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IMPORTANCE OF CROSS-CULTURAL STUDIES FOR A GLOBAL NOISE POLICY

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ABSTRACT

Global noise policies have so far been discussed based on the findings from social surveys on community response to noise in European and American countries. Cross-cultural studies on community response to noise have been conducted since the early 1990s at Kumamoto University to contribute to the global noise policy from the Asian side. The following work has been done: A comparison of community response to road traffic noise between Sweden and Japan, studies on difference in railway bonus between Europe and Japan, the construction of standardized noise annoyance scales and data accumulation on community response to noise in Vietnam. The main results are as follows. 1) Community response to noise was strongly affected by life-styles reflecting the cultural background. 2) There is evidence that vibration affected the difference in railway bonus between Europe and Japan. 3) In order to compare community response to noise precisely and globally, standardized noise annoyance scales were constructed in not only European but also Asian languages by the ICBEN (International Commission on Biological Effects of Noise) method. 4) Using the standardized ICBEN noise annoyance scales in Vietnamese, social surveys on community response to environmental noise have been conducted since 2004. The goal is to contribute not only to a Vietnamese, but also to a global noise policy.

KEYWORDS

Global noise policy, noise exposure, railway bonus, social survey, standardized annoyance scale, Vietnam

INTRODUCTION

Results from social surveys on community response to noise have so far been used for the discussion on noise policies such as determining noise standards and countermeasures. Nowadays noise policy is not only discussed locally as in only one country but also globally as in EU countries and worldwide.

The pioneer work for a global noise policy was performed by Schultz [1] in 1978. Since he proposed one synthesized dose-response curve regardless of noise sources, Kryter [2] criticized his method to unify one dose index of L_{dn} from various noise measures and one response index of % highly annoyed from responses measured with various noise annoyance scales with different scale points and modifiers. Fidell et al. [3] have consistently supported Schultz's work and revised the synthesized curve by adding new datasets several times. On the other hand Fields et al. [4], Moehler [5] and Miedema & Vos [6] showed that dose-response curves are different among noise sources. That is, aircraft noise is more annoying than road traffic noise and railway noise is less annoying than road traffic noise in European countries. The latter finding is reflected in noise regulations of

some European countries as a railway bonus: noise standards for railway noise are 5 to 10 dB higher than those for road traffic noise. However, recent Japanese studies [7, 8, and 9] have not supported a railway bonus. For example, Morihara et al [8] showed that railway noise was as annoying as or slightly more annoying than road traffic noise.

Social surveys on community response to noise have mainly been conducted in European and American countries, and global noise policies have been discussed by using them. However, for broader global noise policy data from developing countries in Asia, South America and Africa should be provided for an international discussion, and cross-cultural differences should be reflected in noise standards or regulations and noise-countermeasures. The authors have carried out social surveys on community response to noise as well as related international studies at Kumamoto University since the early 1990s. They are a) cross-cultural studies on community response to road traffic noise between Japan and Sweden, b) investigating why railway bonus usually found in Europe is not found in Japan, c) constructing internationally standardized noise annoyance scales to precisely compare annoyance in different linguistic regions and d) social surveys on community response to noise in Vietnam in order to contribute not only to a Vietnamese, but also to a global noise policy. In the present paper, the outlines of the above four main projects at Kumamoto University are summarized.

CROSS-CULTURAL STUDY ON COMMUNITY RESPONSE TO ROAD TRAFFIC NOISE BETWEEN JAPAN AND SWEDEN

A cross-cultural study on community response to road traffic noise was carried out in Gothenburg, Kumamoto and Sapporo from 1996 to 1998 with the same social survey and noise measurement methods [10]. The outline of the survey is shown in Table 1. Respondents were all from detached and apartment houses from 18 to 75 years of age who were selected from the residents' registers or voters' lists on a one-person-per-family basis. The sample sizes of detached and apartment house residents were 436 and 706 in Gothenburg, 378 and 459 in Kumamoto and 411 and 369 in Sapporo, respectively. The response rates were from 52 to 76 %.

Questionnaire wordings were translated from the original English version into Japanese and Swedish. The questionnaire was consisted of 40 questions related to environmental, housing and personal factors.

