Community response to noise

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Abstract

Activities from 2008 to 2011 by ICBEN community response to noise team were summarized. That is, individual community-based indexes such as community tolerance Level, Zuricher Fluglarm Index (ZFI) and Frankfurter Fluglarm Index (FFI/FNI) were newly proposed, differences in railway bonus between Europe and Asia were discussed by a Swedish survey, socio-acoustic surveys were reported from developing countries, and annoyance equivalents and dominant source models were proposed as the adequate combined noise model. Furthermore, not only negative, but also positive aspects of sound were discussed as soundscape studies. Finally, seven items were listed as future team activities.

Keywords: Annoyance, combined noise model, dose-response relationships, railway bonus, soundscape

Introduction

The "community response team" deals with more non-specific reactions to noise than most of the other noise teams. The outcome of studies conducted by members of this team is a subjective evaluation of the general noise situation. A number of specific elements from other teams, e.g., "sleep disturbance", together with non-specific parameters like "disturbance" are subjectively combined in a single outcome, i.e., annoyance, by the respondent, and the mean response from a group of residents is reported as the "community response". Studies of "community response" have been, and are being conducted, and attempts have been made to develop a universal dose–response function. Examples are ISO1996,[1] Federal Interagency Committee on Noise,[2] ANSI 12.9,[3] European Union (EU) Noise Directive,[4] etc. There is, however, an enormous spread in the data from different surveys. The community response team has, therefore, tried to facilitate inter-study comparisons by promoting guidelines for conducting and reporting social surveys on noise annoyance. Such guidelines have been distributed to journals and to conferences where these studies are reported.[5-7] The simplified tables of the guidelines for reporting core information of social surveys are uploaded at ICBEN website (http://www.icben.org).

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Recent Research on Community Response to Noise

Dose-response relationships

Establishing dose–response relationships for various noise sources has been the main theme of noise-effect research. The pioneer work was Schultz's synthesized curve.[8] Schultz concluded that all transportation sources could be treated in the same way. Later, this curve has been revised several times.[9,10] Miedema and Vos [11] proposed separate dose–response curves for aircraft, road traffic, and railway noises and showed that aircraft noise was more annoying than road traffic noise (aircraft penalty) and railway noise was less annoying than road traffic (railway bonus). This finding was reflected in an EU position paper which directed noise policies of EU countries. However, some doubt has been thrown on railway bonus by Lim *et al.*[12] and Yano *et al.*[13] New studies on very different types of railways (long diesel freight trains, high speed passenger trains, etc.,) show a large spread in the so-called "bonus". ISO 1996 recommends a bonus of 3-6 dB for conventional electric trains, but no bonus for long diesel trains and very high-speed trains. Furthermore, for aircraft noise, it was found that annoyance in recent years appears to be higher than that predicted by dose–response relationships (Babisch *et al.*[14] and Janssen *et al.*[15]).

Though dose–response relationships have so far mainly focused on noise exposure and % highly annoyed, new approaches were proposed by Gjestland *et al.*[16,17] Brink *et al.*[18] and Botteldooren *et al.*[19] at the ICBEN Congress. Gjestland *et al.* assumed that the annoyance function closely resembles the loudness function and that differences between different surveys could be accounted for by a single

decibel-like parameter named the "community tolerance level." Brink *et al*. reported attempts to develop aircraft noise indices with better granularity and which better reflect the real noise impact. The new indices take into account the number of awakenings and the number of residents that are highly annoyed separately at the Frankfurt Airport and in combination at the Zurich Airport. This is policy-oriented and the outcomes were adopted by the local authorities. Botteldooren *et al*. presented a biologically inspired model based on perception and known psycho-acoustical and physiological effects against simple dose–response models. In order to understand the essence of annoyance, such studies are encouraged.

Cultural comparison and social surveys in developing countries

Noise is not only a local problem but also a global issue. Difference in railway bonus is a good example. Though the railway bonus has been frequently reported in EU countries, recent Asian studies have not supported it. A challenge to find the cause for the gap was conducted by Gidlof-Gunnarson *et al*.[20] They indicated the possibility of non-dose parameters that are important for the annoyance response. The response to railway noise was significantly influenced by the number of trains. At equal Equivalent Continuous A-weighted Sound Pressure Level (LAeq), the annoyance increased with increasing number of trains and at very high numbers (481 trains/day), the annoyance exceeded that produced by road traffic at the same level. Though this may partially explain the gap in railway bonus between Europe and Asia, it may be difficult to fully explain the gap because railway bonus was not found at low numbers in a Japanese survey. Why the railway bonus is not found in Asia but in Europe is not only academically interesting, but also practically useful for the realistic countermeasures for railway noise. Another cultural issue are the social surveys in developing countries. Socio-acoustic survey data have so far been accumulated in developed countries. However, few surveys have been carried out in developing counties. Considering the serious noise situations there, the data should be accumulated for the establishment of their own noise policies. Phan *et al*.[21] conducted road traffic noise surveys in Vietnam and indicated that the dose–response curve was a little lower than the function established by Miedema and Vos and adopted by European Union. The road traffic in Vietnam is characterized by a huge number of motor bikes that people usually use in their daily life. An aircraft noise study by Nguyen *et al*.[22] in Hanoi and Ho Chi Minh City indicates that the average dose–response function for these cities is 2-3 dB above Miedema and Vos's curve. Nogueria *et al*.[23] presented a social survey around Rio de Janeiro Airport. These findings suggest that dose–response curves depend on the culture and its social conditions. Thus more data should be accumulated for establishing noise policies of developing countries.

