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Noise Mapping of Abuja Campus of University of Port Harcourt

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Abstract
A computer-aided noise mapping of Abuja campus of the University of Port Harcourt was performed. ArcGIS 10.7.1 was used to generate coordinates for the sampling points. The generated coordinates for the sampling points were located using Google map mobile application. The noise measurement was done in the morning, afternoon, and evening for a period of seven days using a digital sound level meter at an interval of one minute. An inverse distance weighted ArcGIS geo-statistical interpolation tool was used to create a noise map across the campus. The noise map developed was based on the computed values of the average equivalent noise level of the sampling points. Results obtained were statistically analyzed using two-way ANOVA which showed that noise equivalent level varies for each day and each sampling points. The n-Percent exceeded (L_{10}, L_{50}, L_{90}) as well as the noise pollution level varied for each of the sampling points due to varying activities within the campus. Based on the recommended standard for school by the World Health Organisation, which is 55dBA, some of the locations within the campus have noise levels above the recommended standard, which could be attributed to the noise from heavy duty generators, vehicles, construction works, social activities, religious activities and students chattering. Such noise level could result in noise pollution and could interrupt academic activities.

Keywords: *Noise mapping, ArcGIS, Google map, Sound level meter, University of Port Harcourt*

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1. Introduction

Noise is generally made by human activities and is a kind of pollution that influences individuals' social, financial, and environmental well-being. Noise pollution occurs when noise level is above the permissible level for a given environment (WHO, 2005; FMEnv., 2003). Noise pollution can negatively affect humans both directly and indirectly. The negative health impacts include rest aggravation, hearing disability, inconvenience, cardiovascular impacts, and cognitive functioning, particularly in children and it adversely impacts wildlife (Laiolo, 2010). Many countries around the world have passed laws to reduce noise levels within their immediate environment. In Nigeria, the National Environmental Standards and Regulations Enforcement Agency Establishment Act of 2007 is the major law on noise pollution in Nigeria. The principal aim of measuring noise levels is to ascertain the actual level whether it conforms with an acceptable sound level which the human ears can tolerate. Unfortunately, noise studies in Nigeria are almost exclusively limited to highway, railway, or airport noise. Thus, there is little information regarding institutional noise map of various campuses across the nation.

Educational institutions are among the principal areas where reduction in noise level is desired. Strategic noise mapping can help identify "problem areas" and give information necessary for decision making within the educational environment. The University of Port Harcourt is an academic environment with the goal of promoting academic excellence, research, and innovation through quality programmes, as such is meant to have certain level of serenity, to enable its students' concentrate. Educational areas, thus, need tranquility, because long-term and repeated noise exposure or disturbance may lead to psychological health complications and reduce students' learning ability or motivation. However, due to increase in population and various human activities within the institution there has been an increase in noise levels, which affects or disrupts academic activities. Thus, the aim of this study was to

determine whether the Abuja Campus of University of Port Harcourt has any "problem areas" with noise pollution, and if the Institution's entire sonic landscape aligns with the mission, vision, and strategic goals of creating a "quality learning environment". Consequently, the study utilized Geographic Information System (GIS) abilities to store, analyses, and communicate the results from an integrated data collection campaign to map noise in the Abuja Campus of the University of Port Harcourt.

2. Materials and methods

2.1 Study area

The study area for this work was the busy areas of Abuja Campus of University of Port Harcourt which is located at approximately 4.9069°N and 6.9170°E (Fig. 1). The University of Port Harcourt has a total area of 461 hectares divided into Choba, Delta and Abuja (campus) by three public roads within Obio/Akpor Local Government Area of Rivers State, Nigeria. The University has a student population of about 35,000 to 39,999. The University has lots of businesses and social activities taking place within the institution aside academic activities which form the various sources of noise within the campus.

