Noise from traffic in Kuwait and attitudes of urban residents

P. A. Koushki
Department of Civil Engineering, Kuwait University
Fax : (965) 481-7524, E-mail : Parviz@kuc01.kuniv.edu.kw

Findings of a research project funded by the Research Administration of Kuwait University (Report No.: EV02/99) and completed in 1999 provided useful information – for the first time – on the levels of traffic-generated noise pollution and the attitudes of exposed residents concerning this pervasive urban problem. The Research Report presents the levels of noise pollution measured at local, residential and collector streets, arterial roadways and expressways. This information will benefit both the public and responsible urban policy-makers.

Objectives

In urban/metropolitan areas of the industrialized nations, the problem of traffic noise pollution has been studied by numerous researchers over the last three to four decades. In non-industrialized nations, where the problem of urban noise is even more acute, little is known about levels of noise or residents' reaction to it.

In non-industrialized countries, nearly all urban areas are heavily populated. Ongoing growth and in-migrations, frequent changes in urban land-use development policies, and in most cases a lack of comprehensive land-use/transport planning all characterize most of the city environments. In the oil-rich nations of the Persian Gulf, rapid growth in auto ownership (nearly 3 autos per household), inexpensive fuel, large family size, and consequently large numbers of daily family trips (more than 95% by auto), have all combined with undisciplined driving behaviour to exacerbate the problem of urban noise pollution.

The specific objectives of this research study were to: determine the magnitude of traffic-generated noise pollution level at urban streets and roadways; examine the causal relationships between traffic flow variables (volume and speed) and the generated noise level; and identify exposed individuals' attitudes concerning this pervasive urban problem in Kuwait. Twelve urban roadways were monitored for noise and traffic flow variables.

Traffic volume and speed

The average hourly traffic volume (by mix) and traffic speed, by urban roadway type, are presented in Table 1. The volume data generally indicate that on the average, a collector street has more than 2.5 times as many vehicles per hour as a local residential street; an arterial roadway serves nearly 2.4 times as many vehicles per hour, as does a

Table 1. Mean traffic volume and speed at the study urban roadways

Roadway/	Volume (vph)				Speed
Street Type	Small	Medium	Heavy	Total	(km/hr)
Local	165	31	3	191	63
Collector	428	84	21	533	76
Arterial	1054	171	28	1253	105
Expressway	1715	346	65	2126	136

Table 2. Traffic noise measures at study roadways (Evening period)

Roadway Type	Noise Measures at the Edge			Noise Measures at Resi./Comm.Loc.		
	L_{eq}	TNI	L_{NP}	L_{eq}	TNI[a]	L_{NP}[b]
Local	76	88	83	70	76	79
Collector	75	86	88	72	75	80
Arterial	84	82	89	77	76	82
Expressway	85	86	93	74	67	81

a $TNI = 4 (L_{10} – L_{90}) + L_{90} – 30$ (dBA)

b $LNP = L_{eq} + 2.5 \sigma$

Where: TNI is the traffic noise index, L_{10} and L_{90} are (percentile levels), L_{eq} is the equivalent noise level, L_{NP} is the noise pollution level, and s is the standard deviation of noise level.

collector street; and an expressway carries 1.7 times as much traffic as does an arterial roadway per hour.

The average speed of traffic, on the other hand, does not vary as much as did the volume of traffic on different urban roadways. The overall average speed was 63 (km/hr), at local streets, 76 (km/hr), at collectors, 105 (km/hr), at arterial roadways, and 136 (km/hr), at the study expressways. It is interesting to note that the average speed of traffic at expressways is 16 (km/hr) higher than the posted speed limit at these roadways!

Traffic-generated noise levels

Two profiles of traffic noise levels for the study roadways are presented in Table 2: noise levels measured at 1 meter away from the roadway edge (height of 1.5 m), and those measured at the proximity to residential/commercial locations, both at the same microphone height.

The mean distances between the edge of the roadway and location of residences/commercials were approximately 4 (m) for the local streets, 6 (m) for the collectors, 9 (m) for the arterials, and 18 (m) for expressways.

The evening-period noise levels in Table 2 (The equivalent noise level, Leq, the traffic noise index, TNI, and the noise pollution level, LNP), highlight the generally high noise levels measured at the study roadways in Kuwait. The levels of noise measured during other periods of the day were also very similar to those of the evening period.

A comparison of the TNI and the Leq noise levels for the study local streets indicates that the TNI values are larger than the Leq levels. This reflect the fact that although the noise levels during any period of the day were generally constant, the intruding single-event noise were sufficiently frequent to affect the values of the L_{10} (the highest 10 percentile noise levels), and consequently, the TNI. The frequent misuse of horns, and loud noises of motor cycles, are the main reasons for the high TNI levels at the local streets – where peace and quiet are most needed.

