The opening of a new terminal building and its influences on community response around Hanoi Noi Bai International Airport: Comparison between Arrival and Departure sides

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ABSTRACT

To study about the change of community response in changing circumstance around Hanoi Noi Bai International Airport after a new terminal was launched, three rounds of social surveys were conducted prior and after the operation. A slightly increment of noise level but a considerable change in annoyance levels of the community in the second survey were recorded. Moreover, the last survey showed an undeniable increase of respondent's annoyance level.

In comparisons between Arrival and Departure sides of the airport, a higher level of annoyance in Arrival side was found in all three surveys, and most severe in the second survey. One of the possible reason for this dissimilarity is a notable sleep disturbance level of respondents living under the arrival route, especially at sites close to the airport.

On the other hand, the existence of excess response has been examined by using Horonjeff and Robert's (1997) method. Evidences of excess response have been found at sites located near the airport. This outcome can possibly be explained by non-acoustics factors, such as characteristics of Hanoi surrounding areas, Vietnamese common sense, and so on.

INTRODUCTION

One of the so-called next Asian tigers, Vietnam, has rapidly been developing these recent years. During its process of development, new infrastructures have been built up or enlarged across the country. Among those, a new terminal building (Terminal 2) of Hanoi Noi Bai International Airport is one of the worth mentioning construction as a large-scale building, which has been opened since December 2014. The operation of this new terminal building had increased the ability of serving more flights to and from the airport, entailing an increment of 1.2~1.3 times of daily flights number.

There have been few studies regarding step-change in aircraft noise exposure [1, 2] and its influences in Asia albeit many studies have been conducted in European and North American countries [3, 4]. In such a circumstance, it is a great opportunity to study more about this field with the operation of the new terminal at Hanoi Noi Bai International Airport. A research including three rounds of social surveys and noise measurements around the airport has been organized. Results of these three rounds have been analysed in various categories to compare among each other as well as to examine the differences with other studies.

Albeit a standards regarding acoustic environment was implemented in Vietnam since 1998, there still has not been a specific standard for aircraft noise. For the creation of future standards and policies of this field, this study's outcomes could be used as a part of the data archive for analysis. Furthermore, this research is possibly used as a reference for further studies on Vietnamese living environment, as well as for other researches regarding step-change in aircraft noise exposure in other countries with similar conditions.

METHOD

Social survey

From 2005 to 2013, social surveys on road traffic, aircraft and railway noises had been carried out in several cities in Vietnam [5 ~ 8], but all of these studies were conducted in steady state of noise environment. In two years, 2014 and 2015, a research of step-change in aircraft noise exposure was executed in two phases, before and after the operation of the new terminal, as shown in Table 1. In Phase 1, a survey was implemented from late August to early September 2014 to verify the prevalence of aircraft noise annoyances around Hanoi Noi Bai International Airport before the operation of the new terminal. The second survey was conducted from late February to early March 2015 to investigate changes in community response associated with the above variation in noise exposure while the final survey, which was operated from late August to early September 2015, documented the impact of this step-change in longer period.

Table 1: Two phases of Hanoi Noi Bai International Airport's study in 2014-2015

	Social survey	**Noise measurement**	**Survey item**
Phase 1	August – September, 2014	7th – 14th September, 2014	Prevalence of aircraft noise annoyances before the operation of the new terminal
Phase 2	February – March, 2015	2nd – 9th March, 2015	Changes in community response associated with variation in noise exposure
	August – September, 2015	30th August – 6th September, 2015	Impact of the change in noise exposure in longer period

Survey sites

Figure 1 allocates geographical positions of 13 residential areas around Hanoi Noi Bai International Airport where three social surveys were conducted in 2014 and 2015. Six sites (A1 - A6) in the West were chosen under the arrival route while another five sites (A7 - A11) in the East were picked up under the departure route of the airport. Another two sites, C1 and C2, were selected as control sites in the North, where aircraft noise has small influence. Most selected sites have similar characteristics of rural areas where people start and finish working sooner than urban citizens.

