

Community response to noise around Noi Bai International Airport from 2009 to 2018

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ABSTRACT

Noi Bai International Airport (HNBIA) is the second largest airport in Vietnam. Recently, the rapid development of air transport in Vietnam, together with the urbanization of the area around the airport, resulted in increased levels and wider influential scale of noise due to the airport operation. This study summarizes the results of socio-acoustic surveys on community response to noise conducted around NBIA from 2009 to 2018. The number of flights operated at NBIA and the population density at residential areas around the airport has increased significantly

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in the past nine years. The exposure noise levels (L_{den}) at surveyed sites ranged between 48 and 61 dB in 2009, but increased to range between 54 and 76 dB in 2017. Exposure-response relationships established in the five surveys conducted from 2014 to 2018 were found to be higher than that established in 2009 survey. Especially, an excess response due to the step-change of noise exposure was found when the airport operation changed after the opening of the new terminal at the end of 2014. This effect seems to decline over time but responses remain high when compared to that of the steady state at the same noise exposure level.

Keywords: Aircraft Noise, Community Response, Step-change
I-INCE Classification of Subject Number: 66

1. INTRODUCTION

An increase of flight operation to meet the growing air travel demand have various negative environmental impacts, particularly noise and air pollution, that affects quality of life and health of communities living near the airport [1-3]. However, the number of studies on this issue is very limited in developing countries where the aviation transport has the fastest growth rate [4]. A socio-acoustic survey on community response to aircraft noise around Hanoi Noi Bai International Airport (HNBIA), Vietnam, was conducted in 2009 [5]. The operation status of HNBIA was considered to be stable around the survey period. Since then, the number of operations of the aircraft has gradually increased, especially after the opening of the new terminal building in December 2014 (Table 1). To assess effects of a step change of noise exposure levels around HNBIA, step-change surveys were conducted once before and twice after the operation change happened. As a result, an excess response due to the step-change were found [6]. To clarify whether this excessive reaction decreases over time or continues afterwards, two follow-up surveys were conducted in 2017 and 2018, which are about 3 years and 4 years after the step-change. Study results of individual surveys up to 2017 have been reported at previous Internoise conferences [7-11]. In this paper, the results of socio-acoustic surveys in nine years around HNBIA will be summarized with aims to assess aircraft noise problems and contribute to appropriate noise policy for improving the living environment around the airports in developing countries.

Table 1 – Number of flight movements at HNBIA from 2010 to 2018

Year	Flight number	Passenger number
2010	75,000	10,532,000
2011	79,000	10,798,000
2012	84,000	11,341,000
2013	88,000	12,451,000
2014	101,000	14,191,000
2015	119,000	17,214,000
2016	140,000	20,597,000
2017	161,000*	23,800,000
2018	183,000*	27,000,000

*estimated from passenger number

2. METHODS

2.1 Survey sites

HNBIA has two parallel runways in the east-west direction (11L-29R and 11R-29L). Since the operation direction of the runway is influenced by the wind direction, the use of the flight path toward the east occupied near 80% of the total movements at HNBIA. As shown in Figure 1, nine surveyed sites (Sites 1-9) were selected around HNBIA in the 2009 survey. Four sites (Sites 1-4) located under the main landing path, 3 sites (Sites 7-9) located under the main takeoff route, 2 sites (Sites 5-6) located to the south of the runway. In the surveys from 2014 to 2018, a total of 13 sites (Sites A1 - A13), including 7 sites investigated in the 2009 survey, were selected. Particularly, three new sites A5, A6, A8 located close to the end of the runway of the airport, and two control sites A12 and A13 located in the northeast direction of the airport. The control sites A12 and A13 have almost the same living environment as the other sites, but were assumed to be unaffected by aircraft noise.

