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PAPER

Effects of step change in aircraft noise exposure on activity disturbances: Socio-acoustic surveys around Hanoi Noi Bai International Airport

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Abstract: A new terminal building was opened at Hanoi Noi Bai International Airport (HNBIA) in December 2014 and since then the number of flights has increased. To investigate the community response to a step change in aircraft noise exposure, socio-acoustic surveys were conducted around HNBIA once before and twice after the operation. The sample sizes in the first, second, and third surveys were 891, 1,121, and 1,287, respectively. Since the use of the two runways changed before and after the operation, the noise exposures were not monotonically increased from the first survey. Thus, the differences in $L_{\rm day}$ and $L_{\rm night}$ between before and after the operation ($\Delta L_{\rm day}$ and $\Delta L_{\rm night}$) ranged from -9 to $+5$ dB and from -2 to $+8$ dB, respectively. In this study, listening, resting, and sleep disturbances caused by the step change were investigated. It was found that the exposure–response relationships for those activity disturbances become higher according to the increase in $\Delta L_{\rm day}$ or $\Delta L_{\rm night}$. However, although the exposure–response relationships for listening and rest disturbances were higher than that in the first survey even in the case that $L_{\rm day}$ decreased from the first survey, that for awakening was slightly lower than that for the first survey.

Keywords: Activity disturbance, Sleep disturbance, Annoyance, Aircraft noise, Step change

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1. INTRODUCTION

Opening or closing infrastructure and implementing new noise policies usually result in step changes in noise exposure. These cause in turn change effect (excess response or under response) in the community response to noise, which is greater or smaller than the exposure effect expected under steady-state conditions. Many surveys to investigate the change effects have been conducted in developed countries. Brown and van Kamp [1] reviewed these surveys and concluded that there is a change effect in annoyance with road traffic noise where the change occurred at the source. They also commented that activity interferences may not show the same level of excess response as annoyance by quoting Kastka *et al.* [2], Klaeboe *et al.* [3], and Breugelmans *et al.* [4]. The exception is Öhrström's study [5], which indicated excess response in not only annoyance but also activity interferences. However, there are fewer step-change studies in developing countries, and there is a lack of evidence of the change effect in activity interferences compared with annoyance. Since new infrastructure has been constructed in developing countries such as Vietnam with rapid economic growth, socio-acoustic survey data on the step change in noise exposure should be accumulated for future global noise policies and those in developing countries. Hanoi Noi Bai International Airport (HNBIA) is the second largest airport in Vietnam, and a new terminal building was

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constructed to meet future air traffic demand. To investigate the effects of a step change in aircraft noise exposure on annoyance and activity/sleep disturbances, socio-acoustic surveys were conducted around HNBIA in August–September 2014, February–March 2015, and August–September 2015. The change effects of annoyance and insomnia were reported by Nguyen *et al.* [6]. In this study, we aim to investigate whether change effects are also shown in activity disturbances by using data from the same socio-acoustic surveys around HNBIA.

2. METHOD

2.1. Social Surveys

Social surveys were conducted three times from August to September 2014 (first survey), February to March 2015 (second survey), and August to September 2015 (third survey) around HNBIA, which is in a suburban area 45 km north of Hanoi. Thirteen interview sites were selected for the survey as shown in Fig. 1: Sites A1 to A6 are along the arrival route, A7 to A11 are along the departure route, and A12 and A13 are little affected by aircraft noise. Site A1 is an urban residential area, sites A2, A3, A7, A9, A12, and A13 are farming villages and urban residential areas, and sites A4, A5, A6, A8, A10, and A11 are farming villages. There are two runways in HNBIA: 11R/29L and 11L/29R. The primary wind direction is east (direction for 11) throughout the year but sometimes west (direction for 29) in about 10% of the time. During the surveys, the wind direction was east. Since the north runway (11L/29R) was closed for maintenance from August to December 2014, only the south runway (direction was 11R) was used for all arrivals and departures during the first survey. During the second and third surveys, runway 11R was used for all arrivals and some departures, whereas runway 11L was used for small-airplane departures. HNBIA is used mainly for civil aircraft and partially for military use, but there was no military aircraft operation during the second survey because of Tet holidays.

