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Comparison between old and new noise standards in Nagoya City

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Abstract

The Japanese Environmental Agency (now the Ministry of the Environment) updated the environmental quality standards for noise in April 1999. The new standards replaced the median value of percentile level L_{50} for noise evaluation with the equivalent sound pressure level L_{Aeq}. The standards renewed the classification of areas and time sections. The most significant change was the introduction of category of artery-road-adjacent area.

This report sets the range of the artery-road-adjacent area to 20 m or less from the applicable road to compare the new standards with the old, based on data collected in Nagoya City. The achieved rates for the new standards seem to be on the whole the same as those for the old standards. However, a detailed analysis reveals some differences, such as higher achieved rates in the artery-road-adjacent areas and lower achieved rates in the general areas for the new standards than for the old.

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1. Introduction

In Japan, the median value of percentile level L_{50} had been used for noise evaluation since 1971. However, another noise index had been expected for a more appropriate maximum permissible noise level. Through many studies, the equivalent sound pressure level L_{Aeq} was adapted for several reasons.

The first reason is the development of data-processing units. Japan has been a ''noise-leading country'' so that investigators and researchers had to use noise detectors with limited data-processing functions, for example, at most L_{50}. Today, the progress of technology achieves the calculation of L_{Aeq} inside the noise detectors.

The second reason was that many studies have shown high matching of L_{Aeq} data with the residents' reactions, which is community dose-response [1–5].

The third reason is the guideline values of noise by ISO. In 1975, International Standardization Organization issued the recommendation that L_{Aeq} should be 80 dB or less for people who work 40 h a week to secure their hearings. In Europe, CEC followed the guideline value of ISO, but in the USA, EPA defined 70 dB in L_{Aeq24} as the guideline value in 1974. In Japan, it is said that 66% of workers are under the labor conditions of noise level of more than 70 dB [1].

The fourth reason is the guideline value of noise by WHO. The World Health Organization specifies a guideline value as 55 dB in the daytime and 45 dB in the nighttime in L_{Aeq}, and suggests that each country should set a guideline value with consideration of the infrastructural and cultural elements [6].

The fifth reason is the judgment on traffic noise from Route 43. National road Route 43 in Kobe area (damaged by the Great Hanshin-Awaji Earthquake in January 1995) has been involved in court in a noise issue. In July 1995, the Supreme Court gave a ruling that the government and the Hanshin Highway Public Corporation should take an effective action to suppress the noise and pollution from cars. In the document, the maximum permissible level for noise was specified by L_{Aeq} as 65 dB in inhabited areas within 20 m from the road and 60 dB in the other areas [1].

The sixth reason is international conformance. As a fact, L_{Aeq} and/or its modified Lr are adapted in many countries and regions for road traffic noise regulations. According to the survey of Gottlob, as of 1994, the exceptions were the UK, Australia, and Hong Kong that applied L_{10}, Japan L_{50}, and Belgium L_{95} [7]. Comparative studies in Japan have shown that L_{50} values are lower than L_{Aeq} values by about 6 dB [1]. In the areas that are close to heavy traffic roads, L_{50} is lower than L_{Aeq} by about 4 dB in the daytime and about 10 dB in the morning and nighttime sections.

For the above reasons, the new standards were promulgated in September 1998, and enforced in April 1999 in Japan.

2. The old and new environmental quality standards for noise in Japan

The environmental quality standards for noise in Japan are specified by land-use, time section, road proximity, road category, and road role and size. The classification items are as follows:

2.1. Land-use type

In Japan, according to the land-use law, areas are classified into exclusive residence-type area, residence-type area, commercial-type and industrial-type areas. In Nagoya, the ratios of area type are shown in Fig. 1.

