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Spatio-temporal variability of vehicular traffic, noise and temperature of Minna City, Niger State, Nigeria

Abstract

This study investigated spatio-temporal variability of vehicular traffic noise and temperature of Minna city, Niger State. The study used the 15 minutes Septa-Square technique to count the number of vehicles across the purposively selected junctions and round-abouts. The Noise Meter Level (Dosemeter) was used to generate the vehicular traffic noise at the selected junctions and roundabouts. The thermometer was used to capture the hotness of the selected roundabouts and junctions. The result of the study showed that Tunga Roundabout had 7032 vehicular counts, which was the highest vehicular traffic flow in the city. Barago Roundabout had 93.4dB recorded as the highest noise level and Tunga Roundabout recorded 36^{0}C as the highest temperature reading. The afternoon and evening had the highest records of vehicular traffic flow, increased traffic noise level and the temperature readings. The study recommended the construction of flyover to reduce traffic flow especially at Tunga and City Gate roundabouts. It recommended the construction of link roads to divert traffics to other parts of the city, plant trees at the roundabouts and junctions in order to cushion the effects of high temperature without further delay.

Keywords: vehicle, traffic, noise, temperature

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Introduction

Worldwide, noise pollution has caused serious public health to a good number of people. According to World Health Organization [WHO],[1] an estimated 466 million about 5% global population are disturbed by hearing loss where over 1.1million of the affected people are within the ages of 12 to 35 years with global spending of $750 billion annually. Vehicular traffic noise pollution occurs from the sound of vehicles and commuter passengers. Vehicular noise level can increase with bad vehicle condition and congestion of vehicles at bottle neck roads and roundabouts. It can also occur due to over throttling of the acceleration pedal of the vehicle in motion.[2] Many variables have contributed to the increased noise level pollution in the cities. These factors include bad roads, uncontrolled traffic, high vehicular loud speakers, shouting of passengers, bad exhaust of vehicles, bad engine and others.[3] Rapid population of vehicles and people has resulted to serious noise pollution with their attendant health effects that are making the cities very uncomfortable to live.[4]

Traffic congestion will increase noise pollution compared to free flow conditions.[5] Also, speed at different nodal points or intersections will be influence by vehicular queue, upstream and downstream vehicular volumes, type of lane, type of vehicle and speed limit.[6] The atmospheric weather condition and environmental characteristics such as land scape, rainfall, humidity and temperature as well as visibility influence vehicular noise pollution to some extent[7] For example, bad weather condition is capable of reducing the speed of vehicles to 6-7 mph along the roadway thereby influence noise level.[8,9] The temperature of a place will influence the movement of people thereby has the capacity to affect the vehicular traffic flow.

Temperature rise and its effects have become a global, regional and local phenomenon as cities are affected by Global Climate Change (GCC) which rises along with increased urbanization resulting to UHI effect.[10] Francisco, Wouter and Richard[11] in a global scale study concluded that 27% of the cities in the world and 65% of the urban population are getting warmer beyond the standard comfort level. The exponential increase in surface temperature of the earth is a major issue in global climate change and UHI effects. In the last two decades, the global mean temperature has increased by 0.1˚C per decade, with 2005 being the warmest year on record.[12,13] Therefore, as the globe gets warmer, cities will continue to experience rapid rise in temperature resulting to heat stress and the prevailing health issues. Therefore, the objective of this study is to establish the Spatio-Temporal Variability of Vehicular Traffic, Noise and Temperature of Minna City, Niger State.

Methodology

This study is the spatio-temporal variability of vehicular traffic, noise and temperature of Minna city, Niger State. The study took the coordinates of the purposively selected junctions and roundabouts using the Geographic Positioning System (GPS) as in Table 1. Thus, the Septa-Square 15 minutes technique was used to count the number of vehicular flows at the selected roundabout. The noise level meter was employed to generate the noise level at each roundabout. Also, the thermometer was adopted to record the level of heat generated the roundabouts. The purposively selected roundabouts were Railway, Tunga, Barago and City Gate respectively. The measurements were carried out in the morning (7:00-8:00am), afternoon (1:00-2:00pm) and evening (5:00-6:00pm) simultaneously across the various roundabouts. The mean of the daily records was determined and present in bar charts. The field work took place in a period of one month (four weeks). Minna city lies on the geographical coordinates of 9˚ 36’ 50” N, 6˚ 33’ 24” E with road network and residential areas as shown in Figure 1 and Figure 2 respectively.