The face-to-face interview method was used for all the surveys. One hundred houses were selected per survey site, and the respondents were preferentially selected on a one-person per family basis: father of the family in the first house, mother in the second, and a member other than father/mother and older than 18 years in the third, and this procedure was repeated to obtain 100 respondents. All the houses were detached 2–4 story ones constructed with reinforced concrete. The questionnaire contains 30 questions on house, residential environment, annoyance caused by environmental factors, activity disturbances by aircraft operation, sleep quality, and attitudes to transportation modes.

Annoyance to aircraft noise was evaluated with both a 5-point verbal scale (not at all, slightly, moderately, very, and extremely) and an 11-point numerical scale (extremes labeled "not at all" and "extremely") proposed by the International Commission on Biological Effects of Noise (ICBEN) [7]. Eight activity disturbances (indoor conversation, telephone communication, TV/radio listening, reading, indoor resting, difficulty to fall asleep, awakening, and difficulty to open windows) were evaluated with the 5-point verbal scale. Percent Very Disturbed (%VD) for daytime activities and %Very Sleep Disturbed (%VSD) for sleeping were defined as the rates of respondents who selected "extremely" or "very" at the sites. Percent Very Annoyed (%VA) was also defined similarly as %VD.

2.2. Estimation of Aircraft Noise Exposure

A-weighted sound pressure levels (L_{pA}) were continu-

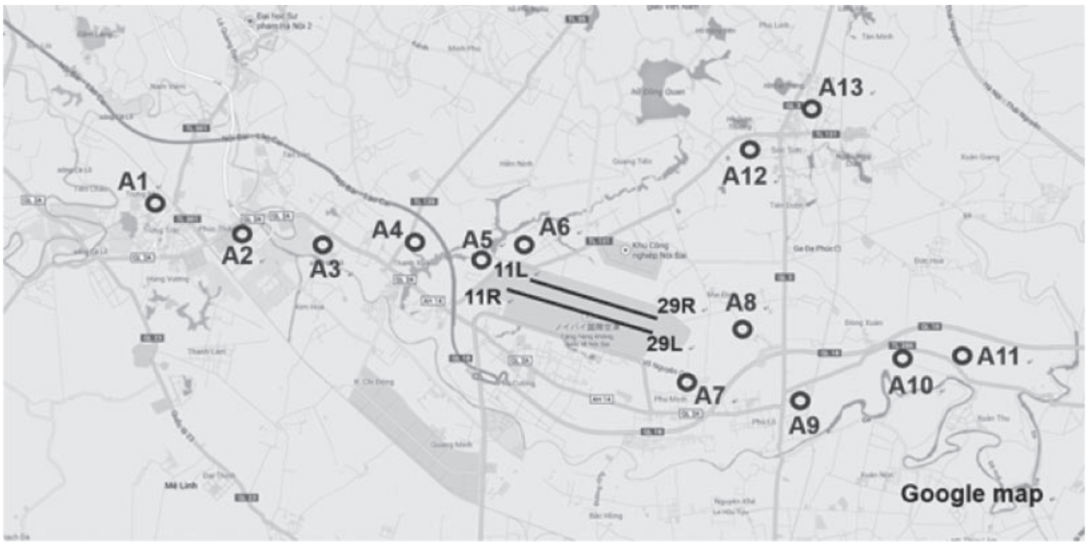

Fig. 1 Survey sites around HNBIA.