2.2. Road proximity

The next classification item is road proximity, which is the classification of "road-facing areas" and "general areas" for the consideration of the large influence of traffic noise. In the old standards, the definition of "road-facing area" was not clarified. However, the new standards separated "artery-road-adjacent area" from the conventional "road-facing area" for areas facing or close to large roads. The Ministry of the Environment recently specifies a distance of 15 or 20 m for artery-road-adjacent areas depending on the road category and size [8].

2.3. Road category

Both old and new standards have road classifications. The classifications are: national highways, city highways, national roads, prefectural roads and municipal roads. The total length of each road category in Japan is shown in Fig. 2.

Furthermore, roads are classified in terms of their roles and sizes. Highways, national roads, prefectural roads, and municipal roads of 4 or more lanes are classified into the artery road type. The other roads including municipal roads of 3 or less lanes are classified into the living-use road type.

2.4. Time section of day

The old standards had four time sections. In the new standards, they are simplified into only two sections: daytime (6:00–22:00) and nighttime (22:00–6:00).

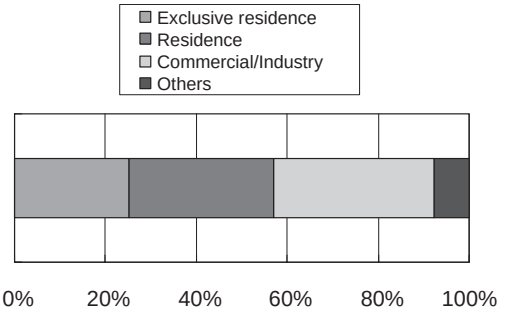

Fig. 1. Land-use type distribution in Nagoya. The shaded portions in the stacked bar show the exclusive residence-type (25.1%), the residence-type (32.0%), the commercial/industry-type (35.2%), and the other area (7.7%) from the left-hand side.

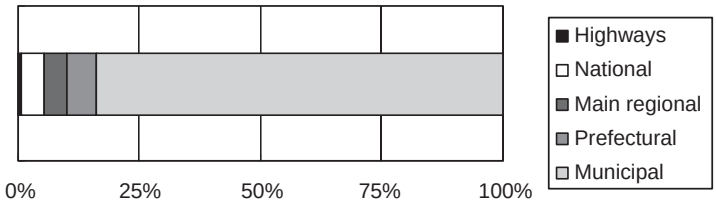

Fig. 2. Road category distribution in Japan. On the length basis: the shaded portions in the stacked bar show the highways (6.0%), national roads (4.6%), main regional roads (5.0%), prefectural roads (6.1%), and the muncipal roads (83.7%) from the left-hand side.

Table 1
Area classifications and maximum permissible levels for noise

	Area No.	Land-use category: Commercial / industry	Land-use category: Residential	Land-use category: Exclusive residential	Proximity [m]: □..20	Proximity [m]: 20 - 50	Proximity [m]: 50 □..	Road type: artery	Road type: living-use	Number of lanes: 1	Number of lanes: 2	Number of lanes: 3	Number of lanes: 4	Max. permissible level [dB]: Day	Max. permissible level [dB]: M/E	Max. permissible level [dB]: Night	Noise index
Old standards	O1	■			■							■		**65**	**65**	60	L50
	O2	■			■						■			**65**	60	55	
	O3		■		■							■		60	55	50	
	O4		■		■						■			55	50	**45**	
	O5	■				■		■		■	■	■	■	60	55	**45**	
	O6		■	■		■				■	■	■	■	50	**45**	**40**	
New standards	N1	■	■	■	■			■		■	■	■	■		**70**	65	LAeq
	N2	■	■	■		■			■	■	■	■	■		65	60	
	N3			■		■		■	■	■	■	■	■		60	55	
	N4		■	■		■			■	■	■	■	■		60	**50**	
	N5	■				■			■	■	■	■	■		55	**45**	

The old and new Japanese environmental quality standards for noise have classifications as summarized in Table 1 [2]. The applied conditions are represented by hatching. The abbreviation O means the old standards, N means the new standards. "Proximity" shows a distance from a road to the measurement point, "Road-type" shows road role and size, and "M/E" in maximum permissible level shows the morning and evening time sections. In this table, O1–O4 are the road-facing areas, and O5 and O6 are the general areas. N1 is the artery-road-adjacent area, and N2 and N3 are the road-facing areas but not the artery-road-adjacent areas. Lastly, N4 and N5 are the general areas. In N3 excluding the first row item, N4 and N5, the condition of distance of 50 m or more from artery roads is added to the representation in Table 1. The maximum permissible noise levels on the A-weighted indices are set to each classification item.

