Data storage system for noise and vibration

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In Japan many self-governments or research groups carry out surveys on noise and vibration. But mostly the raw data of the surveys are not opened to public and are not accumulated efficiently. It is necessary for researchers to compare data of some surveys. So we are assembling data of social surveys on noise and vibration, and constructing a database on computer system. Some data in the database are obtained by ourselves, others are presented by other research bodies. Files in the database are concerning with personal noise exposure, environmental noise, noise and vibration of railroad etc. In this report, each survey and contents of the files are explained. Also the process and problems of data storage and accumulation are discussed.

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1. INTRODUCTION

There are two types of data. In the first one, each one sample is very valuable. The second, each sample means almost nothing. Data of social survey for noise or vibration is the typical example of the second. But by gathering many samples, useful information can be derived from the data. This kind of data is useful only when accumulated.

To accumulate useful data, it is not necessary to be nervous about defects or deficiency of the survey. If the ways are changed so frequently, it becomes impossible to compare with data acquired in the past and merit of accumulation is lost. Based on this idea we are assembling and accumulating various data of noise and vibration. Here, contents of the data and methods of accumulation are presented. Some problems on data management are also dis-

cussed.

2. DATA ACQUISITION

In 1978 we conducted a survey of personal noise exposure. And since 1982 we have been carrying out surveys of residential noise in Nagoya. Also we have been assembling other data of survey for noise and vibration, which are done in consistent form by the municipal authority of Nagoya city.

In Japan many local self-governments carry out surveys to grasp conditions of noise and vibration. As a general rule a report of the survey is issued. However, after that the raw data of the survey is made light of and lost in many cases. To make a further analysis or to see from other view point, the raw data is indispensable. It was lucky to find the data sheets of some surveys covered with dust in the city office of Nagoya. We decided to revive

them. With the great help from students of our laboratory the data was stored in a computer system.

3. CONTENTS OF FILES

At present we have eight types of files about noise and vibration, and some other files related to them. They are listed in Table 1. Most of the files contain not only level values but also information about the measuring point and inhabitants' answer to questionnaires. In following sections details of each file are explained.

3.1 Personal Noise Exposure

Survey of personal noise exposure and environ-

ment in daily life are conducted by Tohoku University and Nagoya University in Sendai, Tokyo and Nagoya.^{1,2)} For a group of 609 persons equivalent noise level every 10 minutes ($L_{eq1/6}$) were recorded over 24 hours using pocket sized L_{eq} recorders. Subject's activities, personal attributes and information about the environment are also obtained. A typical variation of L_{eq} for a person in a day is shown in Fig. 1. Contents of the file of the survey are listed in Table 2.

3.2 Residential Noise Exposure

Since 1982 almost every year we have been conducting this survey in Nagoya.³⁻⁵⁾ The L_{eq} recorder is fixed outside of a house and 144 levels of $L_{eq1/6}$

Table 1 Accumulated data of noise and vibration.

Survey	Research body	Area	Year	Sample	Notes
Personal noise exposure in daily life	1. Tohoku Univ.	Sendai	'76-77	208	L_{eq} every 10 min over 24 h with personal activities.
	2. Tohoku Univ.	Tokyo	'78	190	
	3. Nagoya Univ.	Nagoya	'78	211	
Residential noise exposure	1. Nagoya Univ.	Nagoya	'82	315	L_{eq} every 10 min over 24 h with information around the residence.
	2. Nagoya Univ.	Nagoya	'83	130	
	3. Nagoya Univ.	Nagoya	'84	201	
	4. Nagoya Univ.	Nagoya	'85	200	
	5. Academia Sinica	Beijing	'86	353	
	6. Nagoya Univ.	Nagoya	'87	240	
Environmental noise	1. Nagoya City	Nagoya	'74	1,264	50 (100 '84) level data every 5 s with information around.
	2. Nagoya City	Nagoya	'79	354	
	3. Nagoya City	Nagoya	'84	309	
Source of environmental noise	1. Aichi Inst. Tec. Nagoya Univ.	Nagoya	'85-86	300	100 levels (every 5 s) $\times$ 6 at a point
Road traffic noise and vibration	1. Nagoya City	Nagoya	'78	403	Levels and information of road.
	2. Nagoya City	Nagoya	'83	442	
Railroad noise	1. Nagoya City	Nagoya	'77	5,495	Levels and information of train and track
	2. Nagoya City	Nagoya	'82	4,666	
Railroad vibration	1. Nagoya City	Nagoya	'77	4,952	
	2. Nagoya City	Nagoya	'82	3,626	
Railroad noise of Shinkansen	1. Nagoya City	Nagoya	'76	4,360	Levels and information of train
	2. Nagoya City	Nagoya	'81	4,890	
Railroad vibration of Shinkansen	1. Nagoya City	Nagoya	'76	2,106	
	2. Nagoya City	Nagoya	'81	3,307	
Continuous measuring of street noise	1. Nagoya City	Nagoya	'86	1	L_{50} , L_5 , L_{95} , $L_{eq} \times 24$ a day for 365 days
Awareness for noise in neighborhood	1. Nagoya City	Nagoya	'85	1,200	questionnaire