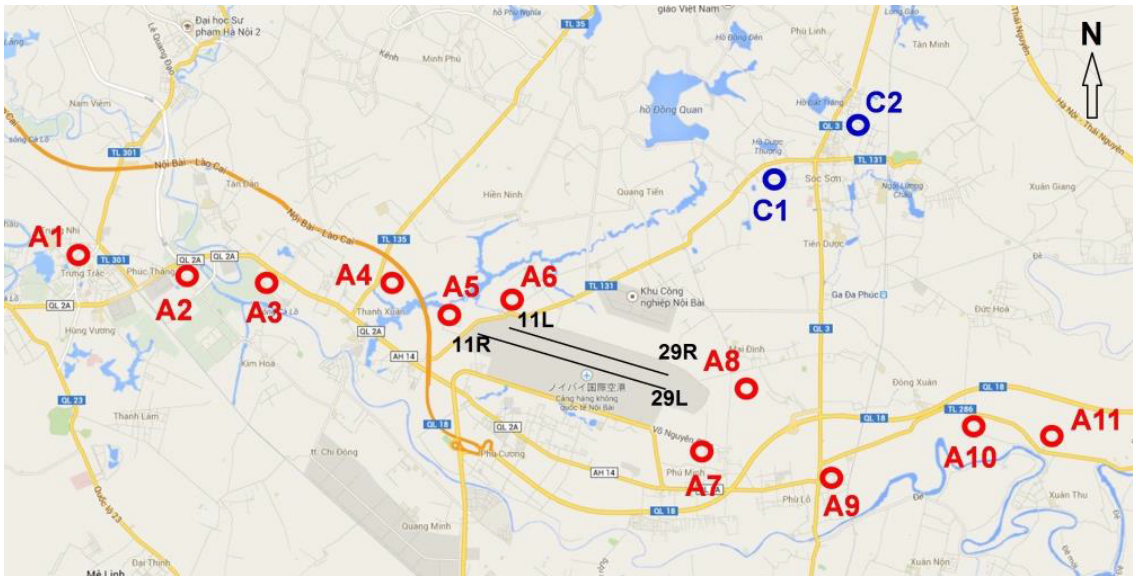

Figure 1 - Map of survey sites around Hanoi Noi Bai International Airport

Questionnaire

Table 2: Question items of the three surveys

Questions answered by respondents				
1st survey	2nd survey	3rd survey		
Q1 - Q6	Q1 - Q5	Q1 - Q5	Housing factors	House type; Length of residence; Area of first floor; Comments on quality of housing
Q7, Q8	Q6	Q6	Residential environment	Climate in the area; Quality of residential environment
Q9 - Q16	Q7 - Q13	Q7 - Q13	Annoyance	From traffic noise (aircraft, road traffic); From air pollution; From neighbor; Frequency of annoyance; Annoyance in specific time and season; Annoyance due to vibration caused by traffic, …
Q17	Q14	Q14	Interferences of daily activities	Disturbances while listening, sleeping, resting, talking, gardening
Q18 - Q26	Q15 - Q23	Q15 - Q23	Sensitivities, attitudes, etc.	Sleeping with open window in certain season; Go to bed time and wake up time in weekend and weekday; Sleeping condition; Sensitivity to weather and environmental factors; Attitudes to the use of transportation vehicles; Using frequency; Comments on safety
Q27 - Q31	Q24 - Q28	Q24 - Q28	Socio - demographic variables	Occupation; Length of time to stay at home; Number of family members; Age
	Q29	Q29, Q30	Participation in previous survey(s)	
Questions answered by interviewers according to observations				
F1	F1	F1	Gender of respondents	
F2 - F6	F2 - F8	F2 - F9	Structural details of the house	Main structure; Number of glass layers, frame types of windows and doors of the living rooms and bedrooms

The three surveys were conducted as that on living environment, with the questionnaire containing inquiries about housing, residential environment, noise annoyance, interferences of daily activities, sleep effects, sensitivities, attitude toward transportation, and socio-demographics. There were some eliminations, additions and modifications among three questionnaires in order to suit with the actual situation; general information of these question items is summarized in Table 2.

Areas for surveys were chosen in a preliminary survey in 2013. Face-to-face interview were used at approximately 100 households at each site by approximately 50-70 prior-trained interviewers. Interviewers tried up to three attempts on interviewing eligible respondents. Qualified respondents were selected in order of fathers, mothers and other adults to gather a well-balanced respondents group.

To evaluate respondents' annoyance caused by noise, two types of scales which were constructed by ICBEN method have been used in the questionnaire [9, 10]. The 5-point verbal annoyance questions and their response categories were used in inquiries relating general annoyance, as well as activities and sleep disturbances. Number of respondents whose answers were within the top two categories from these questions were used to calculate % Very Annoyed (% VA) and % Very Disturbed (%VD), as well as used to evaluate that the respondent was very annoyed/ disturbed or not. It is notable that in all annoyance related questions, the period of time which was asked was "the last one month", instead of "the last 12 months" as in other surveys. Since the objective of this study was focus on a step-change in aircraft noise exposure, thus this alteration was made.

Noise measurement

To record noise levels at survey sites, sound level meters (RION NL-21, NL-22) were connected to microphones, and were settled on the rooftop of highest house at each site, with the fixed height of 1.5m from the roof floor, and at least 1m away from other reflecting surfaces. Aircraft noise exposure was determined with a sampling period of 1s for a week. The level fluctuations of overall noise exposure at all sites were drawn on charts and combined with flight schedule to identify aircraft noise events. Based on the charts drawn for the two sites A3 and A8, which had the highest noise level at each site, aircraft noise events at other sites are also indicated.