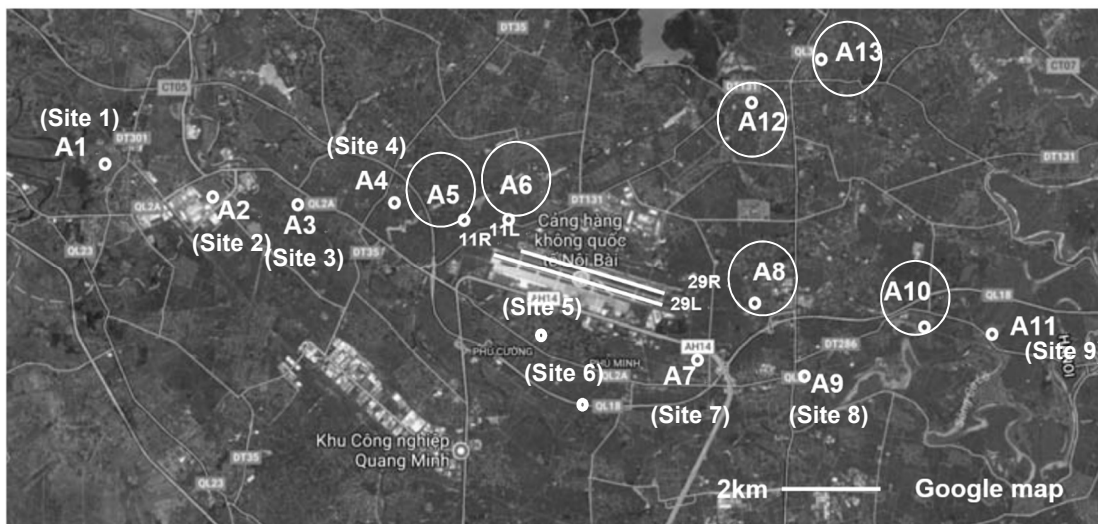


Figure 1. Map of all surveyed sites

(Site—) : Selected sites of 2009 Survey ○ Survey sites added since the 2014 survey

2.2 Questionnaire Survey

In the series of surveys, Vietnamese questionnaires including two standardized annoyance questions recommended by ICBEN [12-13] were prepared. Community responses in the vicinity of HNBIA were collected by the interview method. The percentage of respondents who were highly annoyed (%HA) was defined as the percentage of respondents who chose 8, 9 or 10 of the 11-point numerical scale (0-10). At the survey since 2014, the percentage of insomnia (%ISM) was defined by the frequency of sleep effects as proposed by the International Institute of Sleep [14] was used as an indicator of sleep effect caused by the flight operation during the night time.

In this study, %ISM was calculated by the percentage of respondents who experienced one of the symptoms described in the question of sleep effects three or more times a week. In addition to general annoyance and sleep impacts, exposure to high levels of aircraft noise may adversely affect cardiovascular disease and other health categories [15,16]. Since studies of health effect of aircraft noise has not so far been conducted for residents living near airports in developing countries, in the survey of 2017, data on the

health status of residents such as body mass index (BMI) and blood pressure based on self-report were collected to evaluate the health effects of aircraft noise around HNBIA. Furthermore, in the survey in 2018, the blood pressure was measured with a blood pressure meter (OMRON HEM-6324T). Also, instead of questions about living conditions and the surrounding environment, questions about current health status such as BMI, blood pressure and heart rate were added.

2.3 Flight operation information and noise measurement

In the surveys until 2017, day-evening-night noise level (L_{den}) and nighttime equivalent noise level ($L_{night(22:00-6:00)}$) were estimated from the field measurement of noise levels. Sound level meters (RION NL-42, NL-21, NL-22) were set up on the roof of houses selected at each surveyed site. A-weighted and S-weighted sound pressure levels ($L_{A,S}$) sampled at 1 s were recorded continuously through 7 days. In the survey of 2018, L_{den} and L_{night} were estimated from a noise contours map created by using Integrated Noise Model (INM) instead of field measurements. The necessary data for creating the noise map such as flight logs was provided by the Civil Aviation Authority of Vietnam (CAAV).

3. RESULTS

3.1 Changes in flight numbers and noise levels

The number of flights operated at HNBIA and the population density of the residential area around the airport have increased significantly in the past nine years. Table 2 shows the average number of daily flights operated by HNBIA during each survey period. It can be seen that the number of flights observed in 2018 is about three times higher than that of 2009 and 1.7 times higher than that of 2014. Although the number of flights increased sharply after the new terminal building was put into operation, the airport capacity has been changed, and noise exposures caused by increased number of flights has gradually changed since then.

Table 2 – Average numbers of aircraft noise events

Time period	Operation modes	Surveys					
		8/2009	9/2014	2-3/2015	9/2015	11/2017	8/2018
Day (6:00-18:00)	Arrival	50	84	104	100	125	141
	Departure	51	90	109	107	139	123
	Total	101	174	213	207	264	264
Evening (18:00-22:00)	Arrival	23	32	43	39	48	12
	Departure	14	16	27	22	35	13
	Total	38	48	70	61	83	25
Night(22:00-6:00)	Arrival	9	9	16	14	39	77
	Departure	10	21	26	25	37	94
	Total	19	30	42	39	76	171
All day	Arrival	82	125	163	153	211	230
	Departure	75	127	162	154	211	230
	Total	157	252	325	307	422	460

It is worth noting that the most recent number of nighttime flight events increased by 2.5 times and 1.9 times, compared to the September 2014 “before new terminal building opened” survey and the latest “after the opening” survey for September 2015, respectively. Especially, the recent number of flight events at night increased sharply and occupied about one-fifth of the total number of flights.

Table 3 shows the noise levels obtained during each survey period. L_{den} measured at the sites which were surveyed since 2009 increased from 48 to 61 dB in 2009 and 54 to 66 dB in 2018. Especially, $L_{night(22:00-6:00)}$ was found to increase about 10 dB higher at Sites A3 and A4. This result is consistent to the sharp increase of the flight movements during the night time at HNBIA.

