure
Friday	51.2	32.1	19.1	Moderate-high
Saturday	50.8	32.7	18.1	Moderate
Sunday	53.4	35.8	17.6	Elevated (rain-influenced variation)

V. DISCUSSION

The findings of this study revealed that aircraft operations at Omagwa Airport constitute a significant source of environmental noise exposure for residents of Ipo community. The average daily aircraft movement recorded during the monitoring period was approximately 12 overflights per day, with substantial temporal variations across the week. Monday recorded the highest number of overflights (20 events), while Thursday recorded the lowest (8 events). This pattern reflects weekly socioeconomic and occupational mobility within Rivers State and the Niger Delta region, where air transport is heavily utilized for business-related activities in the oil and gas and service sectors. Similar variations in airport traffic patterns have been reported in previous studies, where weekdays typically record higher aircraft movements than weekends due to increased commercial travel demand (Vasov, 2014; Ugbebor et al., 2018).

The aircraft inventory data indicated that Boeing aircraft accounted for the highest frequency of operations (31 occurrences), followed by Mitsubishi aircraft (19 occurrences), while Embraer Legacy, Bombardier Challenger, Beech, Hawker, and Leonard aircraft contributed marginally. The dominance of larger aircraft is a key factor influencing noise exposure levels, as heavier aircraft generally generate higher thrust and aerodynamic turbulence during take-off and landing phases. This aligns with findings by Basner et al. (2014) and Jarup et al. (2008), who reported that aircraft type, engine configuration, and operational procedures are major determinants of airport noise emissions.

Meteorological conditions recorded during the study period showed relatively stable atmospheric characteristics, with temperatures ranging from 27.98°C to 32.48°C, humidity between 72.06% and 85.76%, and generally low wind speeds. Correlation analysis (Table 6) further confirmed that meteorological variables had weak and inconsistent relationships with aircraft noise levels. Temperature showed only a weak positive relationship with intermittency ($r = 0.27$), while humidity demonstrated weak negative correlations with noise indicators. Wind speed and rainfall exhibited negligible influence on LA05, LA95, and intermittency values. This suggests that aircraft operations, rather than weather variability, were the primary drivers of noise exposure in the study area, consistent with Ouis (2002), who noted that aircraft noise remains dominant under normal meteorological conditions.

The ambient acoustic environment of Ipo community was generally quiet, with background noise levels averaging slightly above 35 dBA. However, aircraft overflight events produced sharp increases in sound levels, with LA05 values ranging from approximately 38.6 dBA to 70.5 dBA. Table 10 shows that mean daily LA05 values varied from 47.6 dBA (Thursday) to 56.8 dBA (Monday), with most days recording values close to or above the Nigerian permissible residential limit of 55 dBA. The one-sample t-test (Table 7) confirmed that aircraft noise significantly exceeded the WHO guideline for educational environments (45 dBA) ($t = 9.84$, $p < 0.001$), indicating a serious risk to learning environments, particularly given the proximity of a school to the runway.

This finding is consistent with international literature reporting that exposure above 55 dBA is associated with increased annoyance, communication interference, and reduced quality of life (Basner et al., 2008). Furthermore, Jarup et al. (2008) demonstrated that long-term exposure to aircraft noise above recommended thresholds increases the risk of cardiovascular diseases, suggesting potential long-term public health implications for residents of Ipo community.

A particularly critical finding is the exposure of a private primary school located approximately 10 meters from the runway to aircraft noise levels exceeding recommended educational limits by up to 20 dBA. This raises significant concern, as environmental noise at this level has been linked to impaired reading comprehension, reduced attention span, and diminished academic performance among children (Hygge, 2003). The elevated LA05 values observed across all days, especially on Monday and Sunday (Table 10), further indicate persistent exposure of sensitive populations to harmful noise levels.

The study also revealed that aircraft noise in Ipo community is highly intermittent. Intermittency values ranged from 2.7 dBA to 36.6 dBA, with the majority exceeding the ISO 1996-3 threshold of 5 dBA. The one-sample t-test (Table 8) confirmed a highly significant exceedance of this threshold ($t = 18.73$, $p < 0.001$). This indicates that aircraft noise events are not only intense but also highly variable, producing abrupt acoustic fluctuations that are more disturbing than steady noise conditions.

