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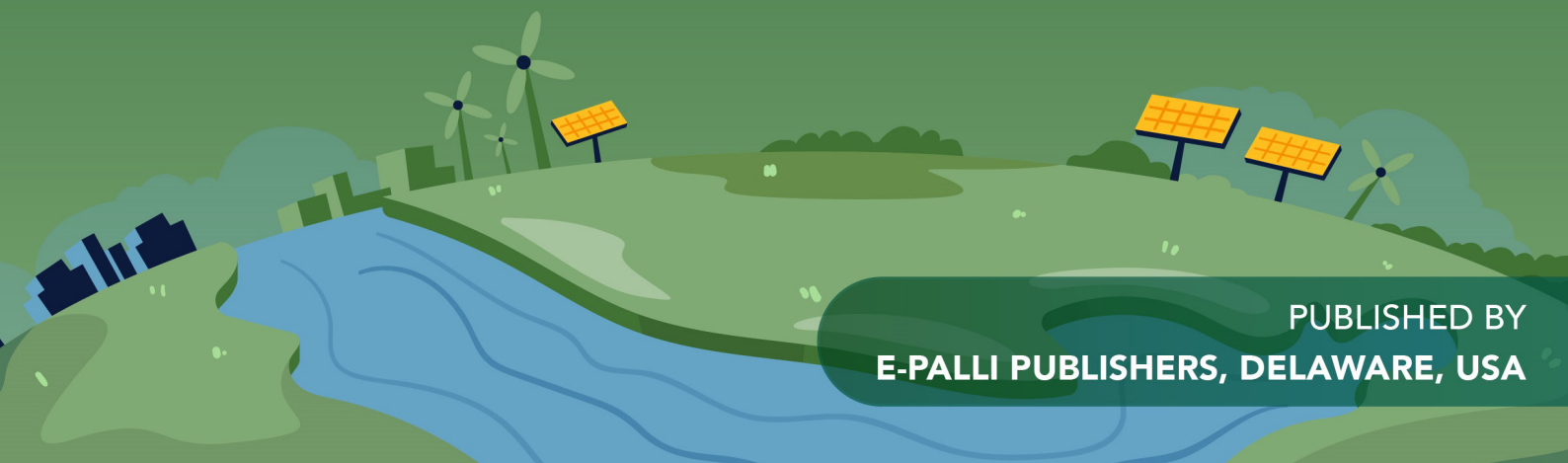

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# Assessment of Road Traffic Noise Differentials in the Land Uses of Jos, Nigeria

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## ABSTRACT

The relationship between land use and traffic has been likened to the chicken and egg relation because of their inter-dependability. For instance, the way land is used affects the generation and character of traffic on the streets and roads corridors. This paper investigated the road traffic noise differentials in the land uses of Jos, Nigeria. Twenty-five (25) road corridors, five (5) in each of the selected land use were purposively chosen to constitute the sample frame for the study. Road traffic noise data were collected at the sampled locations along the selected road corridors using Graiger TL-200 digital Sound Level Meter at 1.5 accuracy level and measured range of 30-130 dB. The road traffic noise data were collected three times a day during peak hour periods, 7:00 - 9:00 am, 12:00 noon - 2:00 pm, and 4:00 - 6 pm from Monday to Saturday. Noise data were measured for 15 minutes at an interval of 6 seconds in each location for six days, making a total of 18 records per location. The RTN data was analyzed using descriptive statistics and regression analyses. The findings of this study revealed that, there was a significant mean difference in RTN levels in the land uses of Jos. This paper therefore, recommends land use dispersal, markets and commodity specification within Jos as a strategy for reducing road traffic noise.

## INTRODUCTION

Rapid urbanization and industrialization in developing regions such as India, China, and Nigeria have led to an increase in the demand for transport (Rode *et al.*, 2017). This has also resulted in a rise in the number of people owning and using vehicles (Joseph *et al.*, 2017). Due to the rising number of vehicles in cities, various environmental issues have been identified. One of these is the noise pollution caused by the vehicles (Gössling *et al.*, 2019).

The term "noise" is derived from the Latin word "nausea," which literally means "unwanted sound" (Basner, 2019). According to Zerihun *et al.* (2017), sound can become unwanted when it affects people's quality of life by interfering with their normal activities. The term "noise" is usually used to describe unwanted sounds that can create annoyance or interfere with a person's conversation (García Ruiz & South, 2019). They can also affect their sleep and reduce their work efficiency (Paiva, Cardoso & Zannin, 2019). Urban noise is composed of the sounds coming from various sources such as trains, aircrafts, and automobiles (Ho & Tang, 2017). Other types of noise include industrial and factory sounds, as well as religious groups (Bello *et al.*, 2018).