Exposure–response relationship

To assess the relationship between noise exposure and response, logistic regression has been applied to find out the association between dependent nominal variable y, and independent variable x as shown in Table 3. Curves of each survey's exposure-response relationships have been drawn based on the analyzed results, to compare among each other, as well as with EU's position paper [11].

Table 3: Variables for logistic regression analyses

	Independent variable (x)	**Nominal variable (y)**
General annoyance	L_{den}	Highly annoyed or not (Top 3 categories of numerical scale)
Activities disturbances	$L_{Aeq,\ day}$	Very disturbed or not (Top 2 categories of verbal scale)
Sleep disturbances	$L_{Aeq,\ night}$	

Decibel-equivalent change effect

Methodology presented by Horonjeff and Robert's (1997) [12] was used to figure whether or not the excess responses of general annoyance appear in the case of Hanoi Noi Bai International airport. The 1st survey curves were chosen as baselines to predict the percentage of Highly Annoyed respondents (%HA) corresponding with noise level in 2nd and 3rd surveys, to investigate the existence of abrupt change effect before and after the opening of the new terminal. Similarly, 2nd survey curves in turn became the baselines for calculating the predictive %HA of the last survey, to examine the appearance of abrupt change effect following an increase in noise exposure level at some sites. Relationships between "Decibel-equivalent change effect", which was the difference between predicted and actual noise exposure, and "Actual change in noise exposure", were illustrated in charts.

To assess the outcome, original evaluation method of Horonjeff and Robert was used. In their words, "data points that lie along the horizontal axis indicate cases in which the baseline dose-response curve for the study correctly estimates the change in annoyance: no abrupt change in effect was observed. Data points in the first and third quadrants … indicate cases in which there was an abrupt-change effect, and the effect resulted in a change in annoyance greater than that predicted from the baseline curve". In other words, excess response is observed when a data point locates in the first and third quadrants, while on the other hand, data points stay in the second and fourth quadrants represent an under response.

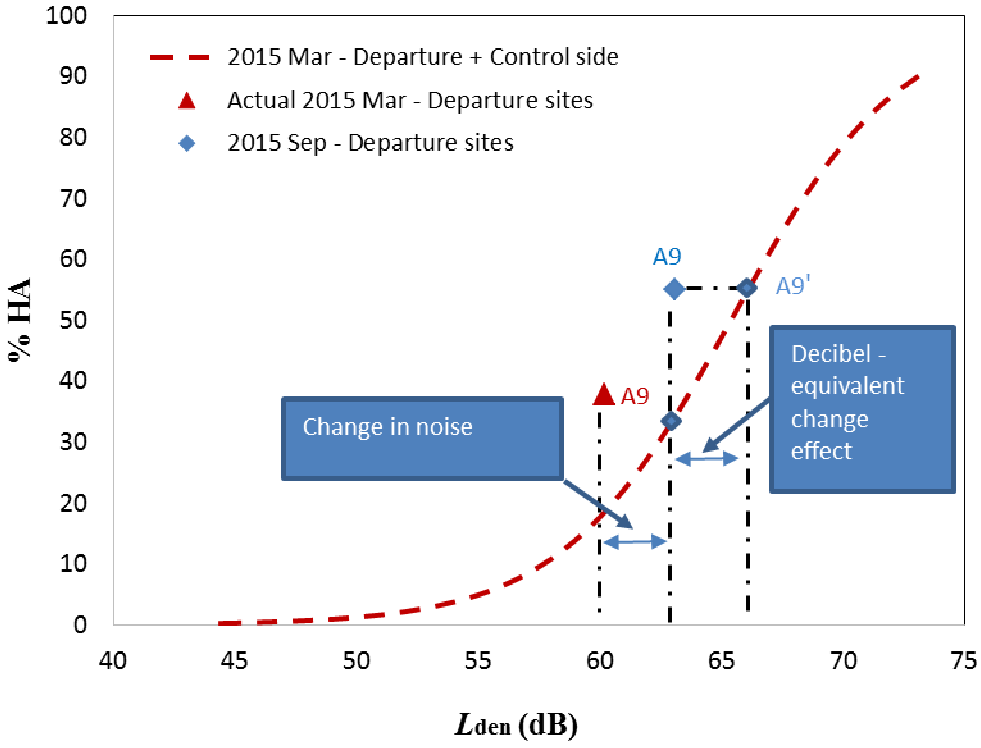

Figure 2: Illustration of "Change in noise exposure" and "Decibel–equivalent change effect"

Figure 2 showed the example of determining "change in noise exposure" and "decibel – equivalent change effect", which is used as variable for the decibel–equivalent change effect's variables. The evaluations of excess response and under response are summarized as in Table 4. In short, excess response appears when there are positive offset values between noise exposures in target survey and previous survey and between noise levels in predicted and target survey. Also, if both mentioned offsets are negative, the excess response occurs. The other cases are regarded as under response.