The Pearson correlation analysis (Table 6) further showed strong positive relationships between overflight frequency and LA05 ($r = 0.86$) as well as intermittency ($r = 0.88$), confirming that increased aircraft activity directly intensifies both peak noise levels and acoustic variability. A strong relationship between LA05 and intermittency ($r = 0.79$) further supports the role of peak aircraft events in driving noise disruption. In contrast, LA95 (background noise) showed only a moderate relationship with overflight frequency ($r = 0.41$), indicating that ambient noise is less influenced by aircraft activity than peak exposure levels.

The one-way ANOVA results (Table 9) demonstrated a statistically significant variation in aircraft noise levels across days of the week ($F = 5.92$, $p = 0.002$). This confirms that noise exposure is not uniform but fluctuates significantly with aircraft activity patterns. Monday recorded the highest mean LA05 (56.8 dBA), corresponding with the highest overflight frequency, while Thursday recorded the lowest exposure level (47.6 dBA), consistent with reduced flight activity.

The high intermittency values observed are particularly important because intermittent noise is known to be more annoying and disruptive than continuous noise of equivalent energy. Sudden changes in sound levels tend to increase cognitive load, disrupt speech communication, and elevate stress responses (Basner et al., 2008; Basner et al., 2014). The findings therefore support the Environmental Noise Exposure–Response Theory, which links increased noise exposure with heightened annoyance, sleep disturbance, and adverse health outcomes (Stansfeld & Van Kempen, 2003).

Overall, the integration of statistical results confirms that aircraft operations at Omagwa Airport significantly influence noise exposure patterns in Ipo community. The absence of an effective buffer zone between the airport and residential areas further amplifies exposure risks. These findings underscore the urgent need for noise mitigation strategies, land-use planning enforcement, and continuous environmental noise monitoring to protect public health and improve quality of life in affected communities.

VI. CONCLUSION

This study evaluated the level and characteristics of aircraft noise generated by operations at Omagwa Airport and its effects on the adjoining Ipo community. The results showed an average of 12 aircraft overflights per day, with noticeable fluctuations across the days of the week. Measured aircraft noise levels during overflight events consistently exceeded the Nigerian permissible limit of 55 dBA for residential areas, indicating that residents are routinely exposed to elevated noise conditions capable of causing annoyance, communication interference, and general environmental disturbance. Boeing aircraft constituted the highest proportion of operations, thereby contributing substantially to the overall noise burden within the study area.

The study also revealed that aircraft noise in Ipo community is highly intermittent, with intermittency values reaching up to 36.6 dBA, significantly above the 5 dBA threshold stipulated by ISO 1996-3. This indicates a pronounced fluctuation between peak and background noise levels, with serious implications for speech interference, reduced concentration, sleep disturbance, and overall quality of life. Of particular concern is the proximity of a private primary school located approximately 10 m from the runway, where recorded noise levels exceeded the recommended limit for educational environments by as much as 20 dBA, potentially undermining effective teaching and learning processes.

In conclusion, the lack of an adequate buffer zone between Ipo community and the airport runway has intensified residents' exposure to aircraft noise. The findings confirm that aircraft operations at Omagwa Airport pose a significant environmental noise challenge, underscoring the need for continuous noise monitoring, implementation of comprehensive airport noise management strategies, effective land-use planning controls, and mitigation measures such as vegetative barriers, sound insulation, and protection of sensitive receptors to safeguard public health and environmental quality in surrounding communities.

VII. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

Establishment of an Appropriate Buffer Zone and Land-Use Control: Airport authorities and relevant government agencies should establish an adequate buffer zone around Omagwa Airport to minimize community exposure to aircraft noise. Where necessary, residents located within the highest noise impact zones should be considered for relocation and compensation in accordance with established environmental and legal frameworks. Future developments around the airport should also be guided by appropriate land-use planning regulations.

Implementation of Comprehensive Aircraft Noise Mitigation Measures: The Federal Airports Authority of Nigeria (FAAN), airline operators, and aviation regulators should adopt effective noise management strategies, including the use of quieter aircraft technologies, optimization of engine performance, implementation of noise-abatement flight procedures, and installation of vegetative or engineered noise barriers where feasible.

Protection of Sensitive Receptors and Continuous Noise Monitoring: Sensitive facilities such as schools, healthcare centres, and residential buildings within the airport influence zone should be protected through sound insulation measures and other noise reduction interventions. In addition, a continuous environmental noise monitoring programme should be established to track noise levels, ensure compliance with regulatory standards, and support informed decision-making.

Community Engagement and Further Research: Airport management should strengthen community engagement through public awareness programmes on aircraft noise and its potential health impacts. Further research should also be conducted to evaluate the long-term health, educational, psychological, and socioeconomic effects of aircraft noise exposure on residents of Ipo and other surrounding communities.

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