



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 1, January 2022

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569

9940 572 462

6381 907 438

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# Noise Pollution Mapping of Woji Town, Port Harcourt

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**ABSTRACT:** This study focused on the mapping of noise at Woji area of Port Harcourt, Rivers State. A sound level meter was used to measure Noise levels at ten (10) select locations in Woji Town for three times a day (morning, afternoon and evening) for three (3) days. Average equivalent noise level (Leq), L10, L90, Traffic noise index and Noise climate were computed using Microsoft Excel, noise maps for morning, afternoon and evening were produced using QGIS software while statistical analysis was done with SPSS. The results range gotten include mean Leq (58.57-76.53dBA), L10 (65.3-82.2dBA), L90 (57.0-71.4dBA), Traffic Noise Index (52.5- 84.8dBA), and Noise Climate (4.216.2 dBA). Average noise levels obtained when compared to World Health Organization standards were higher than the recommended limits of 70dBA for commercial/high-traffic area at Woji junction, Railway Junction and YKC in the mornings and evenings. Noise levels were found to be considerable higher than permissible limits at different locations with potential health risks for Woji residents.

**KEYWORDS:** Noise pollution, mapping, QGIS, Inverse Distance Weighted interpolation (IDW), GIS

## I. INTRODUCTION

Nigeria is one of three countries projected to make up to 35% of urban population growth between 2018-2050 with addition of 189 million individuals[1]. Growing production and commercial activities are required to meet increasing human needs. A high growing, industrialized area translates to more machines and noise generating activities. Some sources of noise include industrial/commercial activities, air, rail and road transport, social/religious gatherings and electricity generators.

Noise can originate from natural or artificial sources. Noise pollution has significant impacts on human health and even more significant is its perceived harmlessness as effects tend to creep over a long period of time. The effects of noise can be categorised as auditory and non-auditory where auditory means noise directly acting on the ear as an organ of the body such as hearing loss, tinnitus and non-auditory noise effects include annoyance, sleeping disorders, stress etc. Using noise measurement tools and techniques helps us to better understand noise and its effect on people. One of such tools is noise mapping.

Noise mapping offers a visual way to understanding noise and pin pointing noise sources. It is an increasingly popular tool for policy makers in tackling noise pollution in their locations. Noise pollution is a geographic issue since it varies between people, geographical location, level of growth and industrialization. It also varies based on its origins and impact level, which depends primarily on the frequency and degree of exposure. The difference in noise levels across geographical space makes it a highly significant spatial phenomenon. Noise maps are useful in assessing conformance to permissible noise levels, setting up and monitoring of noise reduction measures[2].

## II. RELATED WORK

Noise mapping can be done for singular noise sources e.g., aircraft traffic, road traffic, railway traffic etc. It can also be done to cover multiple noise sources to get a general picture of the noise climate of a particular region [3].[4]performed a GIS-based noise assessment and mapping of Bariga, Lagos state. The authors selected locations based on different land uses such as commercial, traffic, residential, and educational. A conventional noise meter was used to measure noise levels at 31 locations. Evenings was noted as the noisiest time of the day. Understanding why noise levels vary can provide a solid basis for noise mapping and seeking a permanent solution to the problem. Noise mapping may help to identify areas with good sound levels, spatial spread of noise, to hotspots that need immediate attention, and land uses that may require changing. In a similar use of noise mapping, the work of[5]on FESTAC town, a largely residential area in Lagos state showed transport-related activities to be

behind the area with highest noise levels. In their study, the bus park in the locality was shown to have highest noise levels surpassing the 55dBA noise limit. The authors noted that survey respondents complained of disorientation and emotional stress caused by noise pollution in their environment.

Works on noise in Port Harcourt metropolis include that of [6] who measured noise levels around ten locations in Port Harcourt and recorded LAeq values between 52.1dBA-120dBA which is higher than WHO permissible limits. Similarly, [7] in their review of residential noise levels around Port Harcourt recorded mean noise levels between 57.5 dBA and 70.1dBA which was higher than World Health Organization recommended limits for residential areas. [8] studied the effect of sleep disturbance induced by traffic noise across Port Harcourt and four other southern Nigerian cities. Results from the study showed that a high rate of sleep disturbance (93.8%-98.8%) reported by respondents.

