ASSESSMENT OF NOISE LEVELS IN SELECTED AREAS WITHIN AKURE, NIGERIA METROPOLIS USING ArcGIS

Olumuyiwa Aderinola[1] and Titilayo Owolabi[2]

[1]Affiliation not available
[2]Hong Kong University of Science and Technology

May 5, 2020

Abstract

The study examined the noise levels in selected areas within Akure Metropolis, Nigeria with a view to generate noise maps using ArcGIS which will help to identify high impact areas and support environmental management in the study area. Some selected areas within Akure metropolis were selected for this study namely; Oja-oba Market (commercial Land use), Ijoka (Residential land use), and the Federal University of Technology, Akure (Futa as an Educational Land Use). The digital sound level meter (IEC651 Type 2) was used to measure noise level in the morning (8:00am-9:00am), afternoon (1:00pm-2:00pm) and evening (4:00pm-5:00pm) for a period of 7days in each of the selected areas. The compiled data were imported into the ArcGIS 10.5 Software for analysis and geo-referencing whereby transforming the data and presenting it on noise contour maps. The study revealed that Sunday bus stop has the highest mean noise level with 64.3 decibel (A) while the lowest noise level was found in Olowookere street with 38.1 dB(A) for the Residential area. Ijomu recorded the highest noise level with 78.6 dB(A) and Erekesan market has the lowest noise level of 61.5 dB(A) for the commercial area. Finally, Northgate has the highest noise level, which recorded 76.3 dB(A) and the lowest noise level was recorded at Library area with 41.0 dB(A) for the Institutional area. 80% of the commercial area is exposed to the highest risk of noise pollution. The residential area was exposed to 18.7% noise pollution which makes the area suitable for housing. The institutional land use recorded 36.6% for total area exposed to noise pollution. This research has provided valuable information for decision makers as a guidance for noise pollution risk management and serve as a reference for future noise limit regulations to be executed in urban areas of Nigeria and other developing countries

1. Introduction

Noise is usually defined as unwanted or undesired sound judged to be unpleasant, loud or disruptive to hearing. Environmental noise is the accumulation of all noise present in a specified environment. Environmental Noise can also be defined as an unwanted or harmful outdoor sound created by human activity, such as noise emitted by means of transport, road traffic, rail traffic, air traffic and industrial activity (Environmental Noise pollution, 2014). A study on environmental noise pollution in Nigeria urban centers found that increase in population, commercial activities and road traffic volume, increase the level of noise generation. Other concomitant noises have been noted to be severe in rapidly expanding cities, towns and regions in Nigeria as observed in the South Eastern States (Onuu, 1992). Many studies on noise pollution have been conducted (Chibuike et al. 2018; Pretzsch et al. 2015; Wang et al. 2014; Baloye and Palamuleni, 2015).

Oyedepo et al. (2018) produced dataset to assess the noise pollution levels in Ota Metropolis and discovered that only 2 out of the 41 locations considered are under normally acceptable situation while the noise levels of other areas are not acceptable.

Noise exposure is not a new phenomenon. Records show that even in medieval times, carriages and horseback riding were banned during the night in some cities in Europe, in order to prevent sleep disturbance (World

Health Organization, 2000). Noise Pollution also known as sound pollution, is the propagation of noise with harmful impact on the activity of human or animal life. The source of outdoor noise worldwide is mainly caused by machines, transport, and propagation systems (Wikipedia, 2016). Noise pollution can damage physiological health problems to people who are continuously subjected to it. In 1999, the World Health Organization (WHO) issued suggested community noise guidelines. It considered various environments noise levels, and noise impacts. In outdoor living areas (backyards, for example), a noise level of 50-55 dB(A) averaged over the daytime is considered moderately to seriously annoying; levels above 45d dB(A) averaged over nighttime hours can disturb sleep; and indoor noise levels above 35 dB(A) impact communication in a school.

Braj and Jain (1995) and Schwartz (2011), describe noise as air pollutant, which differs from other pollutants in the sense that it is transient in nature, and it is not a continuing or persisting phenomenon. Once the noise pollution stops, the environment becomes free of its effects. Garg (2010) expands this concept when he noted that noise is any unwanted sound that is not necessarily random. He noted that noise, particularly loud ones disturb people or make it difficult

for people to hear, and that conversations of other people may also be described as noise by people not involved. He added that any unwanted sound, such as barking of domesticated dogs, neighbors playing loud music, port mechanical saws, road traffic sounds which have now become a part of the urban culture, qualify as noise pollution.

The problem with noise is not only that it is unwanted, but also that it negatively affects human life and well-being. High noise levels can contribute to cardiovascular effects in humans and an increased incidence of coronary artery disease. While the elderly may have cardiac problems due to noise, according to World Health Organization, children are especially vulnerable to noise and the effects that noise has on children may be permanent. Noise poses a serious threat to a child's physical and physiological health and may negatively interfere with a child's learning and behavior (Wikipedia, 2006). Noise is a growing health threat, and if left unchecked, could result to hazardous conditions (Adejobi, 2012).

