Community Response to Road Traffic Noise in Hue City, Vietnam

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Abstract

This paper provides the outline and results of social survey on community response to road traffic noise in Hue City. The social survey was carried out at seven sites in Hue City from August to September, 2012. The average annoyance score is 3.9532 (SD =2.52484) and a noise index based on assessment of public in Hue City is unimportant. $L_{Aeq,1s}$ was continuously measured during 24h from September 3rd to 4th 2012 with sound level metters (RION NL-21 and NL-22); $L_{Aeq,d}$, $L_{Aeq,e}$, $L_{Aeq,n}$ and L_{den} were calculated by using $L_{Aeq,1s}$ values. L_{den} ranged from 60.9 to 79.6 dB. The research has carried out dose-response relationship for general traffic noise annoyance in Hue City by logistic regression method. The dose-response curve in Hue City was slightly lower than that in Da Nang City and much lower than EU's curve. There was a range of 10.9 to 18.1 dB difference between the two curves at the same percent of high annoyance.

Keywords: Community response/Hue City/Road traffic/Dose-response relationship/Noise

1. Introduction

The traditional definition of noise is "unwanted or disturbing sound". Besides, sound becomes unwanted because of its effects on normal life activities as well as other socio-economic development process. On the other hand, the social-economic activities will increase noise levels especially in huge urban.

Hue City is a main developing city of Thua Thien Hue Province. The traffic volume has made noise pollution in Hue City more serious. Road traffic noise source includes all the vehicles in roads and streets of a city as cars, trucks, buses, motorcycles, etc. The ADB's report of Initial Environmental Examination (2012) has shown that first signal of noise pollution in Hue City and noise levels in some places are higher than the noisy technical standard, mainly because of the transport sector. The average monitored values of noise level that are observed in busy urban sites, ranged from 71 to 85 dB and the average values from 2005 to 2007 were from 68 to 77 dB.

The review of past papers, many researchers have shown dose–effect relationship between noise level and annoyance level such as Schultz, 1978; Fidell et al., 1991; Björkman, 1991; Sato et al., 1999 and Klæboe et al., 2004. Also, Yano et al., (2002) studied the community response to road traffic noise in Japan and Sweden with the help of social surveys. These studies confirmed an important relationship between noise and annoyance level. Furthermore, some research has developed a mathematical equation model aimed at predicting the percentage of annoyance in relation to noise levels. Similarly, Katarina Paunović et al., (2009) also researched noise annoyance prediction ability in noisy and quiet urban streets. In 2010, Fyhri and Aasvang conducted a social survey to road traffic noise, and used Structural Equation Models (SEM) for studying the relationship between noise exposure and noise annoyance. These papers show the diversity of issues related to studies of noise and community response as well as negative effects of traffic noise to community.

In Vietnam, there are several studies such as Phan et al., Nguyen et al., of community response to road and aircraft traffic noise in Ho Chi Minh City and Hanoi. Besides, there was also a study by Trinh et al., 2012 of road trafic noise in Hue City. The purpose of this study was to investigate (assessment and analysis) the effects of road traffic noise along streets on community response in Hue City.

2. Methodology

2.1. Surveyed sites

Hue City was chosen for the survey as a main city of central Vietnam. The total area is 71.68 km^2 and located in the latitude of $16^0$30' to $16^0$24' North, the longitude of $107^0$31' to $107^0$38' East; Hue City is center of society, polity, culture and economy of Thua Thien Hue province. The social survey and noise measurement were carried out in Hue City from August 26th to September 4th 2012. Face-to-face interview was tried to 700 people from August 26th to September 2nd 2012. Hence, the road traffic noise survey and measurement were performed at seven sites in Hue City (see Figure 1) from September 3rd to 4th 2012.