A sample of the cumulative frequency distribution of the roadway-edge noise levels during the evening peak period hours is presented in Figure 1. The noise data in Figure 1 shows that 50% of the monitoring time during the evening peak periods the noise from traffic was above 67 dBA, at the local street; more than 71 dBA, at the arterial roadway, and higher than 83 dBA, at the expressway location. In all of these locations, the L_{eq} was above the permissible 65–70 dBA outdoor standards with a significant margin.

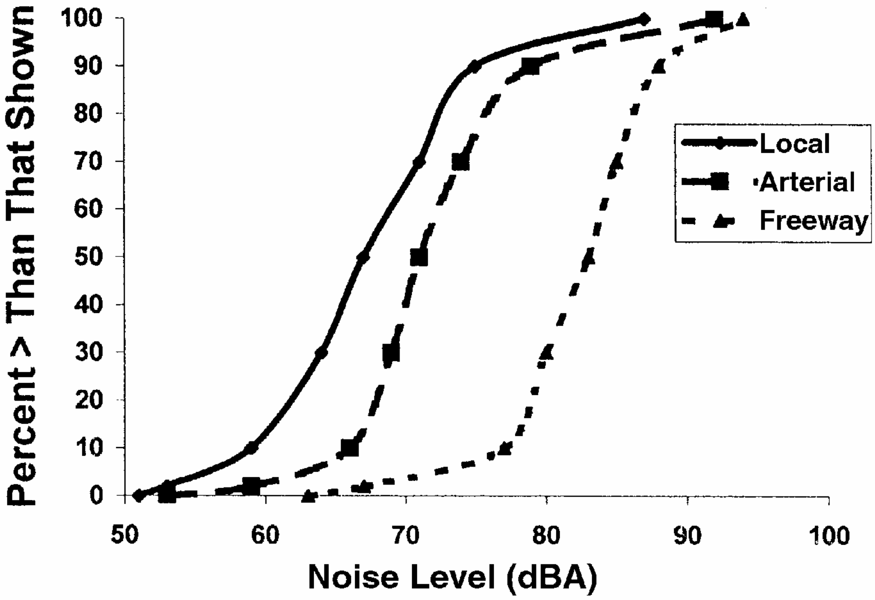

Figure 1. Sample cumulative frequency distribution of noise levels at roadway edge by roadway type

Noise and flow variable relationship

The analysis of correlations performed on the data points to the existence of strong and positive relationships between the generated noise levels and traffic flow variables of volume and speed. As shown in Figure 2, the traffic noise level increases rather significantly with an increase in the traffic volume. For example, traffic noise increased by 4