In considering the adverse effects of noise and the need for control, it is suggested by (Kaushik and Kaushik, 2008) that noise can be controlled by reduction in sources; use of sound absorbing silencers; planting of more trees with broad leaves; and legislation. Noise pollution from commercial areas and other urban factors can be mitigated by applying an important factor which is a computer model like ArcGIS (Karthik et.al., 2015). ArcGIS provides good visualization tools of noise propagation and assist in building a spatial decision support system that can be used for decision making

2. Materials and Methods

2.1 Study Area

Akure lies on latitude 70 5' North of the equator and longitude 50 15' East of the Greenwich Meridian. It is about 370m above the sea level, it is situated within a 48-kilometer (km) radius to major towns in Ondo State, via Ondo to the South, Owo to the East and Iju/Itaogbolu to the North. Easy access and geographical centrality of Akure to these towns have enhanced the growth prospect of the City. The population of Akure in 1963 was put 71,006 and by 1999, the population had risen to 239,124 (NPC, 1996). By the year 2006, the population had increased to 340,021 (NPC, 2006). The city has expanded continuously in all directions in the past two decades. Many significant changes have been experienced in terms of urbanization, industrialization, expansion of road network, and infrastructure. The city has been subjected to persistent road traffic and commercial activities due to overall increase in prosperity, fast development, and expansion of the economy. Very few studies have been carried out to investigate and assess noise pollution in Akure metropolis. This study will examine the noise levels in the selected residential neighborhoods, commercial, and educational areas of Akure Metropolis with a view to considering the quality of livelihood that the residents are being subjected to.

2.2 Methodology

Three areas based on land use have been selected for this study namely Oja-oba Market (commercial Land use), Ijoka (Residential land use), and The Federal University of Technology, Akure (FUTA as an Educational Land Use). This research is based on the result of outdoor and indoor sound level measurements for the selected areas. The noise level of each of the selected areas were conducted with the aid of a Digital Sound Level Meter (IEC651 Type 2) which complies with the IEC standard. 15 locations were selected in each area and a random sampling method was adopted.

The instrument was held comfortably in hand with the microphone at a distance of about 1.2 meters above the ground level and 1 m away from the chest. Noise level measurements was carried out three times daily for a period of 7days in each area. Daily measurements were taken in the morning (8:00am -9:00am), afternoon (1:00 pm-2:00 pm) and evening (4:00 pm-5:00pm). Measurements were recorded every 15 seconds for a duration of 2 minutes on a selected spot to account for time fluctuation of the noise levels using multifunctional digital sound level meter (IE651 Type 2). The longitude and latitude of each spot was also recorded with the help of a hand held Global Positioning System (GPS). The Noise level maps was also prepared using Arc GIS 10.5 software to show the areas with low, medium and high noise level.

3. Results and Discussions

Table 1 shows the noise levels within the selected residential neighborhoods at different time of the day for the noise computation of Ijoka area. The analysis shows that Sunday bus stop has the highest noise level with 64.3 dB(A) recorded in the morning, 53.3 dB(A) in the afternoon and 49.6 dB(A) in the evening. This is due to the market located around this area and the presence of traffic noise. It is noted that Olowookere street which has 38.1 dB(A) in the morning, 47.4 dB(A) in the afternoon and 40.7 dB(A) in the evening which is the lowest noise within the selected areas. It can also be seen from table 4.1 that Ileri oluwase, Ayoni C & S, Breeze FM, Oyedepo street and others have noise level that are within the recommended permissible noise limit of 55 dB(A) and 45 dB(A) for afternoon and evening respectively for residential zones.

Table 1 Noise levels in selected areas within Ijoka.

			Morning dB(A)	Afternoon dB(A)	Evening dB(A)
Locations	Latitude	Longitude	(8:00-9:00am)	(1:00-2:00pm)	(4:00-5:00pm)
Abusoro str	7.21333	5.19875	45.0	42.0	43.9
St Philip	7.20972	5.19869	42.0	39.6	46.5
Cowbell str	7.20943	5.19873	43.7	47.7	40.1
Davog	7.20722	5.19878	52.2	57.0	45.9
Olowookere str	7.21028	5.19857	38.1	47.4	40.7
Alajeseku str	7.21139	5.19821	49.7	50.3	47.4
Alakure	7.20909	5.19802	47.9	48.2	43.4
Ileri oluwase	7.2091	5.1953	50.9	40.6	44.7
Oyedepo str	7.20917	5.19853	49.0	39.4	41.7
Ayoni C&S	7.21055	5.19891	45.8	40.9	44.3
Breeze FM	7.21005	5.19890	43.2	40.4	43.6
Honey bread	7.21029	5.19953	43.0	45.3	43.5
Golden tommy str	7.21105	5.19929	47.2	47.6	48.7
NNPC Mega Station	7.2152	5.19922	60.5	53.5	42.2
Sunday Bus stop	7.215	5.2004	64.3	53.3	49.6