According to studies conducted by Drudge *et al.* (2018) and Pathak *et al.* (2018), vehicular traffic noise is one of the most undesirable sounds that can be created by the railway, aircraft, and road. It is composed of the total sounds that are coming from the various components of vehicles, such as the engine, exhaust, and tires. The increasing number of vehicles on city streets and roads has been known to cause various environmental and psychological effects on people living near these areas (Pallavi & Sohit, 2019; Lin *et al.*, 2018). The intensity of the noise caused by these vehicles varies depending on the type of vehicle, its speed, and the volume of traffic (Okokon, 2018a).

The relationship between traffic and land use has been compared to that of an egg and a chicken, as their inter-dependability allows them to behave in a certain way. For instance, the way people use land affects the character and generation of traffic on roads and streets (Oduwaye, Alade & Adekunle, 2011). Qi, Wang and Lu (2011), explained that the use of land is a process that involves managing the land for its beauty, functionality, and order. The types of activities that land can accommodate vary depending on its use. For instance, it can be used for residential, commercial, agricultural, and industrial activities. Its activities in the distribution, generating, and attracting trips within the city limits also contribute to the development of urban areas.

Urbanization in developing and developed countries, such as India, China, and the US, has increased the number of people living in areas with high traffic noise levels (Okokon, 2018a). According to studies conducted by the WHO (2011) and the European Environment Agency (2014), about 125 million people in Europe are affected by the noise levels generated by road traffic. According to Ögren, Molnár and Barregard (2018), the increasing number of people and the number of car riders are contributing to the development of traffic problems. These problems include delays in travel times, accidents, and noise levels (Bauernschuster, Hener & Rainer, 2017). In Nigeria, the challenge of vehicular traffic noise has become a major issue. Several studies have revealed that certain areas in the country have excessive levels of road traffic noise, exceeding the WHO and EPA's standard



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limits. A number of studies by Adeke, Atoo and Zava (2018); Okeke and George (2015); Anomohanran (2013); Oyedepo and Saadu (2010), have also been carried out on the issue of road traffic noise in Nigeria. These studies revealed that the levels of pollution were higher than the WHO's safety threshold of 55 decibels. A study conducted by Okokon (2017), revealed that people living in certain European cities, such as Rotterdam, Helsinki, and Thessaloniki, had higher exposure to air pollution and road traffic noise. The study also noted that those residing in Lagos, Nigeria, were more affected by the traffic noise. A study conducted by Obisung *et al.* (2016) in five cities in eastern Nigeria revealed that the residents of these areas experienced severe sleep disorders due to the excessive levels of road traffic noise.

Although Jos in the recent past has been a center of urban studies, little attention has been given to road traffic noise especially in the land uses. Therefore, it is against this background that this study considers it necessary to assess the road traffic noise differentials in the land uses of Jos, Nigeria.

## The Nexus between Land Use Planning and Traffic Noise

The unpleasant or excessive sounds that come from traffic are known as traffic noise. It can be caused by various factors such as the volume of traffic, the speed, and the road surface (Jo, 2017). Transportation is very important to the built environment as it allows for the interaction between different land uses. Land use is very important to the built environment as it allows for the distribution of various types of activities and goods. Macpherson and Burgess (2016), noted that the appearance of traffic noise and the conflicts between the use of land and the surrounding neighborhoods are expected to be discussed in the planning process.

Urban development usually begins and grows close to roads, which results in more traffic on these routes and more exposure to traffic noise. This phenomenon is referred to as noise creep. One of the factors that can increase the home density in a given area is the plot subdivision. Road networks are usually constructed to connect residential areas to other areas in metropolitan regions in order to encourage the interaction between the built environment and the various activities in it (Burgess & Macpherson, 2016). It is important to note that these routes are known to be sources of traffic noise. The main causes of traffic noise are the volume of traffic on different roads (Burgess & Macpherson, 2016). As a result, residents who live near these routes are more prone to experiencing health effects related to noise exposure. Obaidat (2008), noted that living in areas with high levels of noise can be less appealing than those in residential areas. This can result in lower land values and justification for the living in noisy locations.