3. Survey and measurement of noise

Noise detectors were installed in typical outdoor noise environments at residential sites in Nagoya City. Thus this paper sets a distance of 20 and 50 m from roads to define the artery-road-adjacent and road-facing areas for the new standards, respectively. A distance of 20 m from roads in this paper corresponds to the area boundary between the road-facing area and the general area on the old standards. The municipal Nagoya area was divided into about $1 \times 1\,\mathrm{km}^2$ to distribute the measurement points to the entire city. The noise indices L_{50} and L_{Aeq} were measured at 10 min intervals for 24 h [2]. This measurement was conducted only on weekdays. This survey excluded rainy or windy days for the uniformity of measurement conditions. Thus the survey since 1985 has resulted in 1196 samples. On the whole, the higher noise level areas from 60 to 65 dB were concentrated in the central part of the city. The low noise level areas were located in the peripheral parts, which are mostly residential areas except some areas that have artery roads with heavy traffic.

4. Results

The results of evaluation are summarized in Fig. 3. The left-hand side panel shows the achieved rates for each area classification for the old standards. The number of effective samples is 975. The right-hand side panel shows that for the new standards. The number of effective samples is 1097. According to the criteria set in this paper, a sample that satisfies the old standards in all time sections is judged as ''Achieved''. As a result of this estimation, 51% of all the samples achieved the old standards. The achieved rate of area O2 exceeded 90% and that of area O5 60%. In other areas (O1, O3, O4, and O6) achieved rates ranged from 20% to 40%. The achieved rate of area N3 was 48%. That of other road-adjacent areas N1 and N2 was more than 60% and for the general areas N4 and N5 was 20% or less. This is because the noise regulation on the new standards in the general areas is tighter than that on the old standards. The total achieved rates for the old and new standards were almost the same, 51% and 49%, respectively. According to the new standards, the achieved rates were high in road-adjacent areas and low in general areas. To

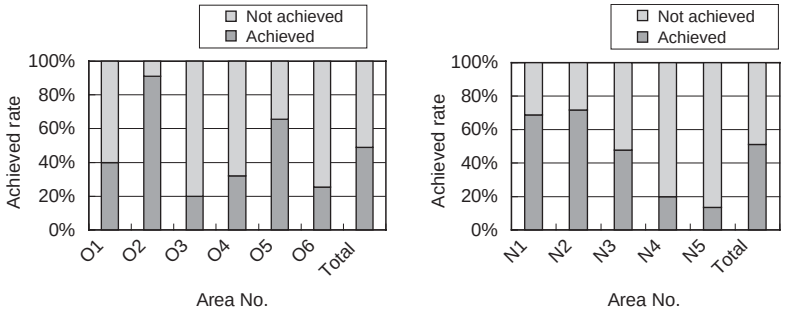

Fig. 3. Achieved rates in old and new standards. The white portions in the stacked bars show the achieved rates, and the dark portions show the not achieved rates. The number of samples: 976 for the old standards; 1097 for the new standards.