Table 2 shows the noise level computation for the selected commercial areas. The analysis shows that Ijomu

has the highest noise level, which recorded 75.1 dB(A) in the morning, 78.6 dB(A) in the afternoon and 70.4 dB(A) in the evening. The high noise level recorded in the morning was due traffic congestion. Erekesan market has the lowest noise level of 61.5 dB(A) in the morning, 68.0 dB(A) in the afternoon and 69.8 dB(A) in the evening. It was observed that most of the selected areas exceed the recommended permissible noise limit for commercial zones of 65 dB(A) and 55 dB(A) for afternoon and evening respectively.

Table 2 Noise levels in selected areas within Olukayode market

Location			Morning dB(A)	Afternoon dB(A)	Evening dB(A)
	Latitude	Longitude	(8:00-9:00am)	(1:00-2:00pm)	(4:00-5:00pm)
Texaco	7.21005	5.19874	73.7	72.3	72.6
Ijomu junction	7.20983	5.19871	75.1	78.6	70.4
Olukayode	7.20929	5.1988	71.6	79.8	69.4
Market center	7.20901	5.19878	71.5	73.2	75.7
Odo ikoyi	7.20889	5.19863	75.3	73.5	73.3
Center mosque	7.2089	5.1982	72.4	75.3	79.5
Post office	7.20911	5.19805	72.6	76.1	77.3
Oja oba	7.20914	5.19827	66.8	72.3	79.5
Deji palace	7.20915	5.19852	65.0	75.1	65.8
Erekesan market	7.21009	5.19887	61.5	68.0	69.8
Old garage	7.21012	5.19887	70.2	65.0	63.8
Arakale road	7.21031	5.1996	74.3	70.0	70.9
Car street	7.21108	5.19927	69.3	73.9	73.7
Ultra-modern Market	7.21157	5.19919	72.9	76.1	76.5
Stadium Junction	7.21160	5.19920	72.3	73.8	74.9

Table 3 shows the noise computation of selected institution areas (FUTA). The analysis shows that Northgate has the highest noise level, which recorded 76.3 dB(A) in the morning, 79.3 dB(A) in the afternoon and 79.5 dB(A) in the evening. The high noise level in the morning was due to the high population of student coming for lecture and traffic noise. The lowest noise level was recorded at Library area with 41.0 dB(A) in the morning, 52.7 dB(A) in the afternoon and 53.2 dB(A) in the evening. Areas like Front of Abiola Hostel, Student Affairs and Senate Area are within permissible recommended noise limit of 55 dB(A) and 45 dB(A) for afternoon and evening respectively.

Table 3 showing Noise levels in selected areas within FUTA

			Morning dB(A)	Afternoon dB(A)	Evening dB(A)
Location	Latitude	Longitude	(8:00-9:00am)	(1:00-2:00pm)	(4:00-5:00pm)
Jadesola hostel	7.30174	5.14358	49.5	45.8	64.6
Front of Abiola	7.30197	5.14258	51.1	41.3	46.1
Aluta market	7.30259	5.14151	60.7	55.7	60.0
S.U.B	7.30424	5.13968	62.9	54.2	58.4
ETF	7.30244	5.13543	53.2	49.9	46.4
SAAT	7.30142	5.13565	46.2	60.2	48.3
Student affair	7.3014	5.1382	50.3	48.9	43.6
Senate area	7.30193	5.13919	47.7	49.1	55.8
Engineering building	7.30309	5.13524	63.4	66.2	65.6
South gate	7.2933065	5.149600	76.5	60.5	78.5
Health center	7.2952227	5.1495071	48.2	45.2	53.3
SAAT Lab	7.2936518	5.1483598	46.7	49.8	45.0
Great Hall	7.2962735	5.1467994	41.7	47.2	57.6

			Morning dB(A)	Afternoon dB(A)	Evening dB(A)
Botanical garden	7.3008658	5.1409787	45.1	48.1	57.1
2 in 1 LT	7.2980901	5.1363959	52.1	57.2	54.2
SET	7.2992814	5.1364599	50.2	57.2	72.2
SMAT Building	7.2981552	5.1349399	51.4	54.4	54.3
3 in 1 LT	7.3010911	5.1338085	65.2	64.8	63.3
FBN LT	7.2980528	5.1328436	65.8	58.6	68.2
Library area	7.3043673	5.1343177	41.0	52.7	53.2
S.O.S	7.3018927	5.1342284	68.4	68.4	66.8
Round about	7.3036951	5.1388386	65.3	66.7	69.0
Northgate	7.3064279	5.1394561	76.3	79.3	79.5