ously recorded every 0.1 s for seven successive days using sound level meters (RION NL-21, NL22) with all-weather windscreens at the 13 sites. A sound level meter was installed at a height of 1.5 m on the flat roof of one house per site. The flight logs of civil airplanes were obtained from HNBIA and the Civil Aviation Authority of Vietnam (CAAV). All aircraft noise events were identified by the flight logs and by referring to the level records at Site A3 for the sites located along the arrival route and at Site A8 for the sites along the departure route. Single-event sound exposure levels (L_{AE}) in each aircraft noise event were calculated from the L_{pA} recording, and equivalent continuous A-weighted sound pressure levels for the daytime (L_{day}) and nighttime (L_{night}) were calculated from L_{AE} values. Considering Vietnamese lifestyle patterns, the daytime and nighttime were identified as 6:00–22:00 and 22:00–6:00, respectively.

2.3. Analysis

To investigate whether the change effects are shown in activity disturbances, a multiple logistic regression analysis was applied with the dichotomous variable "very disturbed (annoyed) or not" as the dependent variable. Independent variables for the analysis were L_{day} (L_{night}), the level difference between first and second or third surveys (ΔL_{day} or ΔL_{night}), gender, age, and sensitivity to noise. Sensitivity to noise was evaluated with the ICBEN 5-point verbal scale and classified into two categories: the two modifiers (extremely and very) as "sensitive" and the others as "not sensitive." It was confirmed that there was no high correlation between noise exposure level and noise sensitivity. All statistical analyses were performed using JMP 11.

3. RESULTS

3.1. Demographic Variables

The numbers of respondents (response rate, %) in the first, second, and third surveys were 891 (68.5), 1,121 (86.2), and 1,287 (98.9), respectively. The higher response rate in the second and third surveys was because the interviewers were strongly instructed to visit the respondents' houses three times at most if not contacted, because the response rate in the first survey was not high as expected. As shown in Table 1, the distributions of demographic variables were well balanced among the three surveys: males and females were equally represented, and 60%–70% in their ≤20s, 30s, and 40s. Such distributions are consistent with the Vietnam census. The percentage of employed people in the first survey was small because some farmers selected "unemployed." Thus, the option of "farmer" was added in the job question in the second and third surveys.

Table 1 Distribution of demographic variables.

Item	Category	Survey		
		1st	2nd	3rd
Gender (%)	Male	54.1	52.5	49.1
	Female	45.9	47.5	50.9
Age (%)	−20s	20.0	22.4	23.4
	30s	23.8	22.7	22.7
	40s	20.8	23.7	21.0
	50s	17.7	15.7	17.5
	60s	11.8	11.5	10.1
	+70s	6.0	4.1	5.4
Occupation (%)	Employed	53.5	60.3	60.4
	Student, housewife, retired, and unemployed	46.5	39.7	39.6

Table 2 Number of flight operations in three surveys.

Period	Flight path	Survey		
		1st	2nd	3rd
Day (6:00–18:00)	Arrival	84	104	100
	Departure	90	109	107
	Total	173	212	206
Evening (18:00–22:00)	Arrival	32	43	39
	Departure	16	27	22
	Total	49	69	61
Night (22:00–6:00)	Arrival	9	16	14
	Departure	21	26	25
	Total	30	42	39
Total	Arrival	126	162	153
	Departure	126	161	153
	Total	252	323	306

3.2. Noise Exposure and Percent Very Disturbed

Table 2 summarizes the number of flights during the day (6:00–18:00), evening (18:00–22:00), and night (22:00–6:00) in the three surveys. The number of flights in the second and third surveys increased around 1.3 and 1.2 times compared with that in the first survey, respectively. However, since the operation of the two runways was markedly changed between before and after the construction of the new terminal building, the noise exposures did not evenly increase at the sites as shown in Table 3. While L_{night} slightly increased from the first to the second or third survey on average, L_{day} decreased from the first to the second or third survey. As shown in detail in

Table 3 Noise exposure and their changes.