The spatial link between the development of urban land use and traffic has been established. According to Burgess and Macpherson (2016), one of the most challenging factors when it comes to planning for land use is ensuring that residential properties do not encroach on busy highways. On the other hand, traffic planning has to consider how to minimize the impact of residential development on existing roads while still improving them. Efficient traffic noise regulation requires a set of practical and rational controls that planners can use to identify the appropriate measures to protect the residents from the effects of traffic noise.

## The Study Area

The objective of this study was to analyze the noise

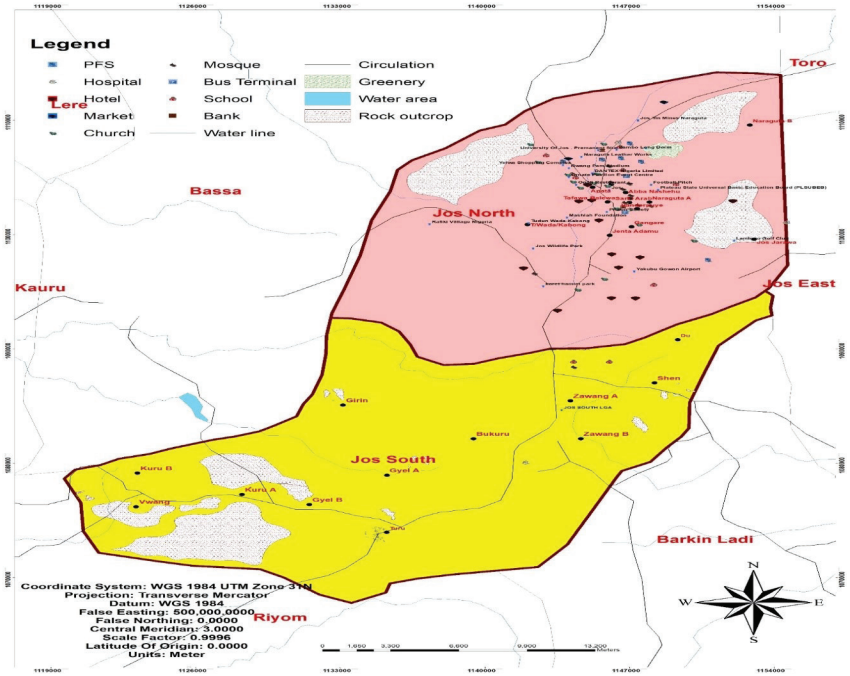


**Figure 1:** The Study Area in its Local Settings
*Source: Plateau State Ministry of Housing and Urban Development (2019)*

levels generated by road traffic in the Jos metropolis. It was conducted on a randomly selected and purposively chosen 25 road corridors. The land uses that were included in the study were residential, commercial, industrial, recreational, and public/institutional. The study was focused on these areas to determine the effects of road traffic on these uses.

The Jos metropolis is composed of the South and Jos North LGAs. The North LGA of Plateau State, Nigeria, has its headquarters in the city of Jos. It has a total land area of 291 kilometers2 and a population of over 440,000. The Jos South LGA is located in the central part of the state of Plateau, Nigeria. It's between latitudes 9° 46' N and 8° 43' E. Its headquarters is in Bukuru town, and it has a population of over 300,000. The city is a center for various administrative, economic, and political activities.

The current population of the Jos metropolis is estimated at over 1,134,806. It's located around 109 kilometers from Bauchi, the capital of Bauchi state, and 200 kilometers from Lafiya, the capital of Nasarawa state. It's also around 298 kilometers from Benue state's capital, and over 300 kilometers from FCT Abuja. Plateau State has a land area of over 10,604 square miles. It spans an altitude range of approximately 1,217 to 1,829 meters (National Bureau of Statistics, 2012).

**Data Collection Method**

The study was conducted to determine the noise levels generated by the traffic in 25 road corridors and five land uses. The selected areas were chosen based on their perceived high traffic volumes. The study was carried out using a Sound Level meter.

Road traffic noise data were collected at the sampled locations along the road corridors using Graiger TL-200 digital Sound Level Meter at 1.5 accuracy level and measurement range of 30-130 dB. The decibels (dB) measurements were set on A-weighting scale as recommended for anthropogenic noise study. The sound level meter was held at about 1.5m high from the ground level corresponding to the ear position of an average human being (Adeke *et al.*, 2018; Jadaan *et al.*, 2013), with its microphone pointing towards the road. The SLM was


**Plate 1:** A Sound Level Meter

calibrated prior to and after the measurement to ensure a reading error within the permissible value of ±0.5 dBA. The SLM was positioned at a distance of 6.5m from the centerline of the nearest travel lane of the road.