### III. METHODOLOGY

Sampling locations considered in this study are Woji junction (S1), Railway Junction (S2), Elijiji (S3), Woji Town Hall (S4), Culvert (S5) Faith Avenue (S6), YKC (S7), Federal Housing Estate junction (S8), Nvuigwe (S9) and Alcon gate (S10). Sampling locations were selected to cover main areas of human activity and to have a fairly representative coverage of the study area. Sampling locations and study area is shown in Fig 1.

Noise levels were measured using a digital sound level meter (Landtek SL-5686P Digital Sound Level Meter). The sound level meter meets IEC 651.2, ANSI 1.4.2 type 2 measuring level range of and 30 – 130 dB. Noise level measurements were taken with the sound level meter at selected locations along the along Woji road. Readings were taken under clear weather conditions (no rainfall or noticeable wind movements). Measurements were taken for morning (7am-9am), afternoon (1pm-3pm) and evening (5pm-7pm) sessions for three working days.

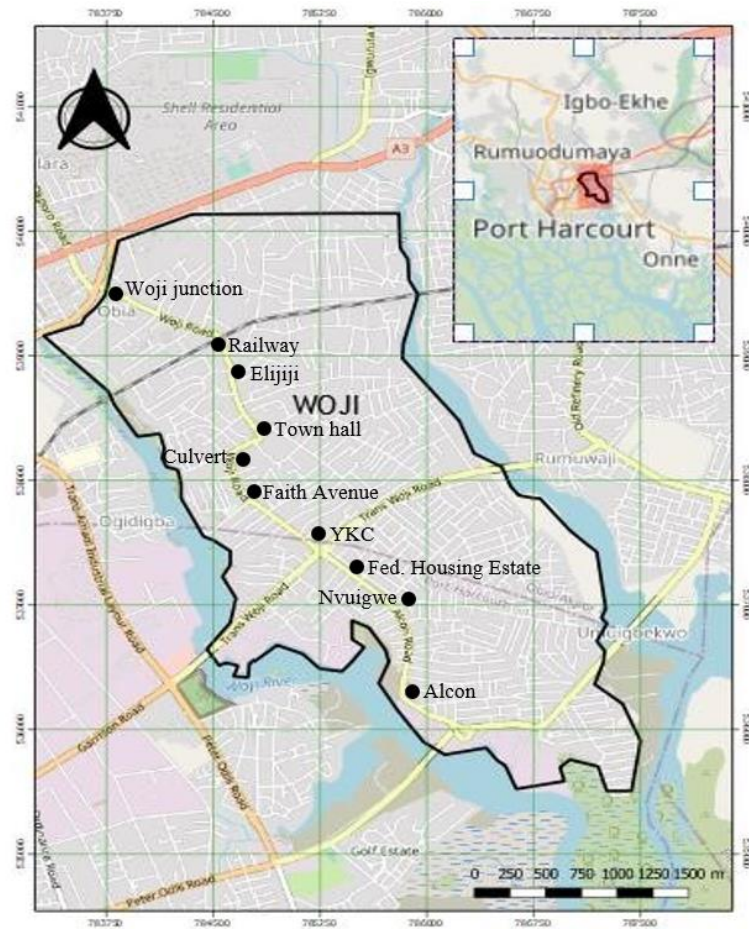


Fig 1. Map of study area showing sample points.

The sound level meter was held with its microphone facing suspected noise sources at a distance more than 1 metre away from any reflecting object. Leq (equivalent sound pressure level) measurements were recorded at intervals of 60



seconds for a period of 10 minutes giving 10 readings per sampling location and period. A total of 10 locations across the study area was selected for this study.

