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# Noise in the City: A Socio-Spatial Analysis of the Actual and Perceived Noise Levels in a Medium-Sized Urban Center

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**ABSTRACT**
Despite substantial systematic studies on noise pollution, studies relating actual noise levels to perceived noise pollution in the context of rapidly urbanizing medium-sized cities of the Global South are scarce. This study examined the perceived impact of noise pollution on the health of residents of Osogbo, Southwest Nigeria. It used a cross-sectional research design that included direct field observation to obtain noise levels and a questionnaire survey to assess residents' perceptions of acoustic disturbance in the study area's residential, commercial, and mixed land uses. Ambient noise levels were significantly higher during the day and night in residential, commercial, and mixed land uses than the WHO-prescribed maximums. Significant variations between different land uses were observed. More than 80% of the respondents perceived their neighborhoods as noisy, indicating a convergence between actual and perceived noise levels. Respondents scored power generators (22.1%), transportation (21.7%), worship places (20.3%), and markets and clubs (14.7%) as important sources of ambient noise pollution. Sleep loss (72.3%), hearing impairment (64.3%), and aggravation of hypertensive ailments (54%) were the acute effects of noise pollution. Few respondents claimed to be aware of the efforts of the government (34%) and neighborhood associations (28%) to stem the escalating rate of noise pollution. Enforcing environmental laws on noise reduction and advocacy that provokes noise-abating behavioral changes among residents could help curb noise pollution in the city.
**Keywords:** Medium-sized urban centers, noisescape, noise abatement, city's livability, ambient noise levels

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## INTRODUCTION

Noise pollution is aptly defined as the intrusion of unwanted, uncontrollable, and unpredictable sounds, not necessarily loud (Jariwala et al., 2017), into the lives of individuals with reasonable sensitivities. It remains an environmental problem of no mean significance in both developing and developed countries' urban centers (Fiedler & Zannin, 2015; Mehdi et al., 2011; Oyedepo & Saadu, 2010). The increased population, attendant urbanization, and industrialization are primarily responsible for the rising incidence and ubiquity of noise pollution worldwide (Ma, Li, and Kwan, 2018; Reed, Boggs, and Mann, 2012; Yuan et al., 2019). Despite empirical studies demonstrating a rapid increase in urban noise levels in developing countries, relevant urban stakeholders have yet to give the problem the attention it deserves (Jariwala et al., 2017).

Noise pollution and its impact on health and well-being have long been ignored. However, this is changing, with several health institutions now viewing the increase in community noise as undesirable and unsustainable. The effects of noise on human health and comfort can be devastating depending on its duration and volume. According to Ackah, Amankwa-Danquah, and Atianashie (2021), these effects are divided into four categories: physical effects (e.g., hearing defects), physiological effects (e.g., increased blood pressure, irregular heart rhythms, and peptic ulcers), psychological effects (e.g., disorders, sleeplessness and late sleeping, irritability, and stress), and effects on work performance (e.g., decreased productivity and misinterpretation of what is heard (Oyedepo 2013). Noise pollution is an important environmental pollutant that affects human performance (Pal and Bhattacharya, 2012). The individuals' survival and healthy existence depend basically on the enabling environment where they reside since disruption of the conducive environment can lead to dysfunction of their health status (Otukong 2002).

In developing countries, particularly Nigeria, the framework for enforcing legislation and noise pollution abatement codes is weak and rarely enforced. The Nigerian federal environmental regulator, the National Environmental Standard and Regulation Agency (NESREA), only provides daily noise exposure limits for different environments. Given the present and future impacts of noise-induced health hazards on urban dwellers, stakeholders must control the noise level. Noise generation in a metropolitan setting can be viewed in relation to city planning disorderliness and increasing vehicular traffic caused by urban growth and development. Several studies have identified weak governance structure and financial foundation as significant factors that hinder the implementation of environmental and other policies and programs in small- and medium-sized cities (Samuel, Agbola, and Olojede 2021; Samuel and Atobatele 2019a, 2019b).

Planning, developing, and establishing a noise control capacity are crucial in noise control efforts. Moreover, abatement plans for noise-generating areas and land-use categories are required. Such policies and programs would be successful and sustainable only if residents, both generators and victims of noise pollution, were involved in the conceptualization, implementation, and postimplementation oversight. It is instructive that the ability of residents to participate in noise abatement programs will be a function of their perception of noise pollution's menace. This highlights the importance of understanding the objective and subjective assessment of noise pollution as indicated by the noise levels with the subjective evaluation of the residents based on their perceptions. Many systematic studies on noise pollution are conducted in large urban centers (Ali and Tamura 2003; Raimbault and Dubois 2005; Tonne et al. 2018), except for a few that focused on small- and medium-sized cities (Oyedepo and Saadu, 2009, 2010; Popescu and Moholea, 2010). Again, a disproportionate number of these studies have focused on single-source pollution from road traffic (Ali and Tamura 2003; Arokoyu, Emenike, and Atasi 2016; Botteldooren, De Coensel, and De Muer 2006; Frei, Mohler, and Röösli 2014; Khan et al. 2018; Oyeleye 2013) to the exclusion of other sources of environmental noise pollution. A comprehensive noise pollution analysis that observes both actual noise levels and perceived noise pollution can reveal the actual situation of the problem and assess how the residents feel about it. Understanding the residents' perceptions can inform people-oriented, community-based policies and other interventions to reduce the threat. To our knowledge, studies that combine objective noise pollution measures with subjective assessment by residents are very rare.

