AN ECONOMIC EVALUATION FOR ROAD TRAFFIC NOISE

DR. HISAO UCHIYAMA

ASSOCIATE PROFESSOR
DEPARTMENT OF CIVIL ENGINEERING
FACULTY OF SCIENCE AND TECHNOLOGY
SCIENCE UNIVERSITY OF TOKYO
2641 YAMAZAKI, NODA CITY, CHIBA, JAPAN

1. INTRODUCTION

The traffic noise problem in Japan has crept slowly for so many years, and now has surfaced explicitly and taken its toll. Unfortunately, absolute countermeasures against such nuissance have not been found. This may lie in the fact that it has been very difficult to estimate the corresponding monetary value of the effects of noise pollution. This research focuses on the derivation of what we can call social cost, caused by noise, especially road traffic noise.

An attempt to derive the actual cost of what we call external diseconomy, such as public nuissance, has been made since the introduction of the concept of social cost in the 1970's. Various concepts for social cost have been discussed and one particular economist, W. Michaelski, categorized these into the following 4 concepts:

(1) Social cost is the gross national economic cost of products.
(2) Social cost is the national economic loss when the optimum state of socio-economy is not established due to some reason.
(3) Social cost is the non-market load which a third economic subject bears but should have been borne by a first or second economic subject who does not take responsibility for it.
(4) Social cost is the implementing cost of whole actions dependent on an economic policy.

Detailed description of the above definitions is omitted here. Michaelski himself selected the definition of social cost as social additional cost, which corresponds to the third one above, because he regarded the operational meaning of social cost important in actual economic policies. Moreover, in measuring social cost, the 3rd concept can be considered appropriate. Also there is a fair consensus among practitioners as to the use of this concept.

A number of practical methods to measure social cost, related to noise are listed as follows: measurement from direct expenditures for equipment or facilities to prevent noise propagation, measurement from depreciation of income or property caused by noise, analysis of court decisions on lawsuits against noise pollution, and analysis of individual perception of noise pollution through the results of questionnaire surveys.

The derivation of social cost from questionaires on which most of the above methods are based might throw the question of reliability on the obtained value as to whether it be the real social cost. That is to say that these questionnaire surveys may entail such problems as the establishment of the reliability of the survey itself, the difficulty in identifying the difference in personal perception of noise, and the ambiguity coming from the measurement of individual subconscious perception of noise.

By applying the method of direct expenditure, the cost paid for the control of noise pollution may be calculated. However, this cost may not reflect the true magnitude of damages due to noise because such equipment or facilities may produce other side effects which may be positive. In addition, it might be impossible to account in detail for individual whole costs which would definitely be assigned to damages due to noise.

These problems may be caused by the lack of obvious external criteria which describe all possible damages caused by noise. It is required that such external criteria which should be normalized in monetary terms be used to derive a more reliable estimate of social cost. Here in this paper, the following three different approaches are applied: (1) Residential land price is adopted as an external criterion, and the depreciation of land price caused by noise is analyzed. (2) Consolation money for mental damages attributable to noise as determined by law is adopted as such criterion, and the relation between this amount of money and the magnitude of noise exposure is analyzed. (3) The amount of investment for environmental protection for a certain expressway is adopted as such criterion, and noise cost is derived from this amount and the expected noise abatement.

2. ANALYSIS BASED ON RESIDENTIAL LAND PRICE

2.1 Premise of the analysis

A basic idea in land-price analysis says that the value of the use of a land is reflected in its land price. If traffic noise brings about the depreciation of the said value, noise cost may be derived. However, the analysis is limited to residential land use only. It cannot be used for commercial and industrial areas because the accessibility to major highways may increase the value of the use of the land rather than depreciate it.

Noise cost cannot be derived from the simple comparison of the residential land price of areas exposed to traffic noise and relatively quiet areas. It requires an involved process wherein the following activities have to be accomplished. First, we must estimate the residential land price properly. Obviously, it depends on the natural, geographic, social and economic qualities of a land. We use these general factors in a statistical process, a multiple regression analysis in order to yield a function describing residential land price. This function is derived from data collected from a "normal" area, i.e. a relatively quiet area, thus producing what we call "normal residential land price". The "normal" land price of an area which is exposed to heavy traffic noise can be estimated using the above function. Thus, its "normal" price can now be compared with its actual residential land price, and the difference may be taken as an estimate of noise cost.