Site	$L_{day(6:00–22:00)}$			$L_{night(22:00–6:00)}$			L_{den}			ΔL_{day}		ΔL_{night}		ΔL_{den}	
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd
A1	52	51	50	45	46	45	55	55	53	−1	−2	1	0	0	−2
A2	52	53	49	45	48	46	55	56	54	1	−3	3	1	1	−1
A3	59	60	57	53	56	55	62	64	62	1	−2	3	2	2	0
A4	52	52	54	46	48	48	54	56	57	0	2	2	2	2	3
A5	60	57	65	51	53	59	61	61	68	−3	5	2	8	0	7
A6	62	61	60	50	57	56	65	64	64	−1	−2	7	6	−1	−1
A7	64	57	57	55	56	55	66	62	62	−7	−7	1	0	−4	−4
A8	64	62	60	58	58	58	66	66	65	−2	−4	0	0	0	−1
A9	61	56	58	55	53	56	63	60	63	−5	−3	−2	1	−3	0
A10	57	54	54	52	52	53	60	58	59	−3	−3	0	1	−2	−1
A11	56	53	54	52	50	52	60	57	59	−3	−2	−2	0	−3	−1
A12	44	39	47	36	38	39	45	45	49	−5	3	2	3	0	4
A13	47	38	46	36	38	44	47	44	51	−9	−1	2	8	−3	4
Average*										−3	−1	1	2	−1	0

*Weighted average of the noise exposure change across 13 sites.

Table 4 %VD for TV/radio listening, resting, and awakening at every site in the three surveys.

Site	TV/radio			Resting			Awakening		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
A1	2	8	0	7	1	1	9	2	0
A2	18	23	21	13	21	15	10	18	17
A3	91	89	77	50	69	56	52	64	56
A4	62	68	91	55	76	74	59	71	64
A5	69	86	89	22	77	87	15	81	61
A6	24	52	82	39	64	75	36	59	65
A7	35	14	57	45	7	33	32	13	31
A8	88	53	68	59	43	63	34	31	42
A9	61	65	59	25	31	50	23	22	42
A10	26	20	39	10	13	28	15	11	25
A11	10	29	23	9	25	15	3	17	12
A12	0	0	1	9	1	0	0	0	0
A13	2	8	1	0	1	2	2	3	2

Table 3, ΔL_{day} ranged from −9 to +5 dB and ΔL_{night} ranged from −2 to +8 dB. Such a trend may be because while only runway 11R was used for both arrival and departure in the first survey, both runways 11R and 11L were used for departure in the second and third surveys. Noise exposure might decrease at sites along the departure route by the separate departures. As shown in Fig. 1, since A7 is located along the departure flight path of 11R, L_{day} seemed to be largely decrease with the use of runway 11L for departure. It can be considered that one of the reasons why L_{night} at A5 and A6 largely increased is due to the take-off roll at the end of runway 11L. We tried to ask HNBAI to provide information about the number of flights in each runway during the survey period, but no information was available. Thus, the exact reasons for the decrease in noise levels have not been confirmed.

%VD for TV/radio listening, resting, and %VSD for awakening at each site are summarized in Table 4. The %VD and %VSD are relatively high at Sites A3–A9 which are close to the runways. In particular, the %VD and %VSD are high at A5 and A6 in the second and third surveys, probably because of the effects of the take-off roll at the end of runway 11L.

3.3. Multiple Logistic Regression Analysis

Since there was no large difference in the effects of exposure changes on daytime disturbances, TV/radio listening and resting disturbances, which had many responses, were selected as the representative dependent variables for the multiple regression analysis for daytime. For a similar reason, awakening was selected as the representative dependent variable for the nighttime effect.

Table 5 Multiple logistic regression analysis of TV/radio listening disturbance.