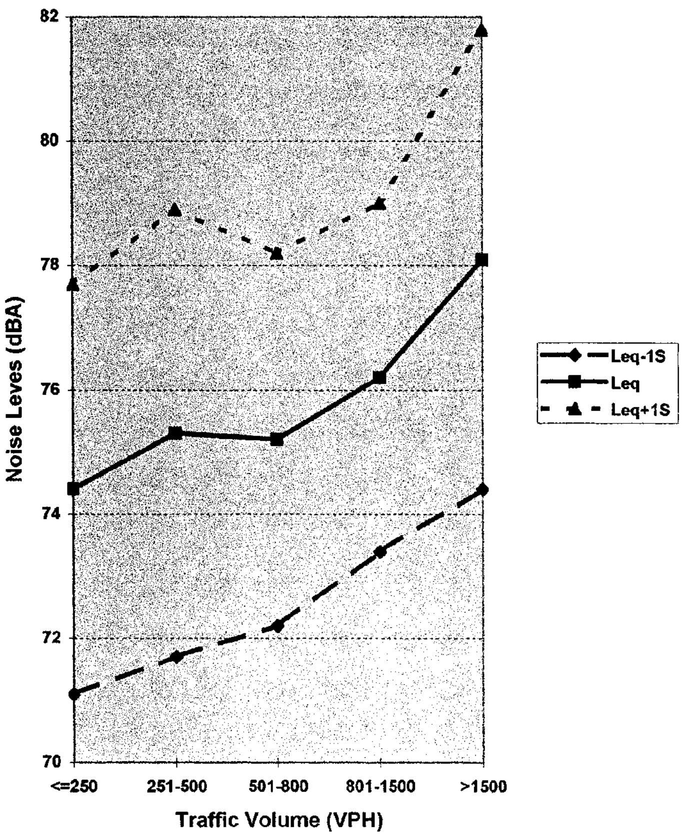

Figure 2. Equivalent noise levels (L_{eq}) by traffic volume

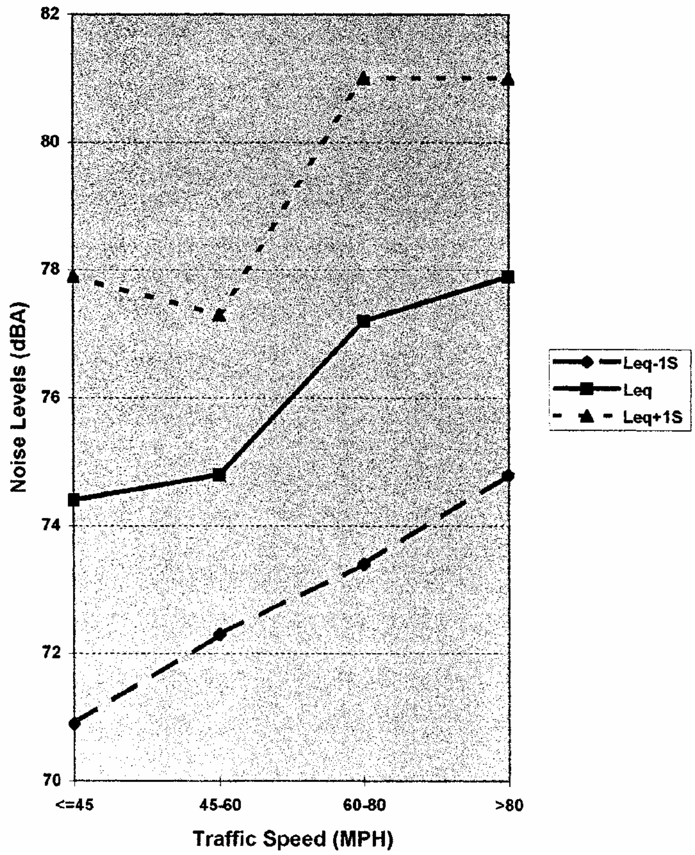

Figure 3. Equivalent noise levels (L_{eq}) by traffic speed

dBA over the range of hourly traffic volumes at the study roadways. The L_{eq} + 1 S (equivalent noise level plus one unit of standard deviation) curve indicates that in nearly 35% of the monitoring times, (area under the standard normal distribution curve), the traffic noise was in the range of 78 and 82 dBA, at the study roadways.

In Figure 3, the focus is on traffic speed. Again, results are similar to those of the hourly volumes – increasing traffic speed, increases the generated noise level. And, again, the effect of higher range of traffic speed is more pronounced on the generated noise level than is the lower ones.

Survey of perceptions

A total of 1350 household heads/commercial unit managers located adjacent to the twelve study roadway sites were person-interviewed and requested to fill in questionnaires. 1182 completed questionnaires were processed for the analysis of attitudes. The questionnaire was aimed at assessing the perceived welfare and annoyance impacts of traffic noise on exposed residents/employed individuals. Eight welfare/annoyance variables were included in the questionnaire.

Since the eight welfare factors (effect of noise on: working, resting, conversation, phoning, eating, reading, watching TV, and sleeping), all represented the exposed individuals' concern/dislike of traffic noise, an attempt was made to combine these variables into a single composite factor.

The result of a correlation analysis performed on the eight perceived annoyance measures and the L_{eq}'s showed that three of the welfare impacts (work, conversation, and eating) demonstrated weak correlations (associations) with the L_{eq}. These variables were therefore eliminated from the principal component analysis. The following model coefficients were estimated for the selected annoyance variables:

$$y_c = 0.2115\,(\text{sleeping}) + 0.2097\,(\text{reading}) + 0.2008\,(\text{resting}) + 0.1895\,(\text{phoning}) + 0.1885\,(\text{watching TV})$$

where, y_c is the single composite annoyance factor (the percent of respondents who were annoyed). The model shows that the annoyance with traffic noise was mainly caused by noise interference with sleep, reading, resting, phoning, and watching TV.

Conclusions

Findings of this research study have shown that traffic noise at urban roadways in Kuwait is rather high for a significant amount of the time. With the planned continuing rapid growth in population and expansion of urban areas, combined with the strong favouring of the auto mode of travel, the future trend – without appropriate remedial measures – is most likely toward a noisier urban environment in Kuwait.

Successful protection of the public from the negative impacts of traffic noise requires effective control of its undesirable aspects. A comprehensive and multidimensional program incorporating all phases of planning, implementation, monitoring, feed-back, enforcement, and education is required to minimize the immediate problem of noise pollution and to improve the quality of urban life, and to curb the long-term harmful effects of this pervasive urban problem. Such a multidimensional program must include noise source emission control, improved roadway geometric design, traffic system management, land-use control, and most importantly, public education and awareness.