Table 1 Outline of the survey

	Gothenburg	Kumamoto	Sapporo
Survey Period	January – June, 1996	May – November, 1996	October, 1997 – October, 1998
Number of Respondents	Detached: 436 Apartment: 706	Detached: 378 Apartment: 459	Detached: 411 Apartment: 369
Response Rate [%]	Detached: 73.3 Apartment: 66.4	Detached: 76.1 Apartment: 64.6	Detached: 63.5 Apartment: 52.0
Noise Exposure Level $L_{Aeq,24h}$ [dBA]	Detached: 46.2 – 73.6 Apartment: 48.5 – 82.3	Detached: 49.3 – 73.7 Apartment: 51.3 – 73.5	Detached: 53.3 – 73.6 Apartment: 52.1 – 70.7
Rating Scale for Key Questions			
1. Not noticed 2. Not annoyed 3. A little annoyed 4. Rather annoyed 5. Very annoyed			

Figure 1 (a) and (b) compare house structures and window types among three cities. Single pane windows were usually found in Kumamoto and double panes were the most popular in Sapporo.

Double panes and triple or more panes were found in Gothenburg. Sound insulations of windows were measured in Gothenburg, Kumamoto and Sapporo and the results are shown in Figure 2.

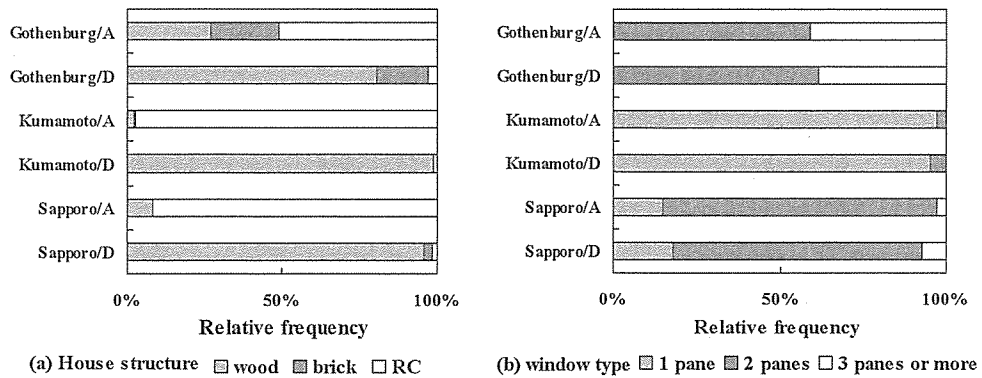


Figure 1 Comparison of the house structure and the window tipe between Kumamoto, Sapporo and Gothenburg

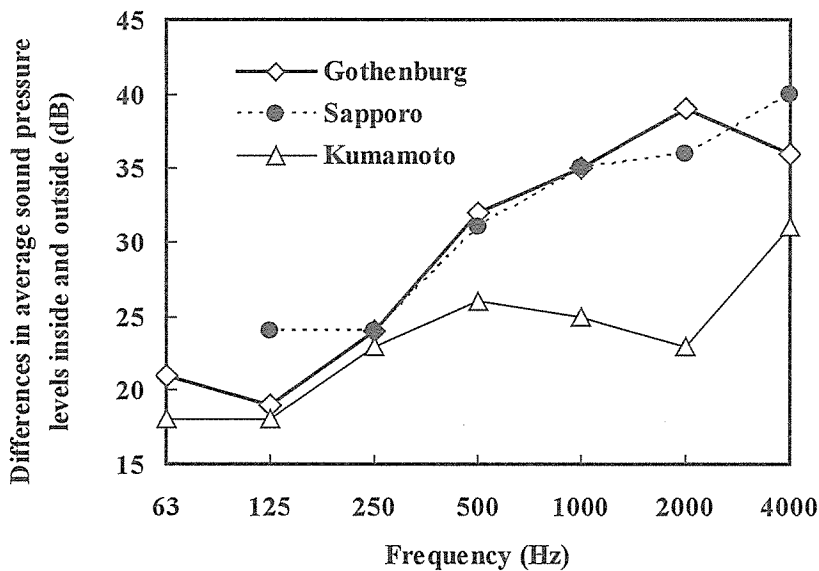


Figure 2 Comparison of sound insulation of the external wall with window among three cities

The averaged sound insulation of windows in Gothenburg is almost the same as that in Sapporo. The Sound insulation of windows in Kumamoto is lower in the middle and high frequency range than that in the two other cities.