Land price is described not only by local factors such as accessibility to the railway station but also by area-wide factors such as geographical relation to nearby CBD districts. Here however, since we want to focus on impacts of traffic noise on land price, the sampling of land price is done in only one large residential area. We only consider local factors affecting the study area, and may neglect area-wide factors. The areas chosen for the study includes Midori-ku, Yokohama and Takatsu-ku, Kawasaki, which are newly developed residential areas. These zones are located in south west Tokyo Metropolitan area and are connected to Tokyo City by the Tomei Expressway and Tokyu Railway Line.

2.2 Land Price Function

Land price is generally determined from the value of the use of a land through the relation between supply and demand as it does for other commercial commodities. Hence, land price can be considered to be formed through this market mechanism which converts the said value into monetary terms. However, since this study does not intend to analyze land price itself through the market mechanism, we assume that land price is determined only as the value of the use of a land which is dependent on the previously mentioned factors which the land possesses uniquely.

The land price data were collected in various residential lots located in 6 zones in the study area. These zones are named Tachibanadai, Tana, Mitakedai, Mominokidai, Yeda and Arima. They have already been furnished with the basic utilities such as water, drainage, electricity and even a gas network supply. The road network system as well as pedestrian facilities has also been improved. It can be said that these zones have already achieved a high level of infrastructure development for residential land use. In a small portion of these zones, however, inhabitants are complaining about highway traffic noise.

Although there may be a lot of factors related to the value of the use of a land, the following 9 explanatory factors are selected through several preliminary statistical examinations:

(1) travel time by train from the nearest station to Shibuya station (one of the bigger terminal stations belonging to Yamate circular railway in Tokyo)

(2) distance of the lot from the nearest station

(3) shape of the lot

(4) size of the lot

(5) situation of the lot with respect to the street corner

(6) direction of the slope of terrain

(7) the situation of a pedestrian road in front of the lot

(8) width of the pedestrian road to which the lot is accessible

(9) location of the lot with respect to the nearest pedestrian road

To what degree each of the above factors contributes to the forming of the residential land price is determined by applying the Quantification Theory I. This method is very similar to a multiple regression analysis, only its use is limited to discrete variables such as the (0,1) variable. The land price of 210 different residential lots in a "normal" area was analyzed simultaneously. Table-1 shows the results obtained.

From the table, the residential land price of a lot can be calculated by summing the nine category scores (i.e. one for each factor) and the constant term at the bottom of the table. The statistical results indicate that if two lots have the same qualities in all factors except one, the difference in land price is due to this one factor. For example, if two lots are similar in all factors except in their distance to the nearest station (e.g. Distance I <600m and Distance II >2,000m), the difference in their land price can also be calculated by merely getting the difference between their category scores in this particular factor (in this case, equal to ¥56,102/m²).

Since the multiple correlation coefficient of this function has a significantly high value of 0.963, it can be said that the factors have been chosen appropriately. The partial correlation coefficients of the individual factors are within the acceptable range of values and they exhibit the tendency of the estimated scores to correspond to generally observed behavior. However, it can be observed from the results that the factor -lot size- has a negative correlation to residential land price which may not be logical and perhaps even strange. But recent newspapers and other publications have reported that land price has actually decreased as lot size increased.

Thus, we have established the reliability of this function to estimate "normal" land price.

2.3 Derivation of Noise Cost

The Traffic Noise Level was measured at 30 lots which were exposed to traffic noise. It is a matter of course that samples used for the estimation of land price did not include these lots. The measurement was done from 10:00 am to 4:00 pm during the 3-day period from March 17 to 19, 1982.