Few large cities in Nigeria, like Lagos, have taken policy and advocacy measures to reduce the elevated noise levels within their domains. However, most medium-sized cities lack the human and material resources and a robust institutional framework to combat noise pollution. Knowledge of actual and perceived noise levels is critical for policies and advocacy encouraging behavioral changes to reduce noise pollution. Effective noise pollution control measures would necessitate the active participation and cooperation of affected individuals and communities, a situation dictated by people's perceptions of the problem's reality and the risk exposure. Against this backdrop, this study seeks to identify the areas prone to noise pollution in

the city, assess the perception of noise pollution by residents, and compare the objective measures of noise pollution with the subjective assessment by residents of the medium-sized town of Osogbo, Osun State, Nigeria.

Extant empirical and theoretical works on noise pollution have linked the escalating noise pollution to several factors, among which the main are population growth, urbanization, poor urban planning, and certain behavioral traits that encourage noise generation (Abankwa, Agyei-Agyemang, and Tawiah 2017; Ma et al. 2018; Mehdi et al. 2011; Morillas et al. 2018; Paunović, Belojević, and Jakovljević 2014).

In attempts to depict the acoustic landscape of cities, scholars have generated noise maps, some of which relate the observed pattern to some city characteristics. For instance, Barrigón (2010) established a relationship between urban noise and inhabited areas on the one hand and population on the other in their study of the noisescape of small and medium-sized cities in Spain. Similarly, Oguntoke et al. (2019) created a risk map for a medium-sized Nigerian city. They found the noise levels higher than the prescribed World Health Organization (WHO) minima across spatial and temporal scales. However, they did not explicitly account for variations attributable to different land uses. Meanwhile, Barrigón et al. (2010) found a relationship between urban noise and inhabitants and between urban noise and inhabited areas in their research of 20 cities in Spain, reflecting the urban structure defined in the strata of the categorization method. In Karachi City, Mehdi et al. (2011) found that noise levels were generally higher in the mornings and evenings because of the commuting pattern of Karachi residents. The average value of noise levels was over 66 dB, which could cause serious nuisance, according to the outdoor noise guidelines of the WHO. The maximum peak noise was over 101 dB, which is close to 110 dB, a level that can cause possible hearing impairment (Berglund, Lindvall, and Schwela, 1999).

Gregory (1998) identified three types of noise sources: (i) those associated with the operation of building services, (ii) those associated with activities and office equipment, and (iii) those associated with environmental sound from outside the building. The first two are internal sources, whereas the third is from external sources. In line with this, Shabi (2016) summarized the sources of urban environmental noise pollution into industrialization (compressors, generators, exhaust fans, and grinding mills participate in producing big noise), construction activities (mining, construction, and welding), social events (partying, clubbing, and religious activities), transportation (vehicles, airplanes, trains, and other transport modes), household chores, and equipment (household gadgets like TV, mobile, lawnmowers, etc.).

Anomohanran and Osemeikhian (2006) identified automobiles, commercial motorcycles, recording houses, and electricity generators as responsible for most noise in Nigeria in their study conducted in Delta State, Nigeria. Similarly, Samuel (2008) attributed urban noise and other atmospheric pollution to the persistence of traffic congestion caused by temporal periodicity in intraurban movements. However, in a study conducted in Ilorin, Nigeria, Oyedepo and Abdulahi (2010) observed that the city's population growth, which increased by more than 50% between 1980 and 2006, was partly responsible for the increase in noise pollution. They also asserted that road traffic is Nigeria's predominant and most generalized noise source. Meanwhile, Essandoh and Armah (2011) stated that the Cape Coast in Ghana is exposed to environmental pollution from increased commercial activities and road traffic. Therefore, this claim associates environmental noise pollution with economic growth. Onuu and Menkiti (1993) also found that the peak noise level in Aba and Uyo, Nigeria, ranges between 86 and 106 dB(A). This noise level exceeds the recommended the 60 dB(A) level for commercial and residential areas.

Other studies have shown that noise pollution harms the health of those exposed to it. In a study of the relationship between ambient noise pollution and sleep in the northern municipality of Belgrade, Serbia, Jakovljević et al. (2006) found that respondents from the noisy area reported having significantly more difficulties falling asleep, being awakened by noise at night more often, and having more problems falling back to sleep. Using a sample of 310 respondents, 192 from noisy neighborhoods and 118 from quiet areas, the study further revealed that noise annoyance, subjective noise sensitivity, and neuroticism were significantly correlated with difficulties falling asleep, time needed to fall asleep, poorer sleep quality, tiredness after sleep, and use of sleeping pills. A meta-analysis of 27 empirical studies published between 1970 and 2010 showed that road traffic noise was positively and significantly associated with hypertension (Van Kempen and Babisch, 2012). In a similar but recent study of 139 low- and middle-income countries, Schwela (2021) discovered an increase in motor vehicle fleets, airport operations, and industries, among other things, as factors responsible for escalating noise levels, with population growth, urbanization, motorization, and, to a large extent, technological development acting as catalysts.