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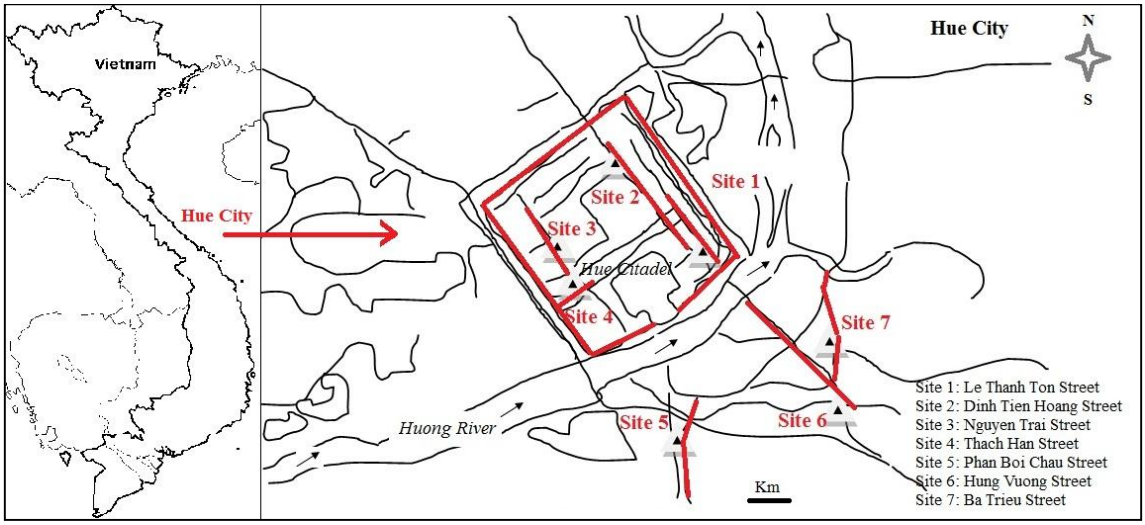

Figure 1: Map of surveyed sites

2.2. Social survey

Social survey on community response to road traffic noise was conducted in Hue City from August to September 2012. The social survey was conducted in form of face-to-face interviews on weekends. The over 18 year old inhabitants were selected with the balance of gender (male/female), generations (senior citizen, middle-aged, youngster). The design of the questionnaire followed to Technical Specification ISO/TS 15666:2003 with an internationally standardized interview method for the assessment of noise annoyance by socio-acoustic surveys. The version of this questionnaire was used in this study for the road traffic noise survey. The questionnaires contained inquiries on house status, surrounding environment, noise annoyance, daily activities, and socio-demographic items. In the questionnaire, the 11_point numeric scale constructed according to the International Commission on Biological Effects of Noise (ICBEN) method was used to assess the respondents' road traffic noise annoyance in Hue City.

2.3. Noise measurement

A-weighted sound pressure levels [L_A(dB)] were measured every second for 24h. Noise levels were measured with sound level meters (RION NL-21 and NL-22). The measurements were performed at reference points that were 1.2 m high and 2.5- 5 m away from the road shoulders. The reference points were selected at the average distances from the roads to the house facades. Since all row house respondents lived in radius 1km of the measurement points, the obtained values represented the exposure values of the same site. $L_{Aeq,day}$, $L_{Aeq,evening}$, $L_{Aeq,night}$, $L_{Aeq,24h}$, L_{dn}, and L_{den} were calculated from the obtained L_A levels. As specified by the European standard, L_{den} is defined in terms of the "average" levels during daytime, evening, and night-time, and applies a 5 dB penalty to noise in the evening and a 10 dB penalty to noise in the night. The definition is as follows:

$$L_{den}=10\lg[(12/24)*10L_D/10+(4/24)*10(L_E+5)/10+(8/24)*10(L_N+10)/10].$$

In which: L_D, L_E and L_N are the A-weighted sound pressure levels as defined in ISO 1996-2 (1987) for the daytime (7-19h), evening (19-23h) and night time (23-7h) period. The short-term vertical noise measurement for apartments was carried out at seven sites in Hue City.

3. Results and Discussion

The research has used correlation analysis, and logistic regression aiming to determine relation as well as compare results between community response and road traffic noise in Hue City. Table 1 has showed the noise at matrix calculated for road traffic noise exposures the sites in Hue City. The road traffic noise exposure was calculated by L_{den} with range from 60.9 to 79.6 dB. The lowest and highest road traffic noise exposure level in Hue City was found at site 4 and 6. In addition, community response with traffic noise equals 3.9532 (SD =2.52484) in average. Measuring community response to traffic noise using 11- point scale showed that the feeling of disturbance by noise to public is quite low. Hence, it can be seen that noise pollution levels are inconsiderable.