Table 4: Summary of evaluation method for decibel – equivalent change effect

	Change in noise exposure	Decibel – equivalent change effect	Evaluated as
Calculation method	Offsets of noise exposure level between target survey and previous survey	Offsets of target survey's noise exposure level between predicted value (base on the baseline) and actual value	
Outcomes	+	+	Excess response
	+	–	Under response
	–	+	Under response
	–	–	Excess response

RESULTS

Sample size, response rate, and demographic variables

About(?) 1300 families were chosen in each survey, and 890, 1109, and 1286 interviews in each survey were done successfully, resulting in the response rates of the first, second, and third surveys were 68.5%, 86.2%, and 98.8%, respectively.

Table 5: Demographic variables in three surveys at arrival and departure sides

		1st survey		2nd survey		3rd survey	
		Arrival	Departure	Arrival	Departure	Arrival	Departure
Sample size		890		1109		1286	
Total response rate (%)		68.5		86.2		98.8	
Gender	Male	54.7	53.7	52.7	52.1	49.3	49.4
	Female	45.3	46.3	47.3	47.9	50.7	50.6
Age	20s-50s	82.7	81.9	86.7	82.1	83.1	86.1
	Over than 60	17.3	18.1	13.3	17.9	16.9	13.9
Length of residence	0-10 years	24.9	28.7	18.2	20.6	26.5	19.5
	Over 10 years	75.1	71.3	81.8	79.4	73.5	80.5
Occupation	Employed	54.7	52.8	64.5	56.5	61.5	59.3
	Students, housewife, retired and unemployed	45.3	47.2	35.5	43.5	38.5	40.7

The results showed that balanced percentages of male and female respondents in all three surveys were recorded in both sides. Besides, the "Golden structure" of Vietnamese population was reflected by a ratio of 80% of respondents were at their age of 20-60s. The data of length of residence illustrated the settled life style of residents living the countryside near Hanoi, with three fourths of respondents had been living in their current houses over 10 years. Details of the three social surveys' results were shown in Table 5.

Noise exposure levels

With 1.2 – 1.3 times increase of daily flight number after the opening of the new terminal building, general noise level considerably varied among surveys, from 45-66 dB L_{den} (1st survey) and 44-66 dB L_{den} (2nd survey) to 49-68 dB L_{den} (3rd survey). The visualization of the change in noise exposure levels among three surveys was shown in Figure 3. In detailed comparison of before and after the new terminal's operation, some sites have considerable changes right after the opening of the new terminal (March 2015) while significant variations were seen at other sites nine months after the operation (September 2015). The results of the 2nd survey in March 2015 shows that under the arrival route, aircraft noise exposure slightly increased while decrease at most sites under the departure route was found The most considerable changes were found at site A5 under the arrival route and site A9 under the departure side.