QGIS software version 3.10.12 was used to produce the Noise Maps with coordinates of the locations obtained from Google Earth. QGIS is a free, open-source geographic information system (GIS) computer software [9]. The software was selected due to its user-friendliness and ease of learning. The software is also lightweight which means it can function in a good number of everyday computers and laptops. Noise maps were produced with aid of an interpolation technique called Inverse Distance Weighted interpolation (IDW). Similar technique was used in some reviewed literature on the use of a GIS-based approach to noise assessment [4]; [10]; [11]. To predict the spatial distribution of the noise levels over an area, Inverse Distance Weighted interpolation uses values surrounding the predicted location. IDW predicts that each given point has a local influence that shrinks with space, giving higher weights based on the distance decay effect to points closest to the predicted location [4].

Noise metrics were computed with the use of their respective formulas:

**Equivalent Continuous Level (Leq)**

$$Leq = 10 \log_{10} \left( \frac{1}{T} \sum_{i=0}^n 10^{0.1L_i} \times t_i \right) \quad (1)$$

**The n-Percent Exceeded Level, Ln (L<sub>10</sub>, L<sub>50</sub> and L<sub>90</sub>)**

$$(m/(n + 1)) * 100 \quad (2)$$

**Noise Climate (NC)**

$$NC = L_{10} - L_{90} \quad (3)$$

**Traffic Noise Index (TNI)**

$$TNI = 4(L_{10} - L_{90}) + L_{90} - 30dB(A) \quad (4)$$

TNI is expressed in dBA.

Where;

T=total observation time

t<sub>i</sub>=duration of individual sound level sampled

L<sub>i</sub>=noise level of ith sample [12]

m = rank number

n = total number of data available.

L<sub>10</sub> = Sound pressure level exceeded 10% of the time

L<sub>90</sub> = Sound pressure level exceeded 90% of the time [13]

**IV. EXPERIMENTAL RESULTS**

Minimum and maximum measured noise levels are presented in Table One while L<sub>10</sub>, L<sub>90</sub>, noise climate and traffic noise index are presented in and Table Two. Noise maps created after interpolation is presented in Figure 2 (a), (b) and (c). Weighted noise levels were put against coordinates of the ten locations in the creating of the maps. Noise maps were colour coded from red to blue hues representing highest and lowest average noise levels respectively.

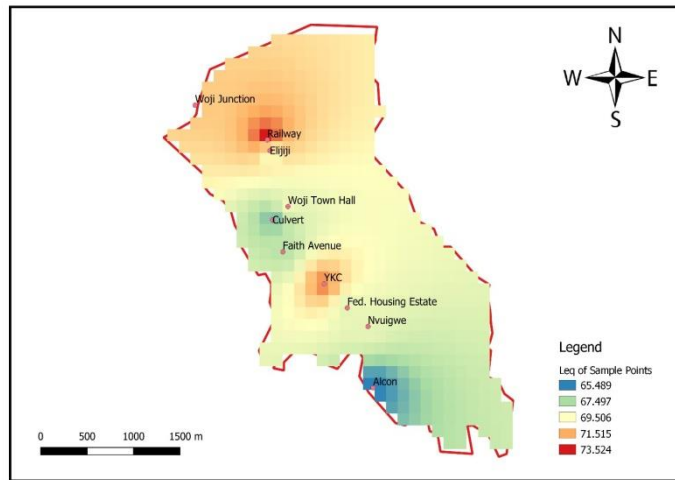
**Table One: Minimum and Maximum noise levels**

