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STUDY OF TRAFFIC NOISE POLLUTION ON BUSY CORRIDORS IN CHENNAI

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ABSTRACT

Elevated noise levels due to vehicular traffic are cause of great concern in residential areas. They can significantly reduce property values apart from causing health hazard. The Traffic Noise Model (TNM) is typically used to estimate noise levels due to vehicular traffic by integrating GIS buffer modeling capability and the TNM methodology. Ten commercial road networks were selected for this study and it was found that the noise levels can be effectively predicted by the developed model. The noise levels predicted were above the prescribed limits. A buffer analysis of noise levels was developed using Arc GIS to represent noise pollution areas in Chennai city. The recognition of road traffic noise as one of the main sources of environmental pollution has led to develop models that enable to predict noise level. The main objective of the present study is to develop an empirical noise prediction model for the evaluation of equivalent noise level (Leq) in terms of equivalent traffic density number under heterogeneous traffic flow conditions. The aim of enlightened governmental controls should be to protect citizens from the adverse effects of airborne pollution, including those produced by noise.

KEYWORDS : Noise Pollution, Corridors, Chennai

Noise is one of the environmental pollutants which creates interference in communication and health hazards (Agarwal and Swami 2009; Prabat and Nagarnaik2007; Phatak et al. 2008a).The World Health Organization (WHO) considered noise as the third most hazardous type of pollution right after air and water pollutions (WHO 2005). People exposed to high-level noise may be affected in one or more of three ways: health, performance, and comfort. Research regarding urban noise pollution and its consequences for the community has been studied by several countries (Phatak et al. 2008b; Kumar and Jain 1998). The most obvious effect of noise is damage to hearing ability, which may be temporary or permanent depending on the exposure time and intensity (Morillaset al. 2002; Yusoff and Ishak 2005). A similar study that focused on the behavior of human beings exposed to traffic noise was carried out in Canada by Michaud et al. (2008). Generally, motor vehicles, which are a very significant part of the urban environment, are an important source of noise emission, contributing 55% to the total noise (Banerjee et al.2008;Nirjaret al. 2003). Yoshida et al. (1997) studied that on densely travelled roads, the equivalent noise level for 24 hrs can reach up to 7580 dB.

In many urban areas the public transport system is very inefficient and inadequate, resulting in extraordinary growth of personalized vehicles. Besides this, the heterogeneous nature of traffic, continuously plying on roads, develops the interrupted traffic flow conditions and is directly responsible for traffic congestion which gives rise to noise pollution.

Literature Review

Traffic noise prediction models play very important roles in highway and non-highway road design schemes and in assessing the contemporary changes in traffic conditions and noise as well. It is due to the fact that there exists no international agreement on index for the determination of road traffic noise, a number of noise prediction models have been developed to assess noise levels in various countries according to their traffic characteristics and road geometry. (Golmohammadi et al., 2007, Jamrah et al., 2006) A GIS-based model was developed by (Li et al., 2002) developed a statistical model to estimate road traffic noise in urban settings. The Federal Highway Administration has developed traffic noise prediction model for the US Department of Transportation by Barry and Reagan which included a programmable calculator program. This model was successful with the uninterrupted traffic flow conditions.

This program was further developed, separately, under the title STAMINA, in several successive versions. The model assumes point sources traveling at constant speed. The accuracy of the method was found to depend on the distance of the receiver from the source and also on vehicular composition (Al-Mutairi et al., 2009). The CoRTN procedure for the estimation of road traffic noise was developed for the UK Department of the Environment

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by Delany, Harland, Hood, and Scholes. It is used as an aid to road design and also for the determination of entitlements to the sound insulation of private dwellings at public expense. In India, research studies on traffic noise pollution are limited as compared to the other developed countries. In urban areas, narrower, over crowded, and medium to heavy congested road network conditions create interrupted traffic flow condition (Banerjee et al., 2008 ;Nirjar et al., 2003; Rajakumara and Gowda, 2008). In earlier studies (Rao and Rao ,1991) two types of equivalent numbers, i.e., equivalent numbers for light vehicles (scooters; EqLv) and equivalent numbers for heavy vehicles (trucks; EqHv), have been computed.

METHODOLOGY

Chennai the capital of Tamilnadu forms one of the developed urban centre's of India with a population of 4.68 million. It is located towards South East along the coastal Plains of India. It is one amongst the four metropolitan cities of India. The vehicle population in Chennai as of 2012 is 3,760,000 vehicles. The total length of road network in Chennai is 2780 Km.