TABLE-1 RESIDENTIAL LAND PRICE FUNCTION

Factor	Category	Category Score	Range	Partial Correlation Coefficient
(1) Travel Time by Train to Shibuya	below 35 min.	5,019yen/m²	8,871yen/m²	0.58
	over 35 min.	-3,852		
(2) Distance of the Lot to the Nearest Station	below 600 m	35,319	56,102	0.79
	600-1,200 m	13,148		
	1,200-2,000 m	-17,783		
	over 2,000 m	-20,783		
(3) Shape of the Lot	regular square	43	12,143	0.35
	rectangular	2,634		
	trapezoid	-2,055		
	polygon	-9,509		
(4) Size of the Lot	below 190 m²	1,571	5,304	-0.03
	190-230 m²	845		
	over 230 m²	-3,733		
(5) Is the Lot situated at a Corner?	yes	8,494	11,955	0.15
	no	-3,461		
(6) Direction of the Slope of Terrain	north	7,529	20,284	0.66
	south	-12,755		
	others	-2,986		
(7) Does the Lot Face a Pedestrian Road?	yes	2,127	24,871	0.23
	no	-22,744		
(8) Width of the Pedestrian Road	below 6.5 m	686	4,449	0.14
	over 6.5 m	-3,753		
(9) Location of the Nearest Pedestrian Road with Respect to the Lot	south	4,203	9,348	0.03
	north	-5,145		
	others	1,503		

Constant Term = 178,140 yen/m²
Multiple Correlation Coefficient =0.963
R.M.S. error = 7,814 yen/m²

This time schedule was chosen because traffic behavior during these hours shows the usual daily variations in traffic conditions. Specification for the measurement was prescribed by the JIS Z 8731* and the median value of the noise level at each lot was obtained.

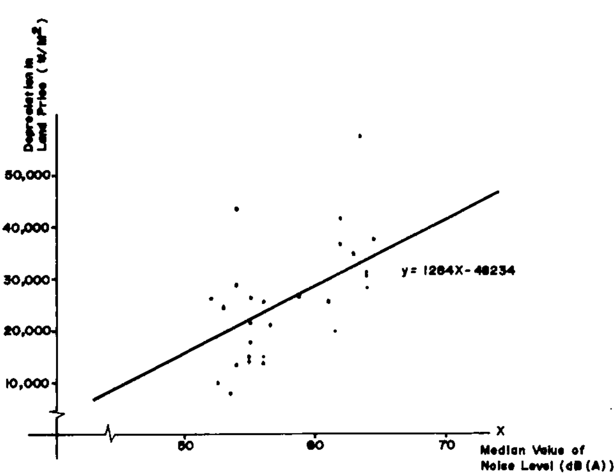
The land price function was applied to these lots to obtain their "normal" land price, and the difference between this price and the actual price for these lots was calculated immediately. Figure-1 shows the relation between this difference in the price and noise exposure level which is taken as the median value of the measured noise level. All these 30 lots were exposed to more than 50 dB(A), and the actual land price was at least 10,000 yen/m² lower than the "normal" land price. If we compare this depreciation with the RMS error of the land price function, which is equal to 7,800 yen/m², it can be observed that there is a significant difference. Thus, we can conclude that impact of traffic noise may be one of the causes of the depreciation in the residential land price (See Figure 1). Although there is much scattering on the figure, we can still derive an equation from the points through a regression analysis. The equation is obtained as follows.

$$Y = 1,284X - 48,234$$

The slope of the line shows that residential land price decreases 1,284 yen/m² with an increase of 1 dB(A). Therefore, noise cost has been derived from the depreciation of land price. This cost may correspond to the third concept of social cost which W. Michaelski had categorized as mentioned before.

* JIS stands for JAPAN INDUSTRIAL STANDARD

FIGURE-1 RELATION BETWEEN DEPRECIATION IN LAND PRICE AND NOISE EXPOSURE LEVEL



3. ANALYSIS BASED ON JUDICIAL PRECEDENTS

3.1 Significance of the Analysis

This analysis is based on judicial court proceedings on lawsuits concerned with complaints against pollution in Japan. The important consequence from these court actions is the amount of consolation money which the court decides to grant the afflicted party. In this case, noise cost can be derived directly from two factors: 1) the money mentioned above and 2) the magnitude of noise as described in the court hearings. The advantage of this analysis lies in the fact that the consolation money (money for mental damages aside from physical damages) is determined solely by court judges without the use of intermediate stages involving other external factors like the depreciation of land price discussed in a previous section. The validity of this type of analysis stems from its legal roots, and thus it can be taken to be acceptable to the society at large.

