# A SOCIAL SURVEY ON COMMUNITY RESPONSE TO ROAD TRAFFIC NOISE IN HANOI

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**ABSTRACT :** Though a number of social surveys on community responses to environmental noise have so far been conducted in Euro-American countries, a few social surveys have been done in Asian countries except Japan. In contribution to the international discussion on global noise policy as well as Vietnamese noise policy, a socio-acoustic survey on community response to road traffic noise was conducted at eight sites of Hanoi in September 2005. The samp le size was 1,676 in total. Noise exposure characterized by frequent horn sound was from 70 to 77 dB *L*Aeq,24h at each site. The % highly annoyed for the top three categories from 11-point numeric scale were almost fitted into Schultz's synthesized curve. Though demographic variables did not affect annoyance significantly except age, the attitudes to noise source and sensitivity to noise greatly affected annoyance. These findings are almost consistent to those obtained by Fields and Miedema et al.

## 1. INTRODUCTION

Since road traffic noise was recognized as one of the serious environmental pollutants and one of the most widespread and growing problems in urban areas, many social surveys have been conducted in Euro-American countries and Japan in order to evaluate the extent of the effect and to develop suitable noise ratings. However, very few social surveys have been conducted in other Asian countries [1]. Among developing countries in Asia continent, Vietnam is one of those now experiencing the rapid economic growth and many other tremendous national changes. Vietnam, therefore, has faced with many serious environmental issues such as water, air and especially noise pollution from industry and transportation system. Reliable data on community response to noise from Vietnam would therefore be an important step as the valuable contribution to the international discussion on the global noise policy as well as Vietnamese noise policy.

Hanoi is the capital of Vietnam with approximately 3.5 million people. Apart from the positive changes Hanoi has progressed for the past 10 years, the city must also face some serious environmental problems such as pollution from road traffic noise. A preliminary survey on community response to road traffic noise was conducted in Hanoi, in September 2004 [2]. This showed that road traffic condition here as in a city of a developing country is quite different from those in developed countries because of a great

amount of motorcycles. These create frequent horn sounds which are not special but usually heard during the day. Furthermore, the survey has brought about a hypothesis in which it can be given that the high annoyance and sleep interference in Hanoi may be mainly caused by the frequent horn sounds. The survey has provided the initial look over the community response to noise in Hanoi, as well as opened up new challenges and more comprehensive approaches for the social survey in 2005.

The purpose of the present study is to investigate the characteristics of road traffic noise, the dose-response relationships in higher noise exposure and the effects of moderators on annoyance through a large-scale socio-acoustic survey in Hanoi in 2005.

## 2. SOCIAL SURVEY AND NOISE MEASUREMENT

A large-scale social survey on community response to road traffic noise together with noise measurement was conducted over four periods in September 2005. The first period was from the 3rd to the 4th of September (weekend;) the second period was from the 10th to the 11th (weekend;) the third period was of the 13th and 14th (week days,) and the last was on 25th (Sunday.) Eight sites in Hanoi were selected regarding their traffic volume as shown in Table 1. The sample size was 1,676 people in which 1,165 were from row house residents and 511 were from apartments. The total response rate was 48.8%.

The modified questionnaire with 5-point verbal scale (extremely, very, moderately, slightly and not at all) and 11-point numeric scale constructed by the ICBEN was used [3]. The questionnaire was translated from the original Japanese to Vietnamese, including 42 questions on housing, residential area, annoyance, activity interferences, symptoms, sensitivity, demographic variables and so on. The questionnaire items were shown in Table 2. All respondents were given questionnaires and supported by interviewers to answer the questions.

Noise measurements were conducted over two periods, the first from 19th to 20th, and the second from 21st to 22nd September 2005. The same noise measurement and traffic volume counting method as previously used in the preliminary survey were applied. The 24 hour-noise measurement was performed at reference points 1.2 m high and from 2 m to 12 m away from the road shoulders. Short-term noise measurement was also carried out at the reference points and other several points simultaneously. Distance reduction equations were formulated based on the short-term measurement. Noise exposure to each house was estimated by the 24-hour noise measurement values and the distance reduction equations. Some vertical noise reduction

**Table 1 Outline of social survey 2005**

| ID | | Site No 1 | Site No 2 | Site No 3 | Site No 4 | Site No 5 | Site No 6 | Site No 7 | Site No 8 | Total or Average |
|---|---|---|---|---|---|---|---|---|---|---|
| Street/ Road | | Ton That Tung | Tran Hung Dao | Tran Quang Khai | Lang | Nguyen Trai | Lang Ha | Truong Chinh | Hong Ha | |
| Social survey date | | 3rd-4th September | 3rd-4th September | 3rd-4th September | 13th-14th September | 13th-14th September | 3rd-4th September | 10th-11th September | 25th-26th September | |
| Sample size | Row house | 25 | 27 | 2 | 337 | 319 | 49 | 324 | 82 | 1165 |
| | Apartment | 83 | 111 | 35 | 0 | 147 | 92 | 28 | 15 | 511 |
| | Total | 108 | 138 | 37 | 337 | 466 | 141 | 352 | 97 | 1676 |
| Response rate (%) | Row house | 53.2 | 23.9 | 15.4 | 48.1 | 50.9 | 47.1 | 61.6 | 73.9 | 46.8 |
| | Apartment | 27.7 | 74.0 | 25.9 | | 69.3 | 42.6 | 77.8 | 60.0 | 47.2 |
| | Total | 31.1 | 52.5 | 25.0 | 48.1 | 55.5 | 44.1 | 62.6 | 71.3 | 48.8 |