**Table 1:** World Health Organization (WHO) guideline for community noise (2005)

| Environment | Critical Health Effect | Sound Level Db (A) | Time (hours) |
|---|---|---|---|
| **Outdoor Living Areas** | Annoyance | 50 - 55 | 16 |
| **Indoor Dwellings** | Speech intelligibility | 35 | 16 |
| **Bedrooms** | Sleep disturbance | 30 | 8 |
| **Schools Classrooms** | Disturbance of communication | 35 | During class |
| **Industrial, commercial and traffic areas** | Hearing Impairment | 70 | 24 |
| **Music through earphones** | Hearing Impairment | 85 | 1 |
| **Ceremonies and entertainment** | Hearing Impairment | 100 | |

Source://www.consultnet.ie

**Table 2:** National Environmental Noise Standards for Nigeria

| s/no | Land use | Maximum permissible Noise Limits (dB) | |
|---|---|---|---|
| | | Day (6 am–10 pm) | Night (10 pm – 6 am) |
| **1** | Any building used as a hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites. | 45 | 35 |
| **2** | Residential Buildings | 50 | 35 |
| **3** | Mixed Residential (with some commercial and entertainment) | 55 | 45 |
| **4** | Residential + industry or small-scale production + commerce | 60 | 50 |

Source: NESREA (2009)

Omubo-Pepple et al. (2010) investigated the effect of noise-induced hearing loss in two locations within the Port-Harcourt metropolis, Nigeria. They concluded that the noise pollution at Port-Harcourt International Airport was harmful to the environment and advised that if specific protective measures were not implemented, it would result in hearing loss and other psychological and pathological effects. Environmental noise can cause tinnitus, hearing loss, sleep disturbance, and other harmful effects on people's health.

The literature on noise pollution inextricably links noise generation with different activities, and its impact on residents' health has been significant. However, it is unclear whether urban residents perceived their activities as the main contributors.

## RESEARCH METHODOLOGY

### *The Study Context*

Osogbo, the capital of Osun State in southwest Nigeria, provides the geographical context for this study. Located at longitude 4°34′ East and latitude 7°46′ North with an area of 47 km$^2$, Osogbo is a fast-growing medium-sized city with a population of 730,529 in 2021 (UNDESA, 2021). Residential land use dominates the city's landscape, but commercial and mixed land use, an amalgam of residential, industrial, commercial, educational, and other land uses, is also important. The industrial land use is not distinct as it is mainly integrated into different land uses, except for the Osogbo Steel Rolling Mill, Osogbo Machine Tools, and Tuns Industries. These uses of land generate varying levels of noise pollution. Meanwhile, the transportation system consists of a rail line and a network of roads comprising motorways, major roads, and streets. These roads are used by various modes of transportation, including private cars, minibuses (known locally as *Korope*), articulated trucks, and motorbikes known as *Okada*. Because these modes are mostly old and rickety, they produce abnormally high noise levels, contributing to ambient noise pollution. The city is home to numerous religious institutions, as evidenced by the many mosques and churches, the majority of which have external loudspeaker systems that emit high-pitched noise that pollutes the environment. Noise pollution in the city heightens during festivities and ceremonies, such as burial, naming, wedding, and other traditional and religious festivals that attract open-air drumming and music. Due to the city's epileptic power supply, households, businesses, and organizations resort to an alternative power supply in the form of electric generators, most of which produce high-pitched noise, thereby raising environmental noise levels. This is particularly noticeable in residential areas at night when there is a power outage. Residents usually switch to their generators, not considering the quantum of noise in the environment.

### *Data Collection and Analysis*

The data for this study were obtained through a field survey, questionnaire administration, and group discussion/interview. The field survey measured noise levels using a sound-level meter in 22 sample sites, including industrial, commercial, residential, transport corridors, and mixed land-use areas (Olojede et al. 2019). The questionnaire was administered to people living,