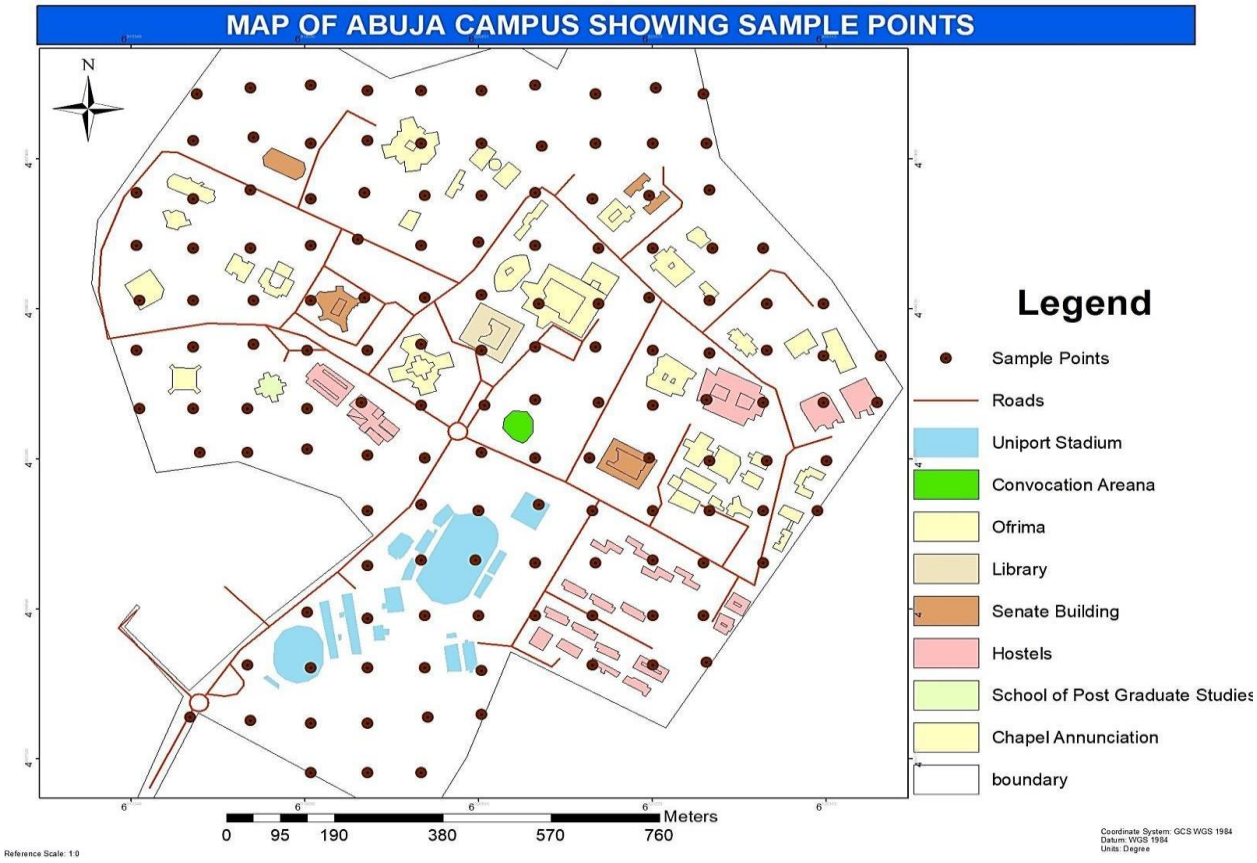

Fig. 1: Map of study area showing sampling points

2.2 Selection of sampling points

The sampling points were obtained by getting the coordinates (Easting and Northing) of approximately ten points in the Abuja campus of University of Port Harcourt using Google map. These points were then inputted into Excel and saved as comma-separated values (CSV) format. The saved file format was then imported into Arcmap, where a base map for Abuja campus of University of Port Harcourt was created using Open Street map. Using the geometrical grid plan of a geographic information system (GIS), one-hundred and fifty-four sampling points spatially distributed across the Abuja campus, with a spacing of 100m between each sampling point, were obtained (Yilmaz and Hocanli, 2006). Adjustments were made on sampling points that fell on top of a roof or other inaccessible locations.