Ten heavy to medium busy commercial corridors of Chennai city were selected for the present study, covering commercial land use only. The Study area is shown in Figure 1. Each site has its unique characteristics, i.e., having typical road width, roadside housing pattern and traffic flow pattern. At each of these locations, measurements were made when there was reasonable traffic activity (in general from 8 a.m. to 8 p.m.). "Sound Level Meter having digital display was used to record the equivalent noise level at different selected locations. The sound level meter was mounted on a stand at a height of 2m above the ground level. Other traffic parameters like traffic volume, road condition and road geometrics were monitored manually. Each vehicle in the stream having mixed traffic system has different noise generation characteristics and this fact makes the road traffic noise problem little complex (Gupta et al., 1984). In order to understand the behavior of road traffic noise or to understand the various relationships, it is necessary to convert all vehicles into some equivalence based on their noise generation characteristics. The Passenger Car Noise Equivalence (PCNE) of particular vehicles represents that, how many times the vehicle is noisier than car (Nirjar et al., 2003). PCNE values can be used to quantify noise produced by different types of vehicles into a common unit and is used in modeling process. Different categories of vehicles and conversion factors and Average measured noise levels used in this study are presented in (Tables, 1 and 2).

Figure 1 : Study Area

Traffic Noise Index (TNI) is the parameter which describes the noise level and fluctuant characteristics. Leq is the preferred method to describe sound levels that vary over time, resulting in a single decibel value which considers total sound energy.

All these parameters for each hour were obtained by integrating all recorded values. Traffic composition included two wheelers, three wheelers, cars, jeeps, vans, buses, minibuses, light commercial vehicles, and trucks.

RESULTS AND DISCUSSION

The average noise descriptors were determined at interrupted traffic conditions for all selected locations and are given in table 2. It was observed that the value of Leq ranges from 60 to 87 dBA, and for most of the selected locations, TNI exceeded by 70 dBA. The TNI had a mean value of 79.15 dBA with range varying between73.3 and 88.6 dBA. It indicated that the TNI values were larger than Leq levels.

A multiple Linear Regression Model is developed. Though there are a number of independent variables which may affect traffic noise, in this study, the important parameters like traffic volume, spot speed and distance of observer from edge of pavement in both directions were taken as independent variables. The model was developed for noise versus speed, volume of traffic and distance from the source of noise. Sample results of regression analysis for two of the selected areas are given in (Tables, 3 and 4).

Buffer Analysis Using GIS

A buffer is an area defined by the bounding region determined by a set of points at a specified maximum distance from all nodes along segments of an object. A buffer is a zone around an object, such as a traffic or noise pollution that has some investigative or analytical significance. For example, high traffic zones may be defined using a 25 square km radius. Such buffers can be drawn around traffic signals and overlaid on large-scale aerial photographs so that researchers can easily recognize the zone's boundaries, even without demarcating signs.

Figure, 2 shows buffer analysis of noise levels at different radii developed in the study area. It is concluded from this analysis that the area up to 10 m is worst affected by noise and beyond 25 m, the noise is considerably less and the effect is tolerable.

Geographic Information System (GIS)

A GIS is a combination of computer software and hardware that permits the storage, retrieval, analysis, manipulation and presentation of geographically referenced data. Commercial GIS packages are available with a wide range of functionality.

The GIS software available for this exercise did not include the functionality to directly model environmental impacts. For the assessment of air quality

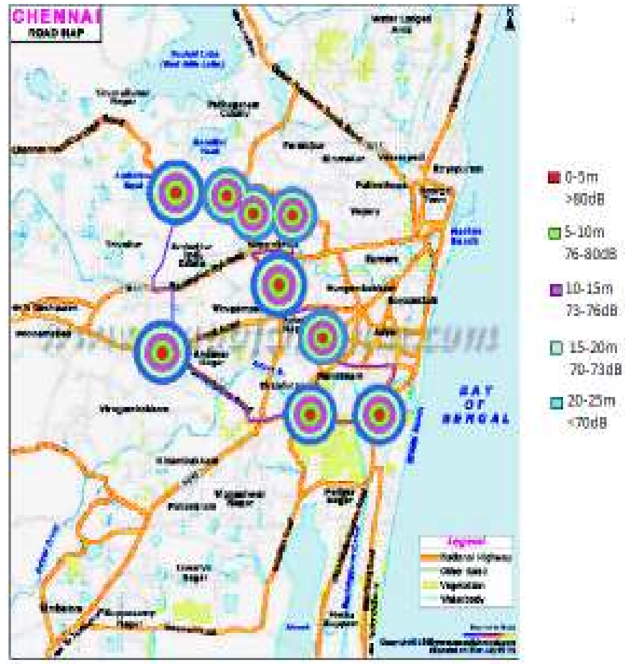

Figure 2 : Buffer Analysis of Noise Levels

Table 1: Different Categories of Vehicles and Conversion Factors for Equivalent Numbers for Light Vehicles (scooters, Nl) and Equivalent Numbers for Heavy Vehicles (Trucks Nh)