On the other hand, the judicial precedents which can be used as reference are not many. Furthermore, these are not consistent as a whole because the background of each lawsuit is quite diffferent from one another. However, in this analysis the judicial process eliminates certain basic limitations of conventional methods of deriving noise cost, such as the possible neglect of important factors, overassessment or overestimation of costs, and ambiguities in the choice of factors.

3.2 Procedure of the Analysis

The samples of judicial precedents were collected mainly from the file of court cases on "noise and vibration". Their total number is 69, and the period covered by lawsuits ranges from 1912 to 1982. However, some of the included samples were not suitable for the analysis. The following cases were considered inappropriate: 1) the plaintiff only wanted to stop the defendant from generating the noise, 2) the damages from vibration were explicitly larger than those from noise, 3) the consolation money as well as te compensating cost for physical damages was not described because the claim itself was not directly concerned with noise, 4) an amount of money which the plaintiff claimed had no meaning since the plaintiff lost in the lawsuit.

Discarding these inadequate samples from the total, the number of suitable cases was reduced to 27, which included possible duplication in counting due to trials appealed to higher courts. Removing such duplications will leave the total number of suitable lawsuits to only 19, and the period covered would range from 1953 to 1982.

The procedure for obtaining noise cost from the above samples is as follows: First, the consolation money awarded in lieu of damages due to noise is lifted from each judicial precedent. Next, excess noise level is calculated as the difference between the noise level which the court itself measured and the environmental standard* for noise for the relevant area. Then, the damaging noise level per hour is determined from the weighted average of the sound energy corresponding to the above excess noise level with respect to hours of exposure. Finally, the consolation money is converted to 1980's price by the use of the consumer's price index. The following is an example of the derivation:

In sample case No.1, the plaintiff and the defendant were neighbours in a particular residential area. The defendant used an air-conditioner everyday during the summer between 1964 and 1969 inclusive. The plaintiff appealed to the court to abate the noise coming from the neighbour's house and to award him payment against damages. The court decided to grant the plaintiff consolation money for mental damages and compensating cost for physical damages and ordered the change of the location of the air-conditioner.

On record, damages were incurred daily from 7:30 am to 11:00 pm (15.5 hrs.) from 25th June to 25th September during the aforementioned years. Therefore, the entire period wherein damages were sustained corresponds to 18 months for 6 years, i.e. 540 days.

The environmental standards for the relevant area are listed here:

1) 8:00am - 7:00pm - - - - - 50dB(A)

2) 7:00pm - 11:00pm - - - - - 45dB(A)

3) 11:00pm - 6:00am - - - - - 40dB(A)

4) 6:00am - 8:00am - - - - - 45dB(A)

The actual noise level was measured by the court as follows:

1) 1964 - 1966 - - - - - - - - - 51dB(A)

2) 1967 - 1968 - - - - - - - - - 55dB(A)

3) 1969 - - - - - - - - - 50dB(A)

* Environmental Standard against noise pollution was enacted in 1971 in Japan.

The average noise level L, for the above 6 years was calculated as:

$$L = 10\log_{10}\frac{1}{6}(3 \times 10^{\frac{51}{10}} + 2 \times 10^{\frac{55}{10}} + 1 \times 10^{\frac{50}{10}})$$
$$L = 52.7 \text{ dB(A)}$$

Therefore, the excess noise level was obtained as 2.7 dB(A) for 11.5 hrs and 7.7 dB(A) for 4 hrs. Then, the excess noise level per hour, L, was determined to be:

$$L = 10\log_{10}\frac{1}{15.5}(11.5 \times 10^{\frac{2.7}{10}} + 4 \times 10^{\frac{7.7}{10}})$$
$$L = 4.6 \text{ dB(A)}$$

The consolation money awarded by the court was 150,000 yen for 540 days. Noise Cost is calculated using the following procedure:

1) consolation money : 150,000/540 = 278yen/day

2) noise cost/15.5 hrs. : 278/4.6 = 60.5yen/dB(A)/15.5 hrs.