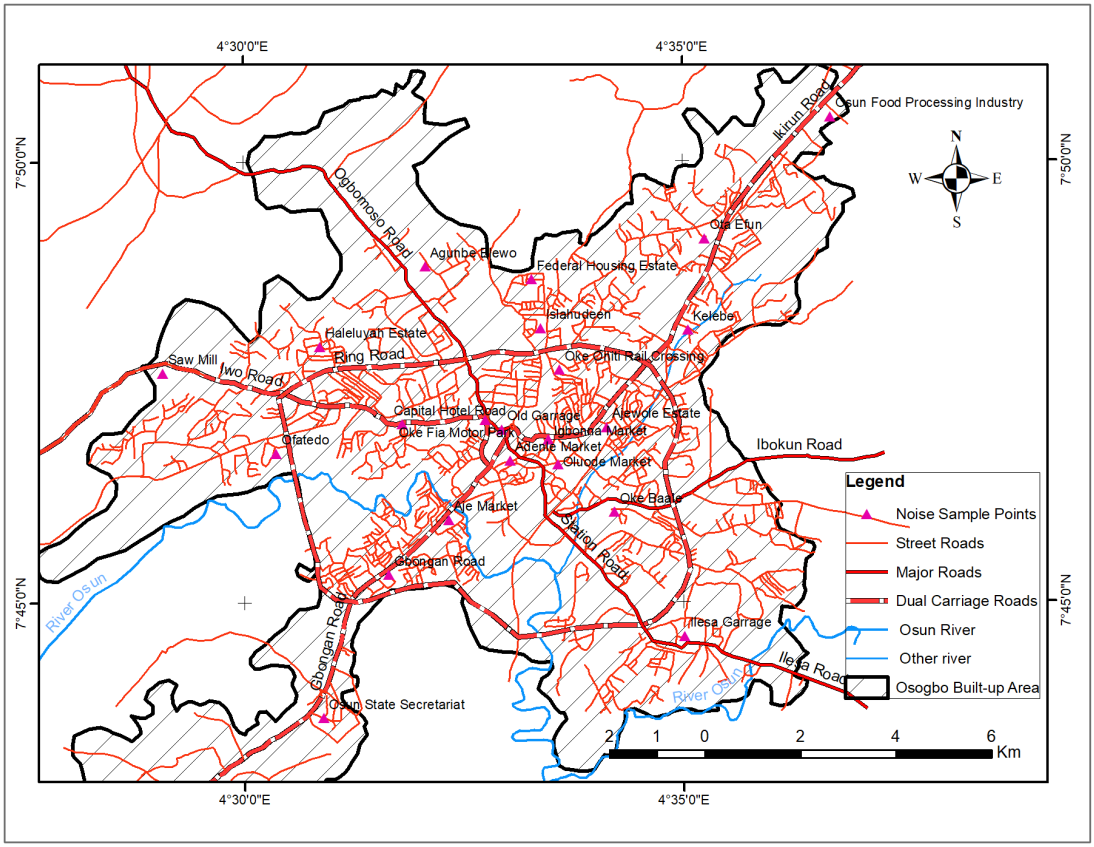


**Figure 1:** The Built-up Areas of Osogbo (2019)

working, or visiting the study's designated sample area. It elicited information on noise sources and causes, variation in noise levels, the effects of noise pollution, and potential steps to mitigate noise pollution in the study area. Secondary data were derived from journals, published online articles, textbooks, maps, the permissive noise level standards prescribed by NESREA (2009) and WHO's Guideline for Community Noise (2005).

### *Field Observation*

Field observation was conducted to obtain observed noise levels for different land uses, including industrial, commercial, residential, transport corridors, and mixed land-use areas. The digital sound-level meter (or decibel meter) was used to measure the level of noise pollution in different areas of the city. It was used to measure the sound level during the day and night. The obtained values were compared with the acceptable WHO standards. In each of these zones, five and three sample points were chosen randomly (in proportion to the size of the land use) to collect sound-level data, for a total of 22 sample areas. Industrial land-use samples were collected in areas with critical industrial activities. In contrast, samples for commercial, residential, and transportation land services were collected irrespectively at markets, streets, and roads. The noise levels were observed for these land-use types from 06:00 am to 10:00 pm and from 10:00 pm to 06:00 am over eight days. The average for day and night observations was calculated for each of the land-use types to determine the average noise levels for each land-use type.

### *Questionnaire Administration*

A total of 195 copies of the questionnaire were administered at 22 locations in the 5 land-use types identified in the study area. The questionnaires were assigned to each type of land use in proportion to each land-use size (Table 3). The questionnaire was designed to collect information on people's perceptions of sources, causes, effects, and other salient issues related to noise pollution in the study area. The questionnaire also asked for demographic and socioeconomic information, such as gender, age, occupation, education status, perception of noise level and sources of noise, health and other effects, and awareness of noise abatement measures. Relevant ethical committees approved the design and instruments for data collection. The authors informed the respondents that their participation was entirely voluntary

and that they could opt out participating during the questionnaire administration. Respondents were also informed that all information provided during the data collection would be kept strictly confidential.

The data collected for this study were analyzed using both descriptive and inferential statistical techniques. In particular, data on the sources, causes, and effects were analyzed using descriptive statistics like means and percentages. Simple percentages and frequencies were also used to analyze the distributions, in line with Adejobi's (2012) study of the spatio-temporal analysis of noise pollution levels in Lagos, Nigeria. The analytical techniques are used to ensure that the results of the analysis speak to the research objectives and questions. Additionally, the one-way analysis of variance (ANOVA) was used to analyze the differences in noise levels among the land-use types for day and night observations. This study hypothesized that there is no significant variation in noise levels (day and night) among land uses.

**Table 3:** Sample Points by Land Use Types

| Land use Type | Sample sites for Noise Meter Observations | | Questionnaire Samples | |
|---|---|---|---|---|
| | Frequency | Per cent | Frequency | Per cent |
| Residential | 7 | 30.4 | 59 | 30.4 |
| Commercial | 4 | 17.4 | 34 | 17.4 |
| Industrial | 3 | 13.0 | 25 | 13.0 |
| Transportation | 4 | 17.4 | 34 | 17.4 |
| Mixed land use | 5 | 21.7 | 42 | 21.7 |
| **Total** | **22** | **100.0** | **195** | **100.0** |

## RESULTS AND DISCUSSION

This study aims to analyze actual and perceived noise pollution to determine if the two converge and assess the impact of noise on the well-being of small- and medium-sized urban center residents. This is important, as any noise abatement measure would require residents' knowledge, awareness, and cooperation to succeed. When and where the residents' perception conflicts with the noise level observed and efforts to reduce noise may not record the desired effect. This study discussed the analysis results of the objective measure of noise and perceived subjective measure of the residents, and compared both to determine whether any convergence exists between them.