Table 2
Comparative achieved rates between old and new standards

Area categories on old standards			Area categories on new standards N1 Achieved	N1 Not	N2 Achieved	N2 Not	N3 Achieved	N3 Not	N4 Achieved	N4 Not	N5 Achieved	N5 Not
	O1	Achieved	15	0	1	0						
		Not	5	19	0	0						
	O2	Achieved	11	0	228	44						
		Not	2	6	3	17						
	O3	Achieved	5	0	1	0						
		Not	16	6	1	1						
	O4	Achieved	5	0	15	2	11	8				
		Not	20	8	20	14	6	19				
	O5	Achieved			9	0			3	0		
		Not			3	2			7	5		
	O6	Achieved	1	0	8	0	3	0			30	69
		Not	8	1	43	13	12	8			13	228

	b
a	

D=a-b

D	N1	N2	N3	N4	N5
O1	5	0			
O2	2	-41			
O3	16	1			
O4	20	18	-2		
O5		3		7	
O6	8	43	12		-56

The right-hand table shows a transfer of a not-achieved rate on the old standards minus a not-achieved rate on the new standards, $D = a - b$.

compare the achieved rates for the old and new standards, the transfer of achieved rates between both standards was investigated. Table 2 shows how many samples in each classification achieved the old and new standards in all the time sections. For example, in the left-top 2×2 cells, 15 samples in area categories O1 and N1 achieved both the old and new standards. Five samples achieved the new but not the old standards. There was no sample that achieved the old standards but not the new. Nineteen samples achieved neither the old nor the new standards. From this table, the transfers between achieved rates and not-achieved rates for both standards are found. About 15% of all the measurement points in the commercial/industry-type area at a distance of 20 m or less from roads except artery roads achieved the old standards, but not the new standards. Almost no measurement points in the area category were transferred from the non-achievement on the old standards to the achievement on the new standards. Many of the measurement points in the residential and exclusive residential areas at a distance of more than 20 m from roads achieved the old standards but not the new standards. These tendencies suggest the fact that more samples in artery-road-adjacent areas achieve the new standards than the old. On the other hand, more samples in the general areas far from artery roads do not achieve the new standards than the old.

Fig. 4 shows a cumulative distribution of L_{Aeq24} classified by distances from artery roads. This figure indicates a critical value for a distance between 10 and 20 m. The new standards describe the threshold as 20 m for artery roads of 3 or more lanes and 15 m for those of 1 or 2 lanes [8].

5. Comments

According to the social survey in Nagoya City, the estimated achieved rates were about 50% for both old and new environmental quality standards for noise. The detailed evaluation showed

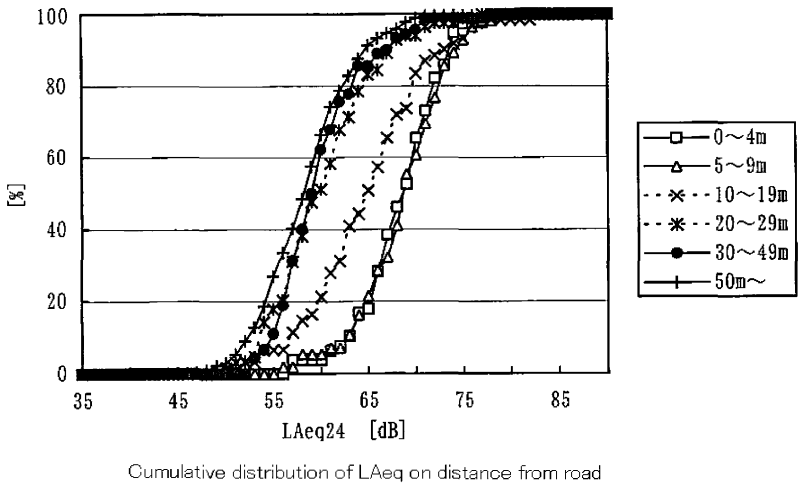

Fig. 4. Cumulative distribution of L_{Aeq} on distance from roads.

higher achieved rates for the new standard in road-adjacent areas than for the old standards. On the other hand, this estimation shows the lower achieved rates in general areas, which are in many cases rather under low noise conditions, with the new standards than with the old standards. The distance dependence of L_{Aeq} shows a critical value of around 20 m from artery roads.

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