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Spatio-Temporal Variability of Vehicular Noise Pollution across different Days of the Week in Suleja, Niger State, Nigeria

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Abstract

This study investigated the spatio-temporal variability of vehicular noise pollution across different days of the week in Suleja town, Niger State, Nigeria. The study used experimental technique to arrive at its finding. The vehicular noise was measured using the noise level meter at 30 different junctions and roundabouts made up of 6 roads and 5 junctions and roundabouts each. The roads were classified as Trunk A (federal road), Trunk B (state road) and Trunk C (neighborhood road) respectively. The study carried out traffic counts of vehicles using the Septa Square 15-minute measurement period to understand the volumes of vehicles in relation to noise generated on each road. The Geographic Information System was used to identify the locations of the purposively selected junctions and roundabouts. Findings showed that the day with the highest vehicular noise pollution was Monday having noise level of 103.3dB. This was seconded by Saturday having vehicular noise pollution of 103.2dB and thirdly by Tuesday having vehicular noise level of 102dB. The day with lowest vehicular noise pollution level was Wednesday having noise pollution rate of 94.8dB respectively. The result of tested hypothesis indicated that there was no significant difference in vehicular noise pollution across different days of the week. However, the study has recommended that commercial motorcycle (Okada) should be banned in Suleja city and heavy-duty vehicles should only be allowed to move during the night period in order to decongest the roads and reduce noise pollution level in Suleja town, Niger State, Nigeria.

Introduction

Vehicular noise pollution has become a contemporary challenge especially in the urban centers as over 5% of the global population is having hearing problem. The young people who are within the ages of 12 and 35 years are seriously impacted by noise pollution (World Health Organization [WHO], 2020). Vehicular noise pollution occurs as a result of sound from the engines of vehicles and noise from passengers. This noise pollution can be accelerated due to over throttling of the acceleration pedal of the vehicle in motion (Olivier, 2012). Bad road, traffic congestion, loudness of speakers in vehicles, shouting of passengers, faulty exhaust pipe of vehicles and bad engines have enormously contributed to accelerated vehicular noise pollution in the cities (Gary and Dieter, 2012). Thus, vehicular volumes, type of lane, type of vehicle and speed limit in both upstream and downstream of the road can immensely contribute to high noise pollution (Emenike and Orjinmo, 2017). Explosive population of people and number of vehicles have made the urban areas generated intense noise pollution which has made the cities very uncomfortable to live (Morrison et al., 2004). Also, other factors that can affect vehicular traffic noise are the weather condition and other environmental characteristics such as land scape, rainfall, humidity and temperature as well as visibility influence vehicular noise pollution up to some level (Nick et al., 2011). For instance, bad weather can reduce the speed of vehicles to 6-7 mph along the roadway thereby influence noise level (Kilpelaninen and Summala, 2004; Andre and Hammarstrom, 2000).

There are health problems associated with vehicular noise pollution. The health challenges caused by vehicular noise pollution are varied in physical, physiological and psychological characteristics. Hearing deformity is a physical effect of vehicular noise pollution. High blood pressure irregular heart beat and ulcers are the form of physiological effects of vehicular noise pollution. Also, the psychological category is in the form of disorder of all kinds, sleeplessness, late sleeping, irritability and stress which can cause reduction in work performance and daily productivity. Sometimes, people and their vehicles are stocked on the traffic lane resulting to the generation of noise capable of causing both psychological and physiological problems such as misunderstanding, ulcer and heart ailments (Smargiassi et al., 2006). Vehicular traffic noise pollution has the capacity to deny residents sleep at night. When the noise level is above 40dB at night and 50dB in the day especially in residential areas will result to human discomfort, poor understanding, low productivity and other health ailments will occur (WHO, 1996; Vibhav et al., 2018).

High level of noise pollution can impair hearing ability of humans. When noise is at 140dB it is capable of making human to lose their hearing since the human ear has the limit of 80 dB if exposed for more than 60 minutes and could experience temporary hearing impairment at 100dB and painfully severe at 140dB which could result to permanent ear loss. Therefore, 90dB noise level should not be exceeded for human health and comfort (WHO, 1996; Ijaiya, 2014). Also, the way cities in Nigeria are planned are very poor therefore have the tendency to induce traffic noise pollution. In Suleja, multiple bus-stops and traffic-flow systems of various sources such as vehicle exhausts from automobile contribute to discomforting traffic noise.