Table 1 GPS coordinates of the purposively selected roads and roundabouts

Road	Roundabout	Northing	Easting
Suleja	City Gate	90"34"55	6034"30
Bosso	Baraga	90"34"28	6034"15
Tunga/Zungeru	Tunga	90"36"16	60'33"23
Paiko/Police	Railway	90"30"39	60"33"30

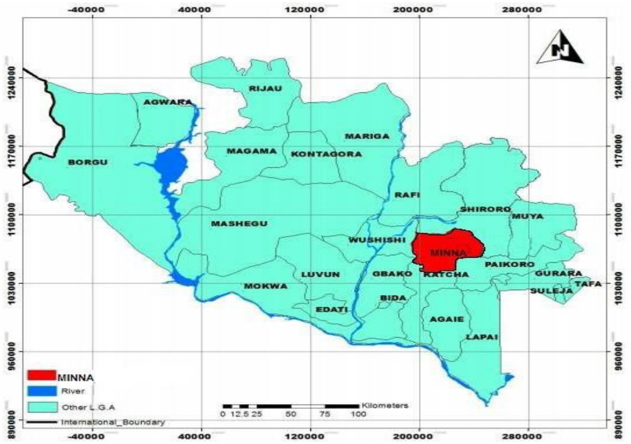

Figure 1 Minna Town in Niger State, Nigeria.

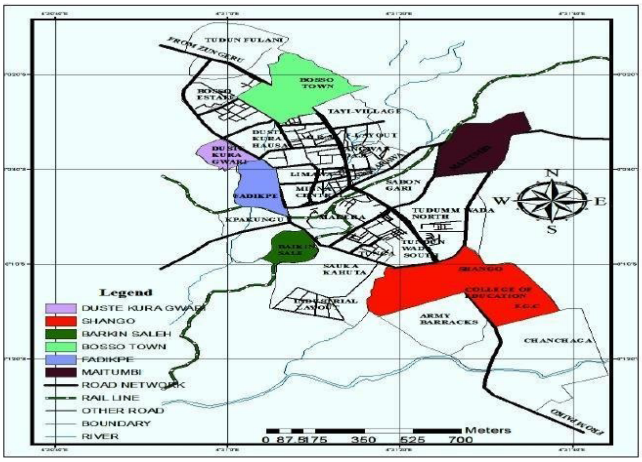

Figure 2 Road network and residential areas in Minna town.

Discussion of results

The vehicular traffic counts indicated that the afternoon of the Tunga Roundabout had the highest vehicular flow at 7032 in the afternoon, 5688 vehicular flow in the morning (Figure 3). The increased vehicular flow at the Tunga Roundabout was suspected to be caused by the Tunga market which usually attracted influx of people and vehicles through the roundabout. The afternoon of City Gate Roundabout had the second highest vehicular flow at 6572 vehicles in the morning and 4384 vehicles in the evening. Barago Roundabout had 3229 vehicular flow in the afternoon and 2989 vehicles in the evening. The roundabout with the least vehicular flow was that of Railway having 2396 vehicles in the afternoon and 2168 vehicles in the evening.

The Barago Roundabout had the highest noise level at 90.9dB in the evening, 93.4dB in the afternoon with low noise level of 84.4 dB in the morning (Figure 4). The second roundabout with high traffic noise was the Railway which recorded90.1dB in the evening, 88.1dB in the morning and 83.1db in the afternoon. The City Gate roundabout recorded the third highest traffic noise level of 87.2dB in morning, 86.2dB in the evening and 82.2dB in the evening. The least noisy roundabout was Tunga with 79.1dB in the afternoon, 69.8db in the morning and 69.7dB in the evening. The variations in the level of vehicular traffic noise were influenced by the spread of road traffic lights across the different junctions and roundabouts in the city of Minna.