### Actual Noise Levels across Land-Use Types in the Study Area

The summary of environmental noise levels reveals that the mean daylight sound levels of industrial land use (72.85 dB), residential land use (55.42 dB), commercial land use (76.61 dB), and transportation use (80.67 dB) are higher than the WHO maximum standards sound levels of 50, 60, and 55 dB for various land uses. Similarly, the nocturnal sound levels for the three land uses were 48, 72, and 61.7 dB for residential, commercial, and mixed land uses, respectively. These figures also exceeded the WHO standards of 35, 50, and 45 dB for residential, commercial, and mixed land uses, respectively. Thus, this scenario suggests that noise has become a significant pollutant in Osogbo city. The study also documented the effect of land-use types on levels of urban noise pollution. Elevated noise levels have been linked to various land uses and the rapid rate of urbanization. Living in a medium-sized urban environment with high levels of noise pollution daily could have detrimental physical, health, and psychological effects that are not always immediately visible but, in the long run, affect the well-being of people.

### *Variation in Noise Levels Among Dominant Land Uses*

**Table 4:** Actual Noise Levels in the Study Area

| Land Use | Actual Noise Level (dB) (Day) | Permissible Noise Level (dB) (Day)* | Actual Noise Level (dB) (Night) | Permissible Noise Level (dB) (Night)* |
|---|---|---|---|---|
| **Industrial Area** | 72.85 | 45 | 53.58 | 35 |
| **Residential Area** | 55.42 | 50 | 43.93 | 60 |
| **Commercial Area** | 76.61 | 55 | 55.86 | 45 |
| **Transport Area** | 80.67 | 60 | 62.01 | 50 |
| **Mixed Area** | 78.44 | 55 | 55.43 | 50 |
| **Average** | 72.80 | 56 | 54.20 | 45 |

*Derived from NESREA, 2009.

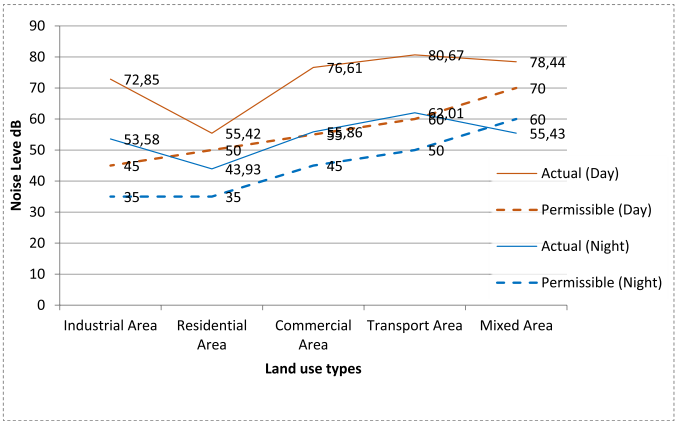


**Figure 2:** Actual and Permissive Noise Levels in the Study Area

This study was set out to test the null hypothesis ($H_o$) that land-use type has no significant effect on noise pollution in Osogbo against the alternative hypothesis ($H_I$) that land-use type significantly affects noise pollution in the city. An ANOVA test

**Table 5:** Analysis of Variance of Noise Pollution across Land Use Types

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Day_Average * Landuse_Type | Between Groups | 1010.16 | 5 | 202.03 | 12.94 | 0.000* |
| | Within Groups | 249.90 | 16 | 15.62 | | |
| | Total | 1260.05 | 21 | | | |
| Night_Average * Landuse_Type | Between Groups | 371.32 | 5 | 74.26 | 3.15 | 0.036* |
| | Within Groups | 376.95 | 16 | 23.56 | | |
| | Total | 748.27 | 21 | | | |

**Significant at 0.05 ($p < 0.05$) alpha level*

was performed at a 95% confidence level to evaluate the effect of land-use types on noise pollution in the city. The fixed factor (or independent variable) is the land-use type, with three categories: residential, mixed uses, and commercial. The noise level was the dependent variable in the analysis. The assumption of homogeneity of variance was first tested, and the result was found to be tenable using Levene's test. Table 5 presents the results of the ANOVA test. It reveals a statistically significant relationship between land-use type and noise levels observed across the land-use types in the study area. The results indicate that the F-ratio of 12.94 ($p$-value = 0.036) for the daylight noise level and 3.15 ($p$-value = 0.000) for the night noise level are significant at the 95% confidence level.

This result implies that the observed differences in environmental noise level in the study area did not occur by chance but varied significantly across all land-use types. Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted. From these results, we can infer that land-use types significantly affect the observed noise levels. The reason for this could not be isolated from the fact that different activities associated with different land-use types generate different noise levels. For example, transportation land-use type generates high traffic noise, which is more endemic than commercial activities in commercial land-use areas. These also differ from noise generated in residential areas, as residential land use involves fewer noise-generating activities. This finding is consistent with the findings of Olayinka and Abdullahi (2010), who ranked noise from transportation activities as the highest in Ilorin, followed by noise from commercial areas, then from industrial and public land use, and noise from residential areas as the lowest.

The ANOVA result is emphasized further by the noise heat maps shown in Figures 3 and 4, which depict the spatial variations in noise pollution during the day and night across different land uses. Figure 3 shows the noisescape of the city during the day. The noise levels in most central areas are high, generally exceeding 65 dB. However, there are pockets of very high noise levels (≥70 dB) that coincide with noise-generating land uses, such as the Ilesa Motor Park (extreme southeastern part of the city), intense commercial activities like the Oluode and Adenle Markets (in the central area, and the industrial land use in the extreme northeast. The low noisescapes are located in the western and southwestern peripheries of the city, the areas with limited daylight activities.