Fig. 1 Variation of personal noise exposure.

Table 2 File of personal noise exposure.

Level	$L_{eq1/6} \times 144$ (every 10 min)
Activity	Every 10 min classified into 9 types (16 types for housewives)
Personal attributes	Sex, Age, Family make-up, Commuting method, Type and structure of residence, Reaction to noise around home, Reaction to noise around the place of work
Others	Date, Time, City name

Table 3 File of residential noise.

Level	$L_{eq1/6} \times 144$ (every 10 min)
Residence	Type and structure, Living floor Structure of window, Distance to a road nearby, Distance to a railroad nearby, Land use, Outstanding noise source
Answerer	Sex, Age, Occupation, Reaction to inside and outside noise, sleep disturbance by noise
Others	Date, Time, Weather, Allocation

(6/h $\times$ 24) are recorded like 3.1. At the same time we obtain information of inhabitants' reactions against noise through questionnaires. Contents of the file are listed in Table 3. In 1986 the same survey was done in Beijing in the same style by Institute of Acoustics Academia Sinica in cooperation with us. The data is also stored in our file either.

3.3 Environmental Noise

Municipal authority of Nagoya has conducted

this survey at five year intervals.⁶⁾ Whole area of Nagoya is divided into blocks (approx. 1 km $\times$ 1 km) according to longitude and latitude. At one point (four points in '74) in a block, noise level is measured 50 times (100 times in '84) every five seconds. At the same time the most prominent noise source is recorded. An example of recording sheet is shown in Fig. 2. In addition information about the measuring point is obtained. They are listed in Table 4.

No.		1	2	3	4	5	6	49	50
Level (dBA)		56	61	62	5		65	60	58
Noise source	Aircraft	1	1	1			1	1	1
	Railroad	2	2	2			2	2	2
	Road Traffic	3	3	3			3	3	3
	Factory	4	4	4			4	4	4
	Construction	5	5	5	5		5	5	5
	Business	6	6	6	6		6	6	6
	Others	7	7	7	7		7	7	7
	Unidentified	8	8	8			8	8	8

Fig. 2 Recording sheet of environmental noise.

Table 4 File of environmental noise.

Level	50 (100 '84) every 5 s
Noise source	50 (100 '84) every 5 s
Measuring point	Land use, Number of lane of a road nearby, Most influential noise source, Buildings nearby, Obstacle between measuring point and noise source, Distance to noise source
Others	Date, Time, Block code, Wind velocity, Weather

3.4 Source of Environmental Noise

The purpose of this survey is to know the appearance rates of typical noise sources. So the way of measurement is fundamentally the same as that of 3.3. Though area is limited in several parts of Nagoya, measurement was repeated six times in a day at a point and information of noise source is more detailed.

3.5 Road Traffic Noise and Vibration

This survey has been conducted by Nagoya city at five year intervals. Along trunk roads in the city, noise levels (L_{95} , L_{50} , L_5 , L_{eq}) and vibration levels (L_{90} , L_{50} , L_{10}) are recorded. Traffic volume and other information about the road are also obtained. In recent survey those data are recorded on mark sheet and read by OMR to be sent to computer file. Contents of the file are listed in Table 5.

3.6 Railroad Noise and Vibration

For eight railway lines in Nagoya exclusive of Shinkansen, noise and vibration caused by trains

Table 5 File of road traffic noise.

Noise level	L_{50} , L_5 , L_{95} , L_{eq}
Vibration level	L_{50} , L_{10} , L_{90}
Measuring point	Land use of the area, Buildings along the road, Distance to the nearest building, Distance to the nearest traffic signal, Condition of ground surface
Road	Structure, Inclination, Width, Number of lane, Types of paving, Roughness of surface, Crack and level difference, Speed limit
Traffic Volume	Per 10 min, each side
Others	Date, Time, Block code, Device

Table 6 File of noise and vibration of railroad.