	Minimum	Maximum
Morning	60.5	82.3
Afternoon	44.1	78.8
Evening	51.6	89.0

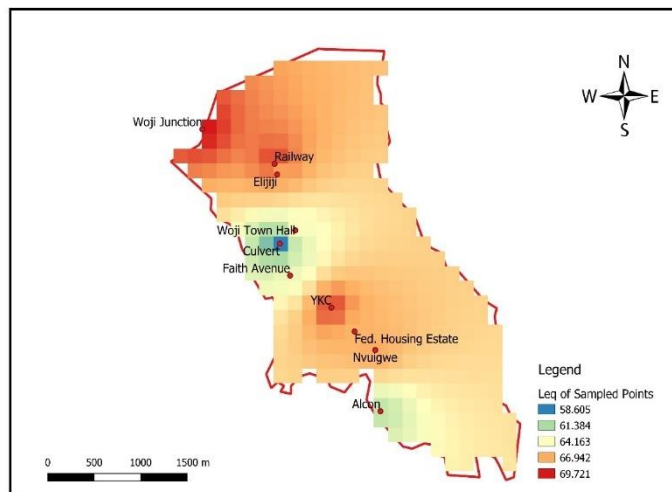


**Table Two: L<sub>10</sub>, L<sub>90</sub>, Noise Climate and Traffic Noise Index**

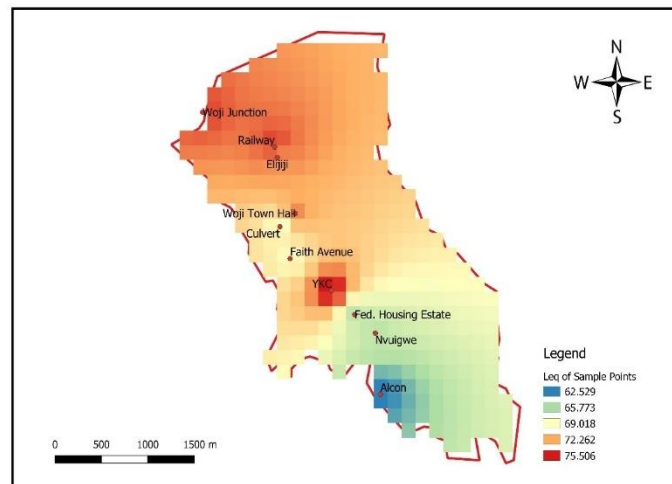
ID	Location name	Time of day	L <sub>10</sub>	L <sub>90</sub>	Noise climate	Traffic Noise Index
S1	Woji Junction	Morning	75.1	67.7	7.4	67.3
		Afternoon	72.7	66.9	5.8	60.1
		Evening	80.3	70.3	10.0	80.3
S2	Railway Junction	Morning	79.8	69.0	10.8	82.2
		Afternoon	72.5	66.3	6.2	61.1
		Evening	80.4	71.0	9.4	78.6
S3	Elijiji	Morning	72.2	64.8	7.4	64.4
		Afternoon	68.8	62.7	6.1	57.1
		Evening	75.8	69.0	6.8	66.2
S4	Town Hall	Morning	71.1	66.9	4.2	53.7
		Afternoon	68.7	58.7	10.0	68.7
		Evening	76.9	67.8	9.1	74.2
S5	Culvert	Morning	69.0	64.5	4.5	52.5
		Afternoon	66.2	50.0	16.2	84.8
		Evening	72.0	65.3	6.7	62.1
S6	Faith Avenue	Morning	70.3	64.9	5.4	56.5
		Afternoon	69.0	57.8	11.2	72.6
		Evening	72.8	65.3	7.5	65.3
S7	YKC	Morning	75.4	68.3	7.1	66.7
		Afternoon	72.6	66.7	5.9	60.3
		Evening	82.2	71.4	10.8	84.6
S8	Fed. Housing Estate	Morning	71.8	65.8	6.0	59.8
		Afternoon	70.8	63.6	7.2	62.4
		Evening	71.8	62.3	9.5	70.3
S9	Nvugwe	Morning	71.5	65.5	6.0	59.5
		Afternoon	71.2	62.4	8.8	67.6
		Evening	70.0	63.3	6.7	60.1
S10	Alcon	Morning	68.2	62.1	6.1	56.5
		Afternoon	65.3	58.8	6.5	54.8
		Evening	68.4	57.0	11.4	72.6



(a)