Plate 1 to Plate 3 shows the spatial distribution of noise levels in the selected areas within FUTA for morning, afternoon and evening respectively. The colors denote the increase in noise levels(decibel) which are represented from green to yellow on the thematic map. Plate 4 shows the line graph which denotes the noise peak and statistical analysis of the noise data

3.1 Detailed Noise Levels in FUTA(Institutional)

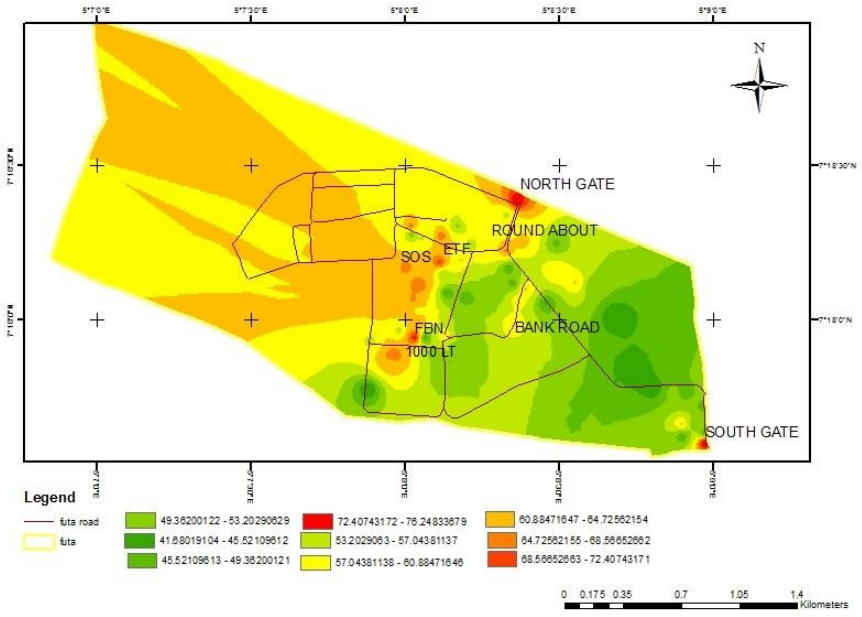

Plate 1 Map Showing morning noise level in selected areas within FUTA

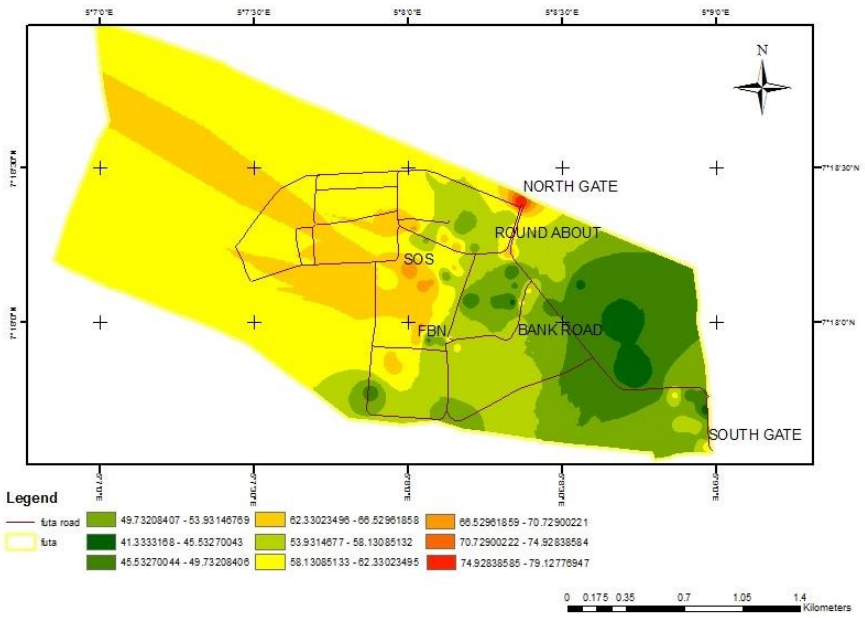

Plate 2 Map showing afternoon noise level in selected areas within FUTA.