Item	Category	Estimate	Standard error	p-value	Odds ratio	Lower 95% CI	Upper 95% CI
Intercept		−11.459	0.691	<0.0001			
L_{day}		0.168	0.012	<0.0001	1.183	1.157	1.210
ΔL_{day}	1st survey				1.000		
	$\Delta L_{day} < -3$	0.727	0.161	<0.0001	2.069	1.509	2.842
	$-3 \leq \Delta L_{day} < 0$	0.743	0.135	<0.0001	2.103	1.618	2.742
	$\Delta L_{day} \geq 0$	1.614	0.165	<0.0001	5.024	3.644	6.966
Gender	Male				1.000		
	Female	−0.091	0.098	0.3499	0.913	0.754	1.105
Age	≤20s				1.000		
	30s	−0.120	0.146	0.4115	0.887	0.665	1.181
	40s	0.105	0.146	0.4744	1.110	0.834	1.479
	50s	0.235	0.154	0.1274	1.265	0.935	1.712
	60s	0.023	0.182	0.9015	1.023	0.716	1.461
	≥70s	−0.290	0.242	0.2300	0.748	0.465	1.201
Noise sensitivity	Not sensitive				1.000		
	Sensitive	1.999	0.100	<0.0001	7.382	6.072	8.999

Table 6 Multiple logistic regression analysis of rest disturbance.

Item	Category	Estimate	Standard error	p-value	Odds ratio	Lower 95% CI	Upper 95% CI
Intercept		−10.851	0.725	<0.0001			
L_{day}		0.137	0.012	<0.0001	1.147	1.121	1.175
ΔL_{day}	1st survey				1.000		
	$\Delta L_{day} < -3$	0.570	0.172	0.0009	1.769	1.263	2.479
	$-3 \leq \Delta L_{day} < 0$	1.105	0.143	<0.0001	3.019	2.287	4.006
	$\Delta L_{day} \geq 0$	1.954	0.168	<0.0001	7.058	5.091	9.854
Gender	Male				1.000		
	Female	−0.095	0.100	0.3426	0.909	0.747	1.106
Age	≤20s				1.000		
	30s	0.155	0.153	0.3112	1.168	0.865	1.576
	40s	0.271	0.151	0.0722	1.311	0.976	1.762
	50s	0.554	0.158	0.0005	1.739	1.278	2.372
	60s	0.553	0.186	0.0029	1.738	1.208	2.501
	≥70s	0.395	0.246	0.1086	1.484	0.915	2.401
Noise sensitivity	Not sensitive				1.000		
	Sensitive	2.157	0.113	<0.0001	8.649	6.953	10.817

L_{day} (or L_{night}), ΔL_{day} (or ΔL_{night}), gender, age, and sensitivity to noise were selected as the independent variables. It was confirmed in advance that the effect of other variables, such as the living environment, occupation, and frequency of aircraft use, was small. Considering the distribution of ΔL_{day}, ΔL_{day} was divided into three categories: $\Delta L_{day} < -3$, $-3 \leq \Delta L_{day} < 0$, and $\Delta L_{day} \geq 0$. Using a similar approach, ΔL_{night} was categorized into $\Delta L_{night} \leq 0$, $0 < \Delta L_{night} \leq 3$, and $\Delta L_{night} > 3$. Although the interactions between L_{day} (or L_{night}) and ΔL_{day} (or ΔL_{night}) for TV/radio listening, rest disturbance, and awakening were also incorporated in the multiple logistic regression analysis, the p-values of the coefficients were 0.056, 0.75, and 0.51, respectively (not significant at 5% level), and thus not considered hereafter.

Tables 5 to 7 summarize the results of the multiple logistic regression analysis. In Table 5, L_{day}, ΔL_{day}, and sensitivity to noise significantly affected TV/radio listening disturbance. Even when L_{day} decreased from the first survey to the second or third survey (in the category of $\Delta L_{day} \leq 0$), TV/radio listening disturbance significantly increased. It has been shown in previous studies [8,9] that the effect of noise sensitivity is significant, and the same result was obtained in this study. Gender did not significantly affect the disturbance. Although age also did not affect the disturbance significantly, the respondents who were in their 50s were more disturbed than those of other generations, as also shown by van Gerven *et al.* [10]. Tables 6 and 7 show almost the same trend as Table 5. However, ΔL_{night} did not significantly affect awakening in

Table 7 Multiple logistic regression analysis of awakening.