3) noise cost/24 hrs. : $60.5 \times \frac{24}{15.5} = 93$ yen/dB(A)/day

Finally, the above noise cost was projected to 1980's price and was found to be 309 yen/dB(A)/day.

3.3 Noise Cost As Estimated From Consolation Money

A summary of the judicial precedents and the noise costs obtained from them is shown in Table-2. The 19th event is a lawsuit involving noise from hammering a pile at midnight, which was emitting noise of very high magnitude - 113dB(A). Since the background of this event is quite different from others, it can not be compared with them. From the table, it can be observed that the noise cost per dB(A) per day has a very wide range of 309 yen to 14 yen. This may be caused not only by the large variation in the exposure hours and the excess noise level, but also the difference in background. One example is the issue of which party between a plaintiff and a defendant first occupied the area concerned. Another is the appropriation of physical damages aside from mental damages. Then there is the question of the social position of a plaintiff and a defendant in their society, the attitude of the society towards them and other socio-cultural values.

However, it is very difficult to analyze these factors in detail, because samples adopted here are limited. Hence, noise cost is calculated simply as the average value for the above 18 samples, this being 81yen/dB(A)/day.

TABLE-2 SUMMARY OF JUDICIAL PRECEDENTS AND CORRESPONDING NOISE COST

Event	Year of Event	Year of Suit	Daily Duration of Damage (hr.)	Total Duration of Damage (mo.)	Excess Noise Level (dB(A))	Noise Cost (Y/dB(A)/ day) (1980's price)
A	1964	1973	15.5	18	5	309
B	1963	1968	7	53	12	247
C	1953	1968	4.95	144.7	8	164
D	1954	1963	10	92	15	112
E	1963	1968	7	53	8	107
F	1953	1962	17	25.5	17	84
G	1961	1970	9	74	14	75
H	1961	1970	9	74	11	63
I	1961	1970	9	74	10	51
J	1960	1964	11	49.4	14	45
K	1957	1967	17	100	20	44
L	1959	1964	7	15.2	37	35
M	1960	1968	12	27.4	18	27
N	1953	1957	15	25	24	24
O	1965	1982	24	111	22	19
P	1970	1982	24	111	16	18
Q	1965	1982	24	111	16	15
R	1970	1982	24	111	22	14
S	1967	1971	9	0.6	60	2,956

4. ANALYSIS BASED ON ACTUAL INVESTMENT FOR ENVIRONMENTAL PROTECTION

4.1 Environmental Protection Cost And Social Cost

Recently, countermeasures for environmental protection along highways have been seen and the amounts of investment have increased. Such public investment is usually made for the purpose of promoting national welfare. The effectiveness of this investment was being analyzed from the view point of economic efficiency only. Therefore, an analysis of the effectiveness of the investment for a certain project which may be difficult to evaluate in monetary terms, such as the investment for environmental protection, has not been implemented. Here, the Joban Expressway was adopted in order to derive noise cost from the amount of investment allotted for environmental protection and the expected noise abatement. This expressway was designed to be truly superior with respect to its roadside environment to any other highway in Japan. The cost of the countermeasures for environmental protection may correspond to the fourth concept of social cost, which was defined by W. Michaelski.

4.2 Outline of the Joban Expressway

This expressway originates from Misato-City in Tokyo Metropolitan area, and goes north to Iwaki-City, Fukushima-Prefecture. The total distance of this expressway is 176 km. Around 44 km. from Kashiwa to Ishioka was operating at the time of this research, and the other part was under construction. The interval from Nagareyama to Kashiwa, around 2.3 km. in length, passes through highly populated residential areas. In answer to the request of the inhabitants, this road section was designed using the following design principles: (1) harmonize the structure with the surrounding landscape, (2) obey the environmental standards.

The entire right-of-way for the road is 77m which includes the carriage way of 32m in the central part of the road site (See Figure-2). At both sides of the carriage way, 20m are provided for green belts which should contribute to noise abatement as well as creation of a good landscape. Beyond these belts, side streets 5.5m in width are added. Prototypes used for the design of the 2.3 km. sections of the Joban Expressway are as follows:

(1) Open cut structure (complete type): around 850m (See Figure-2)

(2) Open cut structure (Provisional type): around 450m. This type is the same as the complete type except for the lack of a penthouse (called a tulip) at the central part of the road.