S. N.	Location	Morning peak hours		Morning Lean hours	
		volume	Average Noise levels (dB)	volume	Average Noise levels (dB)
1	Porur	2534	84	1230	60
2	Ambattur	2774	85.1	1824	64
3	Guindy	2979	80.8	1597	65
4	Anna Arch	2562	87	2562	61
5	Royapuram	2856	84.6	1675	59
6	Nerkundram	2223	85	2823	67
7	T. Nagar	2865	86.3	2865	69
8	Velachery	2859	84	1859	66
9	Ayanavaram	2753	87	2919	57
10	Tambaram	2654	84	1230	60

Table 2: Average Measured Noise Level

S. N.	Category of Vehicles equivalent	Number of Scooters (Nl)	Equivalent Number of Trucks(Nh)
1	Scooters	1.00	0.038
2	Mopeds	1.20	0.048
3	Tempos	2.00	0.073
4	Motor cycles	3.30	0.126
5	Cars	4.03	0.153
6	Buses	18.90	0.714
7	Trucks	26.20	1.000

and noise levels, therefore, established models have been used which predict pollution or noise levels from traffic flows and other data. The results of these models have been incorporated into an appropriate GIS and manipulated in order to produce a map showing predicted levels of the impact. A major advantage of GIS in the manipulation of geographic data, is the ease by which scale can be readily standardised between datasets prior to display or manipulation.

In order to ensure that road traffic noise levels were represented realistically on the road itself or directly at the roadside, it was necessary to convert the road lines into area features by means of the "buffer" function. Once a sound level map is in the GIS and accepted as reliable, it is possible to consider the impact of that traffic noise upon local residents, which in the final analysis, is the reason for making the effort to produce the map in the first place. To this end, a point coverage of all domestic properties in the study area was overlaid onto the modeled sound level map.

CONCLUSION

It can be concluded that the model with Leq (Lv) gives significantly higher correlation coefficient values and can be applied for the calculation of road traffic noise under interrupted traffic flow conditions in urban areas of Indian cities. Spot speed model is built by considering Noise as dependant variable and Traffic volume and Speed as independent variables. The R^2 values varied from 0.75 to 0.86.An R^2 value of 1 is considered to be the best whereas any value above 0.7 is considered to be good. Though the calculated values are more or less same as observed values, the model developed is proved to be robust with actual noise levels in Chennai. The noise levels in Chennai are higher than that of standards specified by Tamilnadu Pollution Control Board (TNPCB) (55 dB). It is concluded from buffer analysis that the area up to 10 m is worst affected by noise and beyond 25 m, the noise is considerably less and the effect is tolerable.

Table 3 :Regression Analysis Result for Porur

S. N.	Distances from noise source (m)	Ground Floor		First Floor	
		Model	R^2 Value	Model	R^2 Value
1.	Edge	$y=93.29+0.39x_1+1.15x_2$	0.83	-	-
2.	5	$y=89.24+0.32x_1+1.31x_2$	0.85	$y=90.86+0.25x_1+1.28x_2$	0.76
3.	10	$y=85.31+0.38x_1+1.02x_2$	0.82	$y=56.32+0.17x_1+1.16x_2$	0.81
4.	15	$y=82.95+0.50x_1+0.93x_2$	0.86	$y=58.50+0.05x_1+1.19x_2$	0.86
5.	25	$y=84.29+0.43x_1+0.93x_2$	0.86	$y=61.74+0.17x_1+0.92x_2$	0.82

Table 4: Regression Analysis Result for T-Nagar

S. N.	Distances from Noise Source (m)	Ground Floor		First Floor	
		Model	R^2 Value	Model	R^2 Value
1.	Edge	$y=83.29+0.39x_1+1.15x_2$	0.93	-	-
2.	5	$y=69.24+0.32x_1+1.31x_2$	0.95	$y=56.86+0.25x_1+1.28x_2$	0.76
3.	10	$y=75.31+0.38x_1+1.02x_2$	0.92	$y=68.32+0.17x_1+1.16x_2$	0.81
4.	15	$y=72.95+0.50x_1+0.93x_2$	0.96	$y=57.50+0.05x_1+1.19x_2$	0.75
5.	25	$y=74.29+0.43x_1+0.93x_2$	0.98	$y=61.74+0.17x_1+0.92x_2$	0.77

y = Noise levels in dB,

x1 = Mean speed of traffic (kmph)

x2 = Total Volume of traffic (veh/hr)

R2 = Regression Coefficient

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