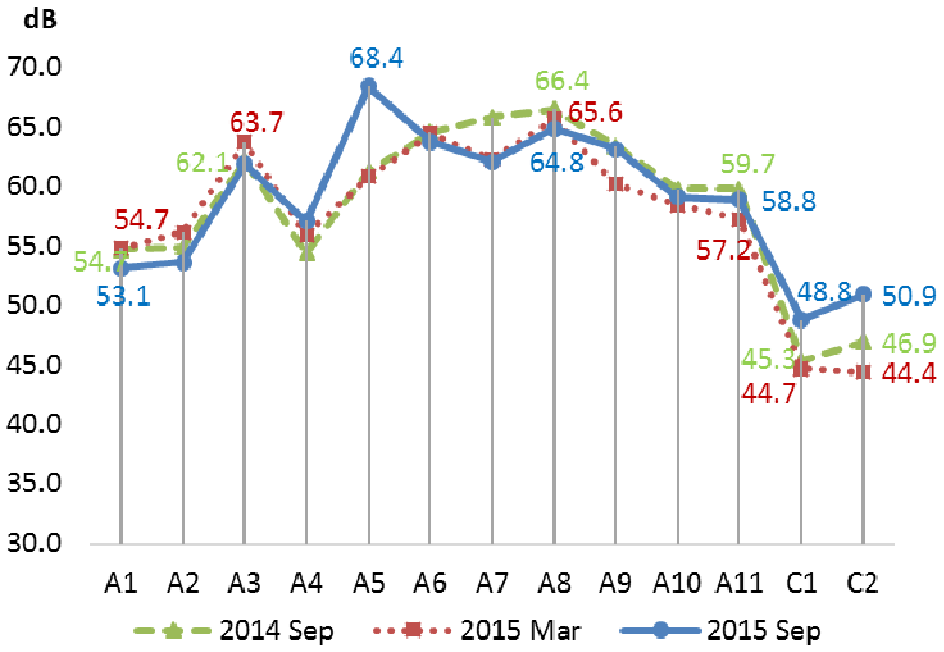

Figure 3: L_{den} at each site among three surveys

Exposure–response relationship

Exposure-response curves for three surveys of Hanoi Noi Bai International Airport were drawn onto the curve of EU position paper [8] as shown in Figure 4. The second survey's curve has the similar shape with the first survey's curve with approximately 5% higher. The third survey curve is notably steeper than the others, especially with noise level above 55dB. In other words, attitude of respondents toward aircraft noise became stricter in the last survey. Besides, all three curves of Hanoi Noi Bai International Airport are above and steeper than the EU's, and the last survey's curve upraises substantially. In short, respondents in Hanoi were more annoyed than people in EU, especially after the operation of the new terminal building.

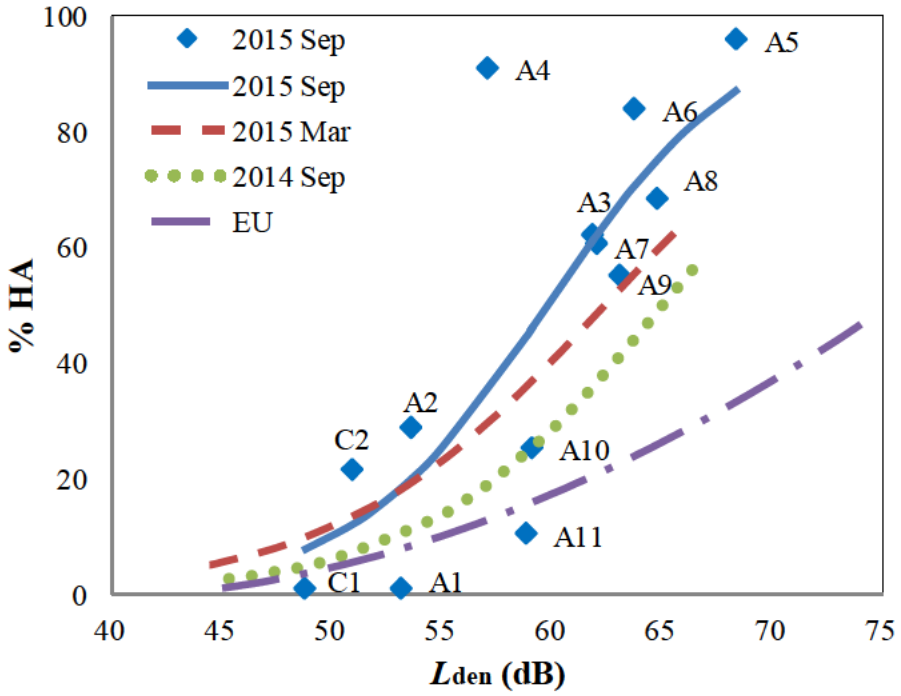

Figure 4: Exposure–response curves for annoyance of three surveys of Hanoi Noi Bai International Airport and EU position paper

Comparison of Arrival and Departure sides

Differences between community response in Arrival and Departure sides of the airport have also examined and demonstrated by curves with the similar method of exposure-response relationship investigation. General annoyance at these two sides was illustrated as in Figure 5.