The road traffic noise levels data was collected from twenty-five (25) locations along the selected road corridors three times a day during peak hour periods of morning (7:00 - 9:00 am), afternoon (12:00 noon - 2:00 pm), and evening (4:00 - 6 pm) from Monday to Saturday. Within each peak period, noise data were measured for 15 minutes at an interval of 6 seconds in each location for six days, making a total of 18 records per location. The locations of the measurement points were obtained using hand held Global Positioning System (GPS) to help compare noise location data with traffic noise data. Sampled locations were carefully but purposively selected in such a way that none was close to airports, factories, rail lines, construction sites/factories, or any other sources of high noise level other than motor vehicles. This was to avoid undue influence on road traffic noise by other noise sources. Measurement locations were chosen to reflect roads with high and low traffic noise.

## RESULT AND DISCUSSION

### Analysis of Road Traffic Noise Differentials in the Land Uses of Jos Metropolis

A one-way between-subjects analysis of variance was conducted to explore the difference between the mean RTN levels of the various land uses in Jos metropolis. Table 1 presents the results of one-way analysis of variance which was used in testing the hypothesis which states that there is no significant difference among the mean RTN level of the various land uses in Jos. The F (4, 145) = 3.996, p-value = 0.004 < 0.05 indicates that, there is a significant mean difference in RTN levels of the various land uses in Jos. Hence, the null hypothesis was rejected. The post hoc result was presented in Table 1.

A post-results comparison using the Duncan multiple range comparison test was carried out to compare the mean scores of the RTN level of the various land uses.

**Table 1:** One-way analysis of variance Results for RTN among Land use

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 235.650 | 4 | 58.913 | 3.996 | .004 |
| Within Groups | 2137.839 | 145 | 14.744 | | |
| **Total** | **2373.490** | **149** | | | |

*Source: Computed using SPSS; Field survey, 2022.*

Table 2 indicates that, the RTN level in Industrial land use were higher as compared to other land uses. Statistically, there was no significant mean difference in the RTN level in commercial and Residential land uses. Similarly, the RTN levels in Recreational and Public/Institutional land uses were statistically the same. This finding is a validation of the fact that both traffic volume and noise levels were generally high along the selected roads in the industrial area.

**Significant Difference among the Mean RTN Level Differentials in the Land Uses of Jos**

A one-way between-subjects analysis of variance was conducted to explore the difference among the mean RTN levels in the land uses of Jos. From Table 3, it can be observed that there is a significant mean difference in RTN level differentials in the land uses of Jos F (24, 125) = 8.866, p-value = 0.000 < 0.05. Hence, the null hypothesis which says there is no significant difference among the mean RTN levels differentials in the land uses of Jos was rejected. The post hoc test result was presented in Table 4.

**Table 2:** Post Results using Duncan Multiple Range Test for RTN among Land uses

| | Land Use | N | Subset for alpha = 0.05 | | |
|---|---|---|---|---|---|
| | | | 1 | 2 | 3 |
| Duncan | Commercial | 30 | 79.9233 | | |
| | Residential | 30 | 80.7600 | | |
| | Recreational | 30 | | 81.0100 | |
| | Public/Institutional | 30 | | 82.9400 | 82.9400 |
| | Industrial | 30 | | | 83.0867 |
| | Sig. | | .306 | .054 | .883 |

*Source: Computed using SPSS; Field survey, 2022.*

A post-hoc comparison using the Tukey HSD multiple comparison test was carried out to compare the mean score of the RTN levels of the various measurement locations. Table 4 presents the result of post analysis using Duncan multiple range test. The result revealed that the RTN levels is higher in Yakubu Gown Road, JD Jang way and Miango road in the industrial, public/institutional and recreational land uses respectively.