Table 3 – Changes of noise exposure levels: Night-time noise levels ($L_{night(22:00-6:00)}$) and Day-evening-night noise levels (L_{den})

	L_{den}						$L_{night(22:00-6:00)}$					
	8/2009	9/2014	3/2015	9/2015	11/2017	8/2018	8/2009	9/2014	3/2015	9/2015	11/2017	8/2018
A1	55	55	55	53	55	53	47	45	46	45	47	44
A2	56	55	56	54	54	56	49	45	48	46	47	47
A3	61	62	64	62	62	61	51	53	56	55	54	52
A4	56	54	56	57	63	61	44	46	48	48	55	53
A5		61	61	68	76	71		51	53	59	69	63
A6		65	64	64	53	64		50	57	56	44	56
A7	57	66	62	62	65	64	48	55	56	55	57	56
A8		66	66	65	66	66		58	58	58	59	57
A9	61	63	60	63	65	66	54	55	53	56	58	57
A10		60	58	59	60	60		52	52	53	53	50
A11	52	60	57	59	59	58	45	52	50	52	52	49
A12		45	45	49	38	41		36	38	39	30	
A13		47	44	51	38	40		36	38	44	29	

3.2 Changes in community responses

As shown in Table 4, there is a dramatic increase of %ISM at Site A5, which increased from 17% in September 2015 to 43.8% in November 2017. This result is consistent with a 10 dB increase in the nighttime noise level measured at Site A5. However, the same trends were not found with the general annoyance defined by %HA. Despite a slight increase in L_{den} between 2015 and 2017, %HA decreased at Sites A7 and A9, which located under the take-off path of aircrafts. A decrease in %HA was seen in all sites under the landing path, except for site A3.

Figure 2 shows a comparison of (a) L_{den} -%HA and (b) $L_{night(22:00-6:00)}$ -%ISM relationships established by using data obtained from all the surveys. The L_{den} -%HA relationships of the follow-up survey in 2017 and 2018, which were conducted about 3 years and 4 years after the step-change, are lower than that of the 2015 surveys which were carried out immediately after the change within the range of L_{den} over 60 dB, but higher than the exposure-response relationship established for the 2009 and 2014 surveys and the curved presented in EU position paper [17]. In other words, the excess response due to the step change seems to decrease with time, but still remains higher than the

reaction before the terminal is completed at the same noise exposure level. However, the $L_{\text{night}(22:00-6:00)}$ -%ISM relationships obtained by the 2017 survey data is lower than that obtained in the previous survey, 2018 is higher than the relationships obtained in the previous survey. The nighttime noise level found in 2018 survey is lower than that of 2017. This result indicated that sleep was influenced not only by the amount of noise exposure but also by other various non-acoustical factors.

Table 4 – Percentage of highly annoyed (%HA) and percentage of insomnia (%ISM)

	%HA						%ISM				
	8/2009	9/2014	3/2015	9/2015	11/2017	8/2018	9/2014	3/2015	9/2015	11/2017	8/2018
A1	6.5	8.2	5.7	2.0	0.0	20.0	1.4	1.1	0.0	0.0	20.0
A2	11.5	9.1	35.8	28.9	14.3	20.0	0.0	6.9	3.1	4.2	20.0
A3	57.0	59.1	71.1	65.3	95.7	60.0	17.0	20.2	21.9	2.2	22.2
A4	68.4	48.2	83.3	92.0	77.8	60.0	17.5	26.5	22.4	19.1	20.0
A5		47.7	73.9	96.0	91.7	90.0	8.9	33.7	17.0	43.8	40.0
A6		70.8	63.8	84.0	83.0	60.0	4.6	7.5	20.0	17.0	10.0
A7	8.3	44.1	12.4	60.6	10.4	20.0	5.4	17.5	9.0	0.0	10.0
A8		58.2	55.1	68.5	33.3	80.0	33.3	1.0	7.4	8.3	10.0
A9	20.0	28.4	37.8	56.0	53.2	10.0	6.7	5.6	24.0	10.6	10.0
A10		10.1	10.3	28.0	34.0	0.0	6.1	5.1	12.1	10.4	10.0
A11	4.7	9.0	5.5	11.2	12.0	40.0	0.0	4.2	5.1	0.0	30.0
A12		0.0	0.0	2.0	0.0	9.1	0.0	0.0	1.0	0.0	0.0
A13		0.0	0.0	3.2	0.0	0.0	6.3	1.4	1.0	0.0	0.0

In this study, hypertension was defined as if the systolic and diastolic blood pressure were higher than 120 and 80 mmHg, respectively. A comparison was made to examine the relationship between L_{den} and % hypertension and $L_{\text{night}(22:00-6:00)}$ and % ISM. Considering p-value given by logistic regression analysis, no significant association was found for hypertension and L_{den} (Table 5). Results of multiple logistic regression investigating risk factors of high blood pressure indicated that “age” and “often drinking alcohol” significantly affected blood pressure. There was significant association between % ISM and $L_{\text{night}(22:00-6:00)}$ (Table 6). An increase in noise level due to the increase in the number of flight movements at night has been shown to have an adverse effect on the quality of sleep and the health of residents living near the airport.