Figure 3 compares the dose-response relationships for general annoyance between the two house types and among the three cities. The general annoyance of detached house residents in Gothenburg is higher than that of the other groups. Figure 4 compares the dose-response relationships for rest disturbance in gardens or on balconies between the two house types and among the three cities. Rest disturbance of detached house residents in Gothenburg is higher than that of Japanese residents. This may be because resting and relaxing in gardens or on balconies is not so popular in Japan, while people in Gothenburg enjoy outdoor activities in gardens or parks particularly during summer. Such a Swedish lifestyle may have an impact on general annoyance. That is, people may respond to

the noisiest situation even if sound insulation of Swedish windows is greater than that of Japanese windows. This is consistent with a finding obtained in a recent aircraft noise survey in Switzerland conducted by Wirth et al. [11].

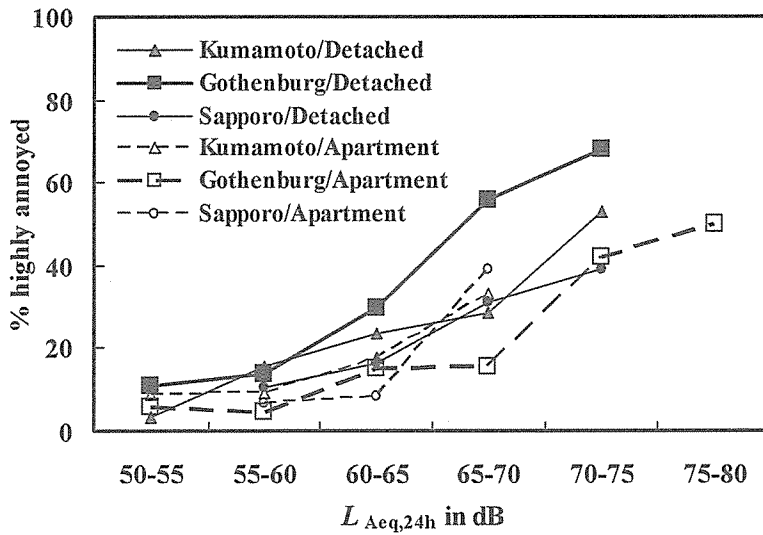


Figure 3 Comparison of dose-response relationships for general annoyance among three cities

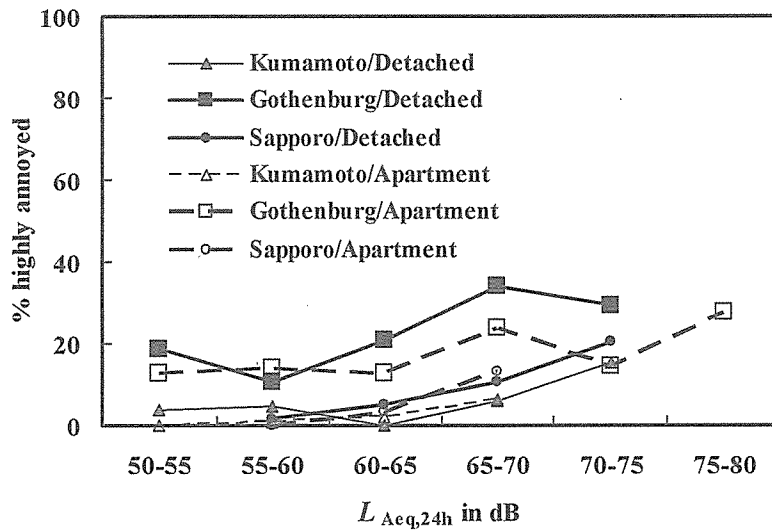


Figure 4 Comparison of dose-response relationships for rest disturbance in the garden or on the balcony

WHY RAILWAY NOISE IS NOT LESS ANNOYING THAN ROAD TRAFFIC NOISE IN JAPAN?

As mentioned in "INTRODUCTION," it has often been reported that railway noise is less annoying than road traffic noise. Fields et al. [4] speculated several reasons for the so-called railway bonus.

For example, railway noise tends to be more regular and predictable than road traffic noise, railway is more energy-saving and nature-friendly than road traffic and railway yields romantic feelings like the orient express and nostalgic ones like contribution to the industrial revolution. Even if these are the reason for the railway bonus, the question still remains why such attitudes do not affect railway noise annoyance in Japan. Many Japanese also know about its nature-friendliness and have romantic and nostalgic feelings towards steam loco motions and old trains.

Morihara et al. [8] discussed the difference in railway bonus between Europe and Japan, focusing on the distances between the houses and railways and roads, respectively. Table 2 compares the distance between the noise sources and the subjects' dwellings in Japan and in Germany. The German data were provided by Schuemer. The average distance from houses to railways and roads were 43 and 10 m in Japan and 106 and 41 m in Germany, respectively. Japanese houses are closer to railway and roads than those in Germany. When houses are close to railways or roads, the residents are affected by not only high noise exposure but also non-acoustic factors such as vibration, exhaust, visual danger and so on.