**Table 2 Questionnaire items**

| | |
|---|---|
| HOUSING FACTOR (Q. 1-11) | House type; Length of residence; Number of floors; House structure; Layers of doors; Type of doorframes; Direction facing doors… |
| RESIDENTIAL AREA (Q. 12-16) | Length of residence; Climate in the area; Relationships with neighbors; Comments on living space… |
| ANNOYANCE (Q. 17-25) | From neighbors; from traffic noise; Frequency of annoyance Specific time; specific season; Vehicle types creating; vibration… |
| ACTIVITY INTERFERENCE (Q. 26) | Annoyance due to road traffic noise; Vibration; TV/radio disturbance; disturbance in falling asleep… |
| SYMPTOM (Q. 27-28) | Symptoms relating hearing ability; Symptoms relating respiration |
| SENSITIVITY, ATTITUDE ETC. (Q. 29-36) | Sleeping with open-windows in certain seasons; Usual sleeping conditions; Environmental factors; Resting with open-windows; environment pollution |
| DEMOGRAPHIC VARIABLES (Q. 37-42) | Occupation; Length of staying home; Members of family; Age ; Gender |

**Table 3 Outline of Noise measurement**

| ID | Survey site | 24 hour noise measuring period | Noise recording | Distance from road shoulder to house (m) | | Distance from road shoulder to the reference point (m) | Distance reduction measurement (LAeq, 3 min, (dB) | Note |
|---|---|---|---|---|---|---|---|---|
| | | | | Minimum | Maximum | | | |
| 7 | Truong Chinh Road | 19/9 9:10 - 20/9 9:11 | | 0.8 | 5.1 | 7.2 | 0.8m 80.6dB<br>3.6m 78.6dB<br>7.2m 77.8dB | |
| 1 | Ton That Tung St | 19/9 10:00 - 20/9 10:01 | | 4.5 | 9.5 | 10.1 | 4.5m 74.6dB<br>7.3m 73.6dB<br>10.1m 71.9dB | Vertical reduction<br>1F 6.2m 73.0 dB<br>2F 9.7m 68.8dB<br>4F 9.7m 72.1dB |
| 4 | Lang Road | 19/9 11:00 - 20/9 11:01 | | 0.7 | 7.1 | 2 | 2.0m 74.6dB<br>7.3m 73.6dB | 9/20 Noise recording at road shoulder for 10 min. from 15:05 Range 110 |
| 5 | Nguyen Trai Road | 19/9 12:00 - 20/9 12:01 | | 6.7 | 13 | 7.7 | 2.3m 75.7dB<br>6.0m 73.7dB<br>13m 70.7dB | 9/20 Noise recording at road shoulder for 10 min. from 14:20 Range 110 |
| 6 | Lang Ha St | 21/9 9:30 - 22/9 9:31 | 22/9 SP Road shoulder 8:50 - 9:03 | 4.5 | 12 | 12 | 4.5m 72.0dB<br>8.0m 70.8dB<br>12.0m 68.6dB | 9/20 Noise recording at road shoulder for 9 min. from 9:13 Range 110 |
| 2 | Tran Hung Dao St | 21/9 10:30 - 22/9 10:31 | 22/9 SP Road shoulder 10:04 - 10:24 | 3 | 7.6 | 7 | 3.0m 69.6dB<br>5.0m 68.9dB<br>7.0m 67.7dB | 9/20 Noise recording at road shoulder for 10 min. from 10:25 |
| 3 | Tran Quang Khai Road | 21/9 11:10 - 22/9 11:11 | 9/22 SP Road shoulder 10:50 - 10:11 | 3.2 | 4.7 | 5 | 3.2m 76.4dB<br>4.7m 76.7dB | Noise measurement<br>2F Balcony 11:47-11:58<br>Bed room 12:02-12:13 |

measurements were conducted at Site 01 – Ton That Tung St. Since this measurement was not enough to estimate noise exposures to all apartments, only noise exposures to row houses were estimated. Thus the data from row houses were solely used for further analysis. There were also only two samples from row houses

along Tran Quang Khai Road and the data was hence not used for comparison among sites. The traffic volume was counted by reproducing a video camera recording.

The outline of noise measurement is shown in Table 3. Noise exposure at site N° 08 (Hong Ha Road) was not measured directly but calculated indirectly by noise data at site N° 07 (Tran Quang Khai Road) and noise data measured from the balcony of a house along Hong Ha Road (Hong Ha Road was closely parallel to and had higher elevation than Tran Quang Khai Road).