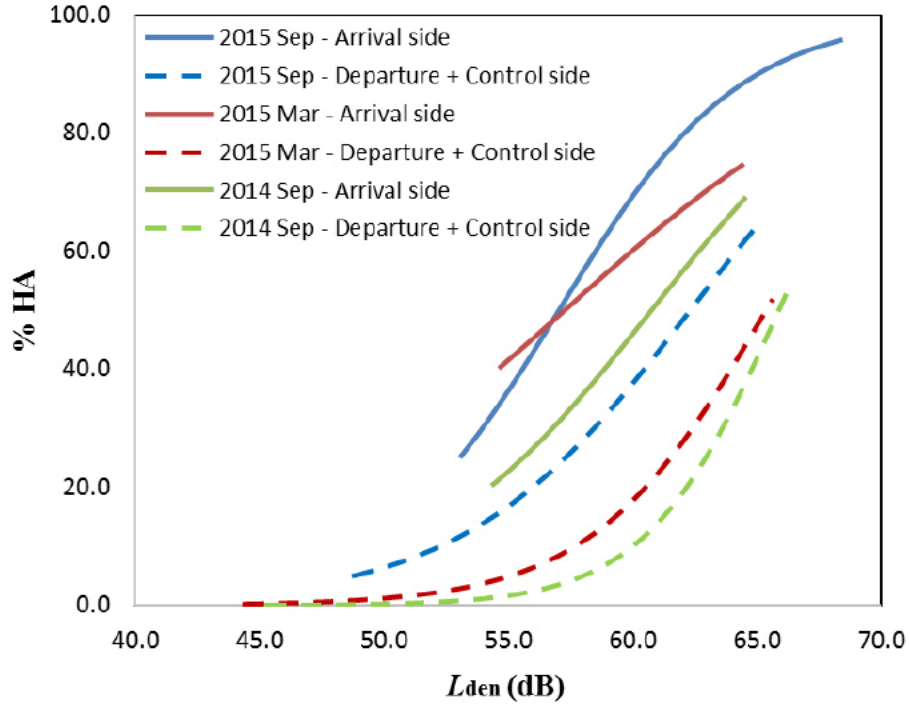

Figure 5: Comparison of general annoyance between Arrival and Departure sides

There were considerable gaps between Arrival and Departure sides' curves. In all surveys, Arrival side has much higher annoyance than the other side. Additionally, a remarkable distinction of the two sides was observed in the 2nd survey. In other words, people who live under the arrival route of the airport met more annoyance than people living under the departure route.

In comparison of activities interferences and sleep disturbances of arrival and departure side, it is apparent that results of activities have similar patterns, which a higher disturbance level was found in Arrival side in all surveys. Most considerable gaps between the two sides were seen in the 2nd survey, while the last survey showed a small variation between these sides.

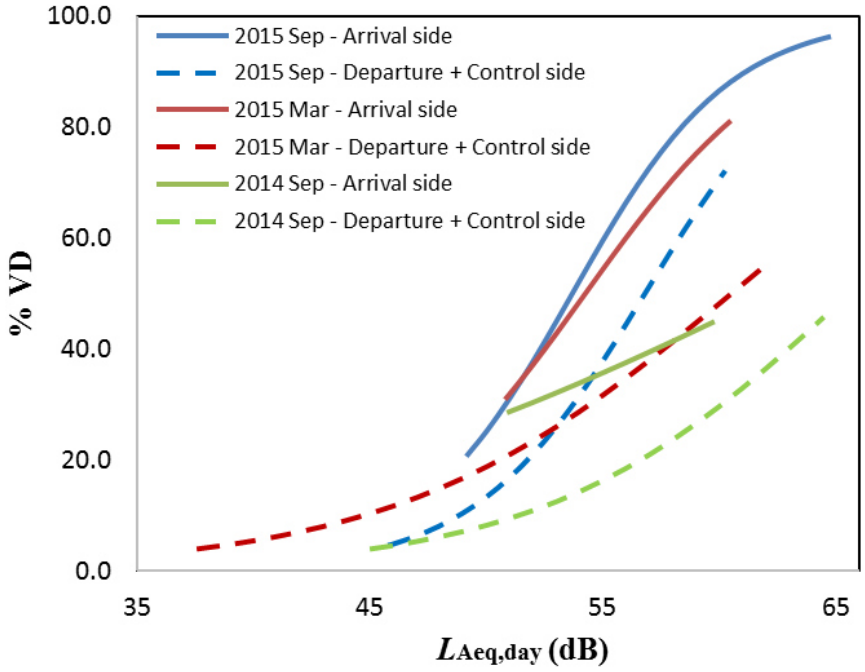

Figure 6: Comparison of TV/Radio disturbance between Arrival and Departure sides

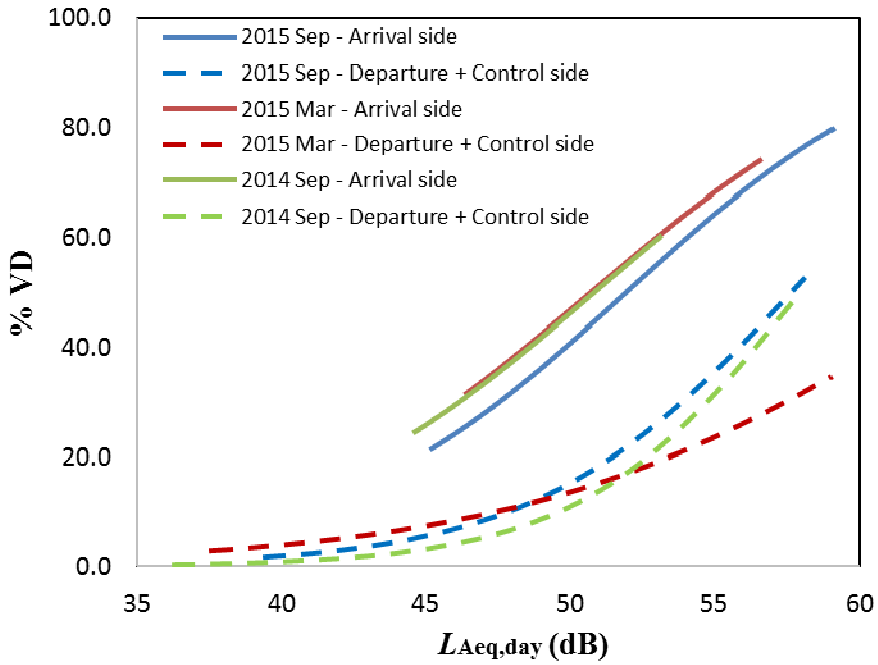

Figure 7: Comparison of Difficulty to fall asleep between arrival and departure sides