Item	Category	Estimate	Standard error	p-value	Odds ratio	Lower 95% CI	Upper 95% CI
Intercept		−8.624	0.607	<0.0001			
L_{night}		0.111	0.011	<0.0001	1.117	1.093	1.143
ΔL_{night}	1st survey				1.000		
	$\Delta L_{night} \leq 0$	−0.272	0.159	0.0860	0.762	0.558	1.040
	$0 < \Delta L_{night} \leq 3$	0.993	0.138	<0.0001	2.700	2.067	3.545
	$\Delta L_{night} > 3$	0.647	0.181	0.0004	1.909	1.340	2.726
Gender	Male				1.000		
	Female	−0.191	0.099	0.0537	0.826	0.680	1.003
Age	≤20s				1.000		
	30s	0.199	0.153	0.1944	1.220	0.904	1.648
	40s	0.360	0.150	0.0167	1.433	1.068	1.925
	50s	0.647	0.157	<0.0001	1.909	1.406	2.598
	60s	0.811	0.184	<0.0001	2.251	1.569	3.231
	≥70s	0.712	0.243	0.0034	2.039	1.263	3.280
Noise sensitivity	Not sensitive				1.000		
	Sensitive	2.062	0.114	<0.0001	7.863	6.306	9.864

the category of $\Delta L_{night} \leq 0$. ΔL_{night} significantly affected awakening in the case of $\Delta L_{night} > 0$, but the odds ratios were smaller than those in the case of TV/radio listening and rest disturbances.

Figure 2 shows the exposure–response relationships for the three disturbances and annoyance among the first survey (reference) and ΔL_{day} or ΔL_{night} categories by adjusting the moderating factors, that is, by inputting the actual rates of the factors. These figures visually illustrate the average trend for the change in the exposure–response relationships among the exposure change categories. The trends shown in Figs. 2(a) (TV/radio listening disturbance) and 2(b) (rest disturbance) are similar to those shown in Fig. 2(d) (annoyance), although the level of change effect of listening and resting disturbances is to some extent smaller than that of annoyance in most noise level ranges. Even if ΔL_{day} is negative (L_{day} decrease from the first survey to the second or third survey), the L_{day}–%VD curves are higher than that for the first survey. Although the L_{night}–%VSD curves in $\Delta L_{night} > 0$ are higher than that for the first survey, that in $\Delta L_{night} \leq 0$ is slightly lower. The L_{night}–%VSD curves in $\Delta L_{night} > 3$ is slightly lower than that in $0 < \Delta L_{night} \leq 3$. All comparisons among the curves shown in Figs. 2(a)–2(d) show significant differences ($p < 0.05$), except the differences between "$\Delta L_{day} < -3$" and "$-3 \leq \Delta L_{day} < 0$" in Fig. 2(a), between "1st" and "$\Delta L_{night} \leq 0$" in Fig. 2(c), and between "1st" and "$\Delta L_{day} < -3$" in Fig. 2(d).