(3) Cover structure : around 825m. The road is completely covered. The space created by the cover is used as a park.

(4) Louver structure : around 197m. The road structure shown in Figure-2 is covered with

louvers like blinds. The louver fulfills two functions : sound insulation and lighting adjustment.

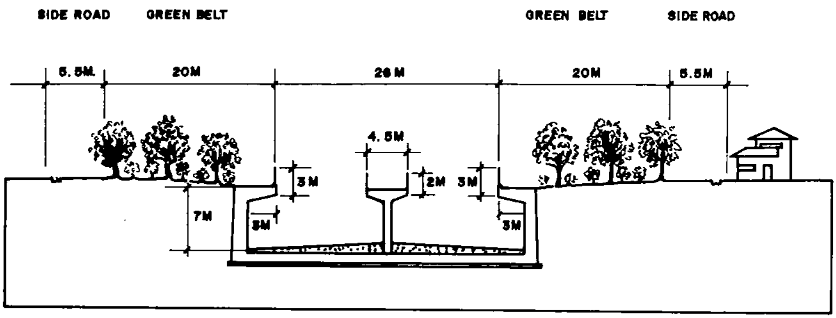


FIGURE-2 TYPICAL CROSS SECTIONAL STRUCTURE OF THE JOBAN EXPRESSWAY

4.3 Derivation of Noise Cost

If we assume that this expressway is designed as a usual or plain expressway giving no special consideration for environmental protection as shown in Figure-3, the median value of the noise level is forecasted as shown in Table-3. In this case, the traffic condition is as follows:

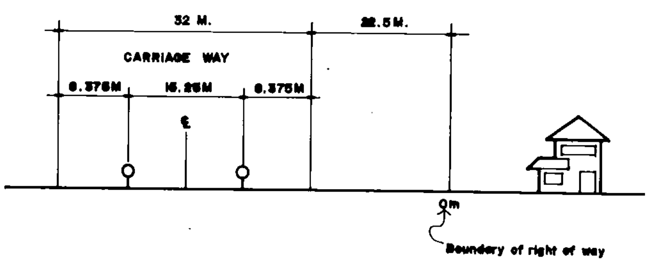


FIGURE-3 CONVENTIONAL CROSS SECTIONAL STRUCTURE OF THE EXPRESSWAY

(1) Daily Traffic Volume : 65,000 vehicles/day

(2) Hourly Traffic Volume: 1,300 vehicles/hr
(5:00 am - 6:00 am)

(3) Ratio of Heavy Vehicles : 42%

(4) Running Speed : 95 km/hr.

The median value of the noise level is calculated by applying the following equation:

$$L50 = 87+0.2V+10\log_{10}(a_1+10a_2)+10\log_{10}\frac{1}{2dS}\tanh\frac{2\pi d}{S}$$

where, L50 : median value of the noise level (dB(A))

V : running speed (km/hr)

a_1 * : ratio of passenger car volume to total vehicle volume

a_2 * : ratio of heavy vehicle volume to total vehicle volume

d : distance of the receiving point from the center of the road (m)

s : headway (m) $S = \frac{1000 \times V}{Q}$

Q : hourly traffic volume (vehicle/hr)

* N.B. $a_1 + a_2 = 1$

In addition to this equation, the excess attenuation by the absorption of the ground is also considered. The results show that L50 decreases exponentially with an increase in distance from the boundary of the road site. Around at the point 387m from the boundary, this L50 is equal to 50 dB(A), which is the value of the environmental standard for this area.

On the other hand, the construction cost for this section is estimated at around 10 to 12 billion yen/km which is almost three times that of the conventional expressway. This means around 7 to 8 billion yen/km could be assigned to the cost for environmental protection. As a consequence, noise cost is considered as an amount of investment which is required to reduce 1 dB (A) per 1 m^2, i.e. cost of environmental protection (yen/m) improved noise level (dB (A).m). Here, assuming that the cost for the environmental protection is 7.5 billion yen/km, it is equal to 3.75 million yen/m for one roadside.