On the other hand, observations of dissimilarities of Arrival and Departure sides were done on two types of sleep problems: “Difficulty to fall asleep” and “Awakening at night”. The results of these categories are identical with notable gaps detected in all surveys. Curves of Arrival side’s disturbances levels stay close among each other, and the similarity occurred at the opposite side. Arrival sector curves locate at a notable higher position than curves of the Departure side, which mean people living under the departure route have lower level of sleep disturbances than people who live under the arrival route, as shown in Figure 7.

Decibel-equivalent change effect

Relationships between “Decibel-equivalent change effect”, which was the difference between predicted and actual noise exposures, and “Actual change in noise exposure”, were illustrated in charts. Since curves for all survey sites counterbalance the differences, which entail a possibility of an inexact calculation, separate curves for Arrival and Departure sides were used as baselines for predicting noise exposure.

Decibel-equivalent change effect evaluation with 1st survey’s baselines

Calculations for the second survey with the baseline of the first survey showed that under responses occurred at 5 of 13 sites, and most of them were sites under the departure route. Besides, excess response happened at 4 sites; among those 3 were arrival sites. On the other hand, under responses appeared at 7 over 13 sites while excess responses occurred at 4 sites in the last survey. It is considerable that all departure sites met the under response while only half of arrival sites encounter the same condition.

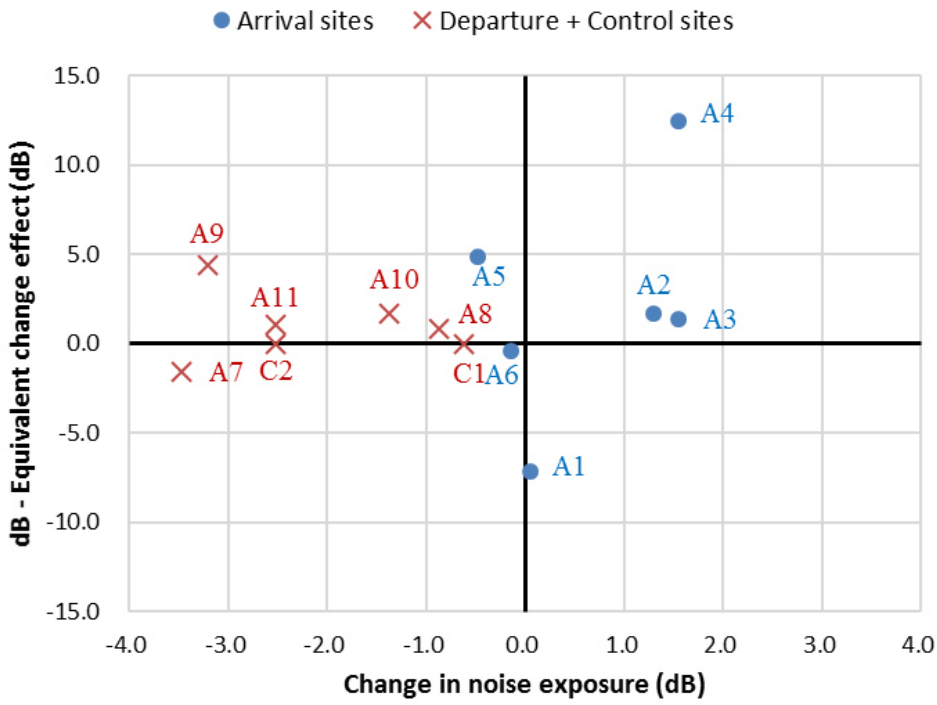

Figure 8: Decibel-equivalent change effect evaluation for General annoyance in the 2nd survey (1st survey’s baselines)