2.3 Noise measurement

Noise measurement was done at different times of the day, viz morning (7:00-11:59am), afternoon (12:00-4:59pm), and evening (5:00-8:59pm) at the selected sampling points. The device used for the noise measurement was SL-5868P digital noise meter with a recording capacity range of 30 -

130dB, frequency range of 31.5Hz - 8KHz, and an accuracy of 1dB. Measurement was taken with the meter in fast response setting and in a one second average noise levels.

2.4 Calculation of relevant indices

Equivalent sound level (Leq)| was calculated by integrating the sound pressure level over a time period using Equation (1) (Ugwoha and Maha, 2019). Total Leq was calculated using Equation (2).

$$Leq = 10log_{10}[\frac{1}{T}\sum_{i=1}^{n}10^{0.1Li}t_i] \quad (1)$$

$$Total\ Leq = 10log_{10}(\frac{10^{\frac{leq1}{10}}+10^{\frac{leq2}{10}}+\cdots 10^{\frac{leq_n}{10}}}{n}) \quad (2)$$

where T is the time period over which Leq is determined, Li is the noise level in the ith sample and t_i is the fraction of the total time, and n is the total number of Leq. Sound level exceeded for 10, 50 and 90% of the time (L_{10}, L_{50}, L_{90}) were calculated by first calculating the probability of exceedance (Percentile) using Equation (3). Thereafter, the percentiles and sound levels were interpolated at a time to obtain L_{10}, L_{50}, and L_{90}.

$$P = \frac{2m-1}{2n} * 100 \quad (3)$$

where P is the percentile, m is the rank and n the number of data. Noise population level (NPL) was calculated using Equation (4) (Ugwoha and Maha, 2019).

$$NPL = L_{50} + (L_{10} - L_{90}) + \frac{(L_{10}-L_{90})^2}{60} \quad (4)$$

2.5 Noise mapping

ArcGIS 10.7.1 software was used to develop noise map for Abuja campus of University of Port Harcourt. The software used inverse distance weighting (IDW) method. IDW provides satisfactory results when the number of elevation points are large and uniformly distributed. IDW interpolation method was used by considering data from noise sources and distances between them. This technique was applied to measure the spatial distribution and range of noise in the area for the three periods of the day.

2.6 Statistical analysis

The noise equivalent levels measured for each day and at different points were compared statistically using two-way ANOVA to check for any significant difference in values.

3. Results and discussion

3.1 Noise map

Noise maps were produced using Leq, L_{10}, L_{50}, L_{90} and NPL and presented in Figures 2 to 6, respectively. A range of five colors were used on the maps, with red representing the highest noise level and blue representing the lowest noise level. The areas covered with red include the Convocation arena, Recreational area, Abuja Park, Chapel of Annunciation, and School of Basic Studies. The increase in noise level was attributed to ongoing construction work around the Convocation arena, social activities at the Recreational area, passengers and vehicular noise at Abuja Park, various religious activities at and around the Chapel of Annunciation, and students chattering at the School of Basic Studies. Similar trend of map was observed for Leq, L_{10}, L_{50}, L_{90} and NPL because Leq and L_n were calculated from the same sound levels, and NPL calculated from L_n. Prolonged stay at the areas covered with red could lead to noise exposure and the associated adverse effects such as hearing impairment, physiological impacts, communication and task interference (Gorai and Pal, 2006; Kiely, 2007; Tripathy, 2008).