## 3. CHARACTERISTICS OF ROAD TRAFFIC NOISE IN HANOI

Figure 1 shows the fluctuation of $L_{Aeq,\,1h}$ at all sites. While the difference between the maximum and the minimum $L_{Aeq,\,1h}$ was small at Tran Quang Khai and Hoang Ha, only 6 dB, the difference was rather big at the other sites, ranging from 11 to 14 dB. This is because there was more heavy traffic volume during nighttime at Tran Quang Khai and Hoang Ha as shown in Figure 5. $L_{Aeq,\,24h}$ is quite high at all sites, ranging from 70 to 77 dB.

The characteristics of road traffic noise in Hanoi are quite different from those in developed countries because of a great amount of motorcycles which emit frequent horn sounds. Motorbike noises are consisted of engine noise and high impulsive peeping sounds. In Figure 2, sharp peaks show the horn sounds. Figure 3 compares the relative cumulative frequencies of sound levels measured in Hanoi, Vietnam and Tomakomai, Japan. The noise level fluctuation in Tomakomai is more spreading from the ground to top since the main traffic here is light vehicle. On the other hand this noise level fluctuation in Hanoi is narrower because of the fact that motorbikes are the major means of transportation which produce frequent horn sounds.

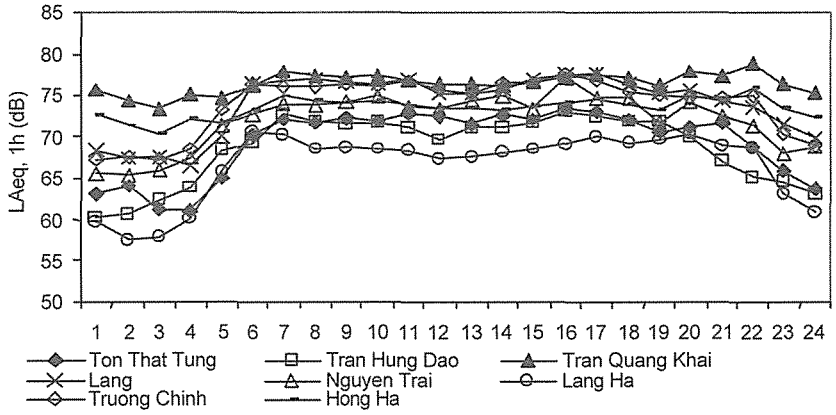


**Figure 1 $L_{Aeq,\,1h}$ at every site**

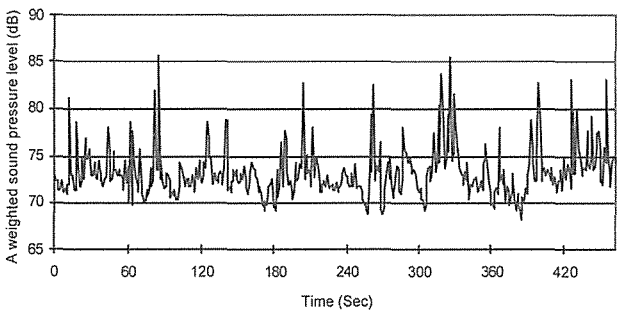


**Figure 2 Sound level fluctuation at 6 pm**

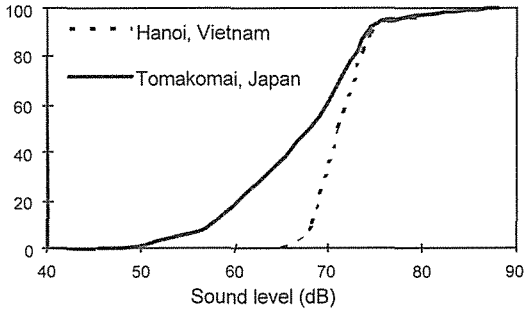


**Figure 3 Comparison of relative cumulative frequency of sound levels between Hanoi and Tomakomai**

Based on the statistics of social surveys 2004 and 2005, it can be assumed that the number of motorcycles in Hanoi is increasing with a very high speed every year. The high intensity of motorcycles in Hanoi roads can be observed more easily at peak hours, i.e. from 7 A.M. to 9 A.M. and from 5 P.M. to 7 P.M. Around this period, the situation of traffic jam, especially on the main traffic roads, often happens at the cause of very high capacity of motorcycles.

According to data collected and analyzed from survey 2004, there were around 10,000 motorbikes passing by the selected point per hour. Meanwhile, from the results of survey 2005, this number has reached over 18,000 motorcycles, and the number of cars and light trucks has also increased. Figure 4 shows the motorbikes volume at seven selected sites in survey 2005. Figure 5 shows the hourly change of heavy vehicle traffic volume. High traffic volume during daytime at Nguyen Trai Road was due to buses, and traffic volume during nighttime at Tran Quang Khai street was trucks.