TABLE-3 FORECASTED L50 (PLAIN ROAD)

Distance from the Boundary of Road Site (m)	Forecasted L50 dB(A)
0	66.2
20	64.1
40	62.8
60	61.8
80	61.0
100	60.3
120	59.7
140	59.2
160	58.7
180	58.3
200	57.9

The expected noise abatement is the summation of the excess noise level over 50 dB(A) measured at the roadside area under the reference condition wherein means for environmental protection have not been implemented. The excess noise level at the boundary of the road site is 16.2 dB(A), and it diminishes towards the point 387m from the boundary. The total expected noise abatement was determined as 3,135 dB(A).m from the integration of the above excess noise level. Thus, the required amount of investment for the environmental protection to decrease 1 dB(A) was calculated as 1,196 yen/m^2 .

Through the implementation of environmental protection, the noise level at the boundary point of the right of way must definitely be kept below 50 dB(A). It is quite obvious that farther and farther from the boundary, noise level decreases more and more. Hence, the result is the establishment of a more silent environment for the roadside area, i.e., noise level is less than 50 dB(A). If the effectiveness of such large noise abatement is taken into account, noise cost should be less than 1,196 yen/dB(A)/m^2 as obtained previously.

At the present time, it is quite difficult to forecast the phenomenon of noise propagation from open cut structures. However, we can refer to some model experiment and from this experiment, sound attenuation patterns (shown in Table-4) can be used. The difference between the noise levels in Table-3 and Table-4 may be an indication of the true effectiveness of the preservation of the environment against noise pollution. In this case, the amount of investment cost for the dissipation of 1 dB(A) was derived as 549 yen/m².

TABLE-4 FORECASTED L50
(OPEN CUT STRUCTURE)

Distance from the Boundary of Road Site (m)	Forecasted L50 dB(A)
0	44.3
10	43.6
20	42.9
30	42.4
40	42.0
50	41.7
80	40.0
over 80	40.0

5. SUMMARY

From these different vantage points, noise cost was derived as follows:

Approach (1) - Depreciation in Real Estate : 1,284 ¥/dB(A)/m²

Approach (2) - Judicial Cases On Noise : 81 ¥/dB(A)/day

Approach (3) - Protection of Roadside Environment : 1,196 ¥/dB(A)/m²

It is difficult to simply compare the above results with each other. However, in order to make the discussion easier, we may assume that a residential lot, 200m² in size, is purchased through a loan payable in 20 years at an annual interest rate of 8 percent. Noise cost for noise level in excess of 20 dB(A) is calculated as around 520,000 yen which may correspond to an annual repayment amount. On the other hand, from the consolation money decided by the court, noise cost for the same excess noise level is calculated at around 590,000 yen per year as shown in Table-5. It is observed that the noise cost derived from the judicial precedents is only slightly higher than that from the land price depreciation. This difference may be caused by the variation in the premise of the derivation, the quality of noise, and other secondary external factors. However, it can be said that the magnitude of the obtained noise cost for the above approaches is not so different from one another. This may indicate that noise cost derived here is reliable to some extent.

TABLE-5 COMPARISON OF NOISE COST

	Judicial Case Analysis	Land Price Analysis
Per 1 dB(A)	81¥/day	1,284¥/m²
20 dB(A) annually	¥590,000	¥520,000

The investment cost for environmental protection was converted to the cost required to reduce 1 dB(A) of noise per m with the objective of keeping the noise level below the environmental standards. The amount of this cost is 1,196 ¥/m², and it can be said that this amount may not be unreasonable with reference to the depreciation of land price (1,284¥/m²). In considering the establishment of a more silent environment wherein social cost may diminish to 549 ¥/m², it may be said that the investment for environmental protection is significantly effective.

In spite of the roughness of the above discussion, it can be said that the magnitude of the nuissance caused by noise can be expressed as a market price. As a first attempt to quantify the monetary value of the effects brought about by road traffic noise, this research may prove to be successful. It is hoped that data collection on the same problem and the comparison of the same issues from different countries would yield a better and more reliable figure of the social cost which can be used in public policy and other relevant applications.