Table 2 Distance between the noise sources and the houses in Japan and Germany

	Our data (Japan)		Schuemer's data (Germany)	
	Railway	Road	Railway	Road
Maximum	414	84	374	208
Mean	43	10	106	41
Minimum	1	1	23	4
S.D.	56	12	56	35

Yano et al. [12] compared dose-response relationships and relationships between noise and vibration exposures among Shinkansen, conventional railway and road traffic. Figure 5 compares $L_{Aeq,24h}$ -% highly annoyed relationships between conventional railway and road traffic and between conventional railway and Shinkansen based on data obtained in the areas where both socio-acoustic surveys and vibration measurements were conducted. Figure 5(a) shows that conventional railway noise is as annoying as or slightly more annoying than road traffic noise. No railway bonus is found. Figure 5(b) shows that Shinkansen noise is significantly more annoying than conventional railway noise. The reason for Shinkansen penalty has been defined in the same way as railway bonus. The

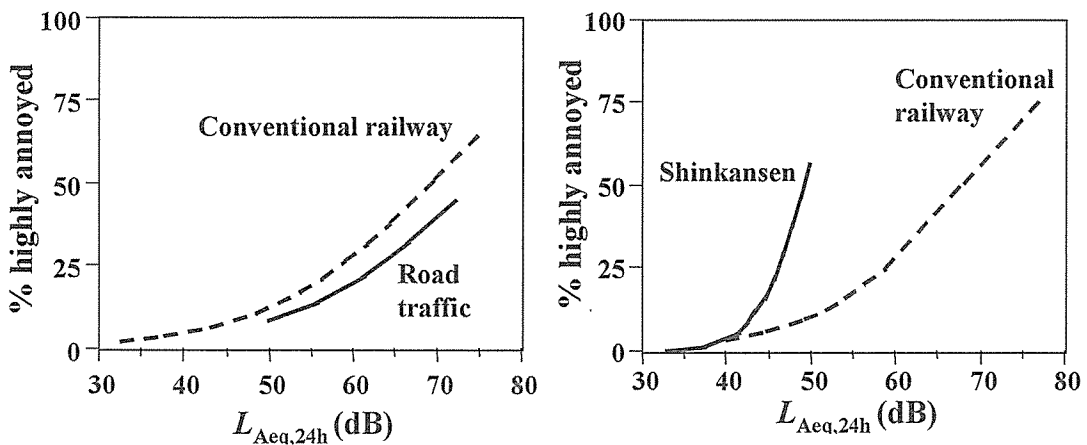


Figure 5 Comparison of $L_{Aeq,24h}$ -% highly annoyed relationships (a) between conventional railway and road traffic and (b) between Shinkansen and conventional railway

attitudes towards Shinkansen are more severe than that towards conventional railway. One reason among others may be the fact that people living along Shinkansen seldom use Shinkansen but more often use the conventional railway.

Such attitudes towards railway and Shinkansen may be important factors for railway bonus and Shinkansen penalty. The authors offer a more objective hypothesis for railway bonus and Shinkansen penalty. It has frequently been reported that vibration from railway is more annoying than vibration from road traffic and that vibration from Shinkansen is more annoying than that from conventional railway. Thus the authors hypothesize as follows:

- 1) Vibration from conventional railway is higher than that from road traffic.
- 2) Vibration from Shinkansen is higher than conventional railway's.
- 3) Vibration affects noise annoyance significantly.

Figure 6 compares the relationships of noise and vibration exposures among Shinkansen, conventional railway and road traffic. Vibration exposure from Shinkansen (L_{Vmax}) is higher than that of conventional railway. L_{Vmax} of conventional railway is almost as high as that of road traffic and clearly higher than road traffic L_{V10} . Road traffic vibration levels fluctuate randomly with many sharp peaks while railway vibration levels fluctuate regularly and trapezoidally. Road traffic L_{Vmax} is just the maximum vibration level during a certain observation time while conventional railway L_{Vmax} is the averaged maximum level for upper 10 events of trapezoidal level fluctuations. Thus conventional railway vibration is substantially higher than that of road traffic. These findings support the above hypotheses 1) and 2).

A recent socio-acoustic survey conducted by Kim et al [13] showed no railway bonus in Korea. Railway bonus and Shinkansen penalty should be discussed further on an international stage.