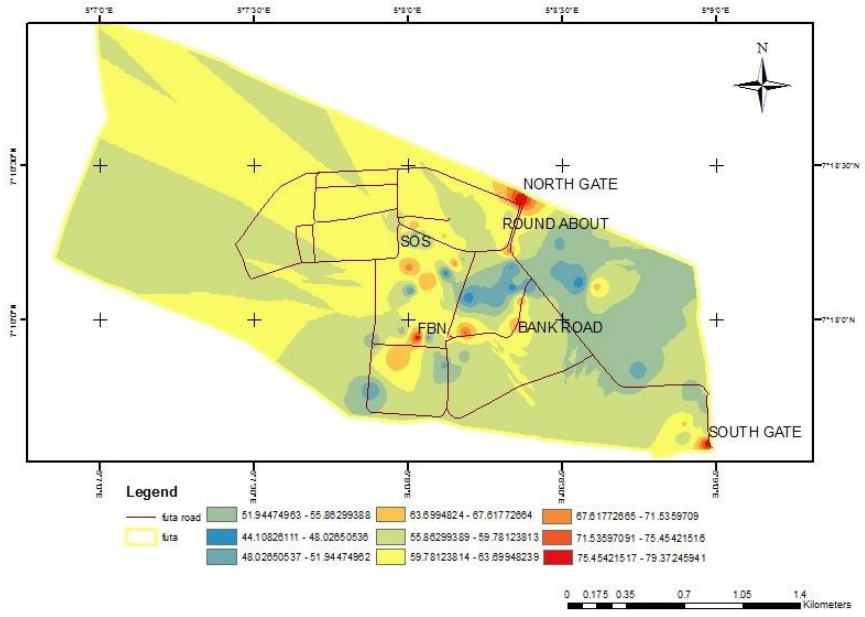

Plate 3 Map showing evening noise level in selected areas within FUTA

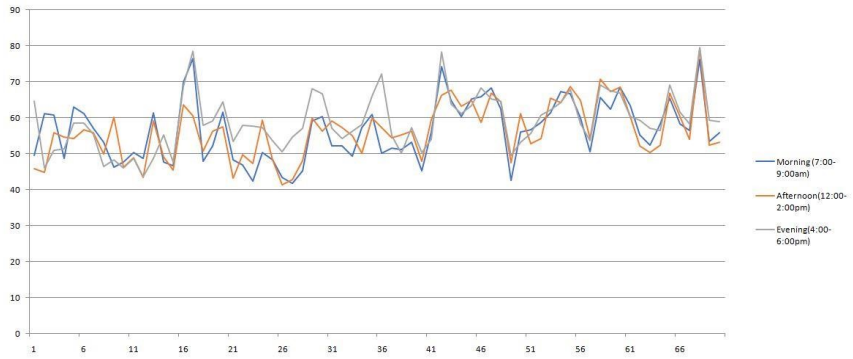

Plate 4 line graph showing variation in noise level in FUTA With the observed trend of high noise values from the line graph, the morning recorded the least noise levels. The mapped values range between 41.7 dB(A) to 76.5 dB(A) for morning, 41.3 dB(A) to 79.3 dB(A) for afternoon and 43.6 dB(A) to 79.5 dB(A) depicting lower and higher limits for the period. South gate and north gate were recorded as places with highest value which was due to the bus stop at the two gates hereby causing noise pollution for the land use. Malu road and Botanical garden has the lowest noise level due to the closeness to thick vegetation (forest). The school of engineering and engineering (SEET) building was assessed for morning afternoon, and evening period, the average noise levels are 63.4 dB(A) ,66.2 dB(A) ,65.6 dB(A) respectively. ETF, 1000 LT, 2 in 1, SET and SOS building. It is found that the noise levels in the lecture theater are above the threshold limits of 55 dB(A) man can be exposed to due to the operations carried out in the area. This noise is due to the high population of students in the area. From the line graph above, it shows that the highest noise value is in the evening and the places with highest occurrences noise pollution is in the morning. Plate 5 to plate 7 shows the spatial distribution of noise levels in the selected areas within Ijoka for morning, afternoon and evening respectively. The colors denote the increase in noise levels (decibel) which are represented from green to yellow on the thematic map. Plate 8 shows the line graph which denotes the noise peak and statistical analysis of the noise data.

3.2 Detailed Noise Levels in Ijoka(Residential)

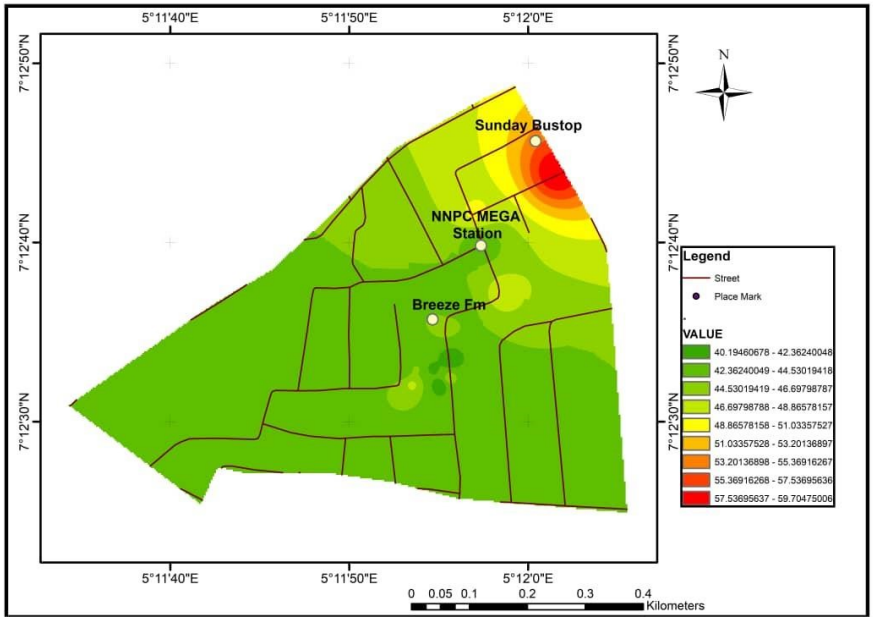

Plate 5 Map showing morning noise level for selected areas within Ijoka.