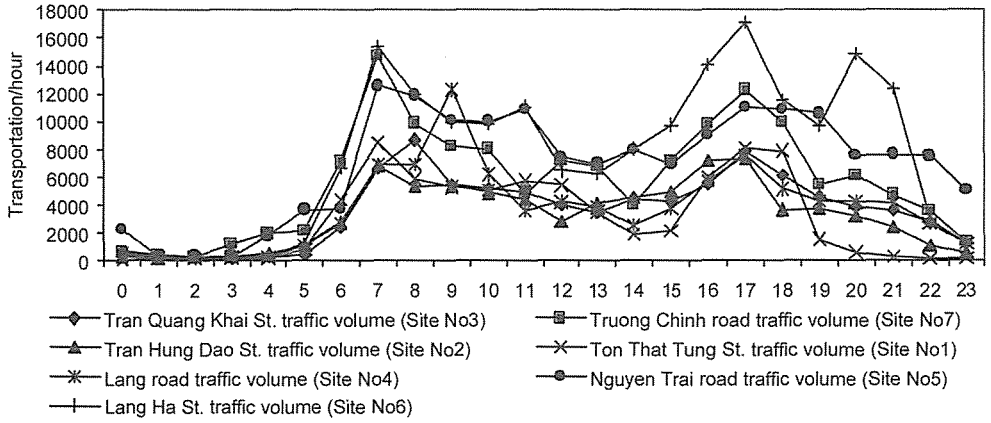


**Figure 4 Hourly traffic volume of motorbikes**

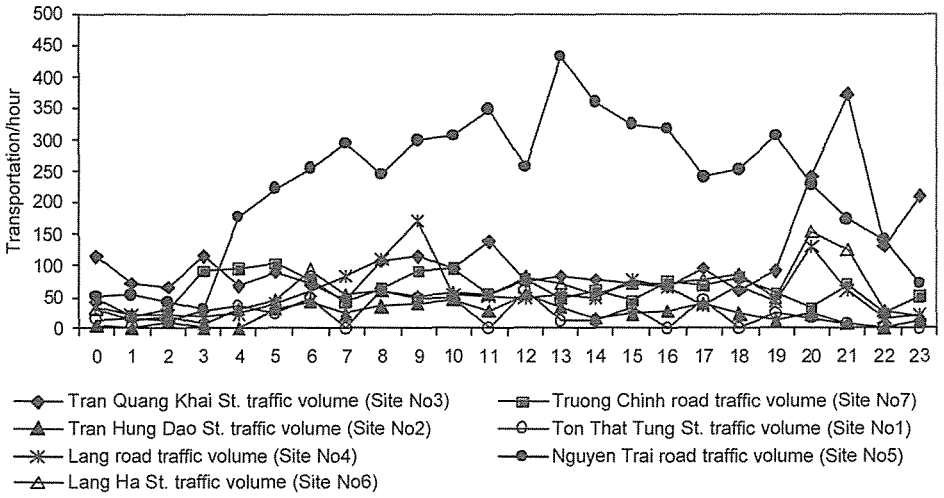


**Figure 5 Hourly traffic volume of heavy vehicles**

## 4. RESULTS OF SOCIAL SURVEY

Along survey sites, houses are built by various materials in which 54% by concrete and brick, 25% by brick, 11% by reinforced concrete, 9% by others and without wooden structure. Most of the houses have windows with single pane (59%). The double-pane ones were only of 5% and 33% for others. The frames were

wooden (44%), aluminum (28%) and others (26%). Seventy five % of respondents have houses with living rooms facing to the main roads, 60% have bedrooms facing to the main roads and 93% did not have gardens. More than 95% of respondents chose the answer "Yes" for the question "Are you annoyed by road traffic noise in a day?", and 84% of respondents felt annoyed everyday due to road traffic noise, especially in late afternoon (74%) while the traffic volumes were usually the highest in a day. Most of the respondents were equally annoyed by motorbikes, cars and heavy vehicles: 60% for motorbikes, 55% for cars and 65% for buses and heavy vehicles. Twenty two % of respondents were extremely annoyed by the road traffic noise and 56% were very annoyed, 22% were very annoyed by road traffic vibration (See Figure 6) and 20% of respondents were disturbed very much by being awakened during their sleeps (See Figure 6). Forty two % of respondents said "yes" to the question "Would you move if there was a better house for you?" but 57% said "no". Sixty three % chose "noise" for the reason indicating why they do not enjoy living in the area while 16% evaluated the quietness in their living area extremely bad and 53% evaluated neither good nor bad