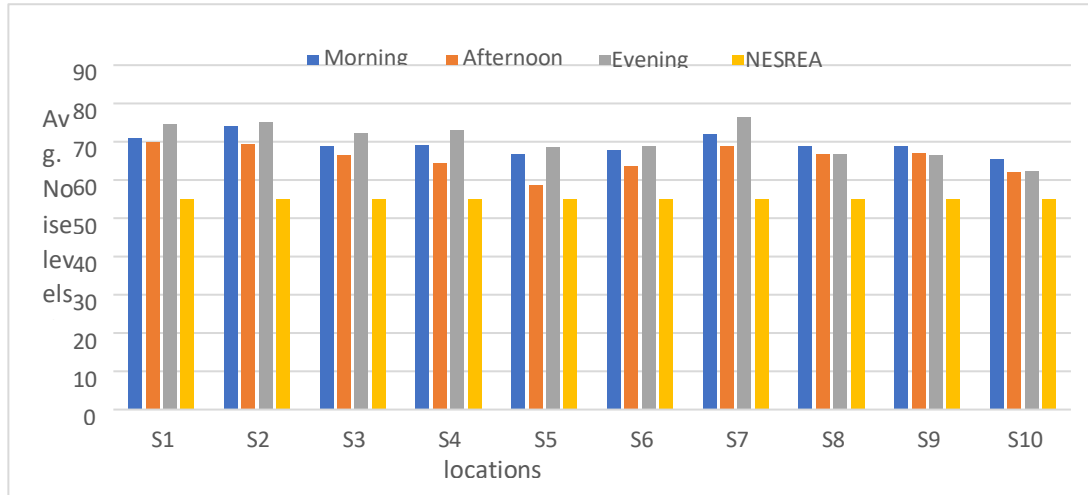


(b)

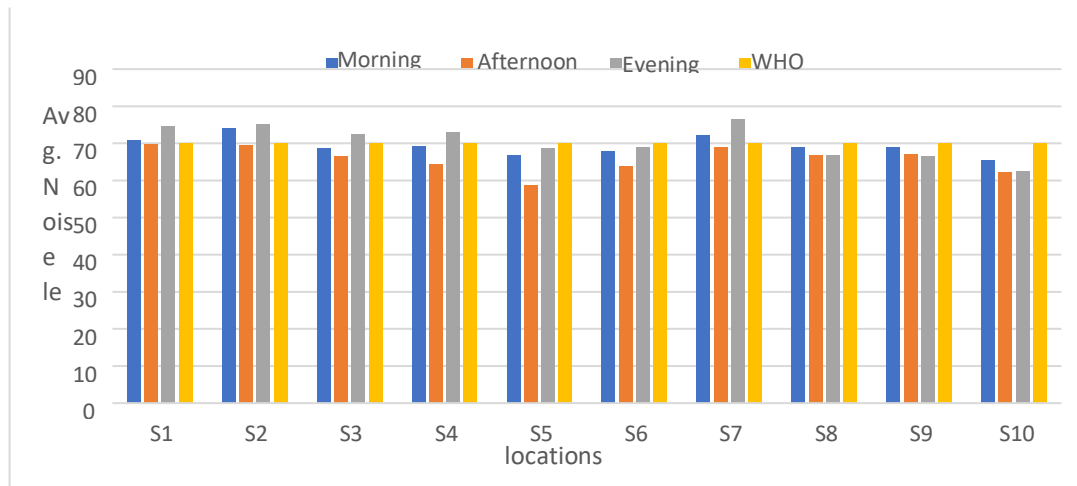


(c)

Fig. 2.Noise mapping using weighted noise levels (Leq) of Woji for (a) Morning (b) Afternoon and (c) Evening



(a)



(b)

Fig.3.(a) Average noise levels compared with NESREA limits (b) Average noise levels compared with WHO limits