Table 1: General acoustic characteristics of all sites in Hue city

Acoustic characteristics	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
$L_{Aeq,day(7.00-22.00)}$	68.9	71.0	71.8	59.8	70.9	77.1	72.0
$L_{Aeq,night(22.00-7.00)}$	58.1	59.1	64.9	50.3	61.6	70.4	66.2
$L_{Aeq,evening(19.00-22.00)}$	68.8	70.2	71.0	59.3	69.7	78.0	71.3
L_{dn}	68.6	70.4	73.2	60.0	71.2	78.6	74.4
L_{den}	69.7	71.4	73.9	60.9	72.0	79.6	74.6
$L_{Aeq,24h}$	67.1	69.1	70.3	58.0	69.2	75.6	70.6
Average annoyance	3.0	3.7	2.5	2.8	5.1	4.9	5.0
%Highly annoyed	3.0	7.1	4.0	1.0	8.1	17.2	15.1

Pearson's correlation results of relationship between community response (road traffic noise annoyance) and equal noise level (L_{Aeq}) in Hue City is shown by Table 2. The results of correction have statistical significance at the 0.01 level, concurrently, Pearson's correlation coefficient with positive signal. It means that there is a positive relationship among factor groups. Especially, correction coefficient among L_{den}; $L_{Aeq,24h}$; L_{dn}; $L_{Aeq,e}$; $L_{Aeq,n}$ are very high (more than 0.9). Regarding the relationship between community responses to noise level is quite low and from 0.205 to 0.220. However, this relationship also exists positive correction and it has statistical significance with $p<0.01$. Besides, comparison between L_{den} measured in Hue City and QCVN 26:2010/BTNMT has shown the existence of noise pollution.

Table 2: Pearson's correlation results

	CR	L_{den}	$L_{Aeq,24h}$	L_{dn}	$L_{Aeq,e}$	$L_{Aeq,n}$
CR[a]	1	0.217(**)	0.216(**)	0.220(**)	0.205(**)	0.216(**)
L_{den}	0.217(**)	1	0.995(**)	0.999(**)	0.988(**)	0.982(**)
$L_{Aeq,24h}$	0.216(**)	0.995(**)	1	0.992(**)	0.993(**)	0.958(**)
L_{dn}	0.220(**)	0.999(**)	0.992(**)	1	0.983(**)	0.986(**)
$L_{Aeq,e}$	0.205(**)	0.988(**)	0.993(**)	0.983(**)	1	0.946(**)
$L_{Aeq,n}$	0.216(**)	0.982(**)	0.958(**)	0.986(**)	0.946(**)	1

[a] Community response (Road traffic noise annoyance) ** Correction is significant at the 0.01 level

In addition, to provide science base for noise standard's planning process, the research has carried out dose-response relationship for general traffic noise annoyance in Hue City by logistic regression method (see Figure 2). Community noise annoyance is defined as highly annoyed and calculated with 27% level of 11-point scale by the European Union. Annoyance was set to dummy variables with 0 and 1. The estimates of parameters and their standard errors are shown in Table 3.