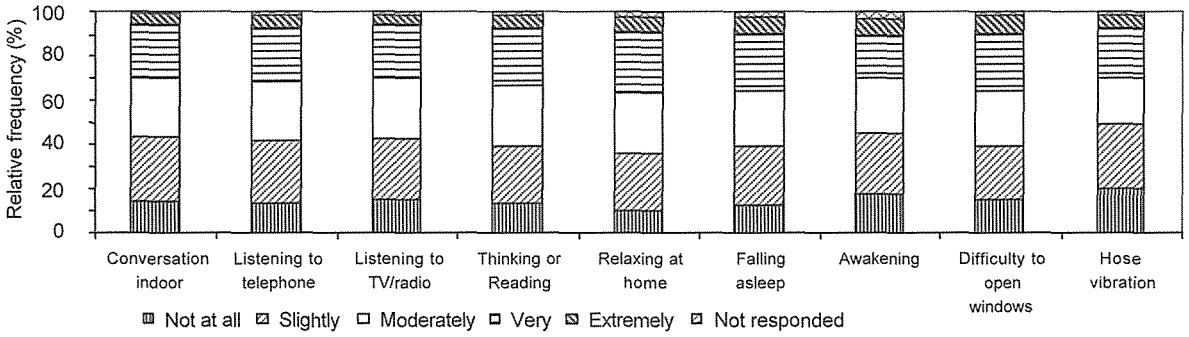


**Figure 6 How disturbed are you by road traffic transportation in these cases**

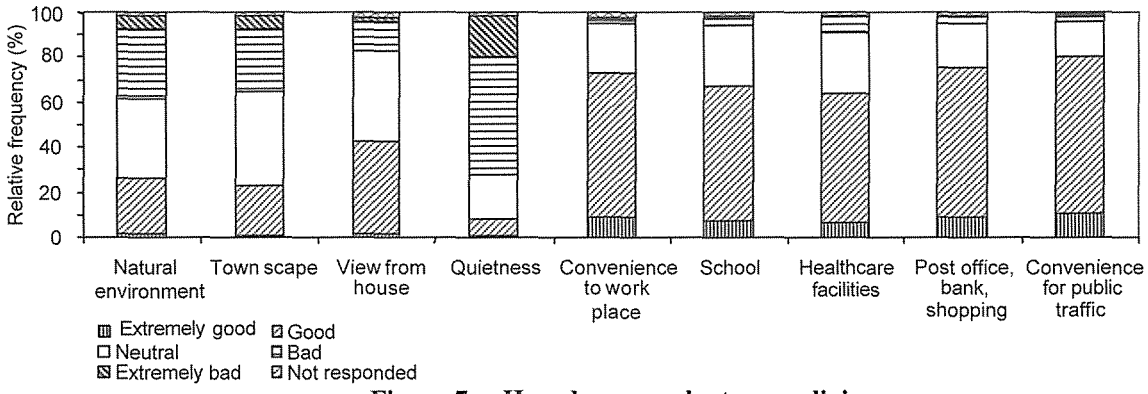


**Figure 7 How do you evaluate your living area**

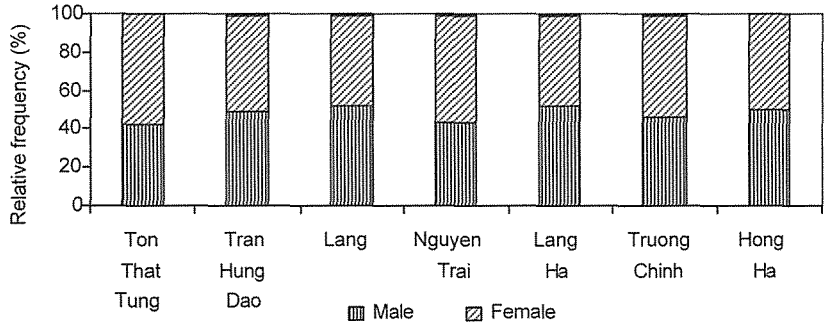


**Figure 8 Gender distribution**

(See Figure 7). The rate between male and female respondents was well balanced among all sites, 47% males and 52% females on average (See Figure 8).

## 5. DOSE-RESPONSE RELATIONSHIPS

When the results are plotted in $L_{dn}$ - % Highly annoyed relationships together with Schultz's synthesized curve [2], there are several interesting points (See Figure 9). The rate of people who responded to top three categories of the 11-point numeric scale was positioned in the middle of Schultz curve zone. Nevertheless, the rate of people who responded to top one category of the 5-point verbal scale was positioned below the zone. This is quite different from the results obtained in Survey 2004. The points from the survey (both top one from 5-point verbal scale and top three from 11-point numeric scale) were in the middle of the zone. The gap between Survey 2004 and 2005 seemed to be due to the difference in the annoyance scale. The extreme modifier in 2004 was "Rat" but "Cuc" in 2005. The intensity of "Cuc" was 97 and that of "Rat" was 89 on the scale of 100 [3]. Since "Cuc" was a little more intense than "Rat," the % highly annoyed in 2005 is quite lower than that in 2004. The rate of people who responded top two from the 5-point verbal scale was positioned in the upper of the zone. The noise exposure range was very limited, just 7dB, and thus data from quieter sites are necessary to draw a typical dose-response curve in Vietnam.