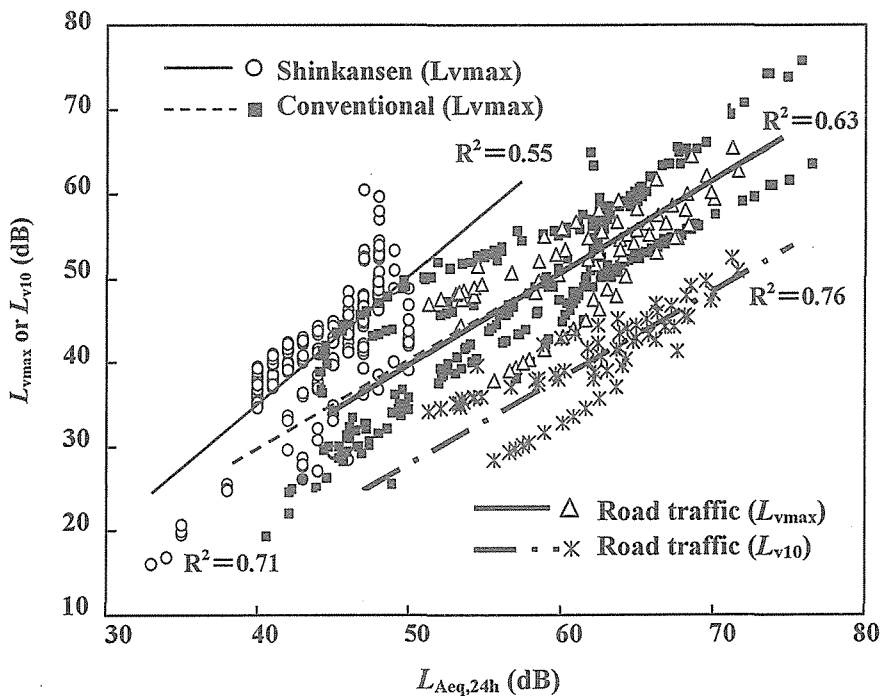


Figure 6 Comparison of relationships of noise and vibration exposures between Shinkansen, conventional railway and road traffic

CONSTRUCTION OF STANDARDIZED NOISE ANNOYANCE SCALES COMPARABLE BETWEEN DIFFERENT LANGUAGES

In order to precisely compare community response to noise obtained in different linguistic regions IC BEN (International Commission on Biological Effects of Noise) Team 6 (Community response to noise) initiated to conduct an international joint study to construct standardized noise annoyance scales comparable between different languages in 1997 [14]. The outline of the experiment was as follows:

- 1) Select 21 annoyance modifiers from the minimum to the maximum in the respective language. This must be conducted carefully by the researchers and is very important for the final results.
- 2) Subjects have to sort the 21 modifiers into nine categories at the maximum.
- 3) They select equidistant four modifiers from the minimum to the maximum for a 5-point annoyance scale. The modifier "not at all annoyed" is fixed at the minimum point in both the 5-point and the following 4-point annoyance scales.
- 4) They select equidistant two modifiers from the minimum to the maximum for a 4-point annoyance scale. The maximum is the same as the one selected for the 5-point annoyance scale
- 5) They evaluate the intensities of the 21 modifiers with a distance from the left end to the marking on a 100 mm line segment.

The criteria to select the final modifiers for the scale points are as follows:

- 1) Equidistance: The modifiers should be equidistant from the minimum to the maximum of the annoyance scale.
- 2) Preference: The modifiers scoring high at the target scale point and scoring low at neighbor scale points should be preferred to those scoring almost evenly at several points.
- 3) Agreement: The standard deviation of the modifiers' intensities should be small.

At the meeting in Sydney 1998 the superiority of either of 5-point and 4-point verbal scales was discussed. Though there was no consistent difference through languages between the two scales, the 5 point verbal scale was slightly better than the 4-point verbal scale. Also it was stated that people could evaluate annoyance in social surveys more detailed than with a 4 point scale. Thus the 5-point verbal scale was decided to be the standardized one. The annoyance scale in English was constructed as follows: extremely, very, moderately, slightly and not at all.