**Table 3:** One-way analysis of variance Results for RTN among measurement locations

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1495.190 | 24 | 62.300 | 8.866 | .000 |
| Within Groups | 878.300 | 125 | 7.026 | | |
| **Total** | **2373.490** | **149** | | | |

*Source: Computed using SPSS*

However, there is no statistically significant mean difference in RTN among these land uses. The RTN levels in Bauchi Ring Road, MM way, Tafawa Balewa Road, DB Zang Road, Wild life Park Road, Tudun Wada road, CBN road, AMB way were lower as compared to other location in the study area and there was no statistically significant mean difference in RTN levels among those locations. In addition, the RTN levels in Hill station road, Bukuru Express Road, Rayfield-Gurra T. Road, Abuja express Road, Bauchi Road were statistically the same, implying that there is no significant mean difference in RTN levels among those locations.

Similarly, there was no statistically significant mean difference in the RTN level among these locations; Farin Gada, Vom Road and Gada Biyu road. Also, the RTN levels in Rukuba road and Dogon Karfe Road were the same. In addition, the RTN levels in Beach RD and British America were the same. Furthermore, the RTN levels in Old Airport Road and Zaria Road were statistically the same.

The Spearman's rho correlation coefficient was used to investigate the relationship between RTN level and humano-environmental consequence. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. The correlation analysis between RTN level and humano-environmental consequence in Jos is presented in Table

Table 4: Turkey HSD Post Hoc Results of Multiple Comparison Test for RTN among land uses

| Location Road | N | Subset for alpha = 0.05 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Bauchi Ring Rd | 6 | 77.4000 | | | | | | |
| MM way | 6 | 77.7000 | | | | | | |
| Tafawa-Balewa RD | 6 | 78.1167 | | | | | | |
| DB Zang road | 6 | 78.5167 | | | | | | |
| Wild life park Road | 6 | 78.5167 | | | | | | |
| Tudun Wada road | 6 | 78.5500 | | | | | | |
| CBN Road | 6 | 78.5667 | | | | | | |
| AMB Way | 6 | 78.9333 | | | | | | |
| Hill station road | 6 | | 79.2500 | | | | | |
| Bukuru Exp. Rd | 6 | | 80.2333 | | | | | |
| Rayfield-Gurra T. Rd | 6 | | 80.3000 | | | | | |
| Abuja exp.RD | 6 | | 80.7833 | | | | | |
| Bauchi Rd | 6 | | 81.1167 | | | | | |
| Farin Gada | 6 | | | 81.3000 | | | | |
| Vom road | 6 | | | 81.3500 | | | | |
| Gada Biyu Rd | 6 | | | 82.5167 | | | | |
| Rukuba road | 6 | | | | 82.8833 | | | |
| Dogon Karfe road | 6 | | | | 82.9667 | | | |
| Beach RD | 6 | | | | | 83.5667 | | |
| British America | 6 | | | | | 83.6167 | | |
| Old Airport Rd | 6 | | | | | | 83.6500 | |
| Zaria RD | 6 | | | | | | 85.0000 | |
| YGowon | 6 | | | | | | | 86.9000 |
| JD Jang way | 6 | | | | | | | 88.4333 |
| Miango Road | 6 | | | | | | | 88.4333 |
| **Sig.** | | **.069** | **.051** | **.070** | **.066** | **.168** | **.053** | **.350** |

*Source: Computed using SPSS*

5. There was a significant and positive relationship between road traffic noise and humano-environmental consequences in Jos ($r = 0.556, p < 0.05$). As a result, the null hypothesis, stating that there is no significant relationship between mean RTN level and humano-environmental consequences in Jos, was rejected. The implication of this result is that an increase in road traffic noise tends to have increased human-environmental consequences.

This finding corresponds with those of Bustaffa, *et al.*, (2022), Tong, and Kang (2021), Clark, Crumpler, and Notley (2020), Von Szombathely, *et al.*, (2018), Roswall, *et al.*, (2015), and Welch, *et al.*, (2013) who held that Low quality of life, socio-economic deprivation, economic viability of the society, unemployment, loss of job, increase in the cases of hypertension, cardiovascular diseases, CVD, noise trauma, diabetes mellitus, hearing

**Table 5:** Correlations between mean RTN level and Humano-environmental consequence in Jos

| Model | | | Humano-environmental consequence | RTN4 |
|---|---|---|---|---|
| Spearman's rho | Humano-environmental consequence | Correlation Coefficient | 1.000 | .556 |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 958 | 378 |
| | RTN4 | Correlation Coefficient | .556 | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 378 | 378 |

*Source: Field survey, 2022*

loss stress related disorders and depression among others are some of the major consequences of traffic noise on human health and wellbeing.