Table 5 – Comparison of high blood pressure ratios at different noise level ranges of the 2017-2018 surveys (L_{den})

		L_{den} (dB)						p value
		<50	50-55	55-60	60-65	65-70	>70	
11/2017	%	51.2	46.6	34.8	16.7	41.2	80.8	0.3091
	Response number	21/41	27/58	8/23	4/24	7/17	21/26	
8/2018	%	55	50	66.7	72.5	45	70	0.8919
	Response number	11/20	5/10	20/30	29/40	9/20	7/10	

Table 6 – Comparison of Insomnia ratios at different noise level ranges of the 2017-2018 surveys ($L_{\text{night}}(22:00-6:00)$)

		$L_{\text{night}}(22:00-6:00)$					p value
		<45	45-50	50-55	55-60	>60	
9/2014	%	2.7	6.9	6.6	33.3		<.0001
	Response number	5/183	14/202	27/410	30/90		
3/2015	%	0.7	10.5	15.2	11.8		<.0001
	Response number	1/148	35/333	39/256	44/374		
9/2015	%	1.0	8.5	13.0	15.6		<.0001
	Response number	2/195	25/293	38/293	77/494		
11/2017	%	5.7	2.0	4.2	9.5	43.75	<.0001
	Response number	8/141	2/98	6/144	18/190	21/48	
8/2018	%	0	23.3	24.1	10	40	<0.05
	Response number	0/21	7/30	7/29	4/40	4/10	

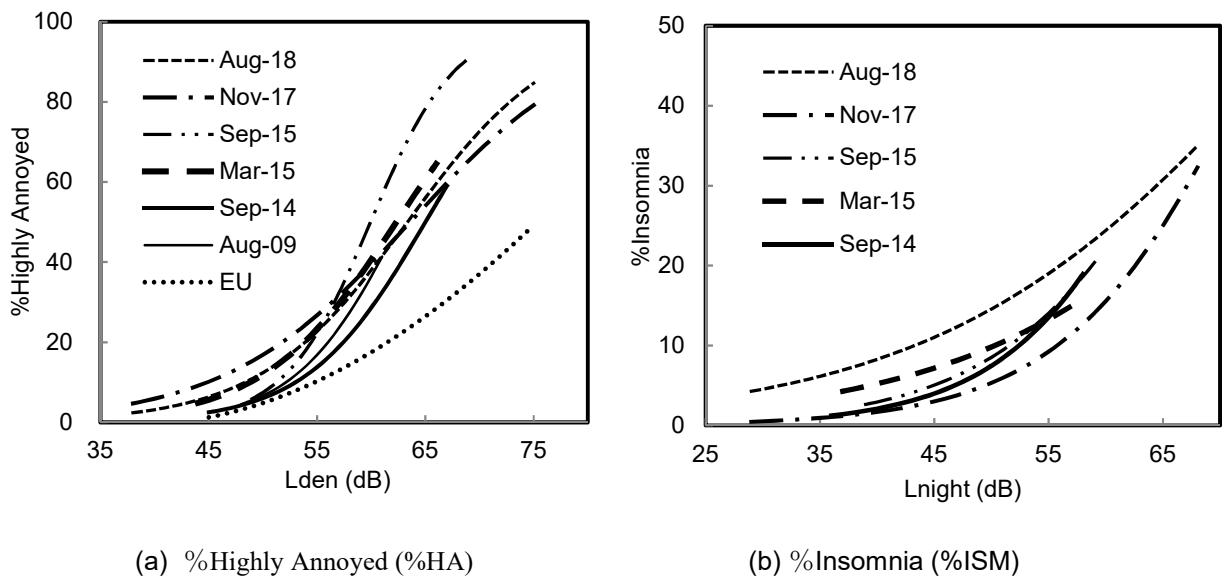


Fig. 2 – Comparison of the relationships synthesized from the data of each survey from 2009 to 2018

4. CONCLUSIONS

In this study, it seems that the excess response due to the step-change decreases over time, but the response is still high compared with those obtained before the opening of the new terminal at the end of 2014 at the same noise level. An increase in the number of flights operated at night negatively affects the quality of sleep. It should be considered to protect the living environment in the vicinities around the airports in Vietnam by restricting night operation and formulating policy regarding aircraft noise.

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