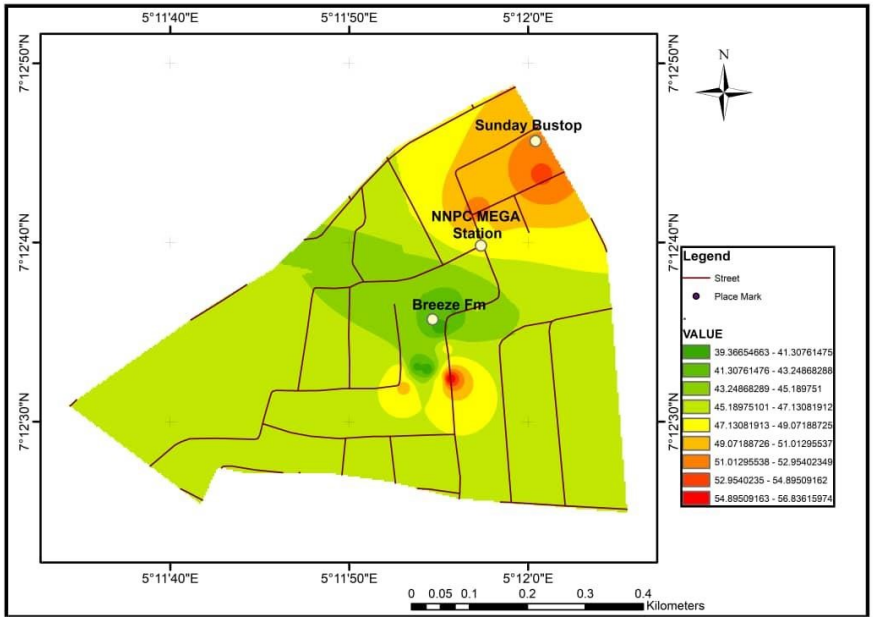

Plate 6 Map showing afternoon noise level for selected areas within Ijoka.

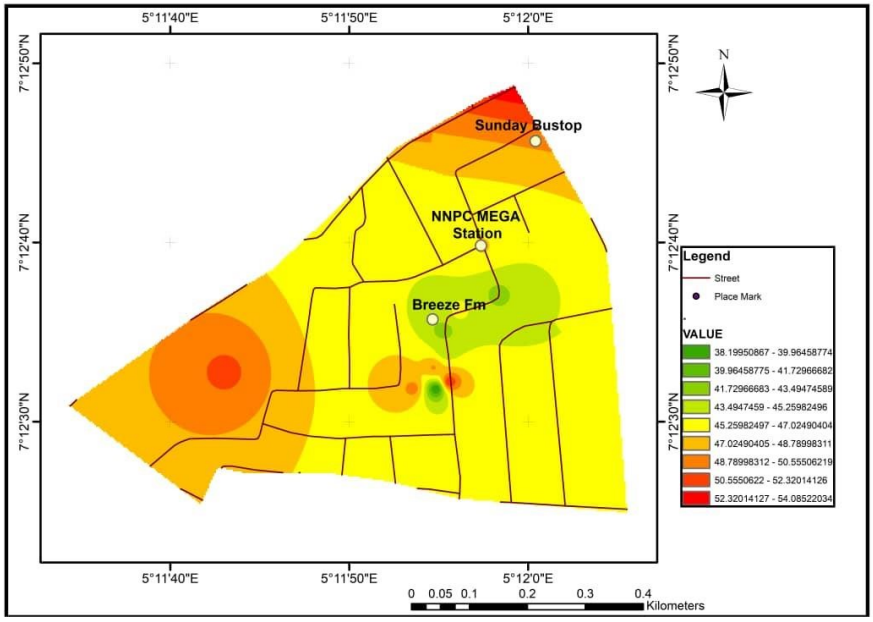

Plate 7 Map showing evening noise level for selected areas within Ijoka

Plate 8 line graph showing variation in noise level Ijoka The average noise level thematic maps and chart are shown in plate 5 to plate 8 at the Ijoka residential area. Research reveals that the residential land use noise peak at 57.5-59.1 dB(A) in the morning, 54.8 to 56.8 dB(A) at afternoon and 52.3-64.1 dB(A) in the evening while the lowest noise value in the land use ranges between 40.2-42.4 dB(A), 39.4-41.2 dB(A), 38.2-40.0 dB(A) in the morning, afternoon and evening respectively. It is observed that areas close to the road side experience the highest noise level, this is as a result of traffic noise. The noise levels in this area are not as high as the educational and commercial area. Plate 9 to plate 11 shows the spatial distribution of noise levels in the selected areas within Oja Oba for morning, afternoon and evening respectively. The colors denote the increase in noise levels(decibel) which are represented from green to yellow on the thematic map. Plate 12 shows the line graph which denotes the noise peak and statistical analysis of the noise data .