Vehicular noise pollution has various impacts on residents of urban area. Brink (2011) studied the relationship between vehicular noise pollution sources within a residential area. The sources of

investigation were noise from road transport and aircraft. The study used self-reported indicators to assess the representative sample of the Swiss population. The findings showed the relocation of residents of high noise areas to calm places due to the associated noise problems of sleep disorder and general disturbance. It therefore, indicates that some people in the city were forced to relocate to other relatively less noise areas due to vehicular noise pollution and the complication of psychological and physiological health implications. The study carried out by Swanson (2013) suggested the impact of street vehicular noise on workers in the city of Sao Paulo, Brazil. It was found that workers (38.8%) along the high noise streets had more impaired hearing and poor coordination of activities than those workers (24.2%) in the low noise areas. The study showed that occupational exposure to urban traffic noise had important role to affect the productivity of workers. The prevalence of noise-induced hearing loss played a significant role in the performance and comfort of workers. It showed that workers across the cities of the world would increase productivity and performance in a situation where the environmental noise is at minimal to the bearing of the body system.

Methodology

Suleja town is located between latitudes 9º9'0'' and 9º13'30'' north of the Equator and longitude 7º7'30'' and 7º12'0'' east of GM (Figure 1). The city is approximately 70KM to the Central Business District (CBD) of Abuja which is the Capital Territory of Nigeria. This close proximity has resulted to influx of people, goods and services to the city of Suleja (Adeleye, 2015). This study employed systematic and purposive sampling techniques to select junctions and roundabouts in the city area. The study purposively selected 6 roads made up of 5 sample points of junctions and roundabouts totaling 30 sample points. The roads were categorized as Trunk A (federal road), Trunk B (state road) and Trunk C (neighborhood road) respectively (Figure 2). The purposively selected roads were based on high vehicular traffic volumes capable of generating maximum noise level.

The study generated three types of data such as the vehicular traffic noise (in decibel dB) using Noise Dosimeter (ND) known as Noise Level Meter (NLM); data from vehicular traffic counts by observation; and vehicular traffic noise location map data using Global Positioning System (GPS) instruments. The data generation was caried out for a period of two months. The Noise Level Meter was used to measure noise levels at the purposively selected junctions and roundabouts (30 in number) at height between 1.20 m and at a distance 2 - 3m as used by other researchers (Serkan et al., 2009; Ramis et al., 2003). The measurements were carried out in the morning (7:00- 8:00am), afternoon (14:00-15:00pm) and evening (17:00-18:00 pm) on daily basis (Monday to Sunday) through the help of field assistants. The noise level meter was Model-CEL-231 calibrated from 30dB to 135dB for vehicular noise level measurement. Also, the study used the Septa Square 15-minute measurement period in which vehicles were counted and vehicular traffic noise level measured in every 15 minutes for the selected hours of morning (7:00- 8:00am), afternoon (14:00-15:00pm) and evening (17:00-18:00 pm) respectively. The Geographic Positioning System (GPS) was used to ascertain the locations of the purposively selected junctions and roundabouts. The sampled junctions and roundabouts were processed and analyzed in the GIS environment.