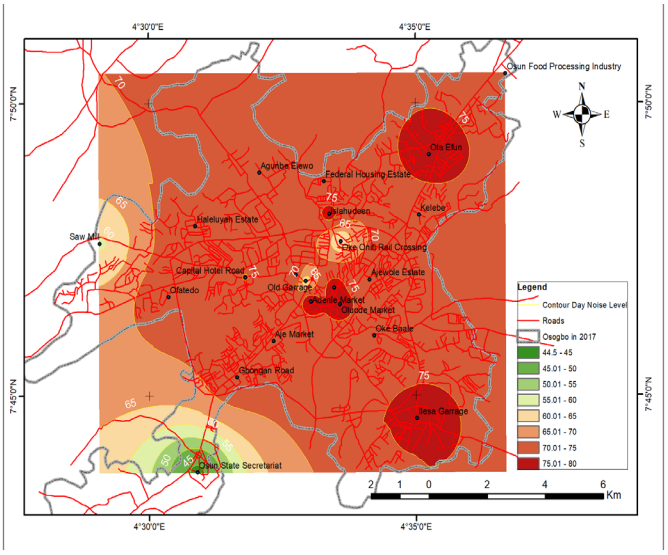


**Figure 3:** Spatial Variations in Observed Noise Levels during the Day in the Study Area

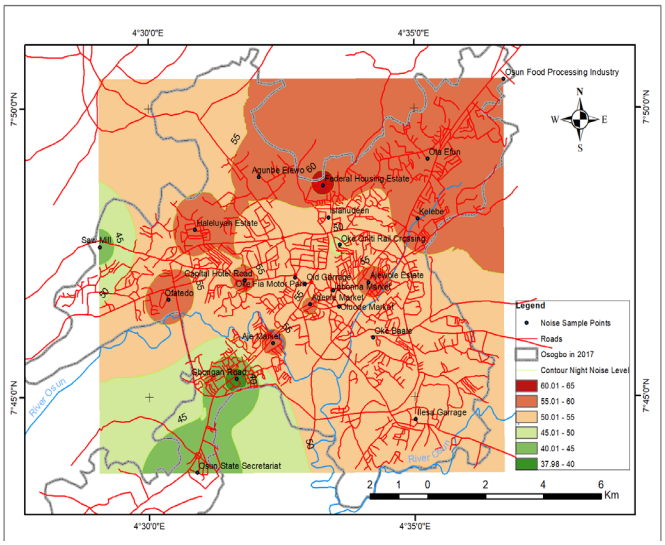


**Figure 4:** Spatial Variations in Observed at Night Noise Levels in the Study Area

**Table 6:** Socio-economic Characteristics Respondents

| Characteristic | Category | No. of Respondents | Per cent (%) | Mean |
|---|---|---|---|---|
| **Age** | · 0 – 20 years | 25 | 12.5 | 44.5years |
| | · 21 – 40 years | 73 | 37.5 | |
| | · 41 – 60 years | 53 | 27.3 | |
| | · 61 years and above | 44 | 22.7 | |
| | Total | 195 | 100.0 | |
| **Gender** | · Male | 87 | 44.9 | |
| | · Female | 108 | 55.1 | |
| | · Total | 195 | 100.0 | |
| **Marital Status** | · Single | 12 | 6 | |
| | · Married | 128 | 65.8 | |
| | · Divorced | 16 | 8.3 | |
| | · Widow and Widower | 32 | 16.7 | |
| | · Separated Parent | 7 | 3.2 | |
| | Total | 195 | 100.0 | |
| **Household Size** | · 1 – 4 People | 21 | 10.6 | 6.4 people |
| | · 5 – 8 People | 87 | 45 | |
| | · 9 – 12 People | 62 | 31.9 | |
| | · 13 and above | 25 | 12.5 | |
| | Total | 195 | 100.0 | |
| **Highest level of Education** | · No Formal Education | 8 | 4.2 | |
| | · Primary | 39 | 19.9 | |
| | · Secondary | 29 | 14.8 | |
| | · Tertiary | 119 | 61.1 | |
| | Total | 195 | 100 | |
| **Occupation** | · Civil Service | 53 | 27.3 | |
| | · Trading | 32 | 19 | |
| | · Farming | 27 | 16.3 | |
| | · Artisan | 33 | 13.7 | |
| | · Others | 13 | 6.7 | |
| | Total | 195 | 100 | |
| **Monthly Income** | · Less than N20,000 | 25 | 12.5 | N53,000 |
| | · N20,000 – N40,000 | 57 | 29.2 | |
| | · N40,000 – N60,000 | 39 | 19.4 | |
| | · N60,000 – N80,000 | 35 | 18.1 | |
| | · N80,000 – N100,000 | 23 | 12 | |
| | · Above N100,000 | 15 | 8.8 | |
| | Total | 195 | 100 | |
| **Ethnicity** | · Yoruba | 125 | 64.3 | |
| | · Hausa | 37 | 18.7 | |
| | · Igbo | 27 | 14 | |
| | · Others | 6 | 3 | |
| | Total | 195 | 100 | |
| **Religion** | · Christianity | 100 | 51 | |
| | · Islam | 88 | 45.3 | |
| | · Traditionalist | 7 | 3.7 | |
| | Total | 195 | 100 | |