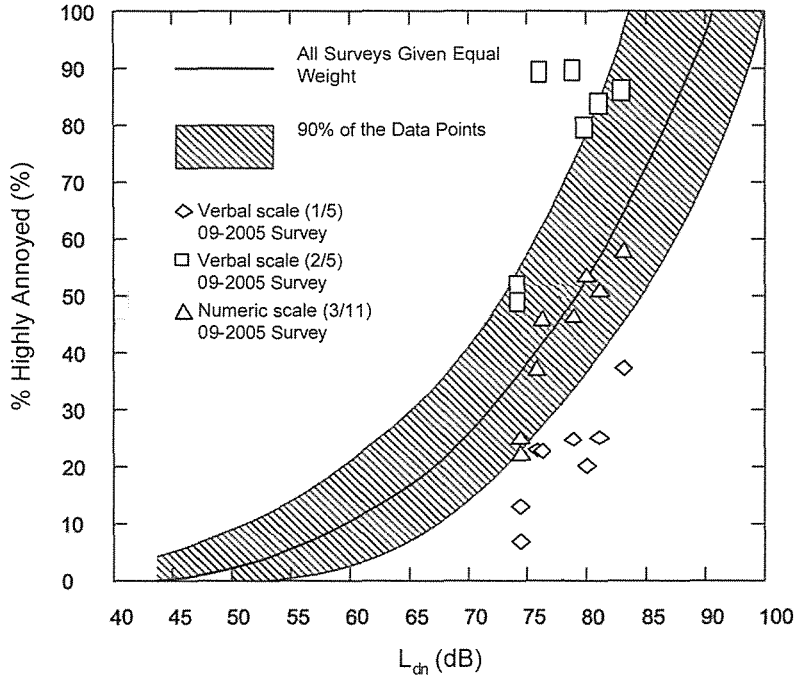


**Figure 9 Hanoi data on the Schultz's curve**

## 6. EFFECTS OF MODERATORS ON ANNOYANCE

On the effects of demographic variables, the respondents were well balanced between males and females among all sites as shown above in Figure 8. Figure 10 shows that females' and males' annoyances are almost the same. Gender did not seem to influence community response to noise, as well as that in former studies [5, 6 and 7]. Figure 11 shows that younger generation was the majority of the respondents at all sites. The respondents were divided into four groups: 20s, 30s, 40s and 50s or more. Though Miedema [6] showed the

difference in annoyance between actively working age (30s and 40s) and the other age (20s and 50s and more), the older the respondents are in this survey, the more annoyed they are as shown in Figure 12.

On the effects of nighttime noise exposure, Figure 13 shows that people living in Hong Ha Road seem to be much more disturbed in sleeping than those at other sites even though $L_{Aeq,night}$ at Hong Ha Road (73dB) is only slightly higher compared to the average one (70dB). Besides, Figure 14 shows that people living along Hong Ha Road were also much more annoyed by road traffic vibration than those at other sites. This can be caused by the special characteristics of the road. Hong Ha Road is a high way and Tran Quang