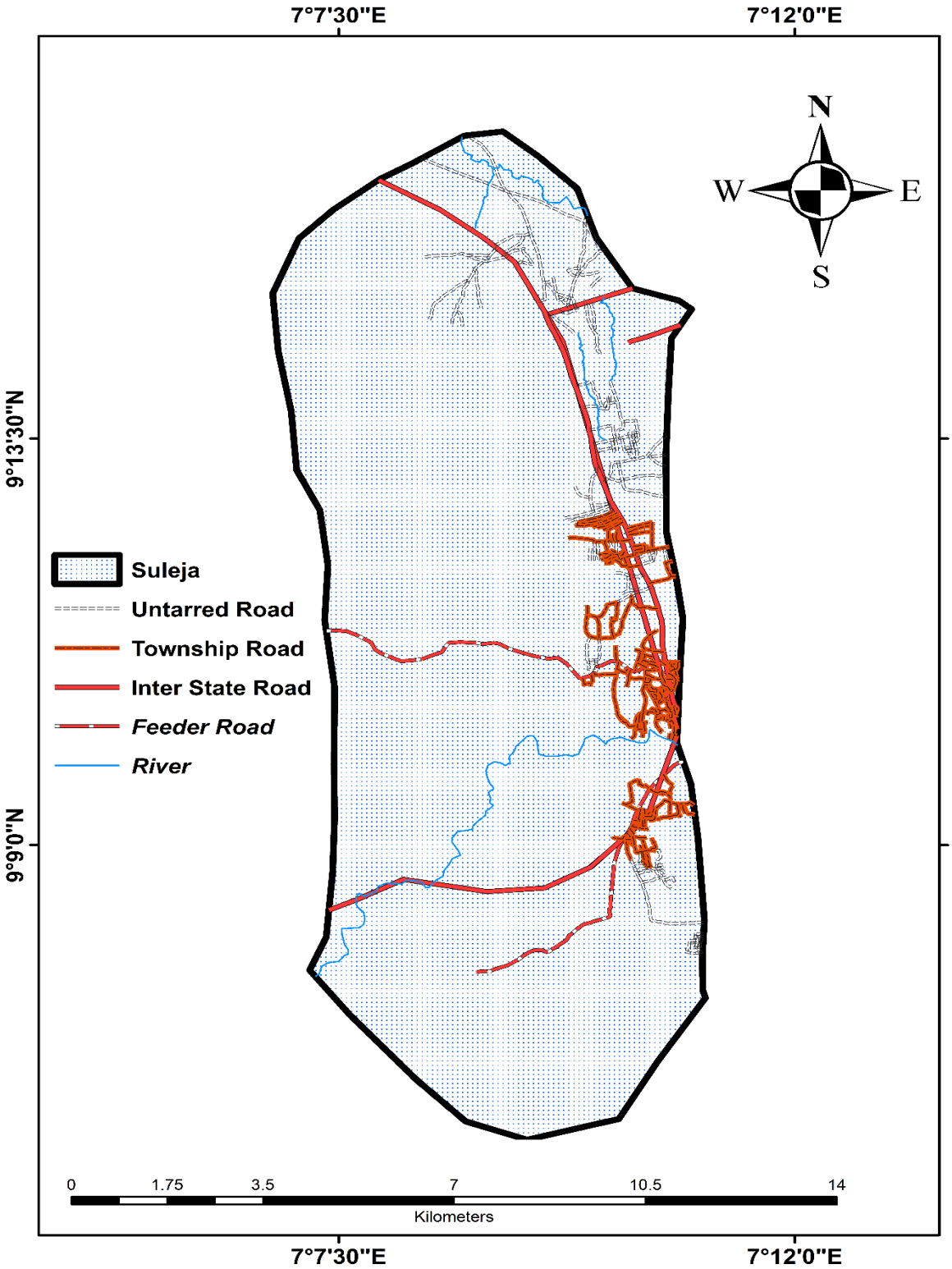

Figure 1: Road Network Map of Suleja

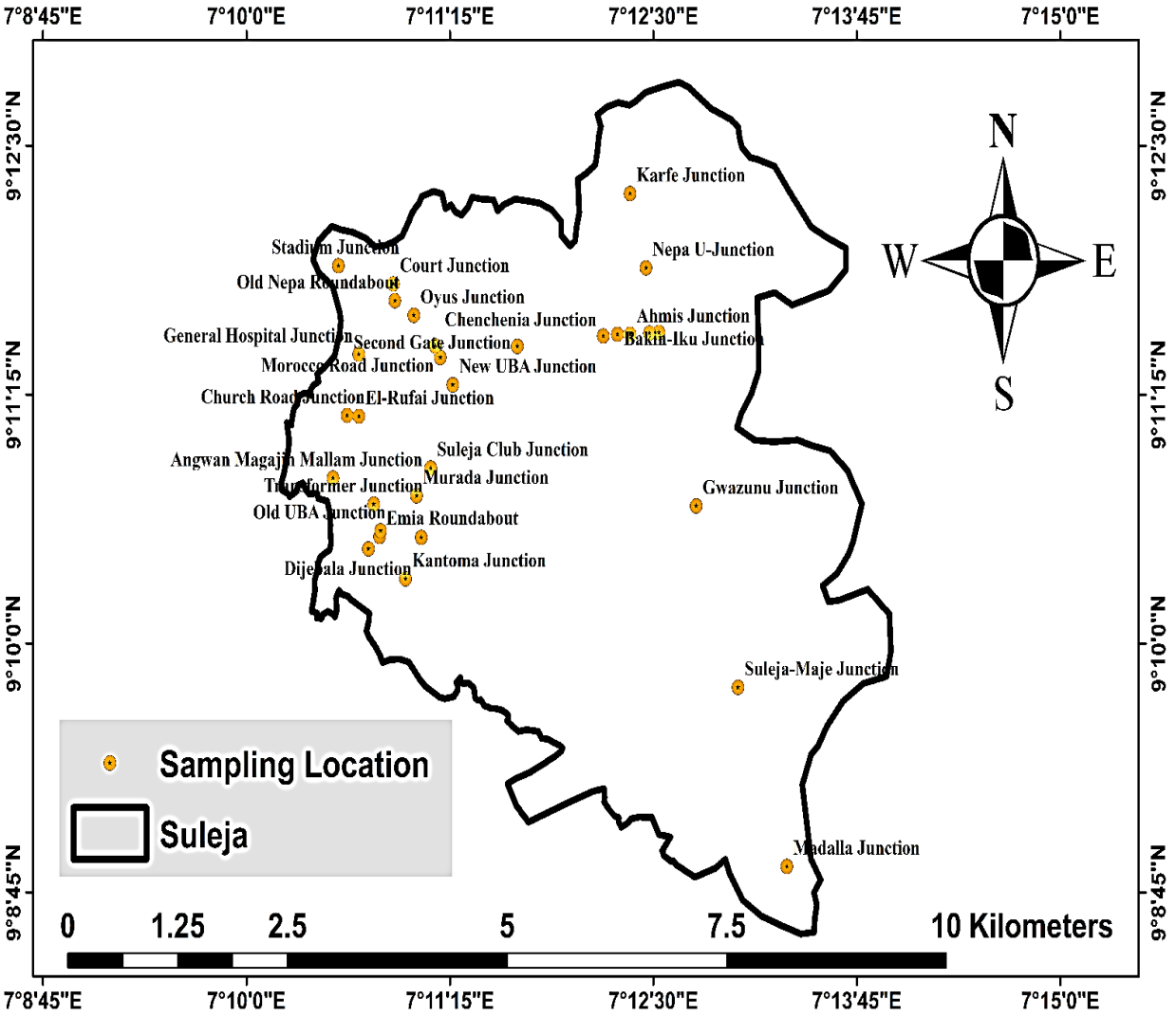

Figure 2: Purposively Selected Samples of Junctions and Roundabouts in Suleja

Results and Discussion

Monday had the highest vehicular noise pollution across the days of the week (Figure 3). The day with the highest vehicular noise pollution was Monday having noise level of 103.3dB. This was seconded by Saturday having vehicular noise pollution of 103.2dB and thirdly by Tuesday having vehicular noise level of 102dB. The days with lowest vehicular noise pollution level was Wednesday having noise pollution rate of 94.8dB respectively. The result showed that the beginning and the weekend parts of Suleja Town had the highest noise pollution levels and the middle part of the weekdays had the lowest vehicular noise pollution. This is as a result of increased commuters' movement at the beginning of the week for work and business which is usually on Monday. The trend showed that from Friday of the weekdays, there was rise in vehicular noise pollution due to the fact that people should be returning to their weekend in Suleja Town. Thus, the vehicular noise pollution showed a rise from Monday, sharp drop on Wednesday and a rise on Thursday through Saturday and a fall on Sunday.