*Source: Author's Fieldwork, 2018*

The night noisescape presents a different picture as the vast area of the city is calmer at night with an observed noise level of 55 dB or less. Only the industrial areas in the extreme northeast of the town recorded a higher noise level exceeding 65 dB. Around the city center, pockets of heightened noisescapes coincide with the location of nightclubs and worship centers. Nightclubs in the city are known for playing high-pitched music and featuring live bands to entertain patrons, contributing to noise pollution. It is also worth noting that adherents of the city's two dominant religions engage in noise-generating nocturnal religious activities such as vigils and open-air crusades, among other activities. Conversely, the area in the western and southwestern parts of the city experiences calmer nights because the noise-generating activities are very low.

### Socioeconomic Characteristics of the Respondents

The generation and management of urban noise are highly dependent on land use, household characteristics, and individual behavior. Therefore, Table 6 shows the distribution of the 292 respondents selected by household and demographic characteristics. As shown in Table 6, 55.1% of the respondents are women, whereas 44.9% are men. The implication is that there is a likelihood of high indoor noise and noise from domestic activities, such as blending, grinding, and other kitchen activities performed primarily by women. This is because it is widely assumed that women talk more than men and engage in more domestic activities (Boateng and Amedofu, 2004).

Regarding land uses, 32.7% of those interviewed lived in residential areas, 23.7% in commercial areas, and 24.7% in mixed land uses. Industrial land uses accounted for approximately 13.6%, whereas other land uses accounted for 5.3%. This result indicates that most respondents were drawn from the city's commercial and mixed land uses. The two land uses contributed an appreciable size (48.7%) of the study area compared to the 32.7% drawn from residential land use. The preceding section illustrates that commercial and mixed land uses have higher levels of diurnal and nocturnal noise than residential land uses.

Individuals' ages are a good predictor of how active and chatty they are (Mougeot, 1999). As shown in Table 6, the majority of the sampled respondents are between the ages of 21 and 40, with a percentage value of 37.5%. The average age of urban residents in Osogbo is 44.5 years. This implies that most people are young and productive, which might allow them to engage in activities that generate urban noise (e.g., engaging in industrial production, playing loud music, partying, and engaging in street protests). Moreover, many of these respondents are of childbearing age; hence, constant crying and screaming from their infants and toddlers will likely contribute to ambient noise levels in their neighborhoods. Regarding the marital status of the respondents, Table 6 reveals that 45.8% of the respondents are married, 16.7% are widowed, 8.3% are divorced, and 29.2% are single. The implication is that married respondents are likely to have children that can be considered noise sources in residential areas. Furthermore, a family's size influences the noise emitted by dwelling units. The survey revealed that the average household size in Osogbo is eight people. Meanwhile, the mean household size was 6.4 people, with approximately 80% having 5 to 12 people, indicating a predominance of large households.

**Table 7:** Residents' Perception of Noise Pollution in Osogbo

| Question Asked | Response | No. of respondents | Percentage (%) |
|---|---|---|---|
| Noise as pollution | Yes | 194 | 99.0 |
| | No | 1 | 1.0 |
| | Total | 195 | 100.0 |
| Sources of noise pollution in your area | Transport | 182 | 92.7* |
| | Markets & Clubs | 123 | 63.0* |
| | Religious area | 170 | 87.0* |
| | Generator | 185 | 94.7* |
| | Music from Neighbour | 106 | 54.0* |
| | Industrial activities | 72 | 37.3* |
| Perceived Neighbourhood Noise Levels | Extremely noisy | 22 | 11.3 |
| | Very noisy | 67 | 34.3 |
| | Noisy | 83 | 42.7 |
| | Quiet | 21 | 11 |
| | Very quiet | 1 | 0.7 |
| | Total | 195 | 100 |
| Awareness of any government intervention to reduce noise pollution | Yes | 22 | 11.3 |
| | No | 173 | 88.7 |
| | Total | 195 | 100 |
| Perceived neighbourhood associations' action in curbing noise pollution | Yes | 18 | 9.2 |
| | No | 176 | 90.4 |
| | Total | 195 | 100 |

* Multiple-choice responses; hence, it wouldn't add up to 195
Source: Author's Fieldwork

### *Perception of Noise Pollution Among Residents*

Noise pollution poses a significant threat to urban sustainability worldwide (Fiedler and Zannin, 2015; WHO, 2005). According to the WHO, noise is a hazardous agent that affects both human health and the environment. In the past, most Nigerians have not paid significant attention to the seriousness of noise pollution and its dangerous consequences.

Almost all of the 295 respondents (99.3%) in the study area agreed that noise was a major source of pollution in the study area. Among these respondents, 99 (34%) stated that they perceived the most noise in the morning hours, whereas 86

(29.3%) agreed that noise pollution is always at its peak in their areas during the evening hours. Moreover, 17.3% said that they perceived the noise most at night, whereas 16.1% perceived the noise the most in the afternoon. In general, 79.4% of urban residents agreed they perceived diurnal environmental noise pollution more than nocturnal noise level. In comparison, 20.6% were more exposed to it at night than during the day. Therefore, this implies that, irrespective of land use, urban residents experience more environmental noise pollution during the day than at night. This result agrees with the findings of Olayinka and Abdullahi (2010) and Abel (2015). They affirmed that in most cities in developing countries, the diurnal noise level is commonly higher than the nocturnal noise.