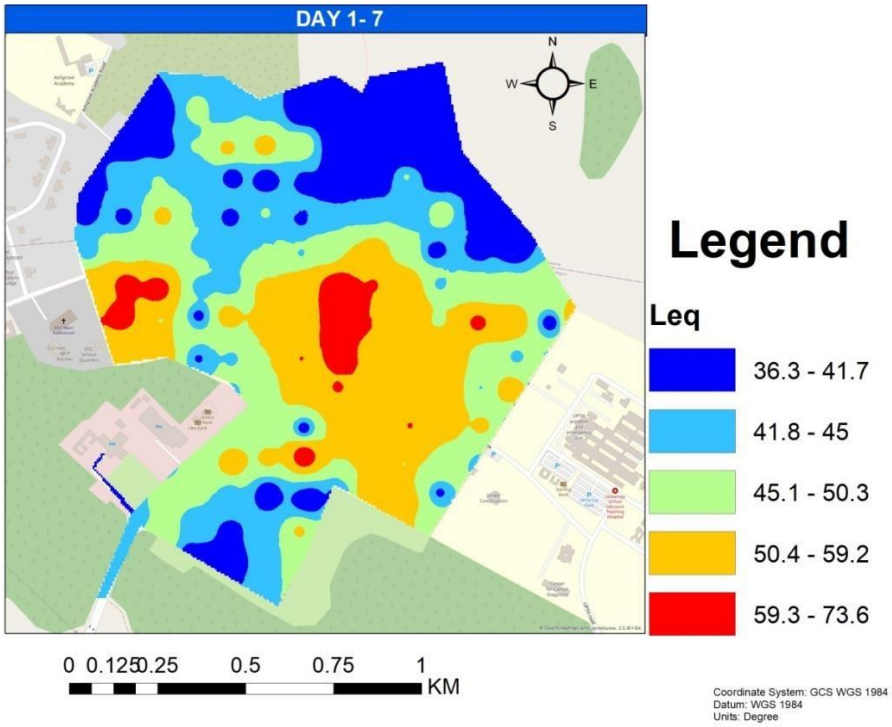

Fig. 2: Noise map from day1-day7

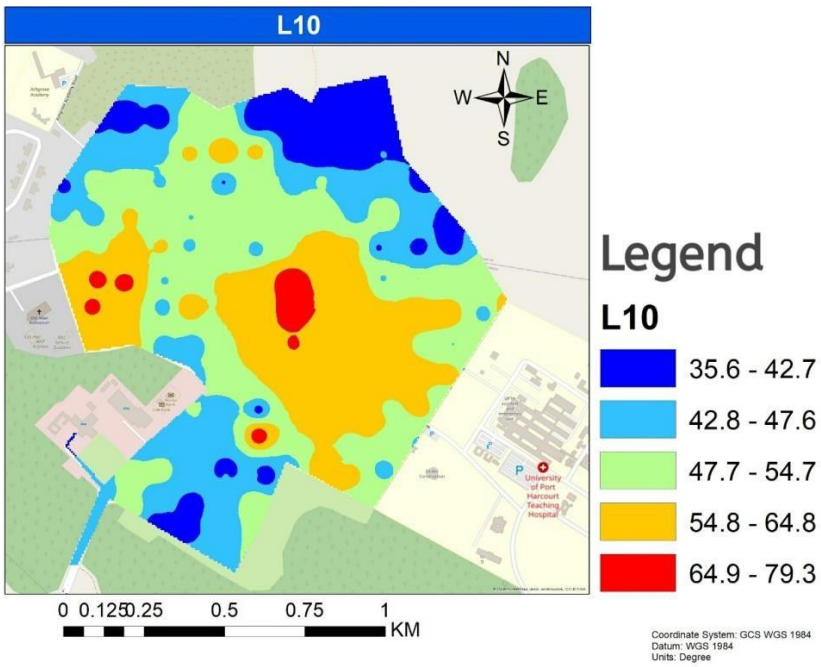

Fig. 3: Map of L_{10}

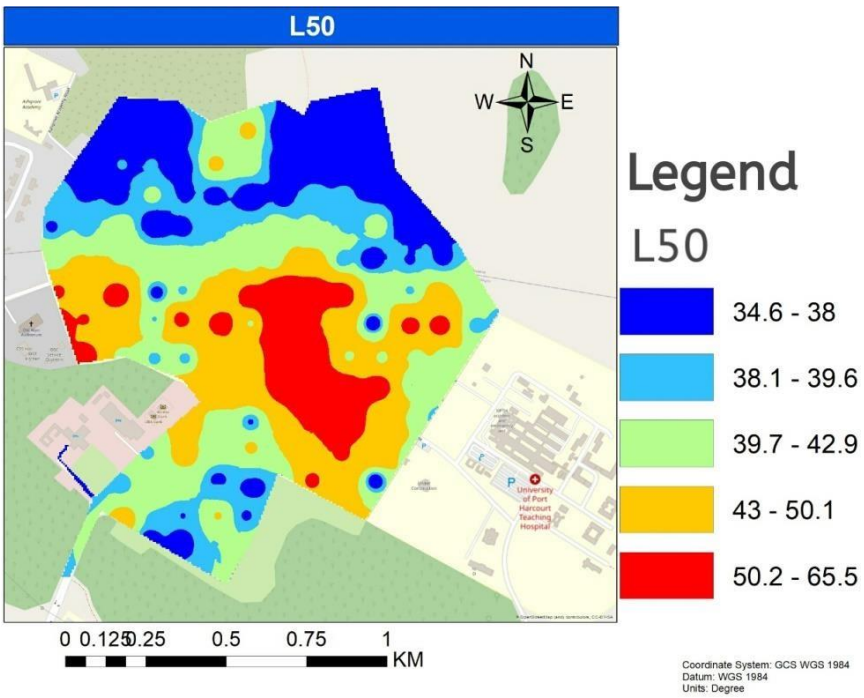

Fig. 4: Map of L_{50}

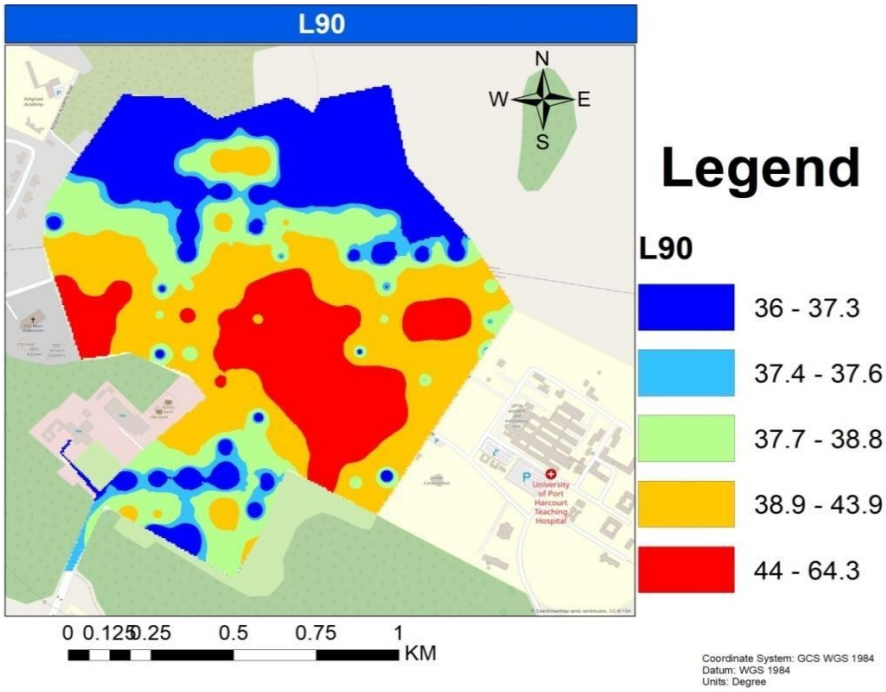

Fig. 5: Map of L_{90}

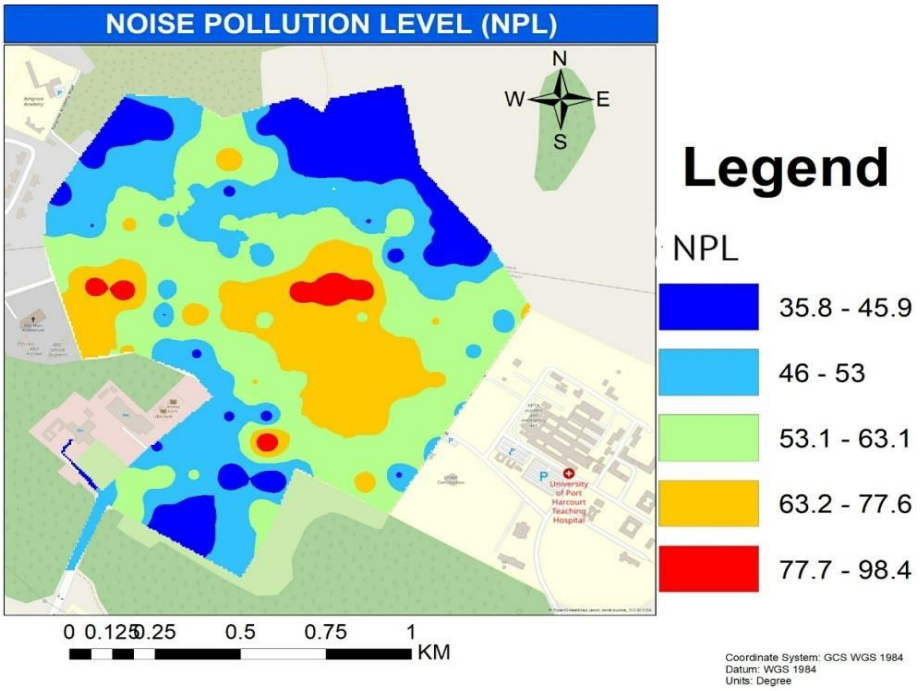

Fig. 6: Noise pollution Level

3.2 Statistical analysis

Noise levels at different points and days were compared for significant difference using two-way ANOVA and the result is summarized in Table 1. Both the Leq values at the different sampling points and those for the different measured days were found to be significantly different with p-values of 1E-170 and 3.19E-14 respectively less than alpha value (0.05). This indicates varying noise levels, probably due to varying activities, at different locations and days in Abuja campus of University of Port Harcourt.

Table 1: Comparison of noise levels at different points and days

ANOVA

Source of variation	SS	Df	MS	F	P-value	F crit
Rows	50282	153	328.6405	17.45091	1E-170	1.219332