From the noise maps, Woji junction (S1), Railway Junction (S2), YKC (S7) to Estate junction (S8) had higher noise values in the mornings compared to other locations. For afternoon, Woji junction (S1), Railway Junction (S2), Elijiji (S3), YKC (S7), Estate junction (S8) and Nvugwe (S9) all depicted higher noise levels for the time period. All locations from Woji junction (S1) through to YKC (S7) showed mid-high noise levels for evenings which was similar to the results obtained in [4]. This could be as a result of rush-hour activities such as tricycle riders who are trying to beat the government-imposed curfew to stop operations, traders trying to make closing sales for the day, road users returning from work, religious and other social activities. However, average noise levels from this study were lower compared to those obtained by [14] in the adjoining industrial area of Trans Amadi. This may be due to Trans Amadi being more of an industrial hub compared to Woji.

Across the three noise maps, Culvert (S5) and Alcon gate (S10) were the regions with the darkest blue hues signifying low noise values compared to other sample locations. These two areas have lesser human activity compared to other locations with less traffic build-up which could be an indicator of why their noise levels were generally lower. This is similar to what was noted in the works of [5] and [11]. A possible explanation for this is that these areas have less vehicular and human activity compared to other locations. Range of noise values gotten over the course of this study was 44.1 – 89.0dB(A) with some areas such as Woji Junction, Railway Junction and YKC with markedly higher



noise levels compared to others. This could portend a heightened risk of cardiovascular diseases for Woji residents as pointed out in the research of [15].

Sleep disturbance is another potential risk for residents in Woji town. All through Woji town it is common to see residential apartments that share the same building with shops and religious houses. Average noise levels from this work were lower than obtained by [16]. A possible reason for this is because noise levels obtained in this study were gotten by measuring noise from ambient/general environment sources instead of direct readings from loud speakers of religious houses.

On the other hand, the proliferation of electricity generating sets used by residents, shop owners and churches could also generate high noise levels similar to what was obtained in the work of [17]. These noise sources feed into the environment and could contribute to an increased chance of sleep disturbance among other health issues for Woji residents. The high likelihood of sleep disturbance among Woji residents is further corroborated by the work of [8]. From Fig 3(a), noise levels recorded in all locations and time of day were above 55dBA for maximum acceptable noise levels for mixed residential areas as recommended by National Environmental Standards and Regulations Enforcement Agency (NESREA). This is similar to results obtained in the works of [18] and [4] which were also above NESREA permissible limits.

The World Health Organization (WHO) permissible limits for noise is 55dBA for outdoor living area and 70dBA for commercial, shopping and traffic areas. Woji junction (S1), Railway Junction (S2), Elijiji (S3), Town Hall (S4) and YKC (S7) were higher than WHO permissible limit during the evenings. YKC (S7) was the highest for this time period. This could be due to the high traffic volume, loudspeakers from commercial activities and other human actions. Religious gatherings often hold in the centre of the road with loudspeakers contributing to the noise generated in the area.

Woji junction (S1) and Railway Junction (S2) were higher than WHO permissible limits for high commercial areas in the mornings. Other studies in Port Harcourt such as in Trans Amadi, and around Port Harcourt metropolis have been shown to fall short of WHO permissible limits. Results obtained from this study agreed with the work of [6]. This could be attributed to the high traffic volume and human activities in these areas at that time of day.

Overall, this study has further demonstrated the use of noise maps as a great visual tool to understanding noise levels over a geographical area as observed in similar works in literature.

## V. CONCLUSION

This study set out to evaluate the noise pollution levels of Woji town, Port Harcourt, Rivers state and also generate a noise map for the area. Noise levels was measured at ten locations along Woji road ranging between 44.1dBA and 89.0dBA. Noise levels around Woji were above NESREA and WHO recommended limits for residential areas for most of the locations measured. Possible causes of sustained noise during the day include continuous flow of vehicular traffic, car honks, open air crusades/religious activities, public address systems, offloading of goods by heavy duty vehicles. High noise levels could pose health risks to residents. It is recommended that the government look into expanding and dualling the road as this will help decongest the traffic situation and likely lead to less noise generated. Also, Federal and states government should provide adequate, enforceable laws on noise pollution in the environment.

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