3.3 Detailed Noise Levels in Oja Oba(Commercial)

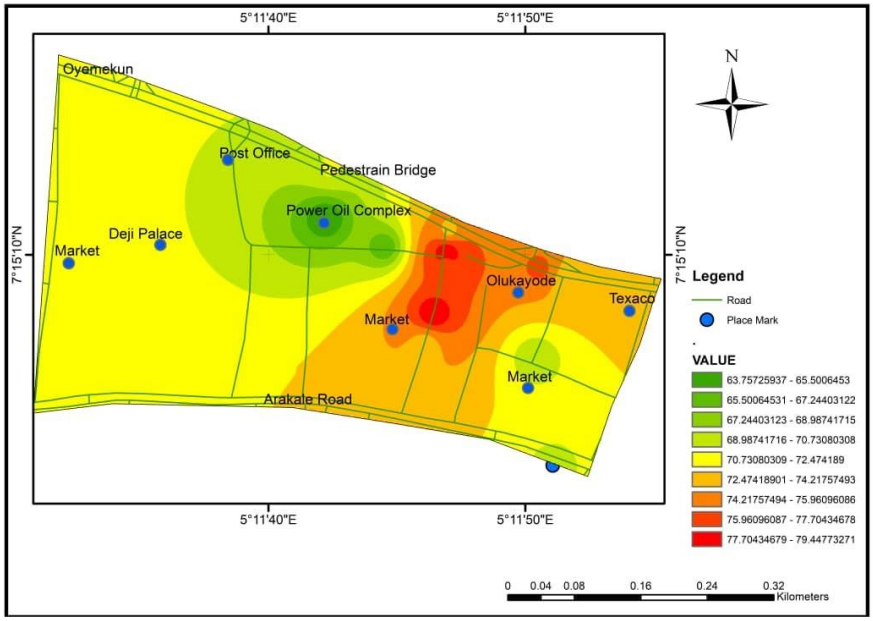

Plate 9 Map showing morning noise level for selected areas within Olukayode market.

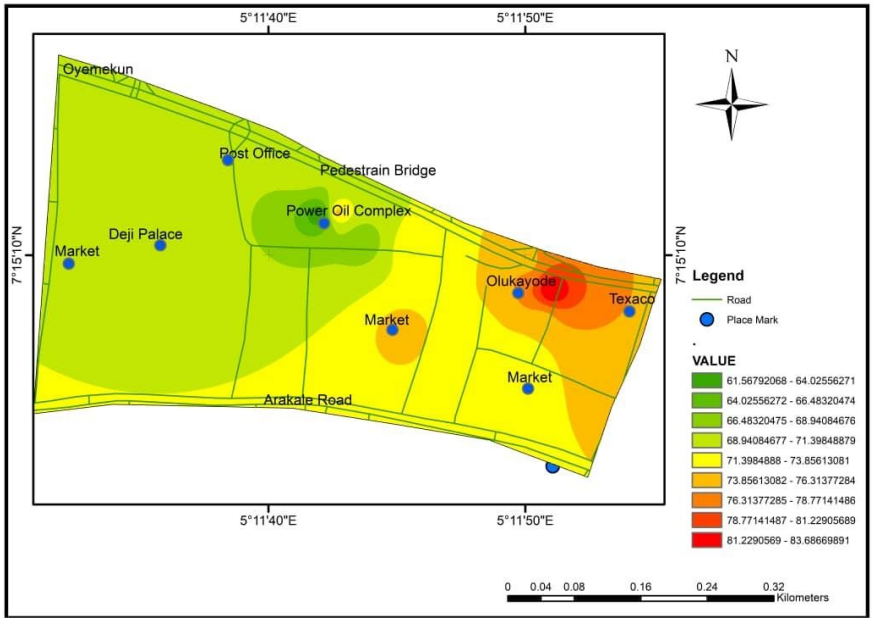

Plate 10 showing afternoon noise level for selected areas within Olukayode market.