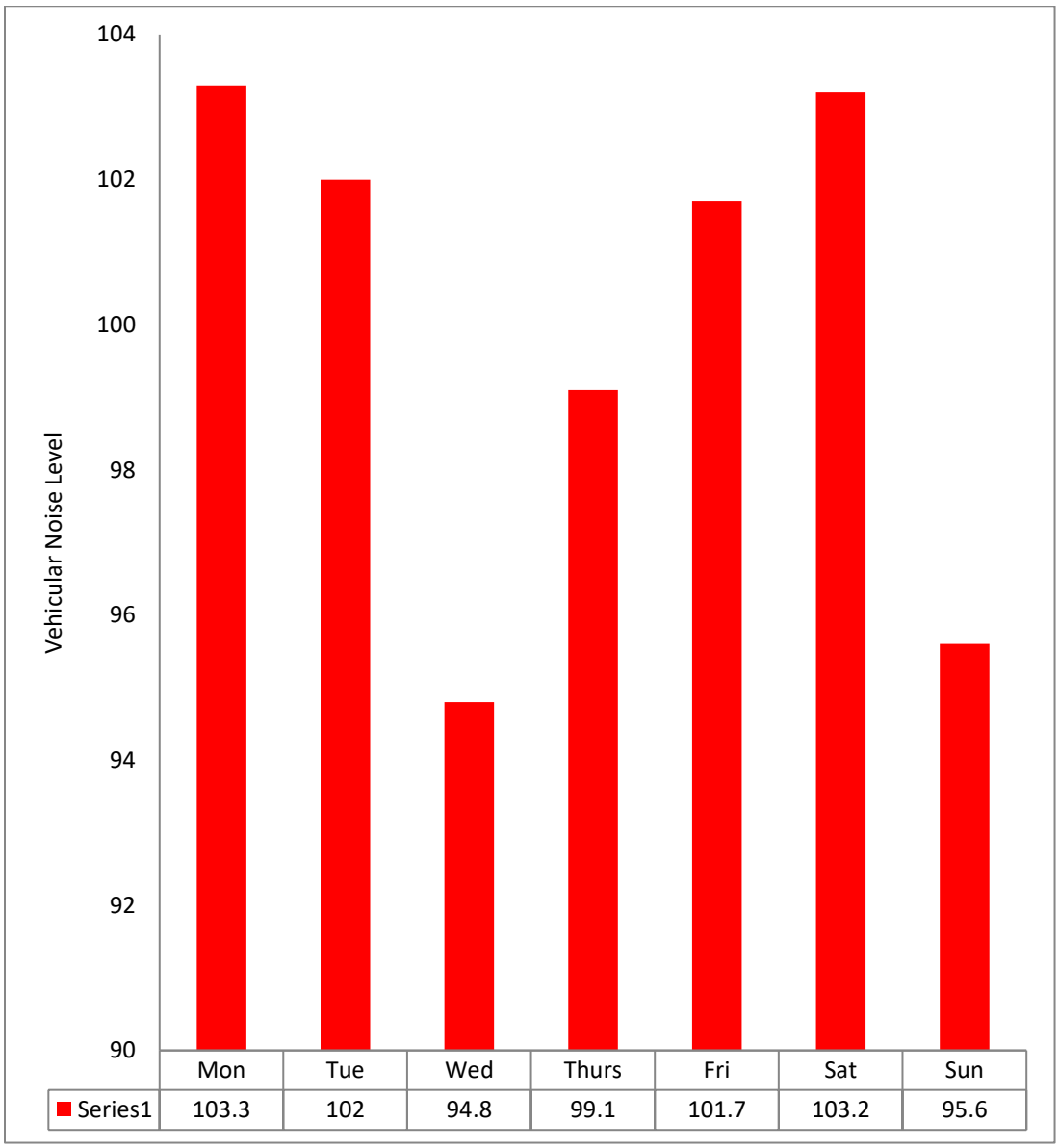

Figure 3: Vehicular Noise Pollution across Days of the Week

The null hypothesis (Ho_2) that leads this study establishes that there is no significant difference in vehicular noise pollution across different days of the week (Table 1). The vehicular noise pollution has calculated P-value of 0.270953 with 6 and 42 Degrees of Freedom (D.F) in a test of two-tailed at 0.05 Significant Levels (SL). The analysis shows that calculated P-value of 0.270953 is greater than 0.05 Significant Levels. This reveals the fact that noise pollution across different days of the week does not differ significantly. This study shows that vehicular noise pollution has highest value on Monday (103.3dB) which has the highest noise pollution level, seconded by highest record by Saturday (103.2dB) and thirdly by Tuesday (102dB) respectively.

Table 1: ANOVA Test Explaining Vehicular Noise Pollution across different Days of the Week

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	536.6542	6	89.44236	1.316918	0.270953	2.323994
Within Groups	2852.555	42	67.91797			
Total	3389.209	48				

This study revealed that vehicular noise pollution was highest on Monday (103.3dB), Saturday (103.2dB) and Tuesday (102dB) respectively. This finding is contrary to conclusion of Malakootian et al. (2012) in Kerman City, Southeast Iran that there was significant difference in vehicular noise pollution across days of the week in the City. The study further unveiled that Friday (72.2dB) had the lowest vehicular noise pollution when compared to Sunday (79.9dB) and Saturday (83.3dB). This study therefore established that vehicular noise pollution was not the same across days of the week.

Conclusion

This study focused on the spatio-temporal variability of vehicular noise pollution across different days of the week in Suleja, Niger State, Nigeria. The city of Suleja is getting highly populated and commercialized due to its proximity with Abuja the Federal Capital Territory (FCT). This study has combined satellite remote sensing and experimental approach to investigate its objective. The result has indicated that vehicular noise pollution varied across different days of the week and type of road in the city of Suleja. The city dwellers are vulnerable to noise induced discomfort, psychological and physiological ailments on daily basis. Thus, the finding showed that there was high congestion of vehicular traffic across various junctions and roundabouts thereby raising the noise level in the city in different days of the week. It was noted that commercial motorcycle (Okada) has severely increased the level of noise pollution in the city. This study has therefore recommended the banning of commercial motorcycle (Okada) in Suleja town. It is also important for heavy duty vehicles to move in the night so as to reduce the rate of noise pollution across the roads. Also, there is urgent need to create more roads in the southern part of the city in order to reduce vehicular jam at roundabouts and junctions thereby reducing the vehicular noise level in Suleja city in the northern part of Nigeria.

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