Table 3 Standardized noise annoyance scales in 12 languages

Language	Category 5	Category 4	Category 3	Category 2	Category 1
Japanese	Hijoni	Daibu	Tasho	Sorehodo	Mattaku
English	Extremely	Very	Moderately	Slightly	Not at all
French	Extremement	Beaucoup	Moyennement	Legerement	Pas du tout
German	Ausserst	Stark	Mittelmassig	Etwas	Überhaupt nicht
Spanish	Extremadamente	Muy	Medianamente	Ligeramente	Absoluta... nada
Dutch	Extreem	Erg	Tamelijk	Een beetje	Halemaal niet
Norwegian	Voldsomt	Mye	Ganske	Litt	Ikke
Hungarian	Réttenetesen	Nagyon	Közepesen	Kissé	Egyáltalannan
Turkish	Fecisekilde	Cok	Ortaderecede	Hafifce	Hicdagil
Chinese	Te bie	Xiang dang	Bi jiao	Hao Xiang you dian	Yi dian ye bu
Korean	Umchungnaje	Meu	Jebupp	Jogum	Junhyia
Vietnamese	Cuc on	On nhieu	Khong qua on	On mot phan nao	Hoan toan khong on

Thus the standardized noise annoyance scales were constructed in nine languages mainly spoken in the countries of the Team 6 members. These were Indo-European languages except Japanese and Hungarian. For a global noise policy, scales should be constructed in Asian languages as well since noise pollution in these countries will become more serious because of the rapid economic growth of some Asian countries. Yano et al. [15] constructed standardized noise annoyance scales in Chinese, Korean and Vietnamese. Table 3 summarizes the 5-point verbal annoyance scales in 12 languages. At present researchers stand at the starting point to conduct socio-acoustic surveys in Asia with standardized annoyance scales and to precisely compare the results among different languages. If researchers want to compare their results internationally and precisely, they may construct annoyance scale according to the ICBEN method in their own language. Danish ICBEN scales for example were recently constructed [16].

SOCIAL SURVEY ON COMMUNITY RESPONSE TO ENVIRONMENTAL NOISE IN VIETNAM

Socio-acoustic surveys have been carried out mainly in European and American countries and Japan. Fields [17] published an updated catalog of 521 social surveys from 1943 to 2000 in which only four Chinese, two Korean and three Thai social surveys were listed from Asia except 70 Japanese surveys. Noise pollution in developing countries will become more serious with the growth of population and economy in this century. Thus socio-acoustic surveys should be conducted in Asian developing countries.

Under the academic agreement between Hanoi University of Civil Engineering and Kumamoto University a series of studies have been carried out since 2002. First of all a standardized noise annoyance scale in Vietnamese was constructed with the method proposed by ICBEN. A preliminary social survey on community response to road traffic noise was conducted by using the scale in an area of Hanoi in 2004, and interview, noise measurement, and traffic volume counting methods were discussed. A large scale survey on community response to road traffic noise was conducted in eight areas along main roads of Hanoi, in 2005. The outline of the survey of 2005 may be found in Phan et al. [18, 19]. Road traffic noise in Hanoi is characterized by frequent impulsive sounds emitted from horns and steady state background sounds formed by numerous motorbike passbys. This is quite different from road traffic noise in Japan which consists of mainly light and heavy vehicle sounds and few horns. We plan to carry out a psychoacoustic experiment investigating the effects of horn sound on road traffic noise annoyance in 2006.

Road traffic noise surveys will be conducted in Da Nang and Ho Chi Minh to draw a wider range of dose-response curve. Aircraft noise surveys will be also conducted around Tan Son Nhat Airport in Ho Chi Minh, the busiest city in Vietnam. Road traffic and aircraft noises are the main environmental noises in Vietnam. Based on these socio-acoustic surveys Vietnamese noise policies will be discussed nationwide and cross-nationally in the near future.

Furthermore social surveys on community response to noise in other Asian countries are strongly required because the existing dose response relationships cannot easily be generalized to any Asian country.

CONCLUSIONS

Noise studies carried out at Kumamoto University were briefly reviewed and showed the importance of cross-cultural studies for a global noise policy. The main findings are as follows:

- 1) General noise annoyance is significantly affected by life styles belonging to the culture of a country.

- 2) As a possible reason for the fact that railway noise is not less annoying than road traffic noise in Japan, it is suggested that vibration from railway is higher than that from road traffic. Since Japanese houses are located closer to railway and roads than European houses, Japanese people are apt to be more exposed to vibration than European people.
- 3) In order to precisely compare community response to noise between different countries, standardized noise annoyance scales were constructed first in nine languages and then in Chinese, Korean and Vietnamese.
- 4) Socio-acoustic surveys on community response to noise have been and will be conducted in Vietnam. These will contribute to not only a Vietnamese but also to a global noise policy.

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