Columns	1427.796	5	285.5592	15.16328	3.19E-14	2.22581
Error	14406.7	765	18.83229			
Total	66116.5	923				

4. Conclusions

Noise maps were generated for Abuja campus of University of Port Harcourt using different noise indices (equivalent sound level, sound level exceeded for 10, 50 and 90% of the time, and noise population level) calculated from measured sound levels from selected sampling points. Some areas of the campus, namely Convocation arena, Recreational area, Abuja Park, Chapel of Annunciation, and School of Basic Studies, exceeded the 55dBA WHO recommended standard for schools. Noise map can be an important tool for evaluating and interpreting environmental noise that can provide information to concerned authorities for mitigation of the noise pollution problems.

References

Federal Ministry of Environment (FMEnv.) (2003) National Environment (Noise standard and control) Regulations. Nigeria.

Gorai, A.K. and Pal, A.K. (2006) Noise and its impact on human being: A Review. Journal of Environmental Science and Engineering, 48(4): 253-260.

Kiely, G. (2007) Environmental Engineering. New Delhi: McGraw-Hill Publishing Company Limited, pp 390-419.

Laiolo, P. (2010) The emerging significance of

bioacoustics in animal species Conservation. Biological Conservation, 143(7): 1635-1645.

Tripathy, D. (2008) Noise pollution. New Delhi: A.P.H. Publishing corporation, New Delhi.

Ugwoha, E. and Maha, T.A. (2019) Impact of Oil Facilities Noise on Workers in a Typical Oil and Gas Industrial Plant. International Journal of Engineering Research and Application, 9(7): 59-68.

World Health Organization (WHO) (2005) Occupational noise: assessing the burden of disease fromwork- related hearing impairment at national and local levels. Environmental Burden of Disease Series. No.9 World Health Organization, Switzerland.

World Health Organisation (WHO) (2009) Night Noise guidelines for Europe. Copenhagen, Scherfigsvej, Denmark.

Yilmaz, G. and Hocanli, Y. (2006) Mapping of noise by using GIS in Şanliurfa Environmental Monitoring and Assessment, 121(1-3): 103-108.