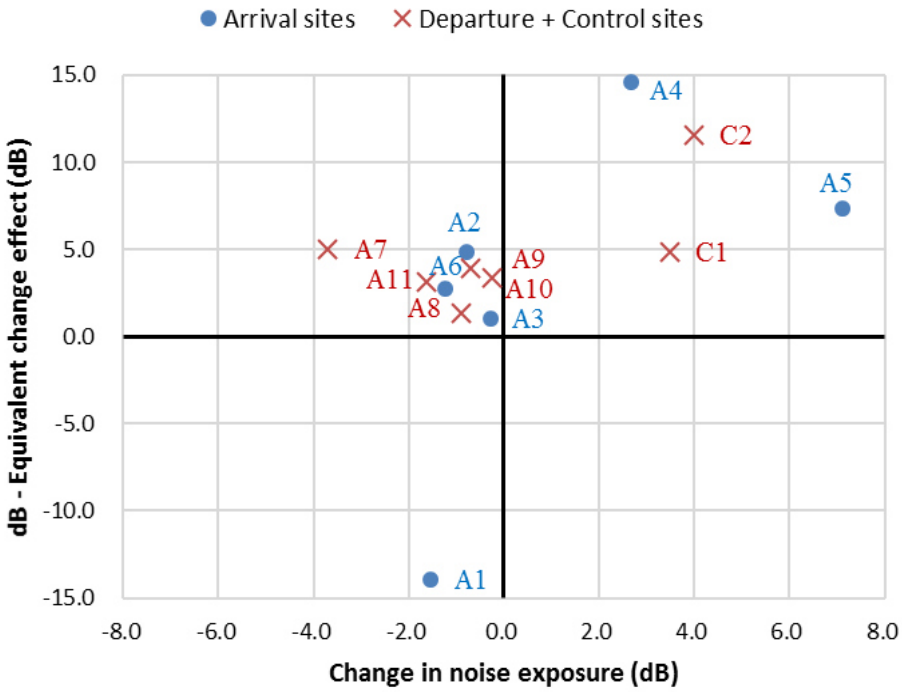

Figure 9: Decibel-equivalent change effect evaluation for General annoyance in the 3rd survey (1st survey's baselines)

Decibel-equivalent change effect evaluation with baselines from second survey

Identical analysis was implemented with the baselines of the 2nd survey on the objects of 3rd survey's data. The results are shown in Figure 10. It is notable that excess response existed at most sites while under response was observed at site A6 in Arrival side and site A7 and A8, A11 in Departure side. However, it was an inconsiderable change effect since difference between actual and predicted noise level was not severe.

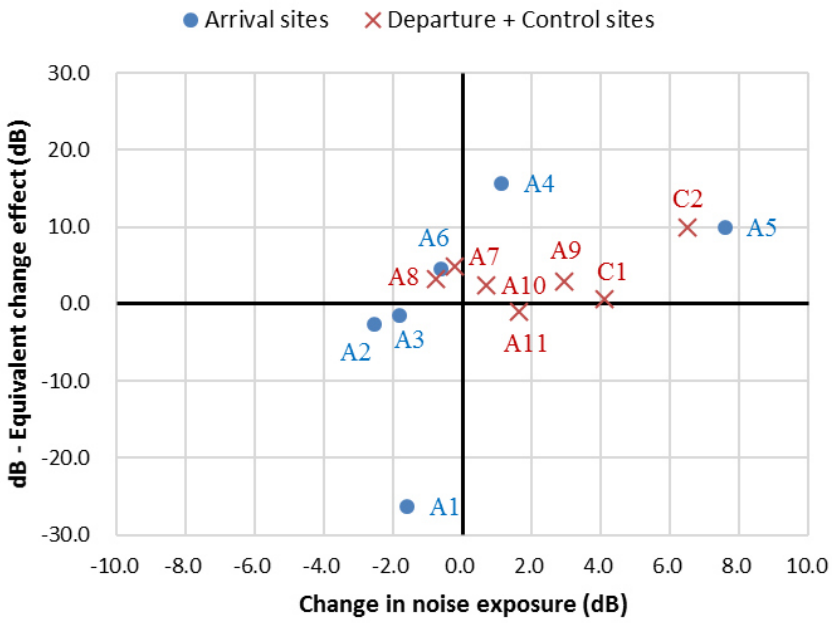

Figure 10: Decibel-equivalent change effect evaluation for General annoyance in the 3rd survey (2nd survey's baselines)

CONCLUSIONS

1) After the opening of the new terminal, most considerable changes of noise exposure level in the 2nd survey were observed at sites A6 and A7 while significant variations were seen at site A5 and A9 in the last survey.

2) Exposure-response curves of the 2nd survey fits on the 1st survey's curve with approximately 5% higher. The last survey curve is noticeably steeper than the other two.

3) All three surveys' curves of Hanoi are above and steeper than the EU's, which means respondents in Hanoi were more annoyed than people in EU

4) There were considerable gaps between exposure-response curves for general annoyance, activities interferences, as well as sleep disturbances of arrival and departure sides of the airport.

5) Decibel–equivalent change effects were obtained with the baselines of the 1st survey. Overall, the number of sites with under response for general annoyance was negligible in the 2nd survey but noticeable in the 3rd survey.

6) Decibel–equivalent change effects with the baselines of 2nd survey were also obtained, but no remarkable outcomes were presented.

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