4. DISCUSSION

4.1. The Change Effect of Activity Disturbances from the Viewpoint of Annoyance Model

The main objective of this study is to determine whether the change effect occurs for activity disturbances in the socio-acoustic surveys around HNBIA. Brown and van Kamp [1] stated, "Several authors have found, or suggest, that activity interferences (speech interference, closing windows, etc.) may not display the same level of excess response as do annoyance measures when noise exposure changes." In this study, almost the same findings as those of Brown and van Kamp [1] were obtained: the level of change effect of listening and resting disturbances is to some extent smaller than that of annoyance, and a much smaller change effect is found in awakening. Fields and Hall [11] showed a simplified and hierarchical model of annoyance. In this model, there are direct effects of noise, personal and attitudinal factors, and immediate effects (activity disturbance and physiological reactions) on annoyance. In addition, there is an indirect effect of noise on annoyance via immediate effects. In other words, noise affects annoyance directly and indirectly via immediate effects. They pointed out that the characteristics of noise may yield negative emotional or cognitive reactions even if the noise is not responsible for activity disturbances. Guski [12] also indicated a similar but more comprehensive model of annoyance and long-term somatic effects. The annoyance model is the one that personal and social factors affect annoyance directly, and noise and personal factors affect annoyance indirectly via short-term effects such as actual interference. For these reasons, the effect of step change on activity disturbance may be less than the effect on annoyance because the annoyance is also indirectly affected by noise and attitudinal factors.

4.2. Increased Responses to Decreased Noise Exposure

Even if noise exposure decreased, annoyance and some activity disturbances increased. As for the reason for the increased response to the decreased noise exposure,