### *Perceived Effects of Noise Pollution on Residents' Health*

A central objective of this study is to analyze the health effects of noise pollution in the study area. To achieve this objective, the authors asked relevant questions. Table 8 presents the responses obtained. Almost all respondents know that environmental noise pollution causes significant health problems for the well-being of residents, as 94% of respondents in the city responded affirmatively. In addition, more than 32% of the respondents reported feeling highly annoyed with noise pollution in their neighborhoods. In terms of the health effects of noise pollution in the study area, the survey found that nearly three-quarters (72.3%) of Osogbo residents frequently experience loss of sleep (insomnia) during the night due to high levels of nocturnal noise pollution from sources, such as nightclubs, generating sets, parties, traffic, and noise from religious activities.

Similarly, approximately two-thirds (64.3%) of the respondents also reported that they had, at one time or another, experienced hearing impairment caused by the level of noise pollution in the atmosphere. Furthermore, 42.7% stated that they had previously experienced a sudden loss of hearing (some lasted for a short period, whereas others led to a permanent loss of hearing). The psychological effect of noise pollution in the study area is also significant, with 49.7% of the study population reporting that they occasionally experience psychological problems, such as stress (46.7%), anxiety (43.8%), and psychosis and emotional instability (33.6%) due to the high noise pollution in their environment.

Environmental noise pollution also produces other effects for the residents of the study area, including loss of concentration (71.7%), speech interference (54%), and worsening of hypertensive symptoms (64.3%). Table 8 further shows that 28% of urban residents in the study area suffer from mild or chronic hypertension, which may be worsened by increased exposure to loud noise. Importantly, 37% of the urban residents had visited the hospital at least once for noise-related ailments. Therefore, we can infer that noise pollution significantly impacts the health and well-being of city dwellers.

**Table 8:** Effects of Noise Pollution on People's Health

| Question Asked | Response | Frequency | Percentage (%) |
|---|---|---|---|
| Awareness of adverse health effects of noise? | Yes | 184 | 94 |
| | No | 11 | 6 |
| | Total | 195 | 100 |
| Level of annoyance experienced from noise pollution | Too much | *63* | 32.7 |
| | Much | 73 | 37.7 |
| | Little | 53 | 27 |
| | Nothing | 5 | 2.6 |
| | Total | 195 | 100 |
| Noticeable health effects of noise | Insomnia | 141 | 72.3* |
| | Hearing Impairment | 126 | 64.3* |
| | Hypertension | 55 | 28.0* |
| | Loss of Concentration | 140 | 71.7* |
| | Psychological effects | 97 | 49.7* |
| | Speech Interference | 106 | 54.0* |
| | Sudden loss of hearing | 83 | 42.7* |
| | Shock due to loud noise | 82 | 42.0* |
| Any experience with these psychological feelings? | Stress | 91 | 46.7* |
| | Anxiety | 85 | 43.8* |
| | Psychosis and emotional instability | 65 | 33.6* |
| Have you ever visited a hospital as a result of a noise-related ailment? | Yes | 37 | 72 |
| | No | 63 | 123 |
| | Total | 100 | 195 |

Multiple-choice responses, hence it wouldn't add up to 195
Source: Author, 2021

## Conclusion

The noise levels in the sampled areas were above the NESREA and WHO recommended limits. The current level of noise pollution in the city poses a serious health risk to all urban dwellers in the area. Furthermore, the discomfort and irritability caused by noise pollution can significantly reduce productivity in both the public and private sectors. Since the transport infrastructure constitutes a key noise source, technical actions on transport systems can produce exciting results. In addition,

effective land-use planning in Nigeria's urban areas could help prevent unnecessary noise pollution at odd hours of the day (i.e., noise from religious worship at midnight). Most cities in Nigeria should take the prevention and mitigation of noise pollution seriously and explore all possible means to combat the threat of noise pollution.

Noise is also a byproduct of people's behavior (e.g., reckless driving, playing music at loud volume, product marketing and street hawking, and religious activities). Therefore, information and enlightenment campaigns, usually produced on radio, television stations, and print media, can be used to invoke behavioral and altitudinal changes that promote noise abatement. A positive behavioral change would help reduce noise pollution in the study area significantly. In addition, environmental noise impact criteria levels for various land uses must be established before any intending developer can be granted planning and development permits. These criteria would allow the noise impacts of any proposed development to be predicted and management strategies proposed. Similarly, the government should enact and enforce laws to limit the number of religious activities and nightclubs in the city to reduce noise pollution from these sources.

Sound urban planning and enforcing planning codes are ultimately required to mitigate the escalating noise pollution in medium-sized urban centers. Due to resource constraints and weak governance structures, many small- and medium-sized African cities find it difficult to create and enforce environmental laws in areas with strong religious and cultural beliefs. This most likely explains the persistence and aggravation of noise pollution in these cities. This study demonstrates that noise pollution contributes to public health problems and affects productivity. Consequently, this study recommends a constructive partnership between the government and residents as a panacea for the debilitating noise pollution in Africa's small and medium-sized cities. This collaboration will make residents active participants in the government's noise mitigation strategies.

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