A simple linear regression was carried out to test if RTN significantly predicted humano-environmental consequences. Table 6 presents the regression analysis of the relationship between RTN and humano-environmental consequences. The R-square value of 0.375 indicates that RTN accounted for 37.5% of the humano-environmental consequences in Jos. The F (1, 376) = 225.806, $p < 0.05$, indicates that the model is significant. The standardized coefficient (b = 0.613, $P < 0.05$) showed that RTN has a positive and significant effect on humano-environmental consequences in Jos. Thus, the null hypothesis was not supported. The implication of this result is that the more the RTN increases, there will be a corresponding increase in human-environmental consequences.

This finding is in agreement with those of Recio, Linares, Banegas, and Díaz (2016), Shin, *et al.*, (2020), Hegewald, Schubert, Lochmann, and Seidler (2021), Wang, *et al.*, (2021), Gilani and Mir, (2022), Smith, Cordoza, and Basner, (2022), who reported that, long-term exposure to excessive road traffic noise has many negative effects on human health and wellbeing such as; hypertension, hearing impairment, tinnitus, cardiovascular diseases, CVD stroke, noise trauma, vertigo, insomnia, and impaired cognitive development in children among others.

**Table 6:** Regression Analysis of the relationship between RTN and Humano-Environmental Consequences of traffic noise.

| **Model Summary** | | | **ANOVA[a]** | | | **Coefficients[a]** | |
|---|---|---|---|---|---|---|---|
| | | | | | | Unstandardized Coefficients | |
| Variable | R | R Square | df | F | Sig. | B | Sig. |
| RTN | .613a | .375 | 1 | 225.806 | .000b | 2.449 | .000 |
| | | | 376 | | | .009 | .000 |

*R-square = 0.375; adj. R – square = 0.374; F (1,376) = 225.806, p < 0.05*
*a. Dependent Variable: humano-environmental consequence, b. Predictors: (Constant), RTN*
*Source: field work 2021*

## CONCLUSION

This research, explored the road traffic noise differentials in the land uses of Jos, Nigeria. Twenty-five (25) measurement points were purposively and carefully selected along major road corridors. Twenty-five (25) road corridors, five (5) in each of the selected land use were purposively chosen to constitute the sample frame for the study. Road traffic noise data were collected at the sampled locations along the selected road corridors using Graiger TL-200 digital Sound Level Meter at 1.5 accuracy level and measured range of 30-130 dB. The road traffic noise data were collected three times a day during peak hour periods, 7:00 - 9:00 am, 12:00 noon - 2:00 pm, and 4:00 - 6 pm from Monday to Saturday. Noise data were measured for 15 minutes at an interval of 6 seconds in each location for six days, making a total of 18 records per location. The RTN data was analyzed using descriptive statistics and regression analyses. The findings of this study revealed that, there was a significant mean difference in RTN levels in the land uses of Jos.

Based on the findings, it can be concluded that the noise levels along all the various land uses measured in Jos metropolis exceeded the permissible threshold noise limits for all the land use zones as recommended by both Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO).

## RECOMMENDATIONS

The study revealed that the level of noise generated by road traffic in the different land uses in Jos was significantly different. To effectively manage the various challenges associated with the distribution of land uses in the city, the state government of Plateau has been requested to establish a comprehensive land use management strategy. The Plateau State Government and the local government areas of Jos have been urged to collaborate and coordinate the use of commodity specifications and the dispersal of markets in the city to reduce the noise levels generated by road traffic. The market located at the University of Jos' campus should also be relocated to a quiet location in order to lessen the volume of traffic along Bauchi Road and AMB way. The Plateau State Ministries of Environment and Physical Planning and Urban Development in conjunction with the management of NASCO Company of Jos should carry out a periodic environmental auditing of the company to ensure its compliance with the environmental noise emission standards thereby mitigating the effects and consequences of noise pollution on the surrounding environment. NASCO company which was formerly located at the outskirt of Jos city center, has since been enveloped by rapid development, hence the need for environmental auditing. Again, buffers such as vegetations and noise proof wall fence should be constructed around the company to reduce the effects of noise pollution.

A bye-pass should also be constructed along the Bauchi and Zaria routes to decongest the RTN in the city. This will allow residents of the city to avoid the traffic and travel to other parts of the country. Jos is a hub for the northern states and some of the states in the North West, and it serves as a connecting point between the FCT and the southern part of the country, among others.

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