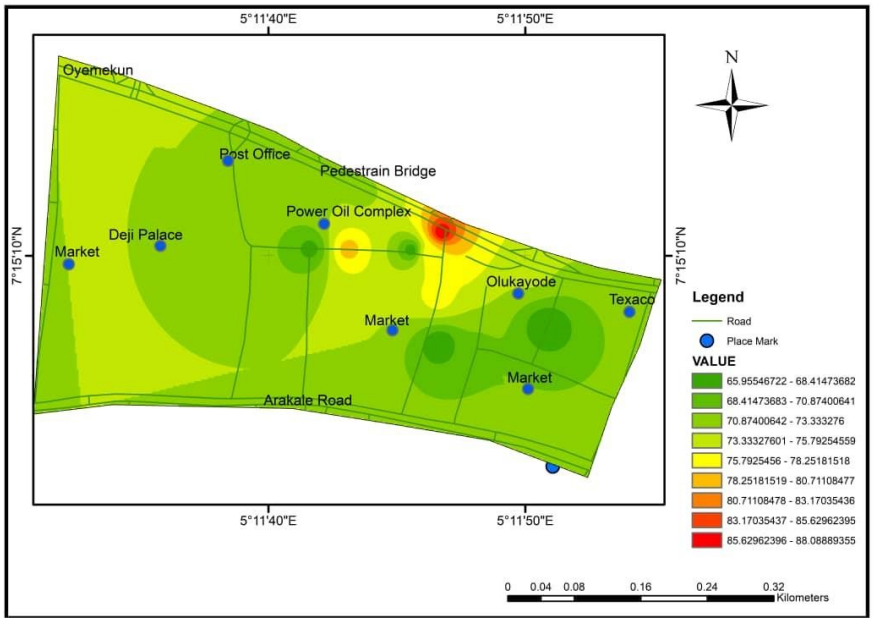

Plate 11 showing evening noise level for selected areas within Olukayode market.

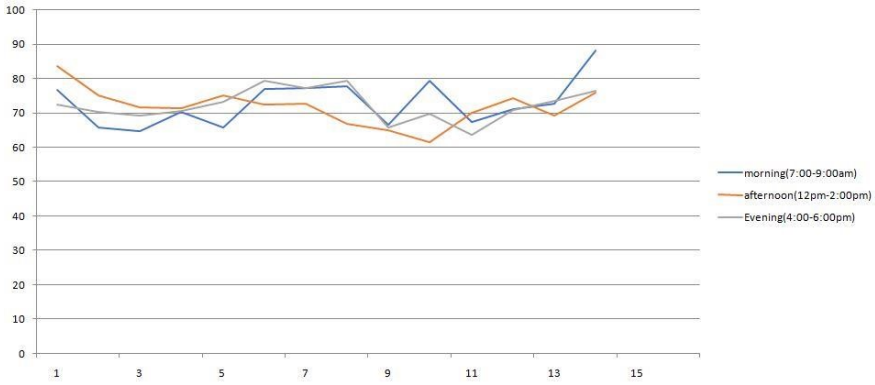

Plate 12 line graph showing variation in noise level Oja Oba

The commercial land use has the highest noise level ranging from 77.0-79.4 dB(A), 81.2-83.7 dB(A) and 86.62-88.7 dB(A) in the morning, afternoon and evening respectively. The highest noise level in the morning was recorded beside Olukayode Adeshida road which was as a result of traffic. The main sources of the noise within the market are mainly from Grinding machines, music players, hawkers, People advertising products using loud speakers, megaphones etc. The Oja oba market also has high noise level due to the population of people in the environment. The highest noise recorded for afternoon noise level was observed at the Olukayode building. This was due to the commercial activities and high population density in the area. This area is known as center of commercial activities in Akure south.

Table 4 Showing Permitted Noise Level at Different Land use.

Type of Land Use	Day time	Night time
Industrial	75	70
Commercial	65	55
Residential	55	45
	Classroom environment	Classroom indoor
Educational	55	45

(Source: WHO, 2009)

4. Conclusions

The study has examined the distribution of noise in selected areas within Federal University of Technology, Akure (FUTA), Ijoka and Olukayode market, via monitoring and GIS-based mapping for decision making purposes. The World Health Organization (WHO) standards were used as limits for noise assessment. The research carried out in the various land use reveals that 80% of the commercial area is exposed to the highest risk of noise pollution. Hence, results records that the highest noise was recorded in the morning and afternoon. The residential area was exposed to 18.7% noise pollution which makes the area suitable for housing. The educational land use recorded 36.6% for total area exposed to noise pollution and 34% of the total lecture theatre is prone to noise pollution on lecture days. It is recommended that Ministry of Environment at the Federal and State level should collaborate to conduct a noise assessment study. Such study will produce a comprehensive noise pollution and regulations standard for sustainable environmental development in Akure with respect to the identified land uses. Also, marketing activities should be re-organized in an environmentally friendly manner and the use of loudspeakers should be discouraged in already noisy environment such as markets.

Declaration of Competing Interest

The authors wish to declare that there are no known conflicts of interest associated with this publication and this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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