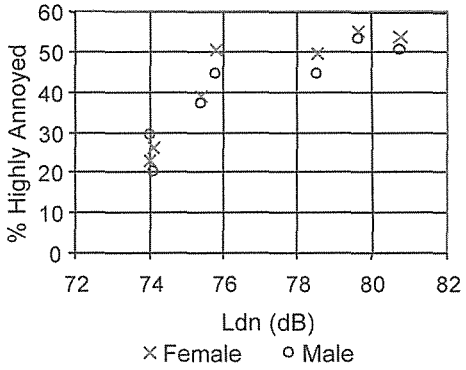


**Figure 10 Comparison of %HA by road traffic noise between male and female**

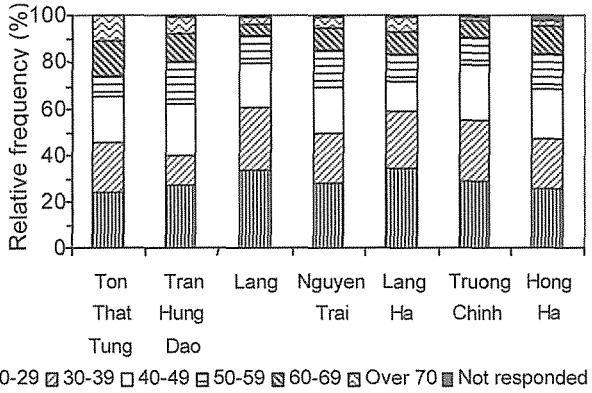


**Figure 11: Generation distribution**

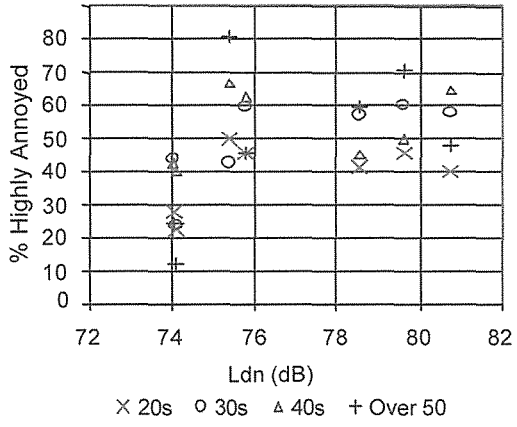


**Figure 12 Comparison of %HA by road traffic noise among generations**

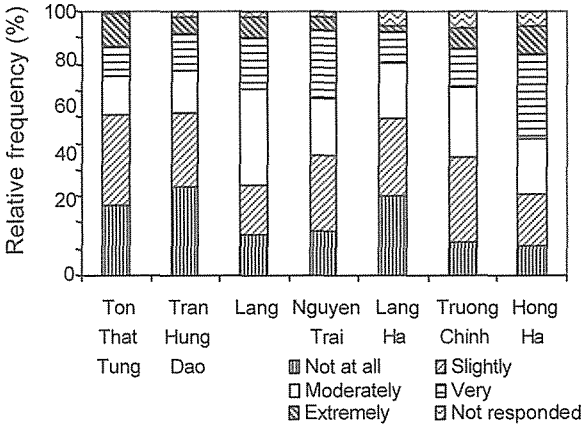


**Figure 13 How annoyed by road traffic noise are you while sleeping at night**

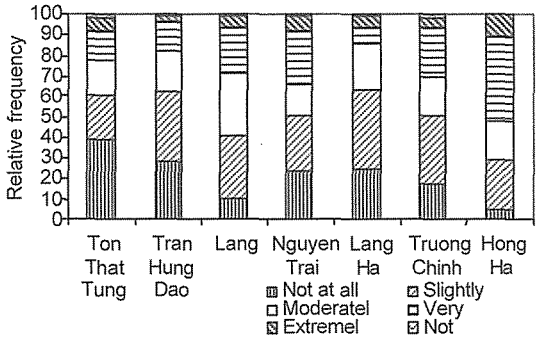


**Figure 14 How annoyed by road traffic vibration are you**

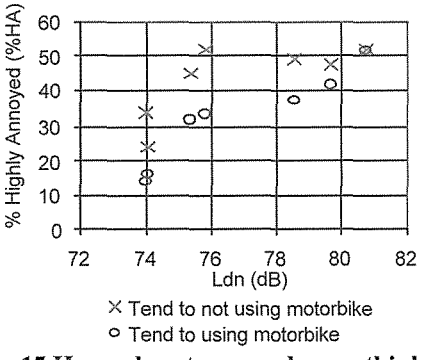


**Figure 15 How advantageous do you think using motorbikes will be for the society?**

Khai Road is a main road with the estimated highest noise exposure in this survey. Both roads have high heavy vehicle volumes especially during nighttime as shown in Figure 5. Moreover, they are parallel and next to each other. Hence people living here were more annoyed at night and also more influenced by road traffic vibration than others.

On the ground of the effects of attitudes towards noise source, the authors hypothesized from survey 2004 that the frequent horn sounds from motorbikes might have some influences on community response to road traffic noise. Responses to the question "How do you evaluate the following transportations as for the society?" were divided into two subgroups: the first group responding to first two categories of 5-point verbal scale included those who refer to the usage of motorbikes as a good thing for the society, the second group responding to last two categories are those who had the opposite opinion. Figure 15 compares % highly annoyed between the two groups: the second group seemed to be more annoyed by road traffic noise than the first one at almost all sites and the difference was 20% HA at the maximum. Other questions such as "How frequently do you use the following transportations?" and "How safe do you think the following transportations are?" were also investigated in relation to the attitudes towards motorbikes by the same group-dividing method. Figures 16 and 17 show the same trend as Figure 15. The groups of people who did not use motorbikes frequently and thought that motorbikes were dangerous seemed to be more annoyed by road traffic noise than the other groups at almost all sites.

Figure 18 shows the hourly change of traffic volume at site 07 as an example and Figure 19 shows the annoying period in a day at all sites. Though motorbike volume was highest at around 7 A.M. and 5 P.M., the respondents felt most annoyed by road traffic noise in late afternoon. Seventy five % felt annoyed from 4 P.M. to 7 P.M. whereas around 58% felt annoyed from 6 A.M. to 8 A.M. It seemed to be more tolerable to road traffic noise in the morning (from 6 A.M. to 8 A.M.) when people were going to work than in late afternoon when they returned home to relax after a hard-working day.