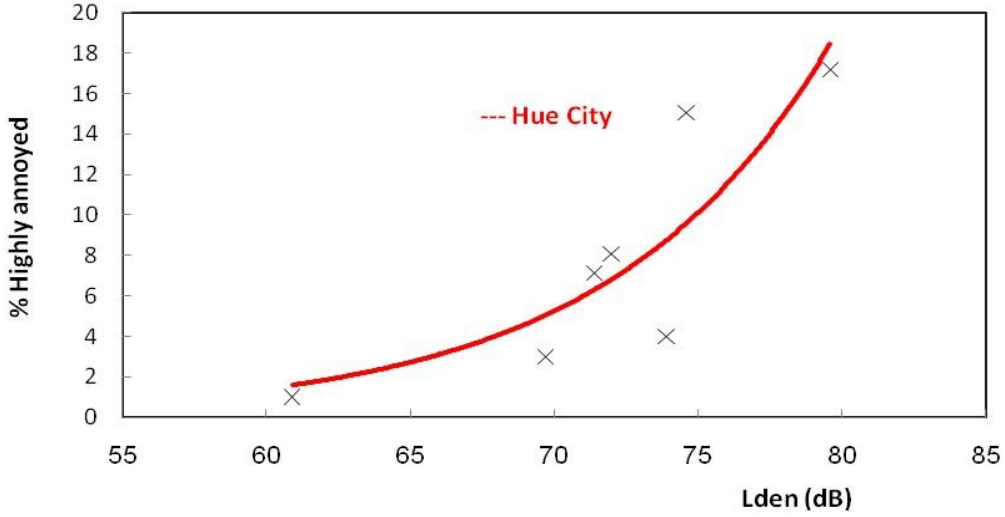

Figure 2: Dose-response relationships for general road traffic noise annoyance in Hue City

Figure 2 shows the resulting trend of logistic curve related road traffic noise annoyance in Hue City. It presents the relationship between community response to road traffic noise and L_{den}; where high annoyance levels are quite low and describe in the general trend of the curve.

Table 3: Results of logistic regression analysis for road traffic noise annoyance

		B	S.E.	Wald	df	P-value	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	L_{den}	0.140	0.037	14.261	1	0.000	1.151	1.070	1.237
	Constant	-12.678	2.774	20.889	1	0.000	0.000		

a Variable(s) entered on step 1: L_{den}

The binary logistic model has a good relevant level with value of -2LL index, which is small enough (-2Log likelihood =350.739). Wald Chi-square has showed that the regression model coefficients achieved statistical significance ($p<0.0001$). In addition, an accurate rate of prediction model is extremely high with 91.3% for the general model. The effect levels of road traffic noise are positive by annoyance level L_{den}. The results are similar with the linear regression model. On the other hand, this logistic model is used to predict community response with road noise (%highly annoyed). Using QCVN 26:2010/BTNMT to calculate and predict % high annoyance with results such as 0.17; 0.68 and 5.33% for L_{den} levels with 45dB (from 21.00 to 6.00 in special sites), 55dB (from 6.00 to 21.00 for especial sites and from 21.00 to 6.00 in usual sites) and 70dB (from 6.00 to 21.00 in usual sites). To compare these results with EU's levels (% highly annoyed) by three L_{den}'s level, there exist the differences with results as 1.0; 6.0 and 25.0% respectively. It means that the EU community is more sensitive to levels of road traffic noise more than Hue City by many times. This is explained by the differences in culture and socio-economic development conditions among countries.

Dose-response relationships have showed the levels of community response to road traffic noise in Hue City. However, for access and comparison, the research has established with the synthesized curve by Hue City 2012 surveys in comparison with Da Nang City and the EU's curve surveys.

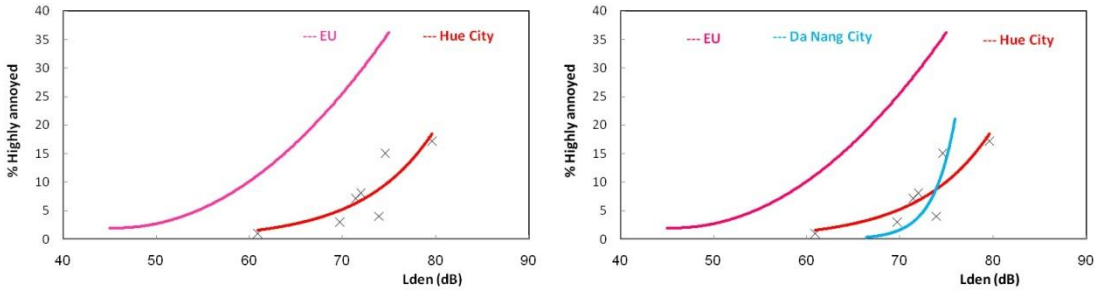

Figure 3: The synthesized curve of Hue City 2012 surveys compared with Da Nang City and the EU's curve surveys

Figure 3 represents the comparison between the high annoyance of Hue City and the EU. The results shown in this figure represent the same trend of Hue City and EU. However, in Hue City, the high annoyance level is lower than the EU's. In addtiton, L_{den} level in Hue City is more than Europe with a minimum value of L_{den} in Hue is 60.9 dB. There is a range of 10.9 to 18.1 dB difference between the two curves at the same percent of high annoyance. Therefore, the figure above confirms that the road traffic annoyance of Hue City is much lower than Europe.