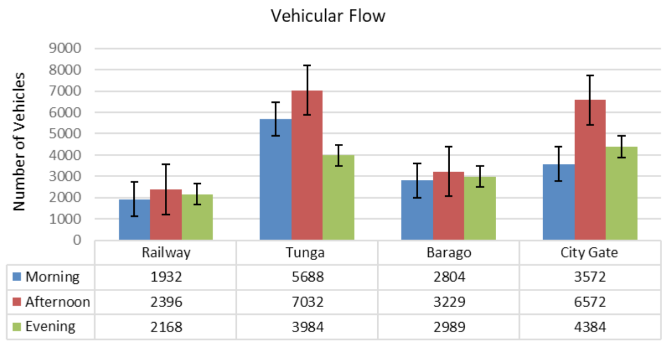

Figure 3 Vehicular flow at selected roundabouts.

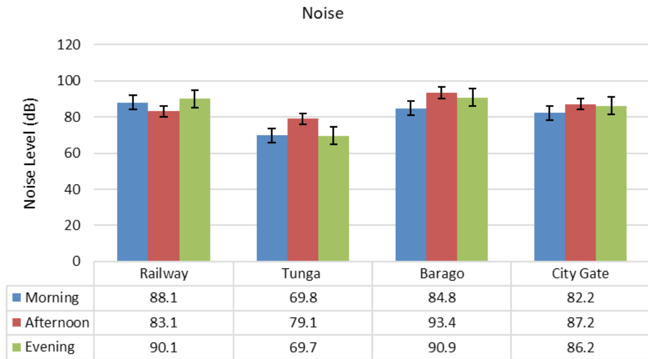

Figure 4 Noise level at selected roundabouts.

The Tunga Roundabout had the highest temperature of 36˚C in the evening, 34˚C in the afternoon and 30˚C in the morning (Figure 5). The second hottest roundabout was the Railway with 35˚C in the evening, 32˚C in the afternoon and 27˚C in the morning. The third hottest roundabout during the period under study was City Gate roundabout having 34˚C in the afternoon, 33˚C in the in the evening and 30˚C in the morning. The roundabout with the least temperature reading was Barago having 30.5˚C in the evening, 30.2˚C in the afternoon and 30˚C in the morning. The findings showed that the afternoon and evening periods of the day had the highest vehicular traffic flow, highest noise and temperature levels respectively across the selected roundabouts.

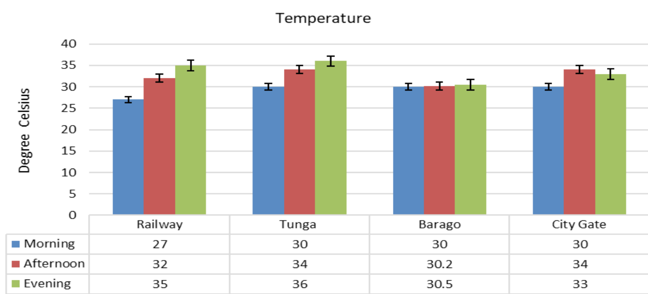

Figure 5 Temperature level at selected roundabouts.

Conclusion

The spatio-temporal variability of vehicular traffic count, noise and temperature levels shows that at roundabouts and junctions, these parameters vary across the different locations. Thus, as the city of Minna is increasing in the influx of people and automobile, there shall be continuous rise of traffic flow at the various roundabouts. The noise level across the various junctions and roundabout is influenced by the number of vehicular traffic flow. The heat that is generated by automobile is added to the natural heat that is radiated by urban pavement materials and vehicular traffic. It is recommended that at a time there will be need to construct flyovers especially at Tunga and City Gate roundabouts where there is increase vehicular flow. The traffic noise can be abated by constructing more link and bypass roads so as to divert traffic flow to other parts of the city. Temperature at roundabouts and junctions can be reduced by planting trees at strategic positions of the junctions and roundabouts. Finally, the policy makers should endeavor to execute the law of traffic offenses on those who generate high vehicular traffic noise by mean of the vehicles. The ability to implement traffic flow offense, noise standard regulations and urban greening of Minna city and other cities of the world will bring about a healthy and safe city. Therefore, city planners should design and implement vehicular traffic regulations and standards without further delay.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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