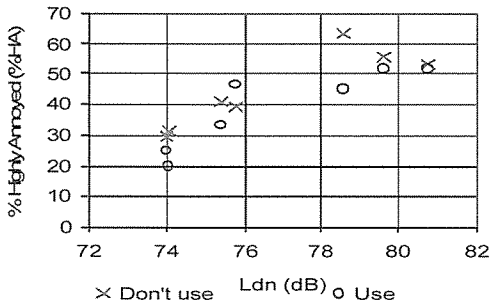


**Figure 16 How frequently do you use motorbikes?**

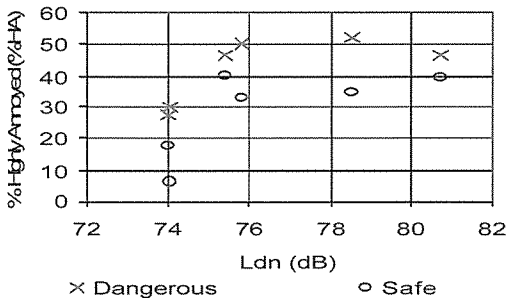


**Figure 17 How safe do you think motorbikes are?**

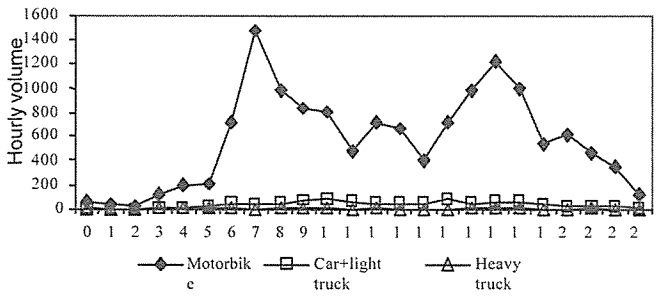


**Figure 18 Truong Chinh road traffic volume (Site N° 7)**

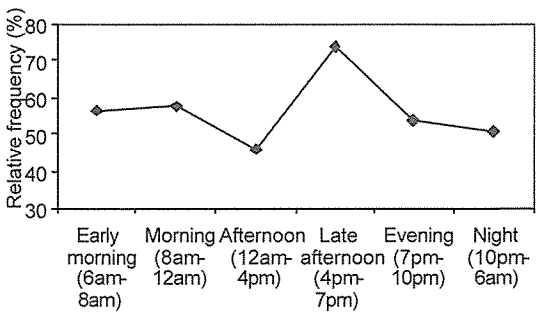


**Figure 19 Annoyance period in day**

On the effects of sensitivities, the groups of people who were sensitive (last two categories of 5 verbal-scale) and insensitive (first two categories of 5 verbal-scale) to hot weather and to air-pollution also were compared. Visually, it is very clear that the sensitive group were more annoyed than the insensitive group at all sites, especially for group sensitive to air-pollution and the maximum difference reached nearly 35%HA (See Figure 20 and 21). Generally, there is a high correlation between noise sensitivity and community response to noise [6]. Figure 22 compares % HA between groups sensitive and insensitive to noise. The sensitive group is clearly more annoyed than insensitive group.

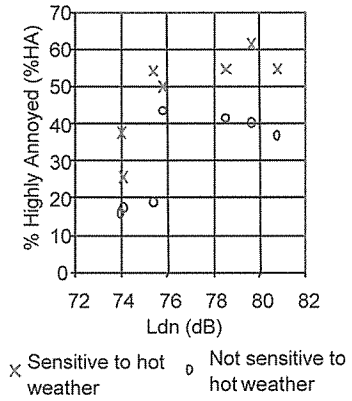


**Figure 20 Comparison of %HA by road traffic noise between groups sensitive and non- sensitive to hot weather**

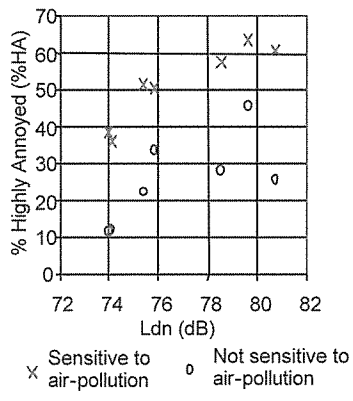


**Figure 21 Comparison of % HA by road traffic noise between groups sensitive and not sensitive to air-pollution**

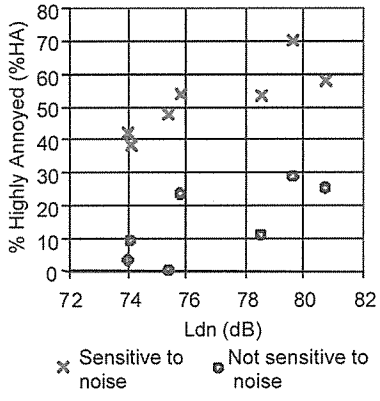


**Figure 22 Comparison of %HA by road traffic noise between groups sensitive and insensitive to noise**

## 7. SUMMARY

The first systematic socio-acoustic survey on community response to road traffic noise was conducted in Hanoi, Vietnam 2005 and the responses to high noise exposures were obtained. Main findings are summarized as follows:

1) Road traffic noise in Hanoi was characterized by the frequent horn sounds.
2) The points of % highly annoyed for the top three categories from the 11-point numeric scale were fitted to Schultz's synthesis curve.
3) The moderators such as attitudes to noise source and sensitivity to noise greatly affected annoyance. This is consistent to the findings obtained by Fields and Miedema et al.

However, more hypothesis tests should be conducted in further research in order to give more steady statistical proofs for results and conclusions. Further surveys are necessary to establish the dose-response curve for road traffic noise in Vietnam.

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