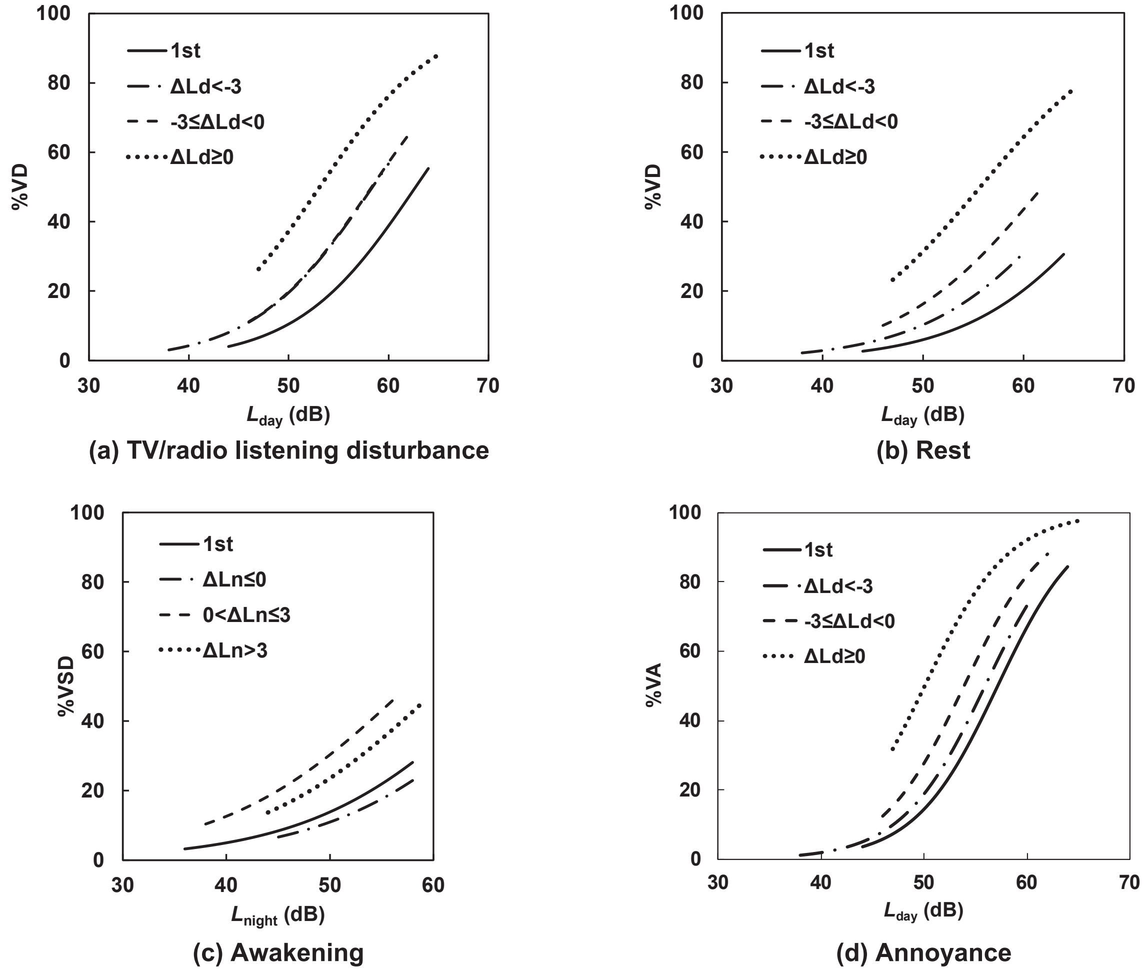

Fig. 2 Exposure–response relationships for exposure change for TV/radio listening and rest disturbances, awakening, and annoyance.

Nguyen *et al.* [6] hypothesized that people living around HNBIA psychologically noticed the increase in aircraft noise emission because of the construction of the new terminal building and the increase in the number of flights, but aircraft noise exposure did not change following the change in noise emission owing to the change in runway use. In other words, the cognition of airport development and operation seems to largely affect annoyance and disturbance response to aircraft noise.

Other than the conceptual explanation mentioned above, some observational findings are obtained as follows: Yokoshima *et al.* [13] showed by the secondary analysis of social survey data in Japan that military aircraft is much more annoying than civil aircraft. On the other hand, Morinaga *et al.* [14] showed in a laboratory experiment that there is no significant difference in noisiness response between military and civil aircraft noises with the same L_{AE} despite the differences in sound quality if the aircraft model is not informed to the participants. Although annoyance response analyzed by social surveys and noisiness response by laboratory experiments are not necessarily identical, this suggests that the cognition of a noise source yields a negative impression in actual daily life. Guski [12] reported that most citizens have a different mental image of each noise source and suggested that a negative attitude toward the noise source increased subjective annoyance. He also emphasized the importance of the cognition that the noise load will not increase, and the authorities will take appropriate measures to decrease annoyance. Kuwano *et al.* [15] showed the difference in the semantic profile of a bell sound between Japanese and German participants. These studies strongly support the findings in our step-change study. Also, from this viewpoint, not only the recognition of airport development but also the change in the number of flights of military aircraft before and after the construction of the new terminal may be related to the change in annoyance. However, since there is no long-term data on the number of flights of military aircraft, it is impossible to discuss the effect of the change in the number of flights of military aircraft at this time.

On the other hand, the effect of the cognition of emission increase during sleep may be smaller than in that during the daytime because people may not clearly recognize the noise source during sleep, but they are directly affected by noise exposure. As shown in our previous study [6], when the sleep disturbance measure is not based on the degree of disturbance but a more objective frequency of disturbance, the level of excess response is smaller than that in this study. Although the L_{night}–%VSD curve is significantly lower in $\Delta L_{\mathrm{night}} > 3$ than in $0 < \Delta L_{\mathrm{night}} \leq 3$, it should be considered that sleep disturbance is not largely affected by the step change because the difference is small and the change effect for awakening is smaller than that for daytime activity disturbances. Also, it may be important that the results shown in Fig. 2(c) reveal different trends between $\Delta L_{\mathrm{night}} > 0$ and $\Delta L_{\mathrm{night}} \leq 0$.

5. CONCLUSIONS

By using data from socio-acoustic surveys around Hanoi Noi Bai International Airport conducted from 2014 to 2015, we determined whether the change effect in addition to the exposure effect was found in activity disturbances. Results showed that the change effect was found in activity disturbances. The effect size for TV/radio listening and resting is almost the same as that for annoyance but slightly smaller. However, that for awakening is smaller than that for annoyance. Although listening and resting disturbances and annoyance were increased even when the noise exposure decreased, such effect was not seen for sleep disturbance. These may be explained by the conceptual annoyance models by Fields, Hall, and Guski and the cognition of the noise source.

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