Noise level	Peak level of each train and back-ground noise at boundary, 12.5 m, 25 m, 50 m, 100 m
Vibration level	Peak level (vertical) and back ground level at 12.5 m, 25 m, 50 m
Train	Time, Direction, Speed, Length, Type and number of train
Railroad	Structure, Rail (short or long) Height (from ground level) Existence of noise barrier
Others	Date, Allocation, Name of line

were inspected by Nagoya city. Data of surveys in 1977 and 1982 are stored. Noise and vibration levels are measured for over twenty trains at about eighty points. List of obtained information is shown in Table 6.

3.7 Railroad Noise and Vibration of Shinkansen

Noise and vibration pollution by Shinkansen super express has been an subject of public concern. In order to grasp the condition, this survey is conducted by Nagoya city.⁷⁾ Measuring points are located along the track. Noise and vibration levels of 20 trains are measured at every point. The details are shown in Table 7.

Table 7 File of noise and vibration of Shinkansen.

Noise level	Peek level of each train and back-ground noise at 12.5 m, 25 m, 50 m, 100 m, 200 m, 400 m
Vibration level	Peek level (vritical) and back ground level at 12.5 m, 25 m, 50 m
Train	Time, Speed, Direction Number of train (12 or 16)
Railroad	Structure Height (from ground level) Existence of noise barrier
Others	Date, Allocation

Table 8 File of awareness for noise in neighborhood (number of questions).

Condition of annoyance and source of noise	7
Opinions on environmental noise	5
Life style	3
Personal attributes (age, occupation, etc.)	8
Other environment (road, railroad, etc.)	7

3.8 Continuous Measuring of Street Noise

There is a noise level display near Rokuban-cho cross road in Nagoya. At the point L_{50} , L_5 , L_{95} of every hour are printed out automatically over 24 hours everyday. It is over ten years since the measurement began. At present data of 1986 is usable on computer.

3.9 Awareness for Noise in Neighborhood

This file contains information in association with noise and does not contain level values. This is the result of questionnaires done in Nagoya. Questions

included in the questionnaires are concerning with environment of noise, opinions, reactions against noise and their attributes. The number of respondents amounts to 1,200. Details of the questionnaires are in Table 8.

4. DATA MANAGEMENT

All the files mentioned above are stored in magnetic disk storage of the computation center of Nagoya university. There are lots of problems to manage the different types of files.

1) Data format

Though the forms of each surveys are almost consistent, they are altered little by little. Accordingly the data format must be flexible enough to follow the alteration.

2) Public service

Though at the moment access to the file is limited within users of the center, we regard the data as public estate. Therefore we are transferring the files into floppy disk of personal computer. Several files have been transferred and are usable on MS-DOS.

3) Data analysis programs

It is not so easy to make a program of statistical analysis for most of the users. Therefore it is necessary to prepare data analyzing programs. Scientific analysis requires a large scale computer. On the other hand analysis in report issued by local government can be done with a personal computer.

4) Combination of data acquisition and storage

Figure 3 shows our data processing system. In the case of personal noise exposure and residential noise, all the level values in the recorder are read out by a personal computer and stored in floppy disk. For environmental noise and road traffic noise data on mark sheets is read by OMR. After this process the data is sent to a file of large scale computer

Fig. 3 Data processing system.

system. But other hand written data is input into the computer manually. These inefficient process will be replaced by automatic data processing devices.

5) Total database of noise and vibration

All the data of different files are desirable to be managed in one database system. This kind of system is very different from ordinary one like literature search. Explanation of the data and the survey itself, and statistical processing utilities must be included in it.

5. DISCUSSION

The first aim of the database was to prevent valuable data from being dispersed and lost. However it is useful for a variety of purposes as follows. So we recommend all the research bodies to create databases of noise and vibration.

- 1) To know the actual condition of noise and vibration.
- 2) To find out the effective methods of improving noise environment. Such as measures to reduce railroad noise, limitation of automobile speed etc.
- 3) To predict the changes of environment caused by urbanization.
- 4) To be used as fundamental data to determine evaluation method and environmental quality standards for noise and vibration.

Data of some other cities are included in our database as well as those of Nagoya. The style of the surveys done in different cities are almost the same as in Nagoya. By coordinating the style of survey, it is possible not only to compare data of different cities but also to extend the use of database. We don't think that the styles of our survey are the best. But we hope our style can provide a reference whenever a new survey is planned. Furthermore we hope to have opportunities to discuss with many groups on the standardization of

database of noise and vibration.⁸⁾

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