Combined noise models

In urban areas of large cities, the acoustic environment is usually very complicated because of noise exposures from multiple sources. In such situations, dose–response curves for individual noise sources may not be enough to evaluate noise effects. Thus, many combined noise models have been proposed and their superiority has been discussed. For example, Taylor[24] showed by analyzing data from social survey around Toronto International Airport that energy difference model was the best among five combined noise models. However, this model does not fit to the situation that dose–response relationship is established for every noise source.[11] Hong *et al*.[25] and Marquis-Favre *et al*.[26] reported the studies of total annoyance of multiple traffic sounds and industrial noise combined with ambient noise in laboratory settings respectively. Both studies showed the usefulness of Vos's model[27] and Miedema's annoyance equivalents model[28] that first translates noise from individual sources into the equally annoying sound level of a reference source and then sums these levels. This model harmonizes the individual dose–response curves. Huy *et al*.[29] compared the power of seven combined noise models including annoyance equivalents model through aircraft noise surveys in Hanoi and Ho Chi Minh City and concluded that dominant source was the best predictor of total annoyance when road traffic noise was dominant. The validity of annoyance equivalents model should be investigated in real-life conditions and a practical combined noise model should be proposed.

Soundscape

Several papers in the soundscape area were presented. At the previous conference in the US, the community response Team wanted to promote such studies, and this comment was repeated at this year's "Team meeting". Elements from soundscape studies may be used to explain the large variations in the annoyance response from different surveys, and the soundscape approach may be used to provide an improvement of the acoustic qualities of a community without necessarily reducing the actual noise levels. So far, however, most soundscape studies seem to be mostly "observations" and their value as input to a process of synthesizing new areas or mitigating old ones are rather limited. However, practical studies have been reported. As for the effects of quiet façade on annoyance, Ohrstrom *et al*.[30] and Gidlof-Gunnarsson and Ohrstrom[31] showed that the quiet side and nearby green areas may also modify the annoyance response. de Kluizenaar *et al*.[32] also indicated the benefit from quiet façade to dwellings. Regarding pleasant acoustic environments, Yang *et al*.[33] showed by a large-scale questionnaire survey that a pleasant sound can considerably improve the acoustic comfort. Jeon *et al*.[34] also indicated by laboratory experiments and field surveys through soundwalkings that water sound enhanced the urban soundscape. Lee *et al*.[35] presented that water sounds improved the soundscape perception and Curcuruto *et al*.[36]

reported that the LAeq was not sufficient to describe the quality of sound environment but parameters of psychoacoustics, time fluctuation, and frequency should be considered. A large-scale soundscape project, European Cooperation in Science and Technology (COST), is now being conducted in Europe. The outcomes from the COST project are expected to be presented at a future ICBEN Congress. There is also an ISO working group on soundscapes.

Other important issues

Wind turbine generators are now highlighted because of green and clean energy. However, they emit much low frequency noise and affect people's well being. Pedersen *et al*.[37] and Janssen *et al*.[38] presented the dose–response response relationships based on a survey in The Netherlands and showed that wind turbine noise was more annoying than transportation noise or industrial noise at comparable levels. Since there are many plans to construct wind farms throughout the world, more data should be accumulated for the policy and the countermeasures of wind turbine noise. The technology of noise mitigation has been developed and many large projects followed by more or less noise emission are planned such as new airports, railway lines, power plants, and so on. The effects of longitudinal and step changes in noise exposure on community response are requisite for the future noise policies. The longitudinal effects of aircraft noise were investigated by Babisch *et al*.[14] and Janssen *et al*.[15] Brown and van Kamp[39] quantitatively reviewed response to step changes in transport noise exposure. At the congress, Laszlo and Hansell[40] reviewed the evidence on human reactions to changes in environmental noise exposures in order to present alternative reaction measures other than annoyance.

Future Activities

A meeting of team members recommended that the following issues should be addressed in the next 3-year period:

1. Positive aspects of environmental sounds
2. Development of supplementary indicators for noise annoyance
3. A better understanding of the annoyance response to explain large survey differences
4. Evaluation of occupational noise (other than hearing loss and physiological reactions)
5. Connection between community response to noise and noise policies
6. Community response to noise in developing countries
7. Cross-cultural studies

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