Based on the above results in Figure 3 on community response to road traffic noise and dose-response relationship, there are also differences between Hue City and Da Nang compared with the EU' curve. There exists a strong bias in the dose-response relationship of Hue City and EU's curve. Also, the small difference between results in Da Nang City and Hue City is similar to the community response to road traffic noise. It can be explained by the same socio-economic conditions in the zone, although there are differences of L_{den} level.

4. Conclusions

The research results have showed that the existence of positive correction between road traffic noise and community response agree with Pearson's correction coefficients, and achieves of statistical significance. The road traffic noise exposure is calculated by L_{den} with a range from 60.9 to 79.6 dB. The lowest and highest road noise exposure level in Hue City was found at site 4 and

site 6 (with L_{den}'s levels equal 60.9 and 79.6 dB respectively). Dose-response relationship in Hue City has shown, and provided the first scientific basis for a noisy environment planning process based on public response. Hence, using regression modeling we propose that we will be able to establish a general urban traffic noisy standard. On the other hand, the results can also be used to propose solutions to road traffic noise, for the public living near to roads in Hue City. It means that possible solutions are reduce housing which faces directly onto the street near dense road traffic, which will improve sleep status and reduce the effects of road traffic noise.

5. References

Asian Development Bank. 2012. **Initial Environmental Examination: Thua Thien Hue Province Water Supply Project Feasibility Study Report**. TA7089-VIE:41456-033.

Björkman, M., 1991. Community noise annoyance: importance of noise levels and the number of noise events. **J. Sound Vibr** (151): 497-503.

Fidell et al., 1991. Updating a dosage-effect relationship for the prevalence of annoyance due to general transportation noise. **J. Acoust. Soc. Am.** (89): 221-233.

Fyhri, A., & Aasvang, G. M., 2010. Noise, sleep and poor health: Modeling the relationship between road traffic noise and cardiovascular problems. **Science of the Total Environment**, 408(21): 4935-4942.

International Standards Organization. 2003. **ISO/TS 15666:2003 of Acoustics - Assessment of noise annoyance by means of social and socio-acoustic surveys**.

Katarina Paunović et al., 2009. Predictors of noise annoyance in noisy and quiet urban streets. **Science of the Total Environment** 407: 3707-3711.

Klæboe R., Amundsen A.H., Fyhri A., Solberg S., 2004. Road traffic noise – the relationship between noise exposure and noise annoyance in Norway. **Appl Acoust** (65): 893-912.

Nguyen Thu Lan et al., 2011. Community response to aircraft noise in Ho Chi Minh City and Hanoi. **Applied Acoustics** 72(11): 814-822.

Phan Thi Hai Yen et al., 2010. Community responses to road traffic noise in Hanoi and Ho Chi Minh City. **Applied Acoustics** 71(2): 107-114.

Sato T., Yano T., Björkman M., Rylander R., 1999. Road traffic noise annoyance in relation to average noise level, number of events and maximum noise level. **J. Sound Vibr** (223): 775-784.

Schultz T. J., 1978. Synthesis of social surveys on noise annoyance. **J. Acoust. Soc. Am.** (64): 377-405.

Thua Thien Hue Statistical Office. 2012. **Statistics yearbook of Thua Thien Hue Province 2011**. Thanh Nien Publishing House.

Trinh Thi Giao Chi & Nguyen Thi Ngoc Ha, 2012. Assessment of impacts of road traffic noise on community living along the roads in the southern area of Hue city. **Journal of Science, Hue University** 73(4): 19-28.

Vietnam Ministry of Environment and Resources. 2010. **QCVN 26:2010/BTNMT: National Technical Regulation on Noise. Hanoi**.

Yano, T., Sato, T., Björkman, M., & Rylander, R., 2002. Comparison of community response to road traffic noise in Japan and Sweden. **Journal of Sound and Vibration**, 250(1): 169-174.

WG_HSEA. 2002. **Position paper on dose–response relationships between transportation noise and annoyance**. European Commission. Office for Official Publications of the European Communities. Luxemburg.